Shree R.R.Lalan College ,Bhuj.

Botany

Name of the Paper : **Plant Diversity and Cytogenetics**

Paper No. : **USCEBO- 101**

Prac.No	Aim / Object	Page No.
1	Study of virus through chart/ Photograph **Exercise** 1: Study of TMV through chart/ Photograph Exercise 2: To Study of virus T-phase through chart/ Photograph	1
2	Study of Permanent slide/ Chart/ Photograph of Bacterium	3
3	Study of Nostoc (Identification) Exercise 1 : Study of external features of thallus. Exercise 2: Study the akinetes and Heterocyst	5
4	Study of Spirogyra (Identification) Exercise 1: Study of Vegetative structure of Spirogyra Exercise 2 : Study of scalarifom conjugation. Exercise 3 : Study of lateral conjugation.	8
5	Study Mucor (Identification) Exercise 1 : To Study Vegetative structure of Mucor Exercise2 : To Study reproductive structure of Mucor	12
6	Study of Riccia(Identification) Exercise 1: Study of external features of gametophyte Exercise 2: Study of anatomy of thallus. Exercise 3 : Study of antheridium. Exercise 4 : Study of archegonium Exercise 5 : Study the structure of sporophyte	15
7	Study of Cell cycle through Chart/ Photograph	21
8	Study of Plant cell through Chart/ Photograph	22
9	Mitosis in Onion Root Tips.	23
10	Exercise 1 : Study of Cell division: Mitosis (Permanent slides) Exercise 2 : Study of Cell division: Meiosis (Permanent slides)	24
11	Study of Nucleic acids through Chart/ Photograph/ Model Exercise 1 : Study the DNA structure Exercise 2 : Study the RNA structure	28
12	Aim Study of Morphology as per theory. Exercise 1: Root:-, types Exercise 2: Stem: - Habit and Types Exercise 3: Types of Stem (Aerial/ underground/Specialized) Exercise 4: Leaf and its parts Exercise 5 : Leaf:-, Phyllotaxy, Exercise 6: : Leaf:- Stipules Exercise 7: Leaf:- types of leaves Exercise 8: Inflorescence: - Racemose, Exercise 9: Inflorescence: - Cymose Exercise 10: Inflorescence :Special types Exercise 11: Study types of Aestivation. Exercise 12: Study of Morphology of Flower	30
13	Classification chart	42
14	Study of angiosperm families: 1)Malvaceae, Plant : *Abutilon indicum* (Linn.) Sweet. 2) Apocynaceae, Plant: *Catharanthus roseus* (L.) G.Don 3) Nyctaginaceae Plant : *Boerhaavia diffusa* 4) Amaryllidaceae Plant: *Crinum asiaticum* L.	43
15	Visits to field: Students are expected to submit Field Report	

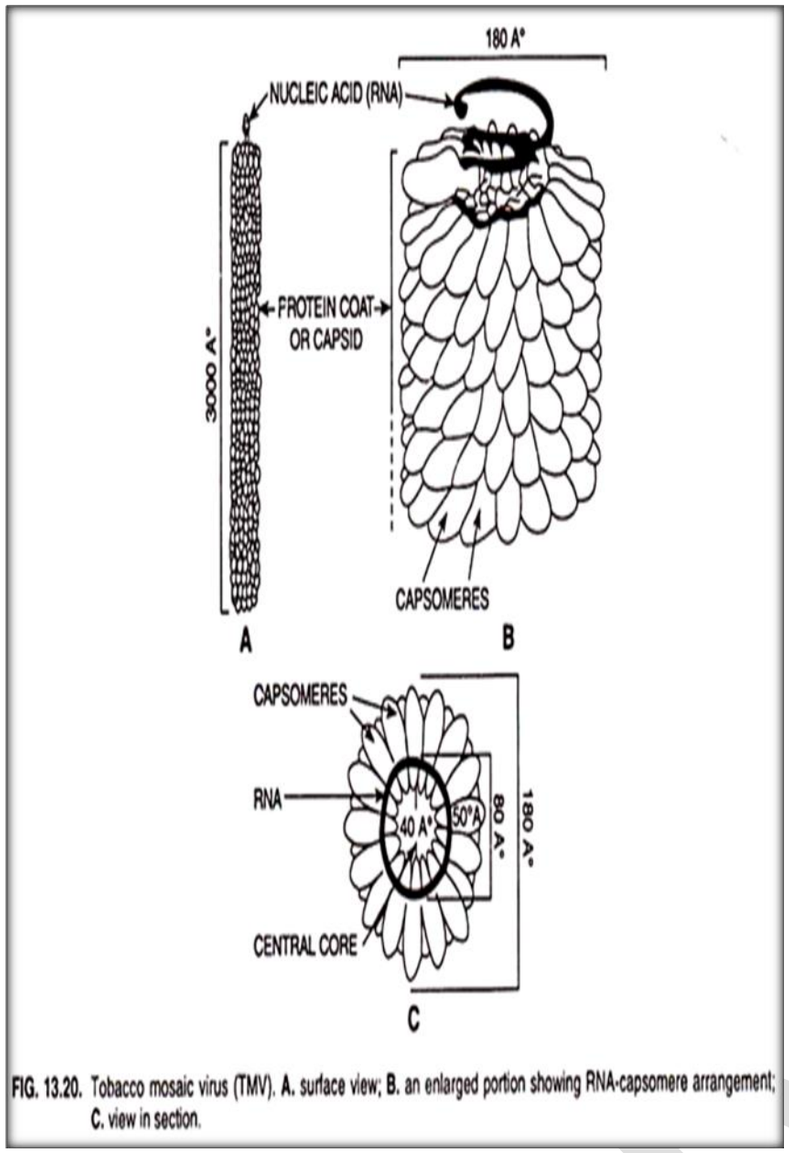


FIG. 13.20. Tobacco mosaic virus (TMV). A. surface view; B. an enlarged portion showing RNA-capsomere arrangement; C. view in section.

Practical No :1
Exercise 1:
Aim : Study of TMV through chart/ Photograph
Comments

- TMV is a simple rod-shaped helical virus consisting of centrally located single- stranded RNA (5.6%) enveloped by a protein coat (94.4%).
- The rod is considered to be 3,000 Å in length and about 180 Å in diameter.
- The protein coat is technically called 'capsid'. R. Franklin estimated 2,130 sub-units, namely, capsomeres in a complete helical rod and 49 capsomeres on every three turns of the helix; thus there would be about 130 turns per rod of TMV.
- The diameter of RNA helix is about 80 Å and the RNA molecule lies about 50 Å inward from the outer-most surface of the rod.
- The central core of the rod is about 40 Å in diameter. Each capsomere is a grape like structure containing about 158 amino acids and having a molecular weight of 17,000 dalton as determined by Knight.
- The ssRNA is little more in length (about 3300 Å) slightly protruding from one end of the rod.
- The RNA molecule consists of about 7300 nucleotides; the molecular weight of the RNA molecule being about 25,000 dalton.

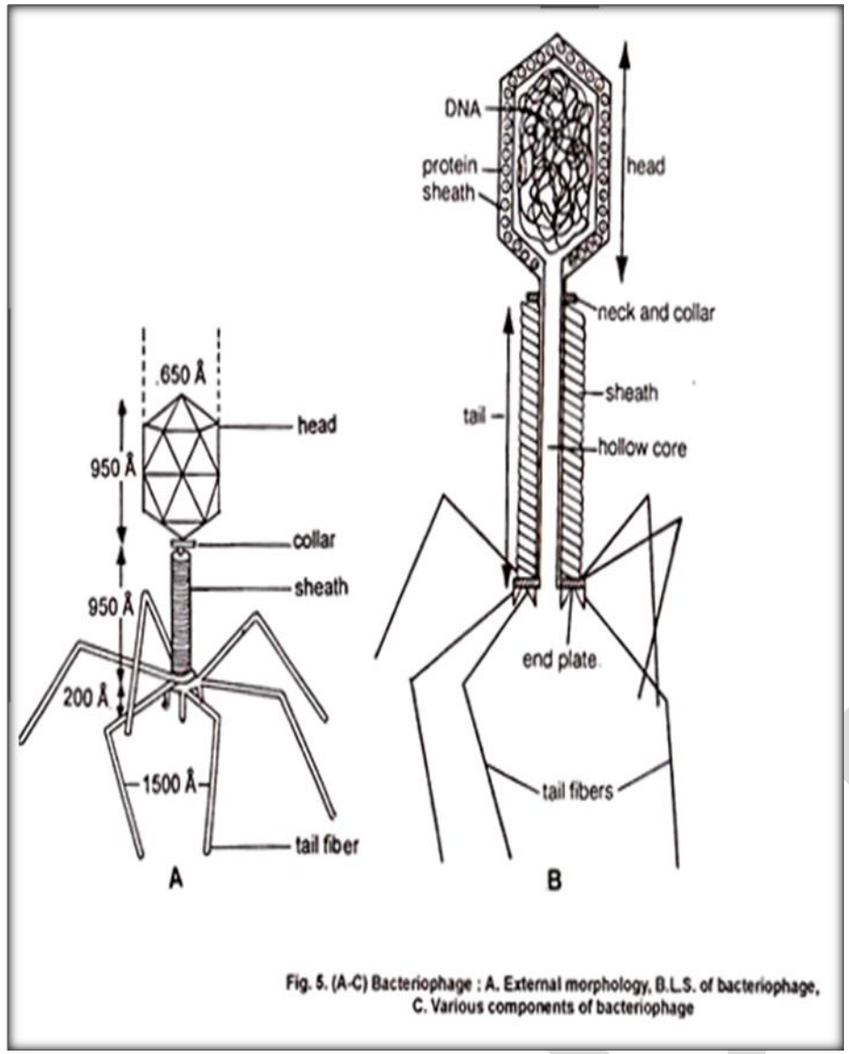


Fig. 5. (A-C) Bacteriophage : A. External morphology, B.L.S. of bacteriophage, C. Various components of bacteriophage

Practical No :1
Exercise 2
Aim : To Study of virus T-phase through chart/ Photograph

With the help of electron microscope, the morphology of the bacteriophage has been studied.

The T even phages show complex symmetry. These viruses are generally tadpole shaped i.e., a 'head' followed by a 'tail'.

The head is hexagonal and like a prism in outline . This shape is also known as elongated icosahedron. It is 950 A° in length and 650 A° in width. The head has a 2-layered protein wall that encloses the double stranded DNA. The wall is 35 A° thick and is composed of about 2000 similar capsomeres. DNA is tightly packed in the head and is about 50 µ long.

Attached to one of the points of the head, through a neck and collar is the tail . The tail has a complex structure and proteinaceous in nature. It is made up of a cubical, hollow, cylindrical core. This core is 800 A° long, 70 A°in diameter and has 25 A° wide central canal. This core is surrounded by a contractile sheath. The sheath is 165 A° in diameter.

The internal diameter of the tube formed by it is equal to core diameter of 70A°. The core is terminated into a hexagonal plate which has six small tail fibres (tail 'pins') at every corner and 6 tail fibres. Each tail fiber is 1500 A° long and is composed of fibrillar protein. The main function of the short tail fibres is to hold the phage fast to the host during sheath contraction and DNA injection while long tail fibres helps in adsorption of the phage on the bacterial wall.

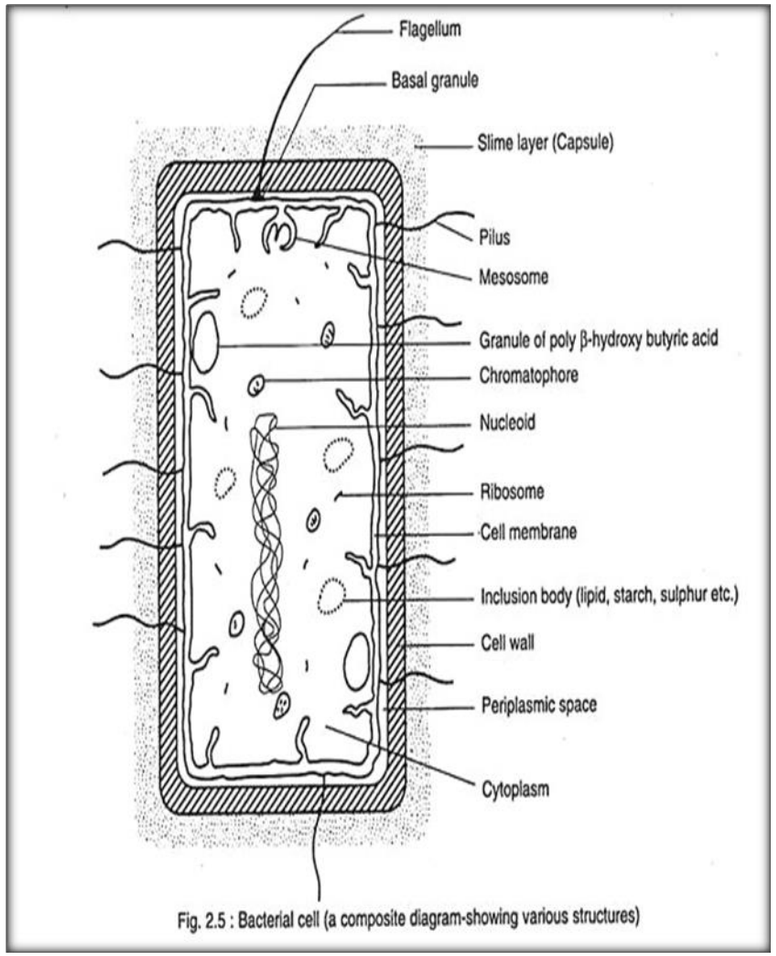


Fig. 2.5 : Bacterial cell (a composite diagram-showing various structures)

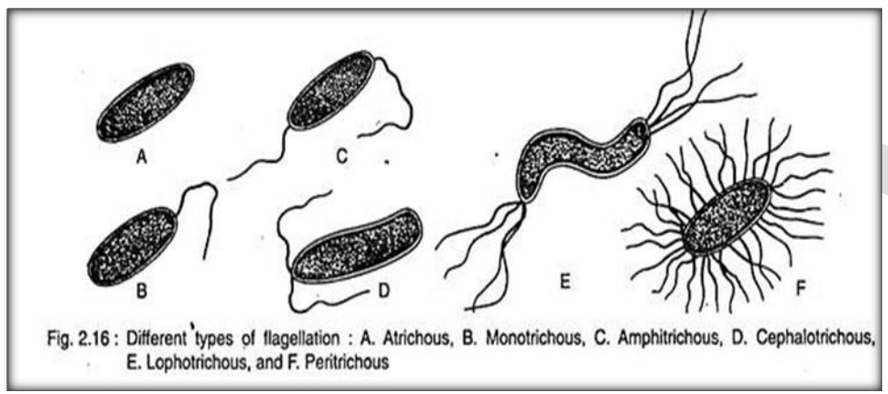


Fig. 2.16 : Different types of flagellation : A. Atrichous, B. Monotrichous, C. Amphitrichous, D. Cephalotrichous, E. Lophotrichous, and F. Peritrichous

Practical No : 2

Aim : To Study of Permanent slide/ Chart/ Photograph of Bacterium

A bacterial cell shows a typical prokaryotic structure.

The cytoplasm is enclosed by three layers, the outermost slime or capsule, the middle cell wall and inner cell membrane. The major cytoplasmic contents are nucleoid, plasmid, ribosome, mesosome etc., and the cell is devoid of endoplasmic reticulum, mitochondria, centrosome and golgi bodies.

A. Slime layer, Capsule and Glycocalyx:

An amorphous viscid secretion of bacterial cell is present as a loose undemarcated region outside the cell, called slime layer (e.g., Leuconostoc). But, when it originates as a sharply defined structure outside the cell wall, it is called capsule (e.g., Pneumococcus). The capsule is about 0.2 µm in width. It gives protection to the cell from desiccation under natural condition.

B. Cell Wall:

The bacterial cell wall is tough and rigid due to the presence of strong fibres composed of heteropolymers called mucopeptides, peptido- glycans, mucocomplex, murein etc.

C. Cytoplasmic Membrane of Bacteria:

The cytoplasmic layer is the boundary layer of the protoplast, situated beneath the cell wall . It is thin (5-10 nm), elastic and semipermeable layer.

D. Cytoplasm of Bacteria:

The cytoplasm is a colloidal system containing both organic and inorganic substances. It lacks mitochondria, endoplasmic reticulum, centrosome and golgi bodies. It contains many ribosomes, few mesosomes, soma inclusions and vacuoles

STRUCTURE	FUNCTION
Cell Wall	Protects the cell and gives shape
Outer Membrane	Protects the cell against some antibiotics (only present in Gram negative cells)
Cell Membrane	Regulates movement of materials into and out of the cell; contains enzymes important to cellular respiration
Cytoplasm	Contains DNA, ribosomes, and organic compounds required to carry out life processes
Chromosome	Carries genetic information inherited from past generations
Plasmid	Contains some genes obtain through genetic recombination
Capsule, and slime layer	Protects the cell and assist in attaching the cell to other surfaces
Endospore	Protects the cell against harsh environmental conditions, such as heat or drought
Pilus (Pili)	Assist the cell in attaching to other surfaces, which is important for genetic recombination
Flagellum	Moves the cell

E. Genetic Material of Bacteria:

The genetic material is present both in nucleoid and plasmid

F. Flagella of Bacteria:

Most of motile bacteria (e.g., Spirochaetes) possess long (5-20 µm), thin (12-30 nm), helical appendages, called flagella.

G. Fimbriae or Pili:

These are extremely thin and short, filamentous, non-flagellar appendages projecting peritrichously from cell surface. Their number is 100-500 per cell and measure 0.5-20 µm in length and 3-25 nm in diameter. They are made up of subunits of protein, the pilin, arranged helically and form hollow filament

H. Spinae:

Spinae are tubular, pericellular rigid appendages. They are made up of single protein moiety, the spinin. They possibly help to acclimatize the cells in different environmental conditions such as salinity, temperature etc. Spinae have been reported in some Gram-positive bacteria.

Hints for Collection

It commonly occurs in abundance after the first few rains.

It is terrestrial as well as aquatic.

It is collected from water pools, paddy fields, waterlogged soil, moist rocks, stagnant water, etc.

It is known to occur as epiphyte on aquatic weeds and endophytically inside Cycas coralloid roots,

Azollaa fern, Blasia and Anthoceros-bryophytes and form lichens in association with fungal members.

Practical No :3

Aim: Study of Nostoc

Identification of Nostoc

Sub-division-Algae.

(1) Thallus simple,

(2) Presence of chlorophyll,

(3) Cell wall of cellulose.

Class-Myxophyceae.

(1) Chromatophore not organised, pigments diffused, blue-green,

(2) Photosynthetic reserve of cyanophycean starch,

(3) True nucleus absent.

Order-Nostocales.

(1) Thallus with trichomes, unbranched or branching false.

(2) Hormogones, heterocysts, exospores and endospores generally present.

Family-Nostocaceae.

(1) Trichomes simple, unbranched, uniseriate and approximately of the same diameter throughout,

(2) Heterocysts and akinetes present,

(3) Trichomes not differentiated.

Genus-Nostoc.

1) Trichomes much twisted into a mass of definite form with a firm colonial envelope,

(2) Heterocysts intercalary and single.

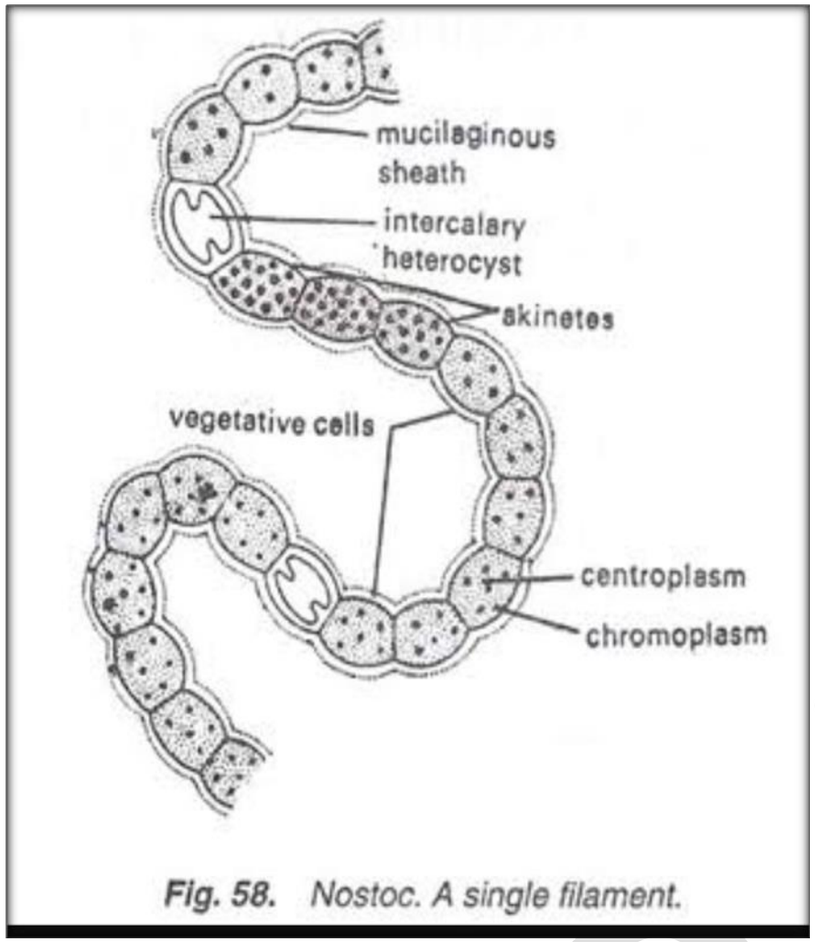


Fig. 58. Nostoc. A single filament.

Practical No :3

Exercise 1

Object : Study of external features of thallus.

Work procedure Place a part of colony on the slide, press it little by another slide so that it spreads flat, stain in safranin and mount in glycerine.

Comments

1. Thallus is colonial. Young colonies are microscopic, spherical and solid.

2. Mature colonies become irregular and hollow.

3. Colonial envelope encloses many filaments. These are much twisted, curved and entangled with each other.

4. A filament has diffluent gelatinous sheath.

5. The trichomes are unbranched. Each trichome is made of cells of uniform size and shape except those called heterocyst which occur throughout.

6. Structure of a cell is typically cyanophycean. It has a centrally located centroplasm, nucleus being altogether absent. Peripheral cytoplasm shows diffused pigments. A few shining cyanophycean granules are also present in this region.

7. Heterocysts are intercalary. These are double wa!lprl, pale yellow coloured with two shining polar granules, one each near the neighbouring cell on either side. Heterocysts are much of the same size of slightly bigger than the vegetative cells.

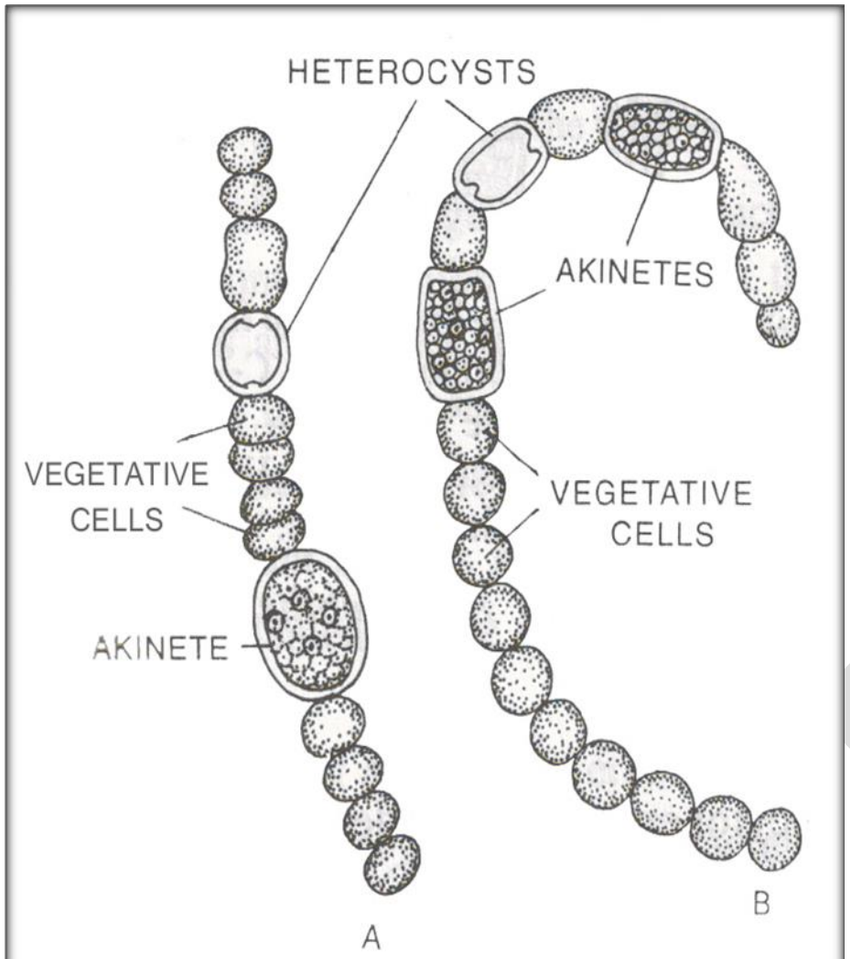


Fig: A part of filament bearing Heterocysts and Akinetes.

Practical No :3
Exercise 2

Object : Study the akinetes and Heterocyst

Work procedure Press a piece of mature colony to spread the filaments. Stain in safranin, mount in glycerine and study.

Comments

1. Akinetes are developed only in a mature colony. These occur in large number, in series between two heterocysts. Usually all vegetative cells between two successive heterocysts develop into akinetes.

2. Akinetes are thick walled, sometimes ornamented, rich in food reserves and cyanophycean granules.

3. Akinetes are liberated due to decay of colonial sheath. These germinate to form a new thallus.

Heterocysts

1.Each filament is composed of many rounded cells that are arranged in a chain-like manner or in beaded form. ... In the filament, some cells are larger in size and thick-walled, called heterocysts..

2. These cells perform two functions, reproduction and Nitrogen Fixation.

Hints for Collection,

It is widely distributed in stagnant/fresh fater ponds and streams. It may fonn either floating masses or scum on the water surface. It is generally found in reproductive stages during spring

Practical No: 4

Aim: Study of Spirogyra

Identification

Sub-division-Algae.

(1) Filamentous thallus,
(2) (2) Presence of chlorophyll,
(3) (3) Cell wall of cellulose.

Class-Chlorophyceae.

(I) Chloroplasts grass-green,
(2) Photosynthetic reserve is starch.

Order-Zygnematales (Conjugales).

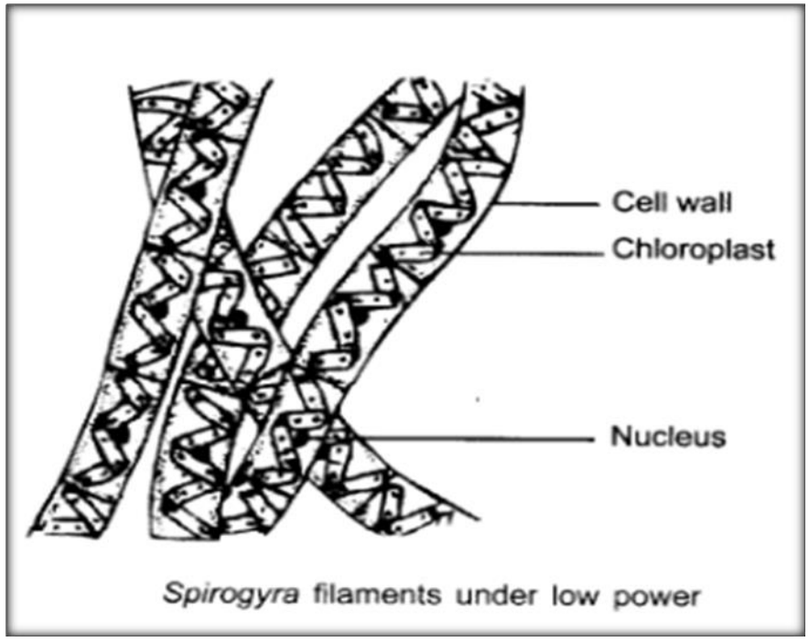
(1) Absence of flagellated reproductive cells,
(2) Sexual reproduction (conjugation) by amoeboid gametes.

Family-Zygnemataceae.

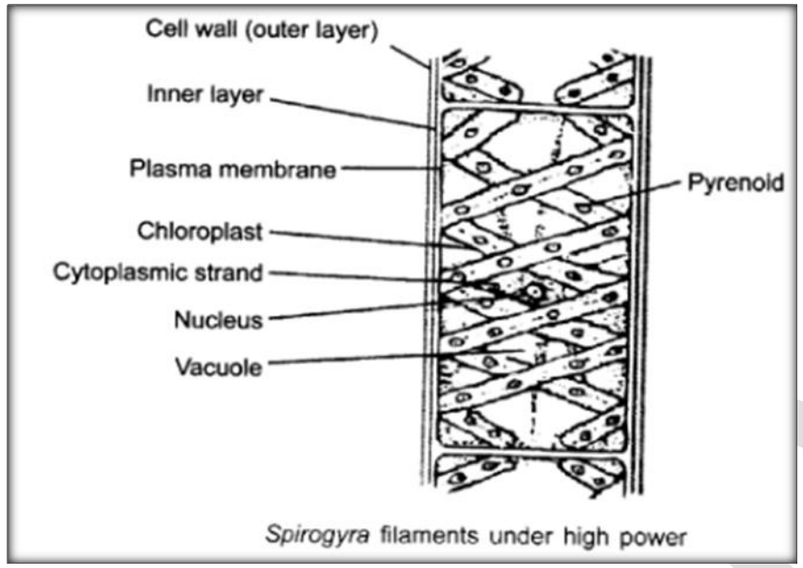
(I) Unbranched and uniseriate filaments,
(2) Chloroplasts either parietal and ribbon shaped or single/two, axial and stellate.

Genus- : Spirogyra

(1)Ranging between two and ten, spiral-shaped ribbon-like chloroplasts exist inside them. ...
(2)Their bodies are characterised by multicellular filaments, which is present underneath a mucilaginous sheath.



Spirogyra filaments under low power



Spirogyra filaments under high power

Practical No: 4

Exercise 1

Object : To Study of Vegetative structure of Spirogyra through class work Material and permanent slide.

Work procedure: Take a few filaments, stain with safranin, wash in water and mount in glycerine. Study the thallus and cell structure.

Comments:

1)The plant body of Spirogyra is an un-branched filamentous thallus measuring about 1 mt. in length.

2)The Spirogyra filament is very slimy due to the presence of mucilage sheath that lines the whole filament. The mucilage often holds the filaments together in a matted blanket.

3)Each un-branched filament of Spirogyra consists of a number of elongated cylindrical cells of similar type joined end to end.

4)The terminal cell is dome-shaped. In attached species, the lower non-green cell is called holdfast or hapteron

5) Each cell of Spirogyra filament is cylindrical and consists of 2 parts: cell wall and protoplast.

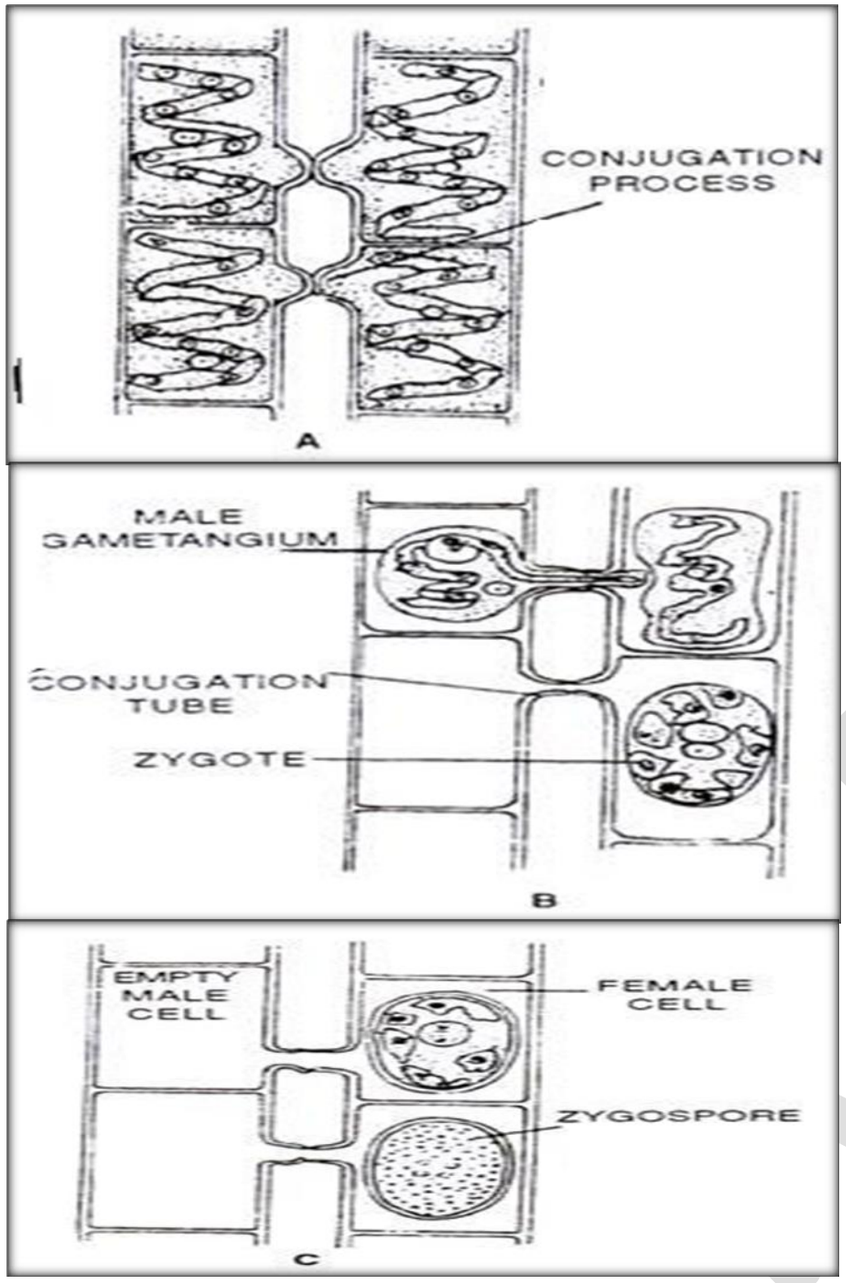
6) The cell wall surrounds the protoplast, is protective and consists of two layers i.e. inner cellulose layer and outer pectose layer.

7)The transverse wall (cross wall) between adjacent cells has middle lamella (septum).

8)The protoplast is differentiated into many parts, from outside to inside; they are plasma membrane, primordial utricle (=peripheral cytoplasm), large central vacuole and a nucleus.

9)The primordial utricle contains 1-16 spirally arranged ribbon-shaped chloroplasts along with various organelles. The margin of chloroplast may be smooth or serrated. In the chloroplast, a row of pyrenoids present at regular intervals. Each paranoid consists of a central protein core surrounded by a starch sheath.

10) A single nucleus present at the central cytoplasmic mass that held in the center of vacuole. The nucleus held in position by radiating.



Stages in scalariform conjugation of *Spirogyra*.

Practical No: 4
Exercise 2

Object: Study of scalarifom conjugation.

Work procedure : Take a few filaments, see if stages of scalarifonn conjugation are present. Stain such filaments with safranin, wash in water and mount in glycerine. Study different stages and draw.

Comments

1. Sexual reproduction takes place by conjugation.
2. Each cell of the filament fonns non-motile gamete.
3. Two filaments take part in this process. Thus the species showing scalarifonn conjugation are heterothallic.
4. Two filaments lie opposite one another throughout their whole length.
5. Each cell produces a conjugation tube towards the opposite cell of another filament.
6. Protoplasts are contracted, rounded or elliptical in shape, and are called gametes.
7. Gametes migrate from one gametangium to another during fusion. Thus cells of both threads are completely empty (because gametes generally fuse in conjugation tube). In other species zygospores occupy gametangium of one filament, leaving cells of the other filament empty.
8. A young zygospore has four stellate chloroplasts. Completely mature zygospore has thick, three-layered, ornamented and coloured (blue) wall.

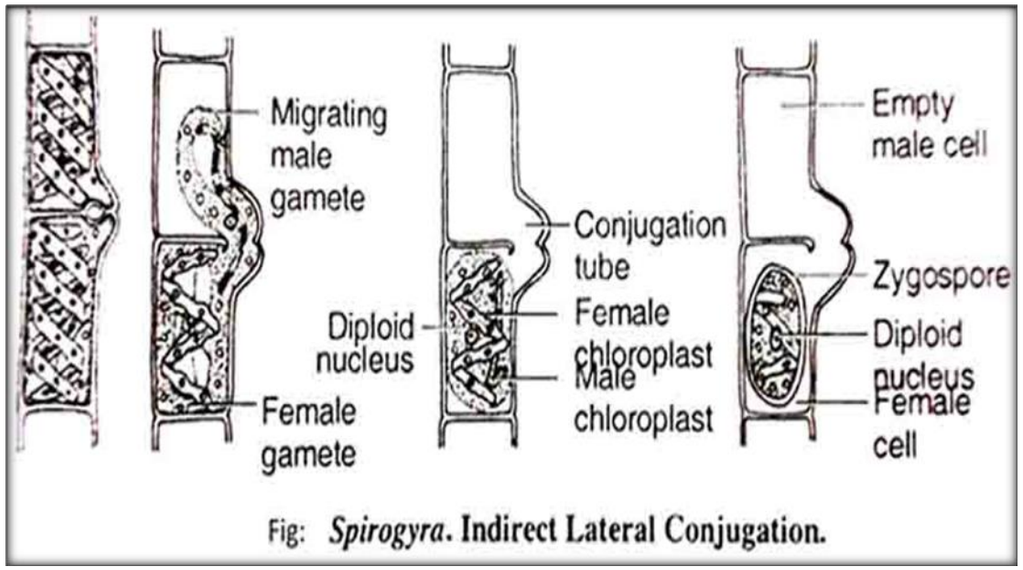


Fig: *Spirogyra*. Indirect Lateral Conjugation.

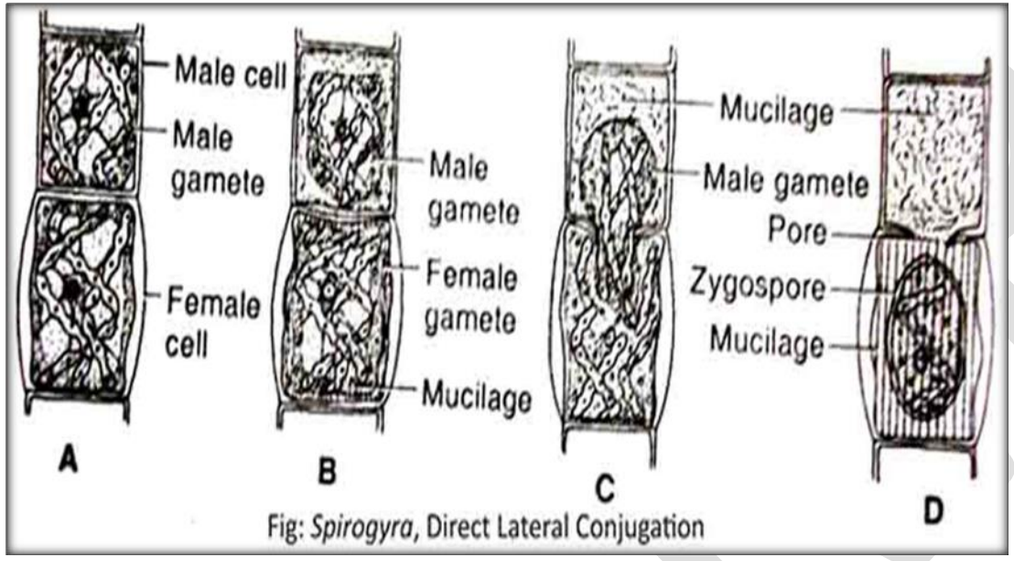


Fig: *Spirogyra*, Direct Lateral Conjugation

Practical No: 4
Exercise 3
Object : Study of lateral conjugation.
Work procedure Study the slide showing various stages of lateral conjugation.
Comments
1. Lateral conjugation is comparatively rare.
2. Both male and female gametes are produced by the same filament. Hence, the species are called homothallic.
3. The cells or male and female gametangia produce a small conjugation tube each near the cross wall common to both these cells.
4. Both male and the female gametes creep into the conjugation tube where these fuse.
5. Both, male and female cells become empty, the zygospore being fonned inside the conjugation tube.
6. Zygospore is ornamented or smooth. The wall is three layered and may also be coloured.
It is of two types: Indirect and Direct Lateral conjugation.

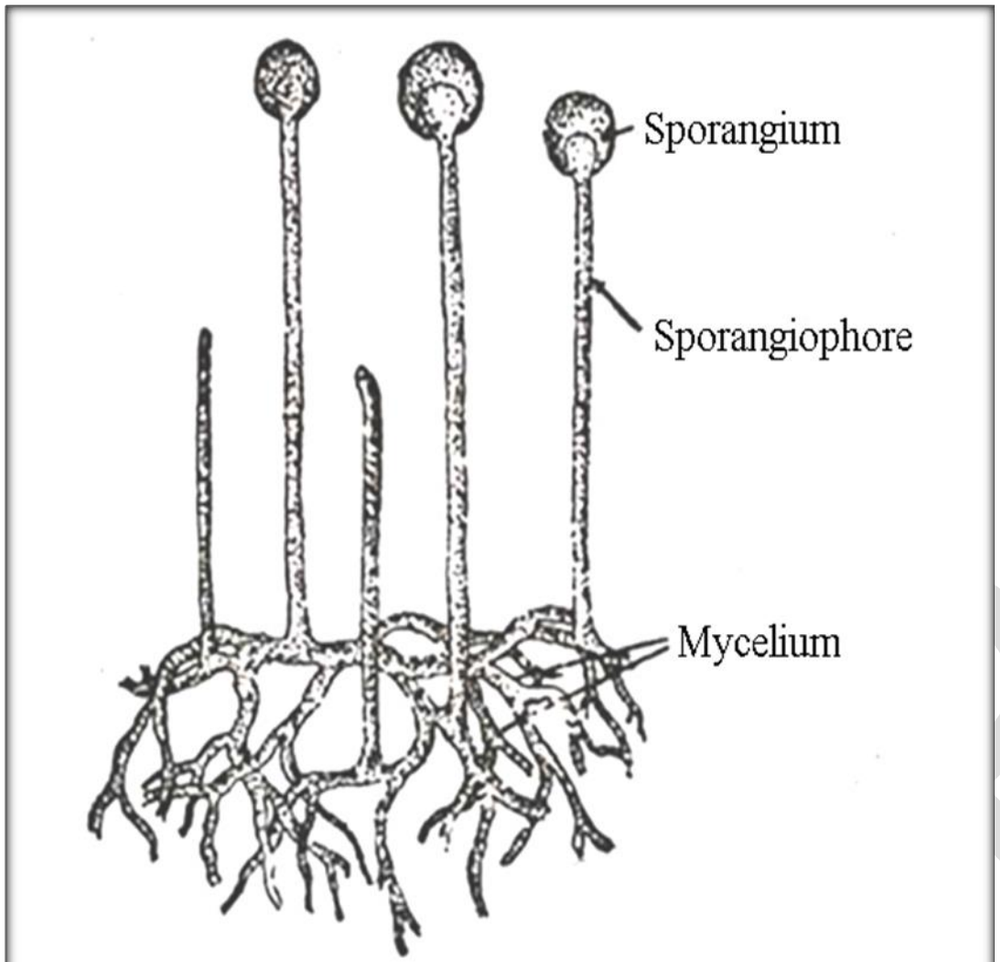


Fig: *Mucor*. Mycelium with sporangiophore and sporangia

Practical No: 5

Object : To Study Mucor through class work Material and permanent slide.

Identification

Kingdom-Mycota.

(1) Chlorophyll absent,
(2) Reserve food glycogen,
(3) Cell wall of fungal cellulose.

Division-Eumycota.

A definite cell wall.

Sub-Division-Zygomycotina.

Asexual reproduction by non motile spores-aplanospores.

Class-Zygomycetes.

(1) Gametangia morphologically similar,
(2) Sexual reproduction forms a zygospore.

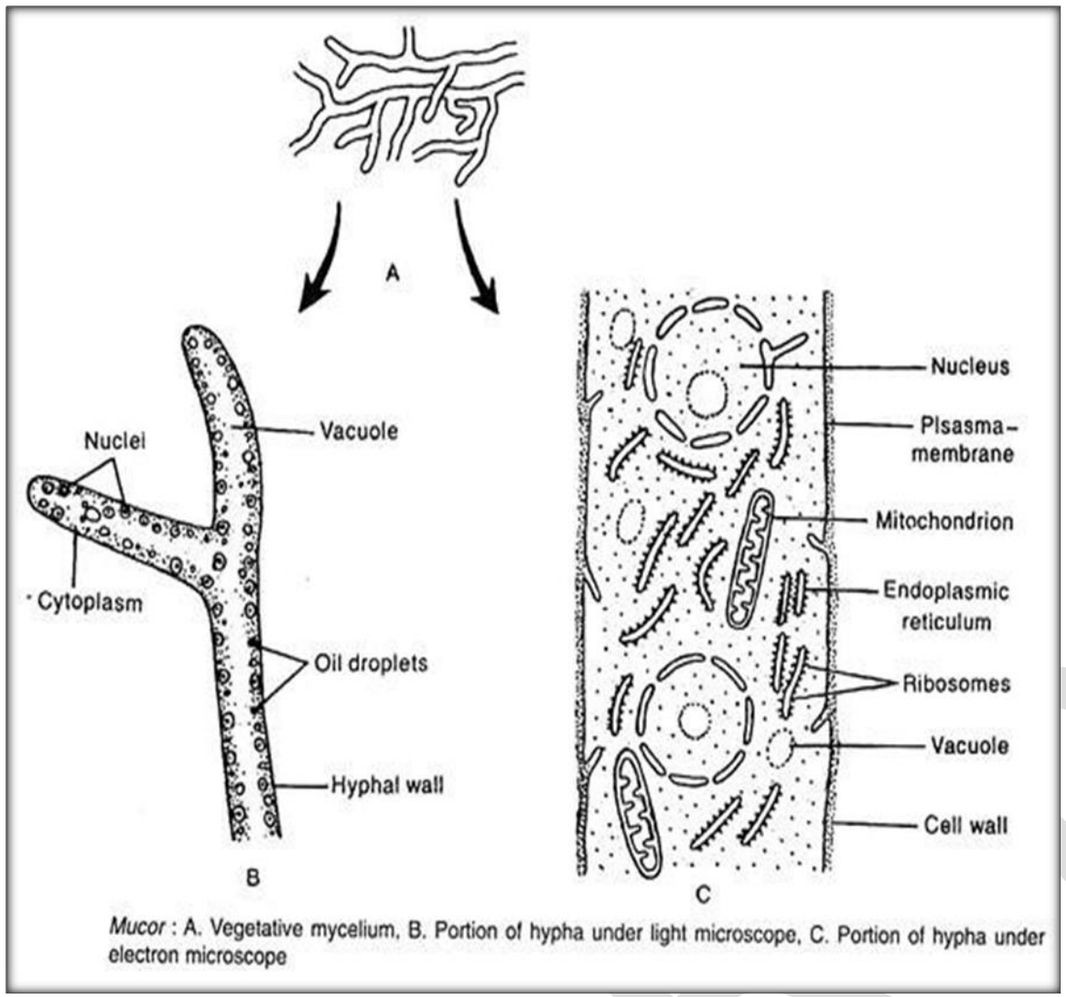
Order-Mucorales.

(1) Mostly saprophytic,
(2) Asexual reproduction by typical non-motile aplanospores.

Family-Mucoraceae.

(I) Sporangia with many spores, and well developed columella,
(2) Sporangial wall relatively thin and easily breakable or deliquescent.

Genus- *Mucor*:



Mucor : A. Vegetative mycelium, B. Portion of hypha under light microscope, C. Portion of hypha under electron microscope

Practical No: 5
Exercise: 1

Object : To Study Vegetative structure of Mucor through class work Material and permanent slide.

Work procedure : Collect diseased hosts, preserve them in formalin or alcohol. Also grow Rhizopus by keeping a slice of bread in moist chamber. This provides ready-made material for study

Comments:

1) They grow mostly as saprophytes on decaying fruits and vegetables, in soil (Mucor strictus, M. flavus), on various food- stuff-like bread, jellies, jams, syrups. M. mucedo, is a coprophilous species (grows on dungs of herbivorous animals like cow etc.), known as black mold.

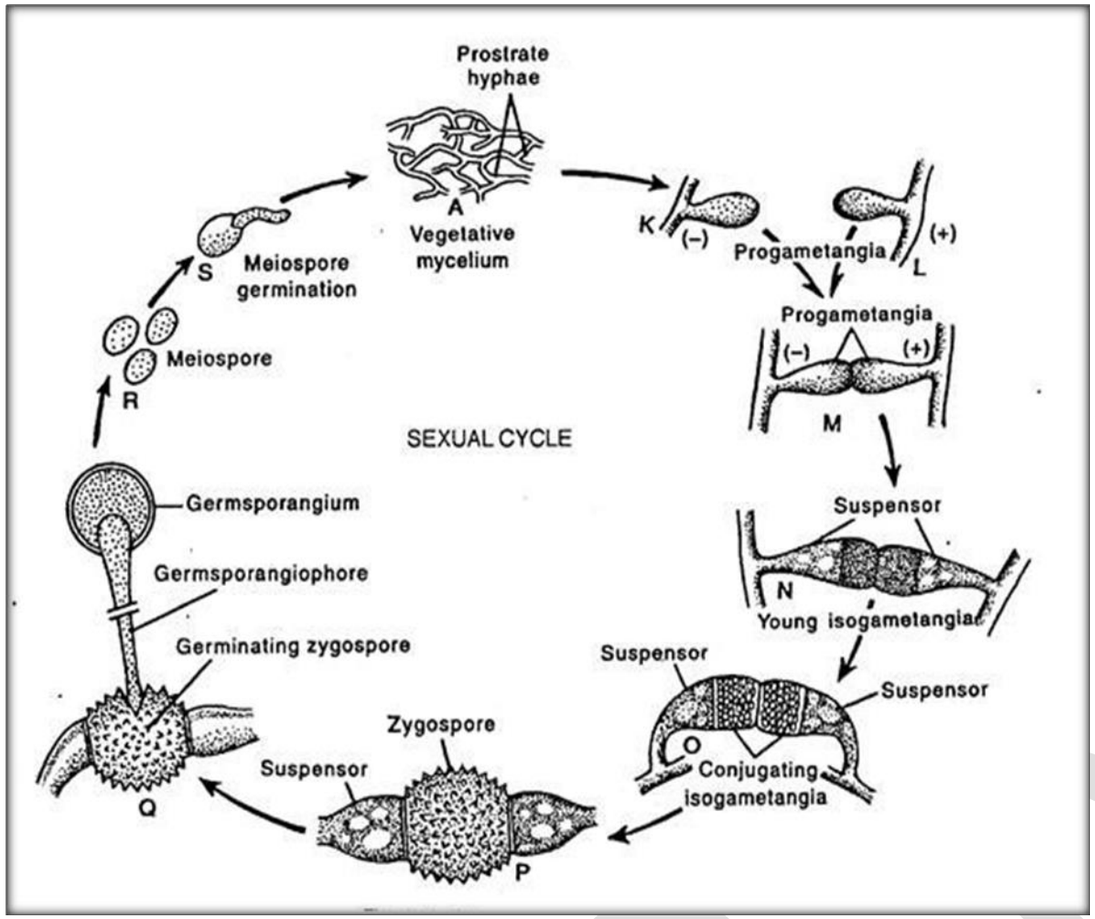
2) The vegetative plant body is eucarpic, consists of white cottony coenocytic much-branched mycelium.

3)The mycelia ramify all over the substratum.

4)The hyphae are usually prostrate, but some of them penetrate into the substratum and serve the function of both anchorage and absorption of nutrients .

5) The hyphal wall is microfibrillar, consist mainly of chitin-chitosan. In addition, other substances like other polysaccharides, lipids, purines, pyrimidines, protein, Ca and Mg are also present. Inner to the cell wall, cell membrane is present which covers the protoplast.

6)The protoplast contains many nuclei, mitochondria, endoplasmic reticulum, ribosomes, oil droplets, small vacuoles and other substances



Various stages in sexual reproduction.

Practical No: 5

Exercise: 2

Object : To Study reproductive structure of Mucor through class work Material and permanent slide.

Work procedure These are gametangia which are formed rarely. The spores are grown on potato chip by placing a few spores in sexual reproductive structures and then picking up zygospores from the centre. Zygospores are the fusion products of gametangia. Stain with cotton blue and mount in lactophenol.

Comments

1. The genus is heterothallic and the sexual reproduction takes place only when mycelia of + (plus) and - (minus) strains meet.
2. The phenomenon can be demonstrated by a 'Potato culture plate' where, on the two opposite ends, mycelia of + and - strains were grown. These met in the centre to produce the zygospores. The zygospores appeared as a black streak in the centre of the potato chip.
3. The hyphae of the opposite strains produce erect branches. A transverse division separates the terminal gametangium from a proximal suspensor cell. Suspensor is straight, large and swollen.
4. The two isogametangia (also called coenogametangia) conjugate to form a zygospore (zygote) which has a thick wall and rough outer surface.
5. Zygospore divides meiotically after a period of rest. It germinates by producing a promycelium which develops a sporangium (often called zygosporangium) at its tip.
6. The sporangium produces many multinucleate spores. These germinate to form new mycelium.

Hints for Collection

Riccia is very common in both hills as well as in plains.
All the species grow on damp soil and rock.
In plains Riccia can be seen growing amongst brick work or unused soil just after a few heavy showers.

Practical No: 6
Object : Study of Riccia
Identification
Division-Bryophyta.
(1) True roots absent,
(2) True vascular strands absent.
Class-Hepaticopsida.
(1) Mostly thalloid,
(2) Rhizoids without septa,
(3) Chloroplasts without pyrenoids,
(4) No columella in capsule.
Order-Marchantiales.
(1) Scales present,
(2) Two types of rhizoids present,
(3) Air chambers and air pores present.
Family-Ricciaceae.
(1) Air pores are simple,
(2) Sex organs in the mid-dorsal groove,
(3) Sporophyte composed only of capsule, foot and seta being absent.
Genus-Riccia.
(1) Scales on the margins,
(2) Assimilatory filaments are unbranched and vertical.

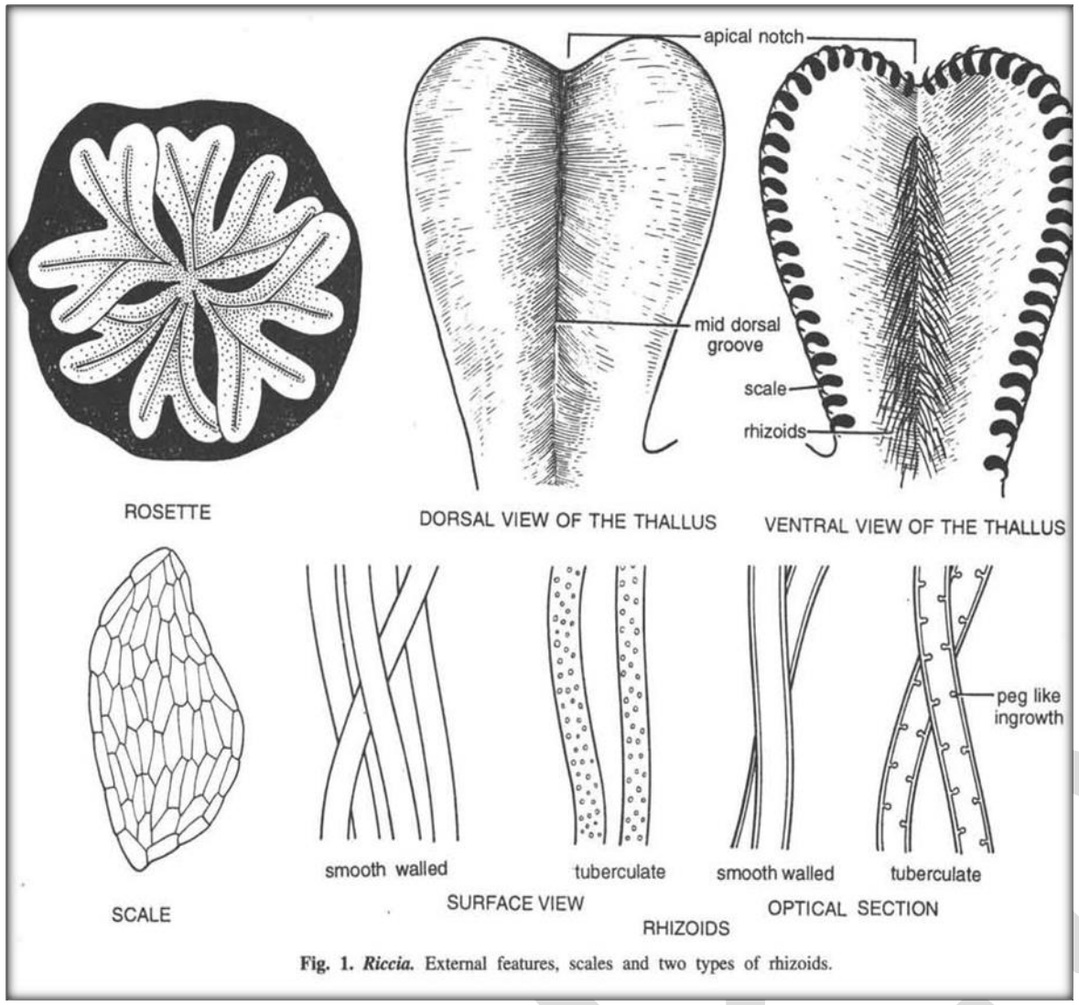


Fig. 1. ***Riccia.*** External features, scales and two types of rhizoids.

Practical No: 6

Exercise 1

Object : Study of external features of gametophyte

Work procedure Study the external features of the gametophyte, both from dorsal and ventral surfaces. Observe the two types of rhizoids and violet colored scales.

Comments

1. The plant body is thalloid, dorsi ventral , prostrate and ribbon-like.
2. A rosette is fonned due to repeated dichotomies of the thalli.
3. The thallus is linear to wedge shaped with an apical notch at the apex and thickened midrib in the sagittal axis. On the dorsal side, the midrib is traversed by a mid-dorsal groove.
4.On the ventral side, scales and rhizoids are present. The scales are present at the margins. The rhizoids arise from the midrib region.
5Each scale is violet colored, multi cellular and one celled thick.
6. Rhizoids are of two types--(i) smooth walled and (ii) tuberculate. The smooth walled rhizoids have inner smooth walls whereas tuberculate rhizoids produce tuber-like or peg-like ingrowths of their inner wall which project into the lumen of the rhizoids.
7. Sex organs are present in the mid-dorsal groove and are embedded in the thallus. The sporophytes, however, may be seen as black dots, when mature, under the dissecting microscope.

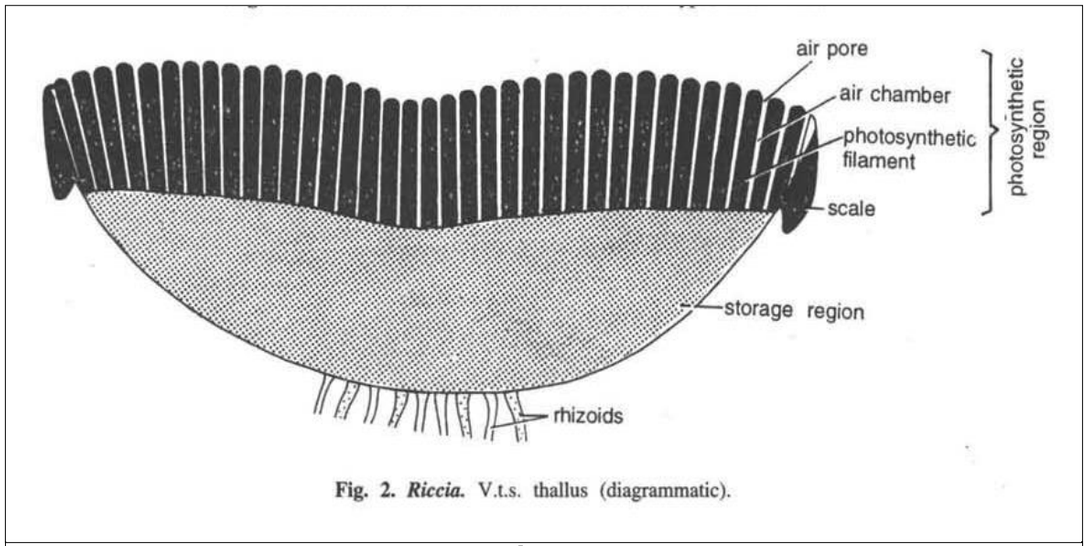


Fig. 2. *Riccia.* V.t.s. thallus (diagrammatic).

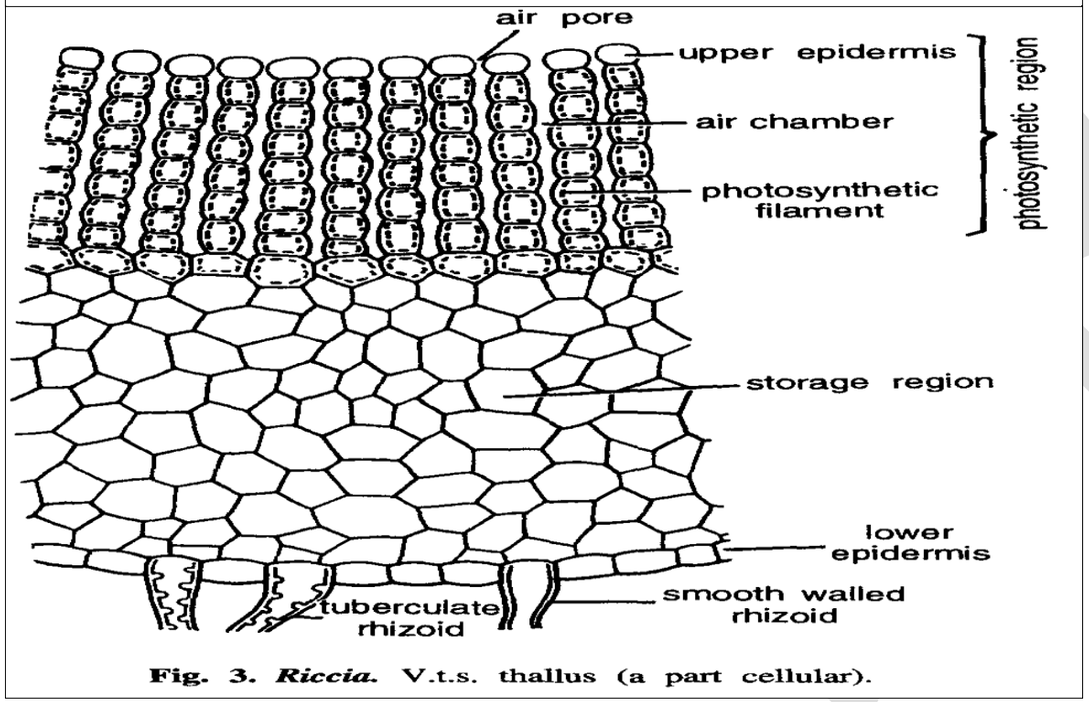


Fig. 3. *Riccia.* V.t.s. thallus (a part cellular).

Practical No: 6

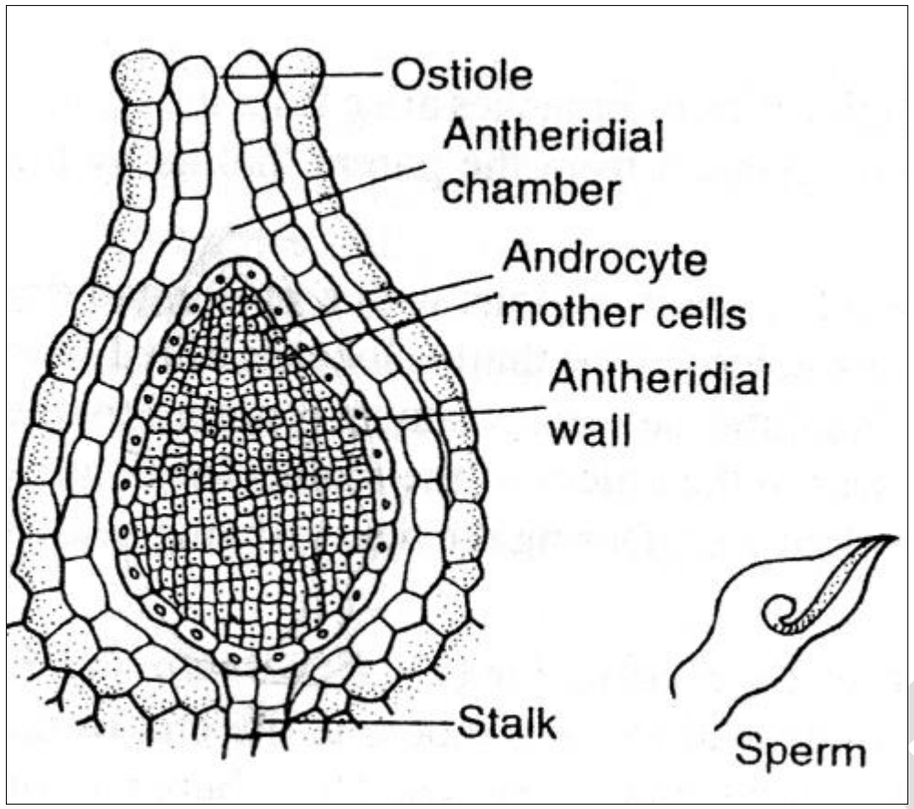
Exercise 2

Object : Study of anatomy of thallus.

Work procedure Place the thallus in pith. Cut T.s. and stain either in safranin or fast green. Mount in glycerine and study

Comments

1. The thallus is boat-shaped in a vertical transverse section.
2. It is thick in the midrib region and gradually thins out towards the margins.
3. The thallus is dorsiventrally differentiated into an upper green photosynthetic region and a lower colourless storage region.
4. The lower epidermis bounds the storage region on the lower side and bears the usual two types of rhizoids (smooth walled and tuberculate) in the centre.
5. The storage region consists of compactly arranged parenchyma. These cells contain starch.
6. The photosynthetic region consists of vertical rows of unbranched assimilatory filaments, separated by narrow air chambers. The cells of the filaments are barrel-shaped and each possesses numerous chloroplasts.
7. The air chambers open to the outside through simple air pores which are the intercellular spaces between the upper epidermal cells.
8. The uppermost cells of the assimilatory filaments are somewhat large. They lack chloroplasts and are thus colourless. These form an ill-defined upper epidermis.
9. On the two margins of the boat shaped section, violet coloured scales are present.



A mature antheridium;

Practical No: 6

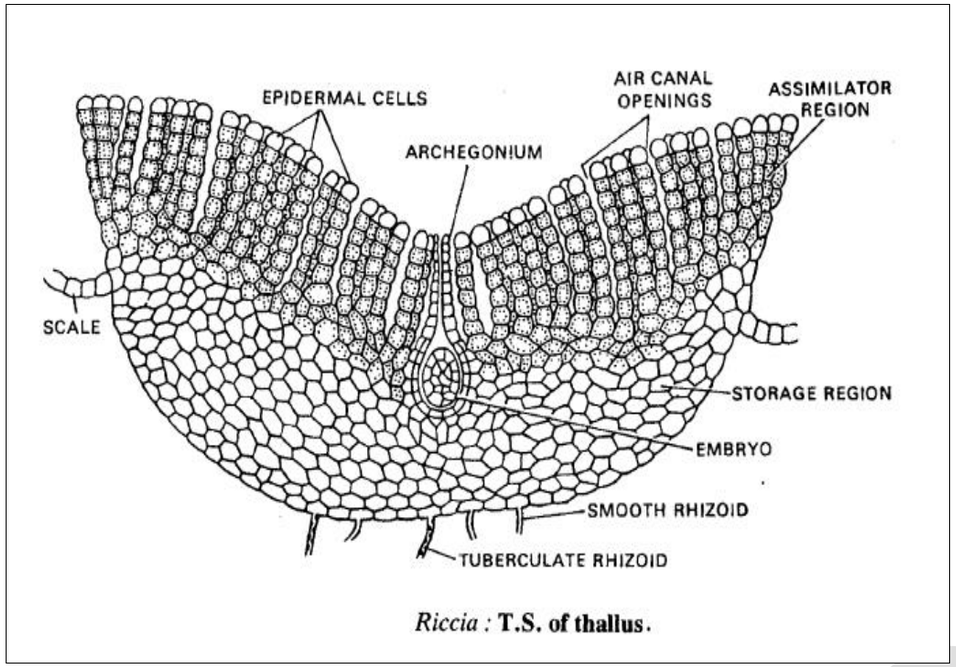
Exercise 3

Object : Study of antheridium.

Work procedure Cut L.s. of thallus through mid-dorsal groove. Stain in fast green, mount in glycerine and study the antheridia.

Comments

1. The thallus is monoecious, both the sex organs being situated in the mid-dorsal groove. (R. bischoffi and R. curtisii are dioecious).
2. The antheridium is present inside a cavity called antheridial chamber which opens outside by antheridial pore.
3. The antheridial chamber with antheridium, lies embedded partly in the tissue of the photosynthetic region and partly in the tissue of the storage region.
4. A mature antheridium consists of a small stalk and a globular or club-shaped body.
5. The stalk is short and few celled. The body is composed of a central mass of either androcytes or antherozoids, surrounded by a single layer of sterile jacket. The cells of the jacket are tangentially elongated.



Riccia : **T.S. of thallus.**

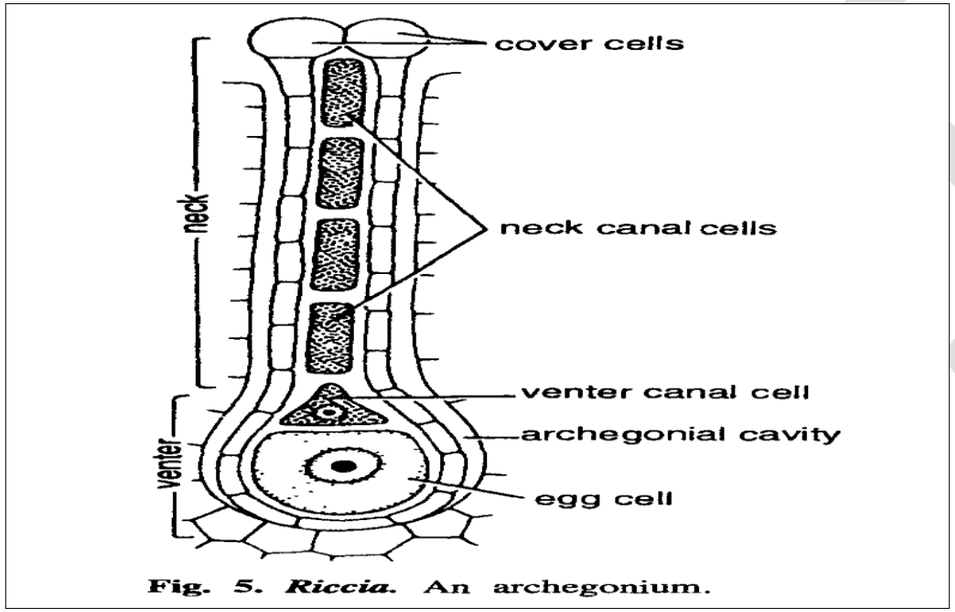


Fig. 5. *Riccia.* An archegonium.

Practical No: 6

Exercise 4

Object : Study of archegonium.

Work procedure Cut L.s. of thallus through mid-dorsal groove, stain the section in fast green, mount in glycerine and study the archegonium.

Comments

1. The thallus is monoecious and both the sex organs are situated in the mid-dorsal grrove.
2. A nearly mature archegonium is flask-shaped.
3. Archegonium is shortly stalked and consists of a broad venter and a long neck.
4. Wall of the venter is one celled. The venter has one venter canal cell and an egg cell.
5. The neck consists of 6 vertical rows of cells and is 6-9 cells in height. It possesses 4 neck canal cells.
6. The neck is surmounted by four cover cells.
7. Before fertilization, all the axial cells except the egg cell degenerate and the cover cells spread open to facilitate the entry of antherozoids.

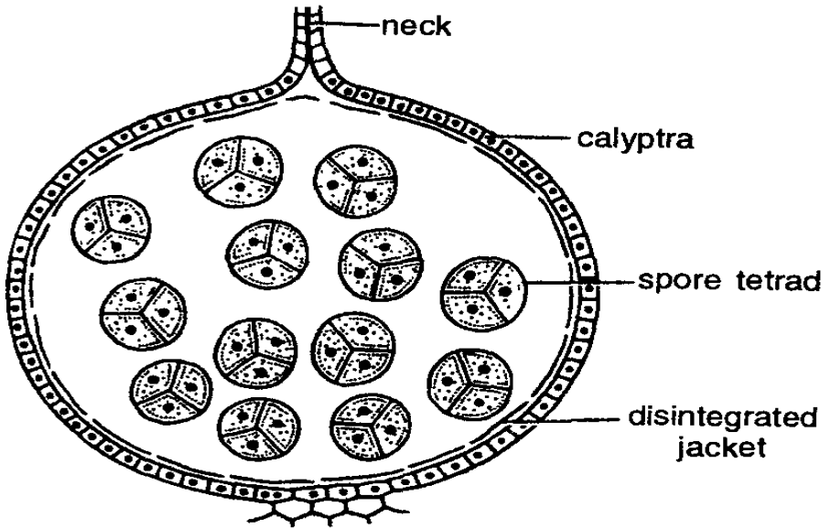


Fig. 6. ***Riccia.*** V.t.s. sporophyte.

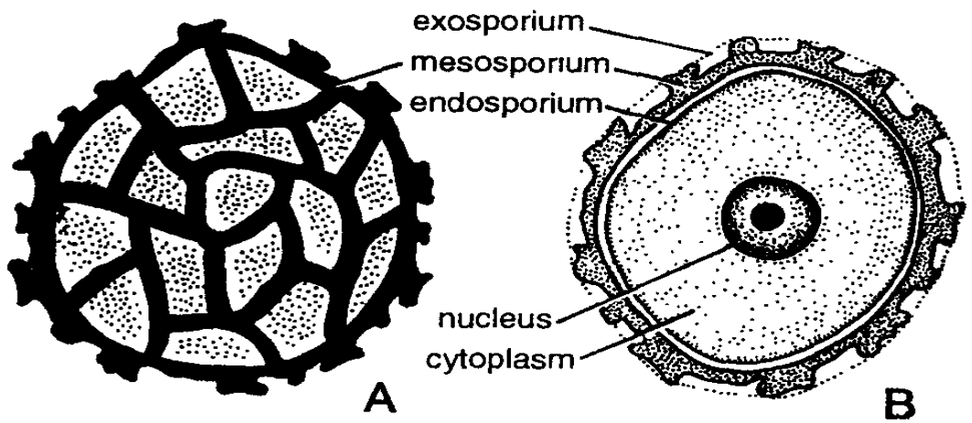


Fig. 7. ***Riccia.*** Spores **A.** Surface view. **B.** Optical view.

Practical No: 6

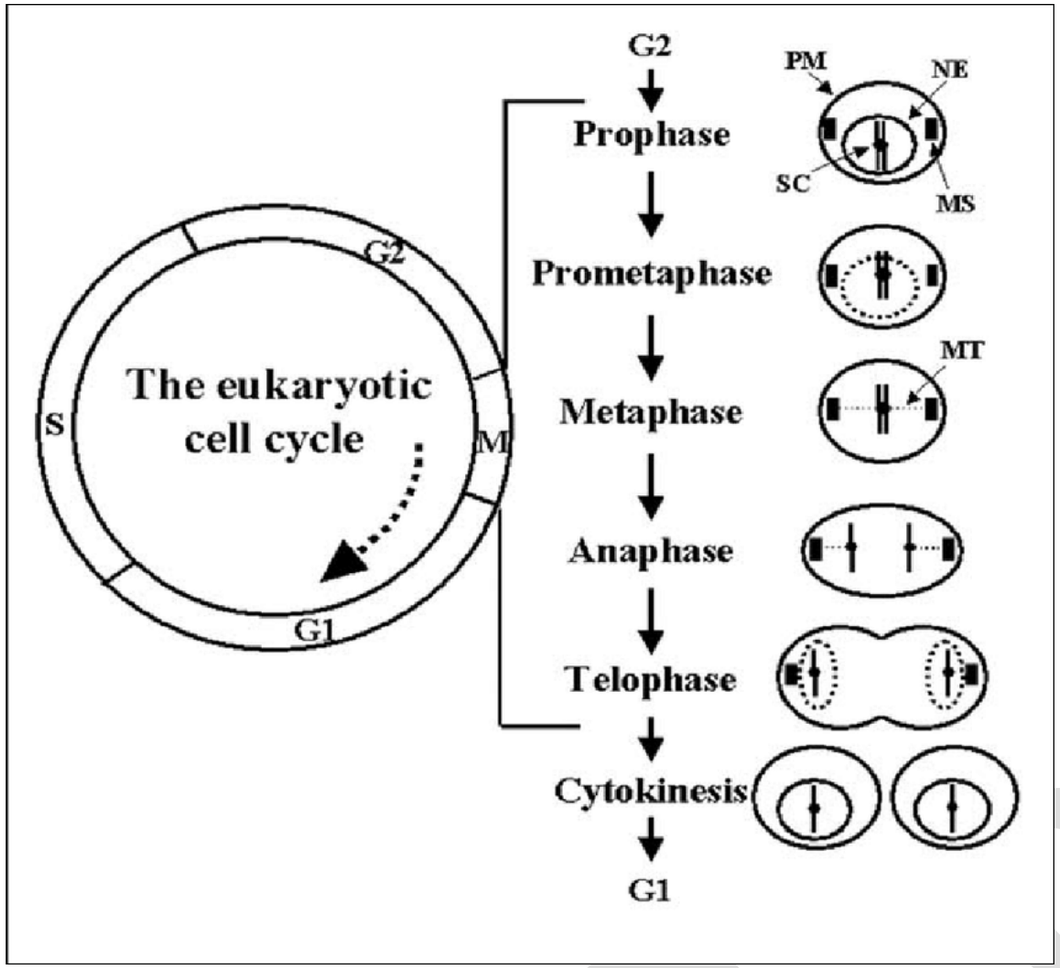
Exercise 5

Object : Study the structure of sporophyte.

Work procedure Cut L.s. of the thallus through mid-dorsal groove, stain in safranin or fast green, mount in glycerine and study the sporophyte.

Comments

1. The sporophyte is embedded in the tissue of the thallus. It is present in the venter of fertilized archegonium.
2. Sporophyte is represented only by the capsule, foot and seta being absent.
3. The young capsule has a jacket layer and a 2-layered calyptra, derived from venter.
4. The mature sporophyte has spore tetrads arranged tetrahedrally (except R. pearsonii) or spores. These remain surrounded only by outer layer of calyptra, the inner layer of calyptra and the jacket disintegrates.
5. The spores are discharged only after the disintegration of the thallus.
6. Each spore ranges from 0.05 to 0.012 mm in diameter and consists of spore wall, enclosing within a rich cytoplasm and a nucleus.
7. The spore wall is three layered. The outermost layer is the exosporium which is thin and cutinized. The middle mesosporium is thick and the innermost endosporium is thin and homogenous. The entire spore wall is irregularly thickened and folded.



Practical No: 7

Object : Study of Cell cycle through Chart/ Photograph

Comments

Cell cycle, which refers to the whole process from the first split that produce new cells to the end of second division, including two stages of the interval and split.

The interval can be divided into three phases: DNA synthesis (G1 phase), DNA synthesis stage (S phase) and late stage of DNA synthesis (G2 phase)

1. G1 phase. This period will vary from different cells, the majority of cells in the body will differentiate and implement their respective functions after the completion of last division. The early stage of this G1 phase is being called G0 phase, and the cells began to satisfy the needs for precursor substances, energy and enzymes of the next split synthetic DNA at the last stage of G1 phase.

2. S phase – The critical moment of the cell cycle. DNA is doubled by replicating, and the somatic cells become tetraploid, each of which is converted into two chromosomes connected by centromere. At the same time, it synthetised histones and duplicate the central particle. S phase generally takes several hours.

3. G2, is the final preparation for the division. The central particles have been completed, formatting two central body and synthesising RNA and tubulin etc. G2 period is relatively constant, usually need 1 to 1.5 hours.

Split Period

The mitosis will need prophase, metaphase, anaphase and telophase, which is a continuous process, dividing into two sub-cells from brood cells. Generally, this period needs 1 to 2 hours.

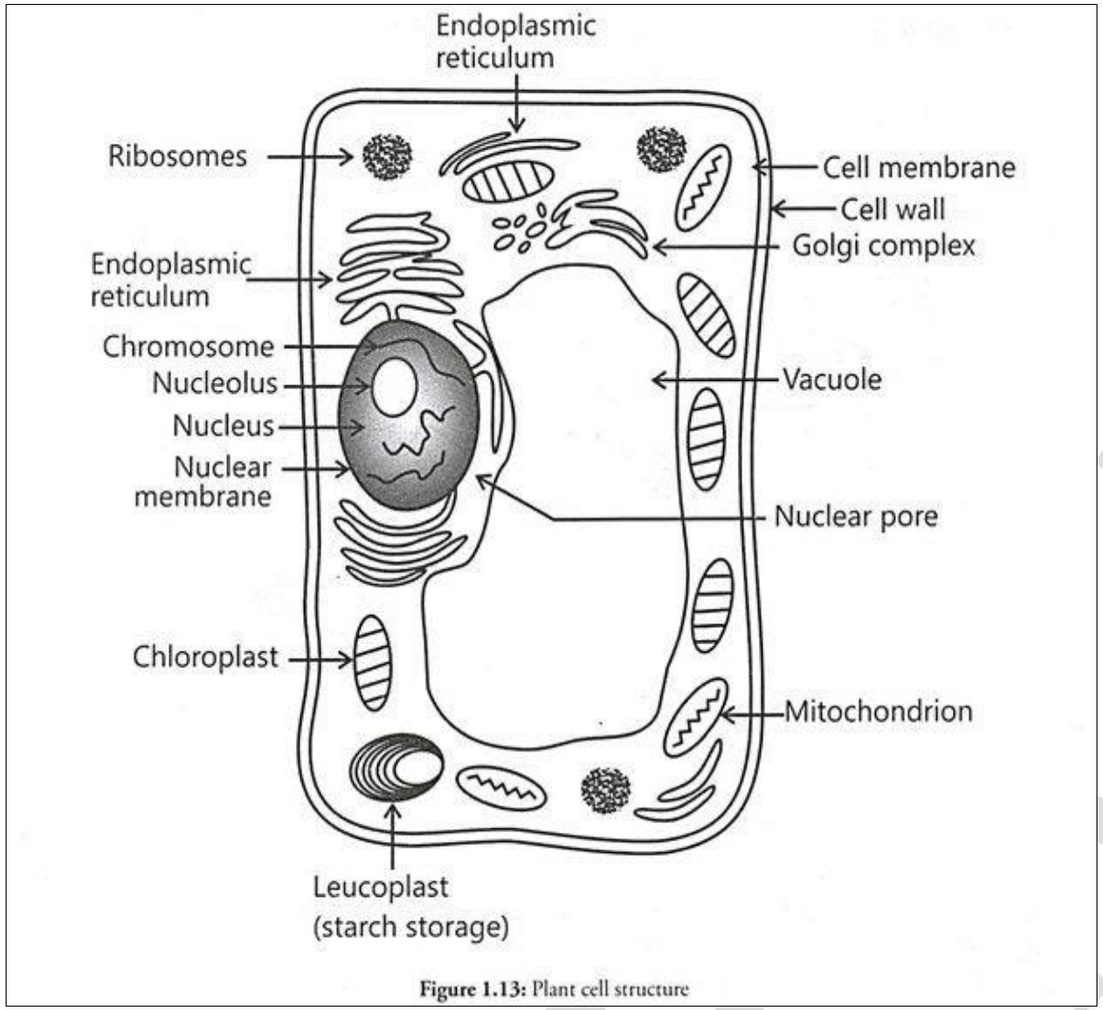


Figure 1.13: Plant cell structure

Identification

Since the cell shows cell wall and chloroplasts, it is a plant cell.

Practical No: 8

Object : Study of Plant cell through Chart/ Photograph

Work procedure : Take out a leaf of Hydrilla or peel off epidermis of leaf of any angiospermic plant. Stain with safranin and mount in glycerine.

Comments :

1.The outermost is the cell wall made of cellulose.
2. Cell wall is followed by cell membrane.
3. Inside the cell membrane is the cytoplasm and the nucleus.
4. Cytoplasm contains chloroplasts, mitochondria, golgi bodies, endoplasmic reticulum and ribosome's.
5. The characteristic green colour of the cell is due to the presence of many chloroplasts distributed throughout the cytoplasm.
6. Nucleus is situated in the cytoplasm. It shows nuclear membrane, nucleolus and chromatin network present in nucleoplasm.

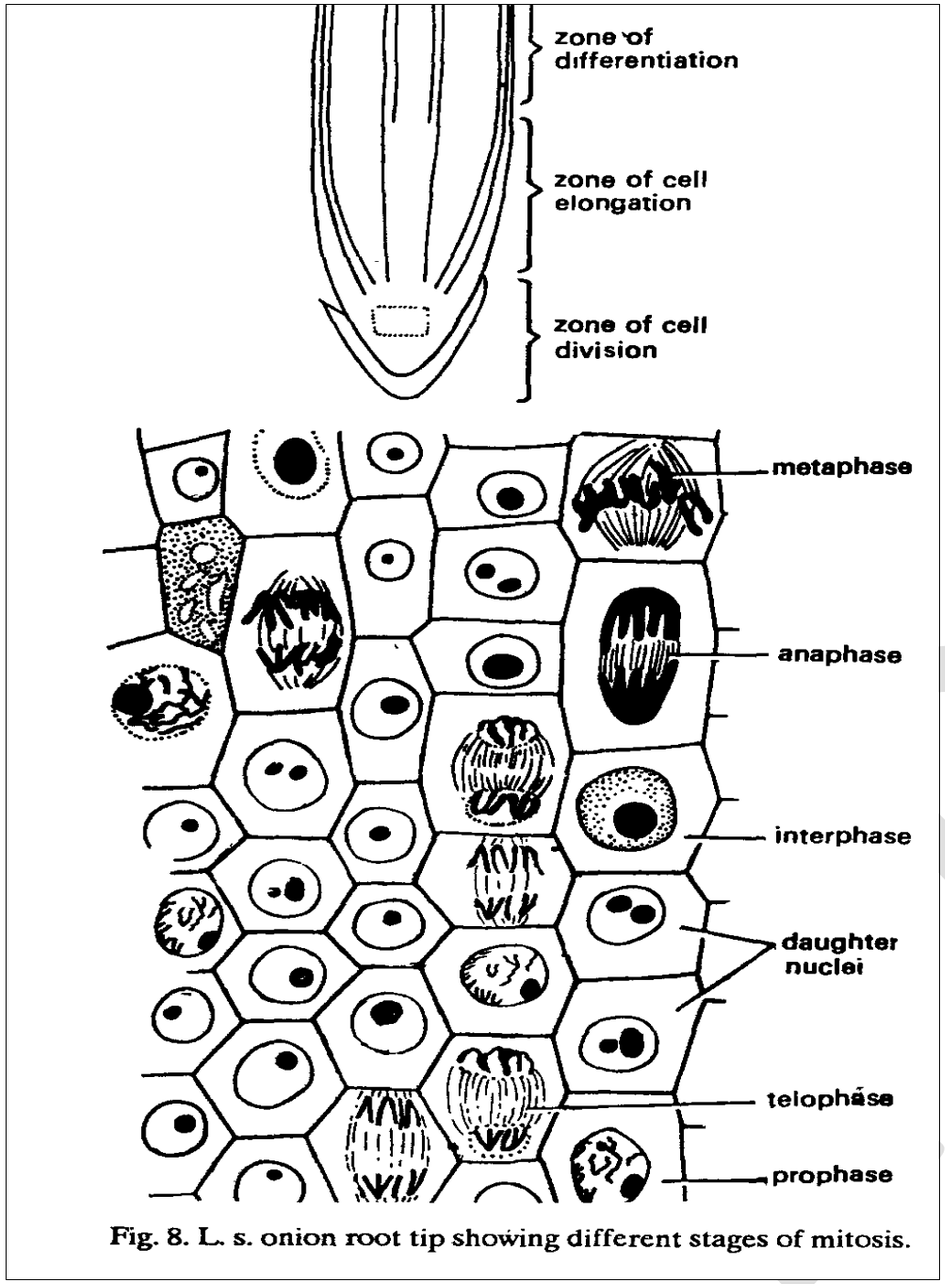


Fig. 8. L. s. onion root tip showing different stages of mitosis.

Practical No: 9

Purpose : Mitosis in Onion Root Tips.

Mitosis is a type of cell division which results in the formation of two daughter cells. These cells are identical to the parent cells and have the same number of chromosomes. Mitosis occurs in vegetative cells. It can be best observed in onion root tip.

Materials required: Onion plant with root, Feulgen stain, 1 N HCl, Scissors, Forceps

1. Razor blade ,Pasture pipette, 1.5 ml microfuge tubes, Dissection probe with wooden back, Microscopic slides and cover slips, Water bath, Light Microscope

Procedure

Take the onion plant with newly sprouted roots and cut two root tips using scissors and transfer them into a plastic microfuge tube.

Fill 2/3 of the tube with 1N HCl using a dropper.

Place the tube in a 60°C water bath and incubate the tube for 12- 15 minutes.

Remove the tube from the water bath after the incubation.

Discard the HCl from the tube using a Pasture pipette to the running tap water.

Add some drops of distilled water into the tube and rinse the root. Then remove the water from the microfuge tube using the Pasture pipette. (Rinse the roots at least three times).

After the washing step add 2-3 drops of Feulgen stain into the tube with root tips and incubate the roots for 12-15 minutes. (During the incubation, the very tip of the root will begin to turn red as the DNA stains the numerous small actively dividing cells at the time).

After the incubation remove the stain using a Pasture pipette.

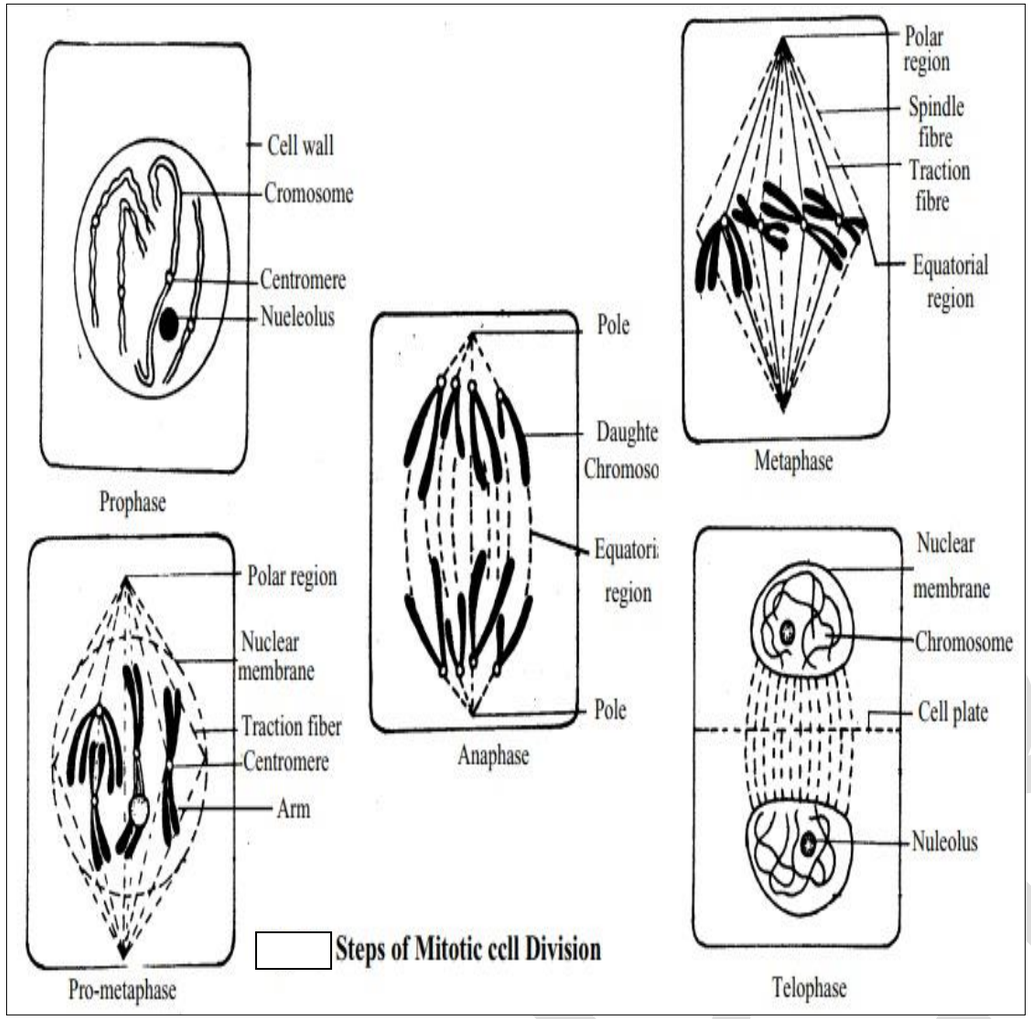
Again rinse the root tips with distilled water. (Rinse the roots at least three times).

Transfer a root from the tube to the centre of the microscopic slide and add a drop of water over it.

Take a razor blade and cut most of the unstained part of the root.

Cover the root tip with a cover slip and then carefully push down on the cover slide with the wooden end of a dissecting probe. (Push hard, but do not twist or push the cover slide sideways). The root tip should spread out to a diameter of about 0.5- 1cm.

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.



Practical No: 10

Exercise 1

Object : Study of Cell division: Mitosis (Permanent slides)

Materials and technique Prepare a squash of the onion root tip as described earlier.

Observations The slide shows almost all the stages of mitosis.

The various stages of mitosis are:

1. Prophase

- The process of mitosis is initiated at this stage wherein coiling and thickening of the chromosomes occurs
- Shrinking and hence the disappearance of the nucleolus and nuclear membrane takes place
- The stage reaches its final state when a cluster of fibres organizes to form the spindle fibres.

2. Metaphase

- Chromosomes turn thick in this phase. The two chromatids from each of the chromosomes appear distinct
- Each of the chromosomes is fastened to the spindle fibres located on its controller
- Chromosomes align at the centre line of the cell

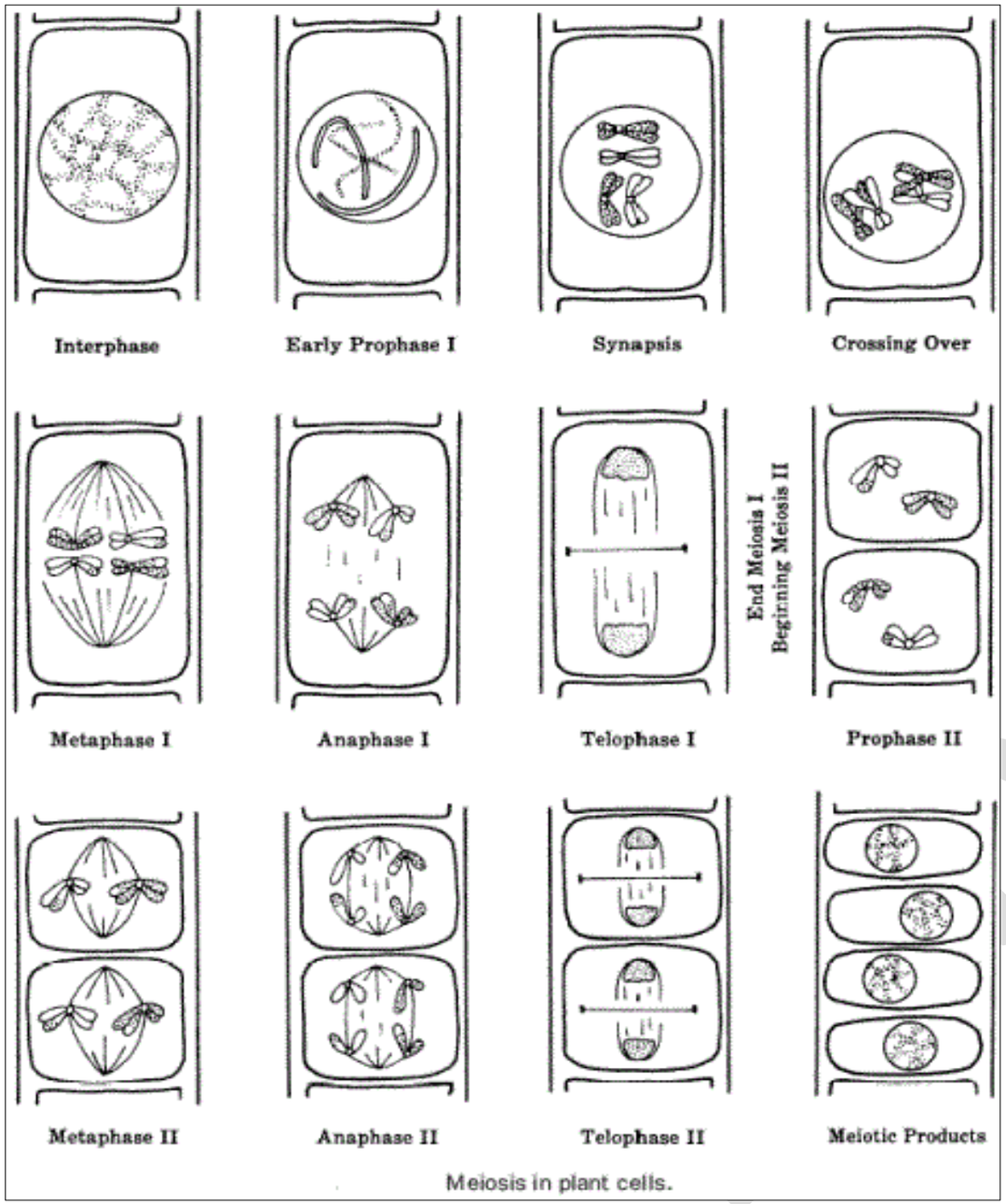
3. Anaphase

- Each of the chromatid pair detaches from the centromere and approaches the other end of the cell through the spindle fibre
- At this stage, compressing of the cell membrane at the centre takes place

4. Telophase

- Chromatids have reached the other end of the cell
- The disappearance of the spindles
- Chromatin fibres are formed as a result of uncoiling of daughter chromosomes
- The appearance of two daughter nuclei at the opposing ends due to the reformation of the nucleolus and nuclear membrane
- At this phase, splitting of the cell or cytokinesis may also occur.

Post mitosis, the next stage is referred to as interphase which is part of the cell cycle that is non-dividing and between two consecutive cell divisions. A cell spends most of its life in the interphase. It comprises the G1, S and G2 stages.



Meiosis in plant cells.

Practical No: 10

Exercise 2

Object: Study of Cell division: Meiosis (Permanent slides)

Meiosis is a cell division that is characteristic of organisms which reproduce sexually. During this division, genetic material is duplicated once and nucleus divides twice. As a result four daughter cells are formed.

Work procedure:. To study meiosis by smear preparation.

Materials and Technique Prepare a smear of young anthers of Asphodelus or Tradescantia as described earlier.

Observations Following stages can be seen in different slides of melosls

Meiosis-I (heterolytic or Reductional division)

Meiosis-I has four different phases or stages:

1. Prophase-I

- It occupies the longest duration in Meiosis-I.
- It is divided into five sub-stages or sub-phases.

i. Leptotene

- This phase starts immediately after interphase,The size of cell and nucleus increases
- The chromosomes appear long, uncoiled thread-like in structure bearing many bead-like structures called chromomeres.
- The nuclear membrane and nucleolus remain as it is.

ii. Zygotene

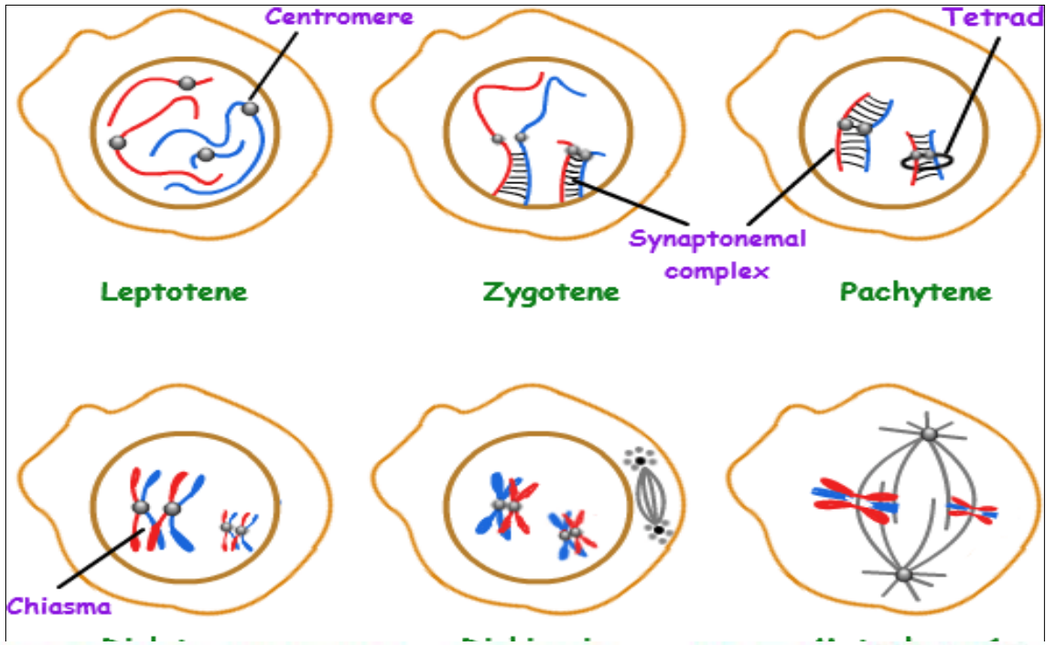
- Homologous chromosomes come closer and start to pair up along their length.
- The pairing of homologous chromosomes is called Synapsis and the paired homologous chromosomes are referred as bivalents.
- The homologous chromosomes are held together by ribonuclear protein between them.

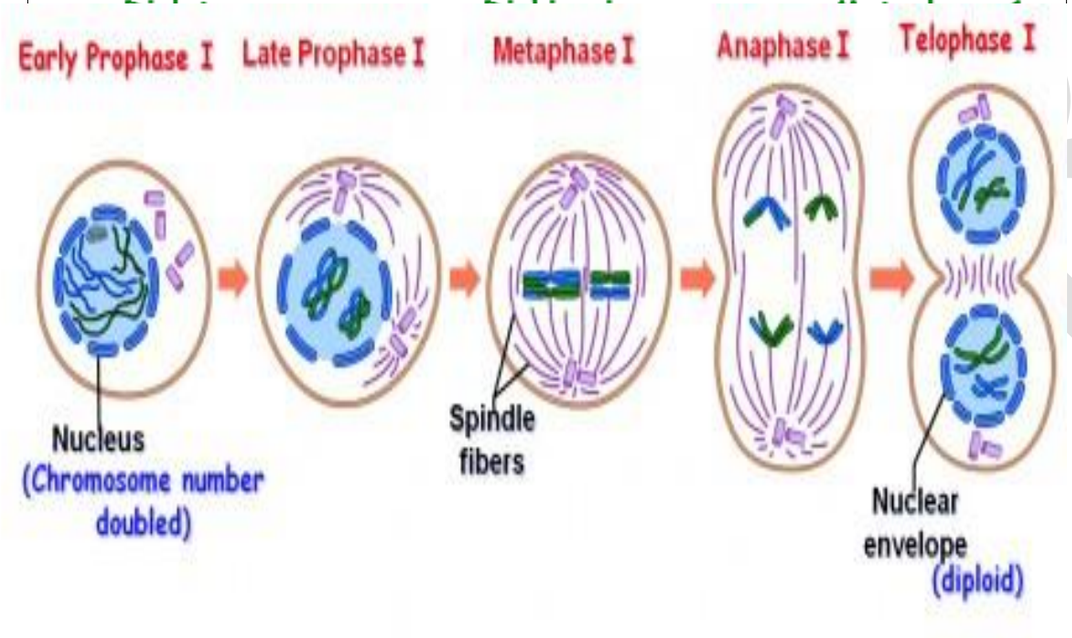
iii. Pachytene

- The chromosome become shorter and thicker.
- Each chromosome of the bivalents splits longitudinally to form two chromatids such that bivalents is composed of four strands and is known as a tetrad.
- Crossing over is the most important genetic phenomenon of meiosis which causes variation in genetic characters in offspring.

iv. Diplotene

- Bivalents (chromatids) repel each other.





- Homologous chromosome (two non-sister chromatids) begins to separates but separation is not complete, they remains attached to a point with a knot like structure called chiasmata (singular – chiasma).
- The number of chiasmata varies. Depending upon the number of chiasmata, chromosome appears different shape.
- 1 chiasmata: cross like 2 chiasmata: ring like

Many chiasmata: series of loop

- Nuclear membrane and nucleolus begins to disappear.

v. Diakinesis

- The chiasma moves towards the end of the chromosomes (tetrad) due to contraction of chromosomelastly slips over separating the homologous chromosome. This movement of the chiasmata towards the end of chromosome is called terminalization.
- By the end of diakinesis the nuclear membrane and nuleolus get completely disappeared and the chromosomes are free in the cytoplasm.

2. Metaphase-I

- The spindle fibres organized between two poles and get attached to the centromere of chromosomes.
- Chromosome moves to equator
- The bivalent chromosomes are arranged in the equatorial plate in such a way that 2 metaphasic plates are formed.

3. Anaphase-I

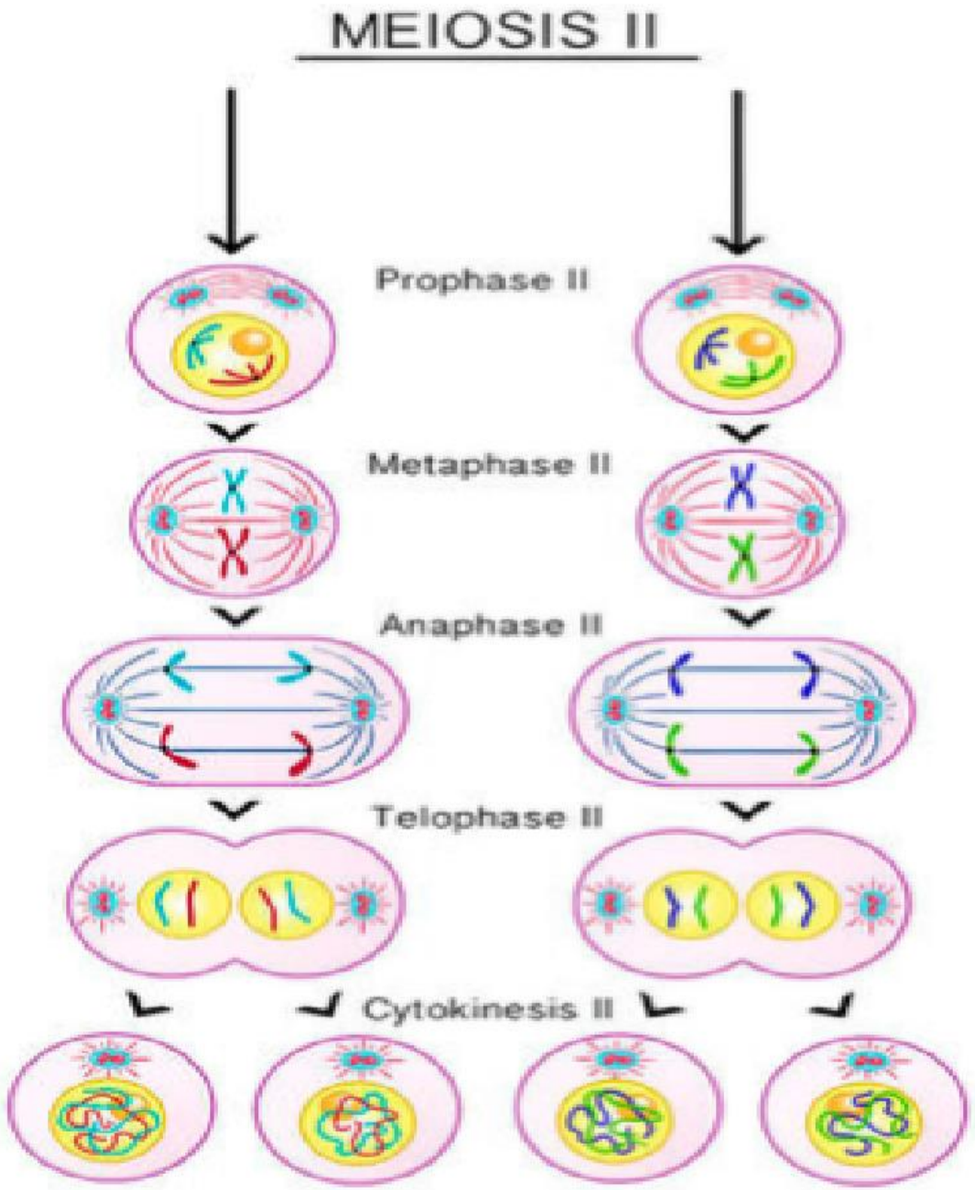
- Spindle fibres contracts and pulls the whole chromosomes to the polar region.
- The separated chromosome is known as dyads
- Now the separated chromosome moves toward opposite poles.

4. Telophase-I

- Two groups of chromosome formed at each pole and organized into nuclei.
- The nuclear membrane and nucleolus reappears.
- The chromosomes get uncoiled into chromatin thread.
- The spindle fibres disappear totally.

Cytokinesis I

- Cytokinesis may or may not follow nuclear division (meiosis-I Cytokinesis occurs by cell plate formation method in plant cell and furrowing method in animal cells.



Interphase II or Interkinesis

- The two cells or nuclei thus formed pass through a short stage called interphase-II. Sometimes, interphase-II is absent.
- It is the resting phase between meiosis-I and meiosis-II.
- It is either very short or may be absent
- No DNA synthesis occurs.

Meiosis-II (Homolytic or equational division)

- Meiosis-II is exactly similar to mitosis, so it is also known as meiotic mitosis.
- In this division, two haploid chromosome splits longitudinally and distributed equally to form 4 haploid cells.
- It completes in 4 stages.

1. Prophase-II:

- The dyads chromosome becomes thicker and shorter
- Nuclear membrane and nucleolus disappear
- Spindle fibre starts to form

2. Metaphase-II:

- The dyads chromosomes comes to equatorial plane
- Spindle fibres organize between poles and attaches to centromere of chromosome.

3. Anaphase-II:

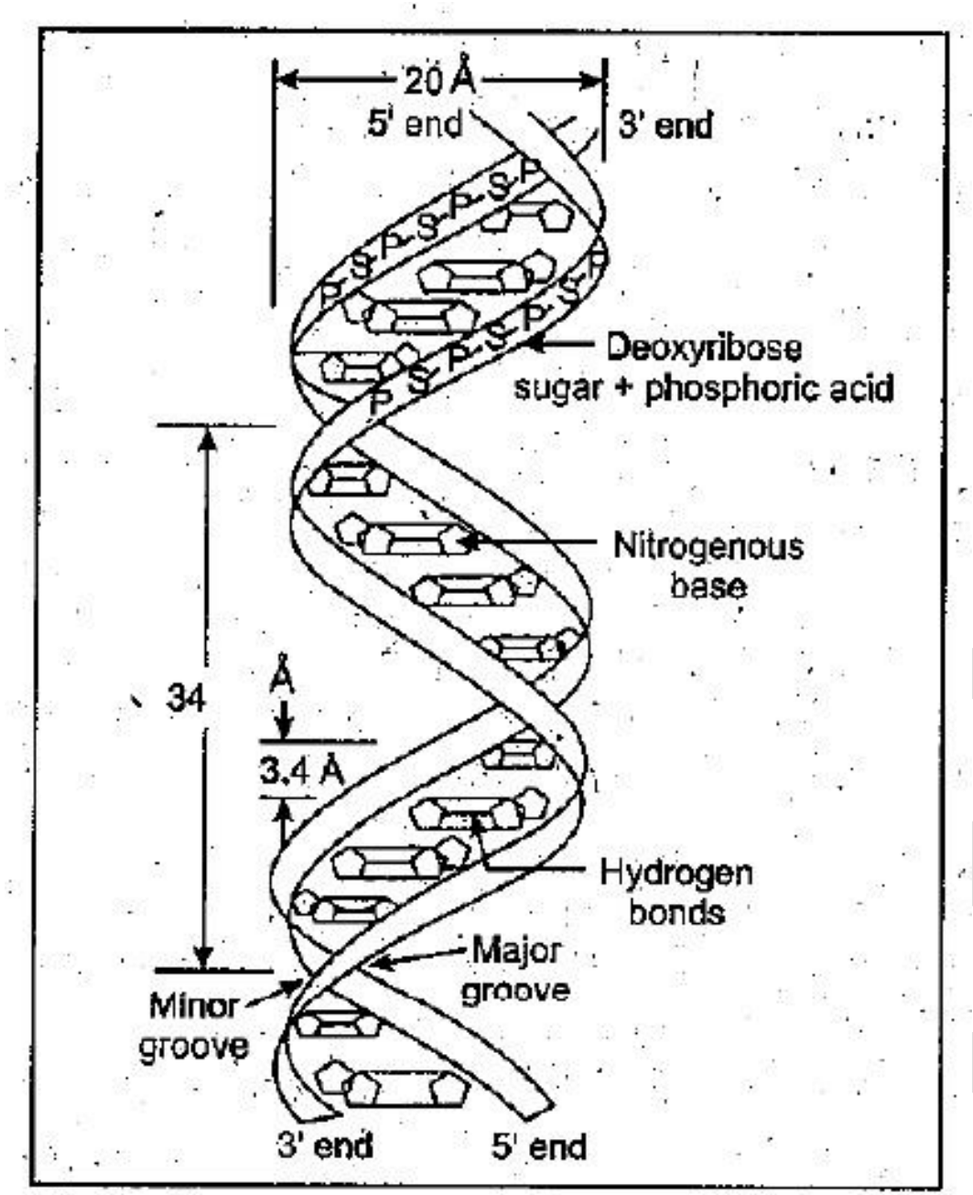
- Centromere of each chromosome divides and sister chromatids separates to form two daughter chromosome
- Spindle fibre contracts and pull the daughter chromosome apart towards opposite pole.

4. Telophase-II:

- Chromosome become organize at respective pole into nuclei
- Chromosome elongates to form thin networks of chromatin
- Nuclear membrane and nucleolus reappears

Cytokinesis-II:

- The result of cytokinesis is four haploid daughter cells (gametes or spores).
- Cytokinesis takes place by cell plate formation in plant cell
- Successive methods: cytokinesis followed by each nuclear division resulting in 4 haploid cells. Eg. Monocot plants



Structure of DNA (Watson and Crick's model)

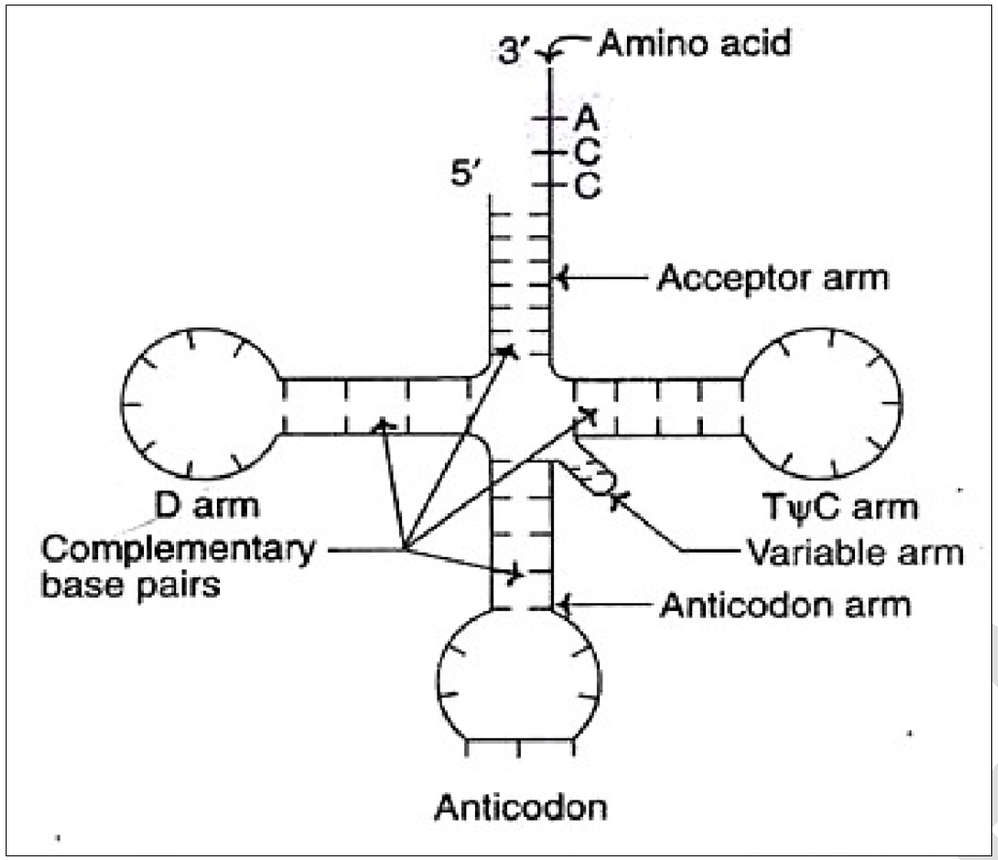
Practical No: 11

Aim Study of Nucleic acids through Chart/ Photograph/ Model

Exercise 1

Object : Study the DNA structure

1. DNA is made of two helical chains coiled around the same axis, to form a right-handed double helix.
2. The two chains in the helix are anti-parallel to each other, i.e., the 5′-end of one polynucleotide chain and the 3′-end of the other polynucleotide chain is on the same side and close together.
3. The distance between each turn is 3.6 nm (formerly 3.4 nm).
4. There are 10.5 nucleotides per turn (formerly 10 nucleotides).
5. The spatial relationship between the two strands creates major and minor grooves between the two strands. In these grooves some proteins interact.
6. The hydrophilic backbones of alternating deoxyribose and negatively charged phosphate groups are on the outside of the double helix.
7. The hydrophobic pyrimidine and purine bases are inside the double helix, which stabilizes the double helix of the DNA.
8. The double helix is also stabilized by inter-chain hydrogen bond formed between a purine and pyrimidine base.
9. A particular purine base, pairs by hydrogen bonds, only with a particular pyrimidine base, i.e., Adenine (A) pairs with Thymine (T) and Guanine (G) pairs with Cytosine (C) only.
10. Two hydrogen bonds pairs Adenine and Thymine (A = T), whereas three hydrogen bonds pairs Guanine and Cytosine (G ≡ C).
11. The base pairs A = T and G ≡ C are known as complementary base pairs.
12. Due to the presence of complementary base pairing, the two chains of the DNA double helix are complementary to each other.
Hence the number of A' bases are equal to the number of T' bases (or 'G' is equal to 'C) in a given double stranded DNA.
13. One of the strands in the double helix is known as sense strand, i.e., which codes for RNA/proteins and the other strand is known as antisense strand.



Transfer RNA structure

Practical No: 11

Aim Study of Nucleic acids through Chart/ Photograph/ Model

Exercise 2

Object: Study the RNA structure

RNA is a polymer of ribonucleotides held together by 3′, 5′-phosphodiester bridges. Although RNA has certain similarities with DNA structure, they have several specific differences

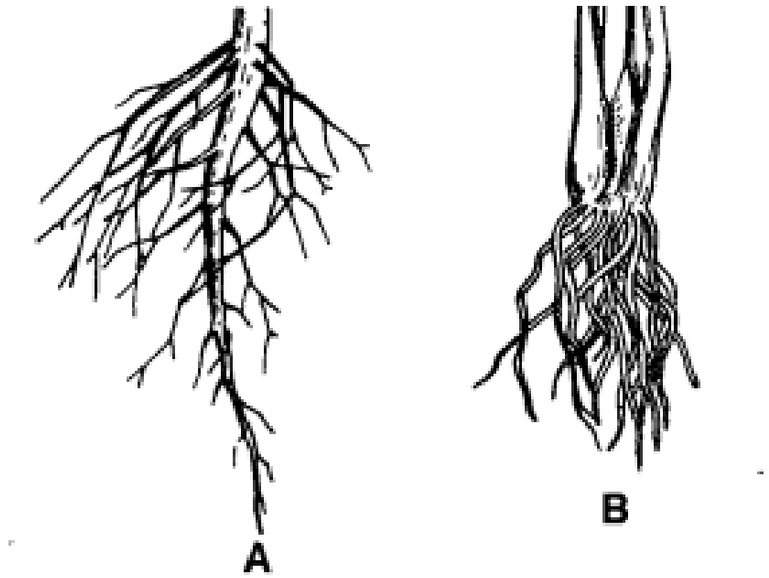
1. Pentose: The sugar in RNA is ribose in contrast to deoxyribose in DNA.
2. Pyrimidine: RNA contains the pyrimidine uracil in place of thymine (in DNA).
3. Single strand: RNA is usually a single-stranded polynucleotide. However, this strand may fold at certain places to give a double-stranded structure, if complementary base pairs are in close proximity.
4. Chargaff's rule—not obeyed: Due to the single-stranded nature, there is no specific relation between purine and pyrimidine contents. Thus the guanine content is not equal to cytosine (as is the case in DNA).
5. Susceptibility to alkali hydrolysis: Alkali can hydrolyse RNA to 2′, 3′-cyclic diesters. This is possible due to the presence of a hydroxyl group at 2′ position. DNA cannot be subjected to alkali hydrolysis due to lack of this group.
6. Orcinol colour reaction: RNAs can be histologically identified by orcinol colour reaction due to the presence of ribose.

Types of RNA:

The three major types of RNAs with their respective cellular composition are given below

1. Messenger RNA (mRNA): 5-10%
2. Transfer RNA (tRNA): 10-20%
3. Ribosomal RNA (rRNA): 50-80%

Besides the three RNAs referred above, other RNAs are also present in the cells. These include heterogeneous nuclear RNA (hnRNA), small nuclear RNA (snRNA), small nucleolar RNA (snoRNA) and small cytoplasmic RNA (scRNA). The major functions of these RNAs



Types of roots. A. Tap root, B. Adventitious root.

Practical No: 12

Aim : Study of Morphology as per theory.

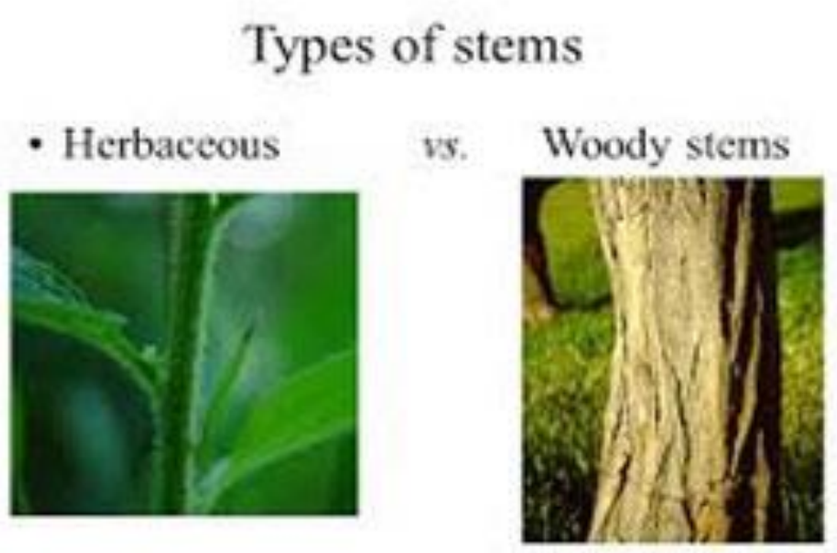
Exercise 1

Object : Root:- types

Root. A part of the plant axis that mostly grows towards the soil and is concerned with absorption of water and minerals.

1**. Tap Root .** A stout, tapering main root arising from the radicle and from which arise smaller lateral branches e.g., Neem, mango..

2. Adventitious Root: . Roots that grow from any part of the body other than the radicle; e.g., Sugarcane, Bryophyllum



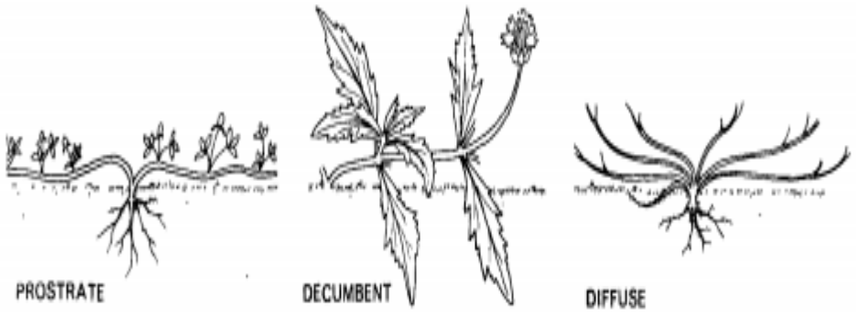
Exercise 2

Object: Stem: - Habit and Types

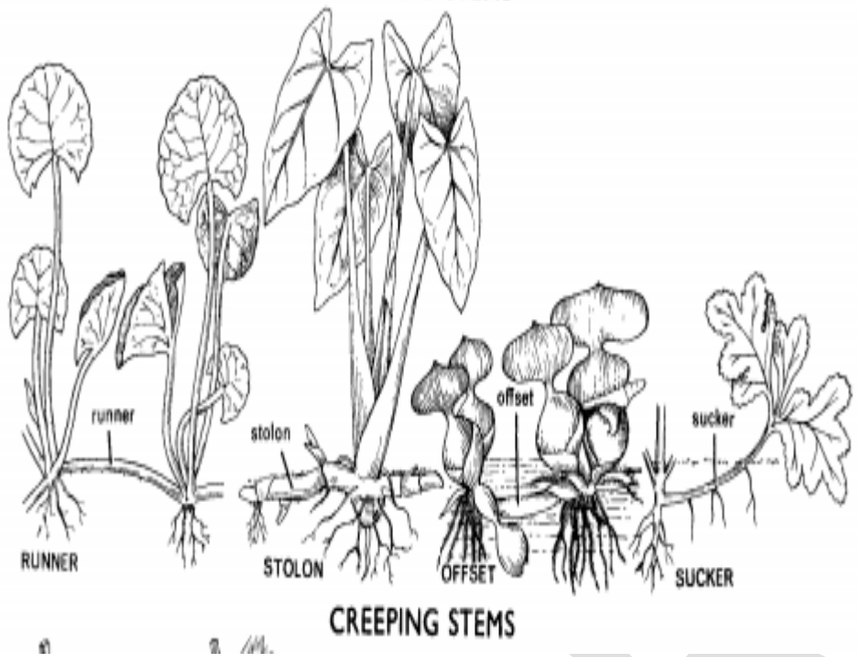
Stem. Main axis of the plant; leaf and flower bearing as distinguished from root bearing axis.

1. Herbaceous. A term referring to any non woody plant; e.g., Fumaria, Rananclius.

2. Woody. Trees and shrubs in which increase in diameter of stems and roots continues from year to year; e.g., Buhinia, Melia.



TRAILING STEMS



CREEPING STEMS

Exercise 3

Object : Types of Stem **(Aerial/ underground/Specialized)**

Aerial. Which remains above ground in air; e.g., Sesbailia, Abutilon, Ipomoea.

(a) Erect. A rigid and strong stem holding itself in an upright position; e.g., Sesbania.

These are of following 5 types. 1.caudex 2.culm 3. Scape 4. Excurrent 5. deliquescent

(b) Weak. A stem which is not strong enough to keep itself in an upright positon; e.g., Cuscuta. These are (i) trailing, (ii) creeping and (iii) climbing.

(i) Trailing. A weak stem spreading on the ground; without rooting at the nodes. It is of following 3 types.

(A) Prostrate (Procumbent). A trailing stem lying flat on the ground; e.g., Portulaca, Basel/a,

(B) Decumbent. Lying on the ground, but with the apex ascending e.g., Tridax, Lindenbergia,

(C) Diffuse. A trailing stem with many spreading branches; e.g., Coronopus, Boerhaavia, .

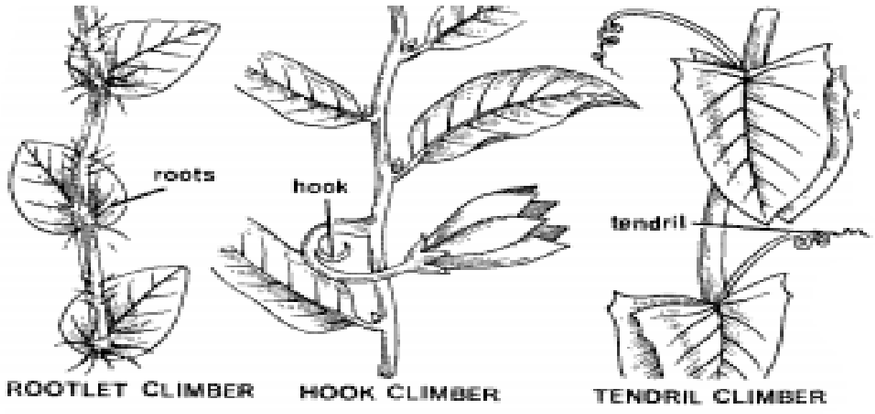
(ii) Creeping. A weak stem creeping on the ground, but rooting at the nodes. These are of 4 types.

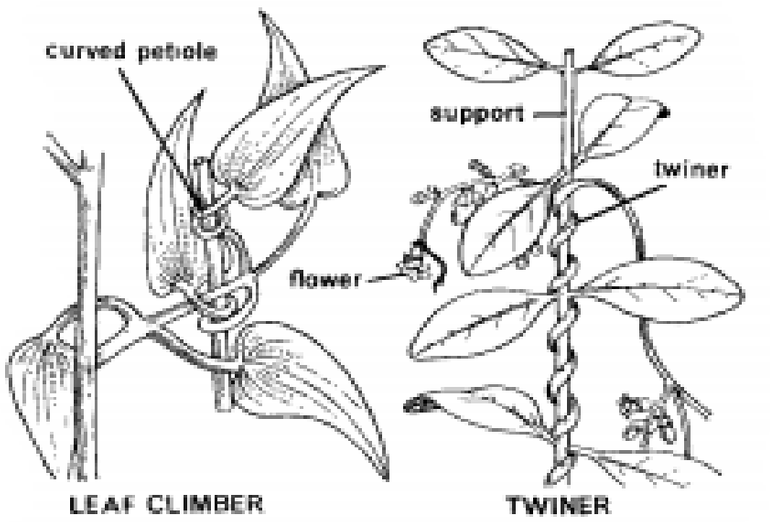
(A) Runner. A slender, elongated, prostrate, aerial branch with long internodes, creeping on the ground and rooting at the nodes, e.g. , Hydrocotyle asiatica, grasses

(B) Stolon. A slender, elongated, horizontal stem, at or below the surface of the ground that gives rise to a new plant at its tip; e.s., Dracaena, Colocasia, Tecoma grandifiora

(C) Offset. A horizontal, short, more or less thickened, prostrate branch, producing at the apex a tuft of leaves above and a cluster of small roots below; e.g., Pistia, Salvinia, Eichhomia,

(D) Sucker. A creeping stem developing from the underground part of the stem but growing obliquely upwards and directly giving rise to a leafy shoot or a new plant; e.g., Chrysanthemum, Mentha piperita (Peppermint)





(iii) Climbing. A weak stem attaching itself to any neighbouring object by some special struct~res and then climbing it. These are of following six types.

(A) Rootlet climber. A stem climbing by its roots given off from its nodes; e.g., Pothos, Ivy

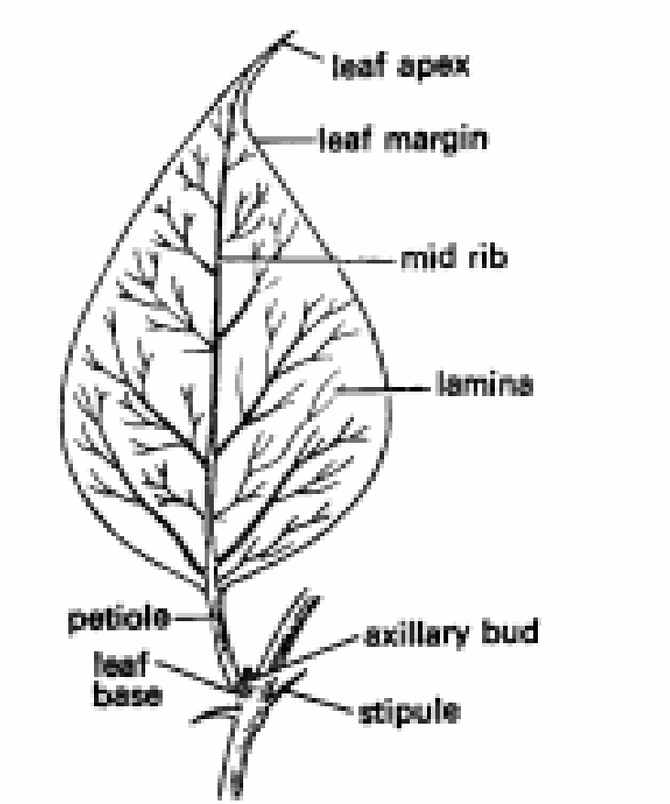
(B) Hook Climber. A weak stem climbing by the help of recurved thorns e.g., Bougainvillea, or hook; e.g., Artabotrys or prickles; e.g., climbing rose.

(C) Tendril climber. A weak stem climbing by its slender, leafless, spirally-coiled structures known as tendrils; e.g., Lathyrns, Passiflora, Cucurbita

(D) Leaf climber. A weak stem climbing by its petioles e.g., Clematis or leaf tips e.g., Gloriosa

(**E) Twiner.** A long, slender and branched stem, which climbs by twining its body round the support ; e.g., cuscuta Clitoria tematea

(F) Lianes. A long woody perennial twiner; e.g., Hiptage, Camel's foot climber.



Leaf and its parts.

Exercise 4

Object : Leaf and its parts

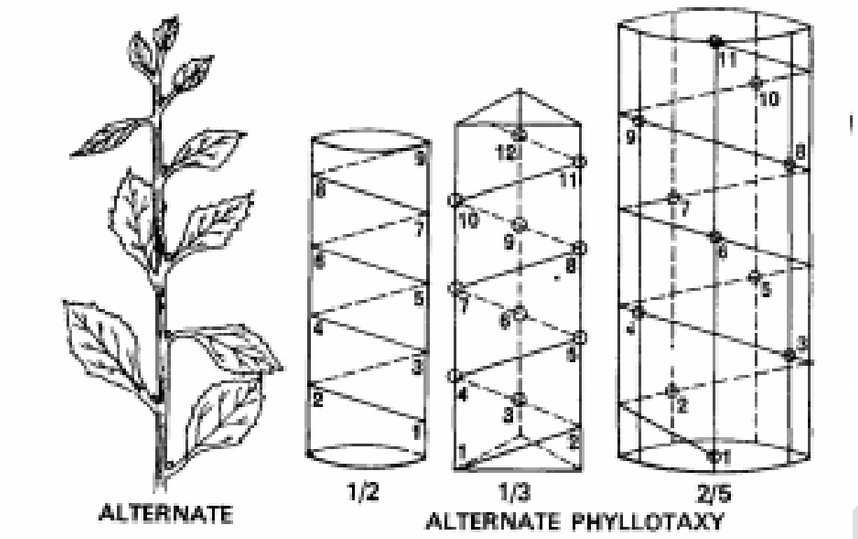
Leaf. An organ of limited growth arising laterally and from superficial tissues of the shoot apex and usually dorsi ventral

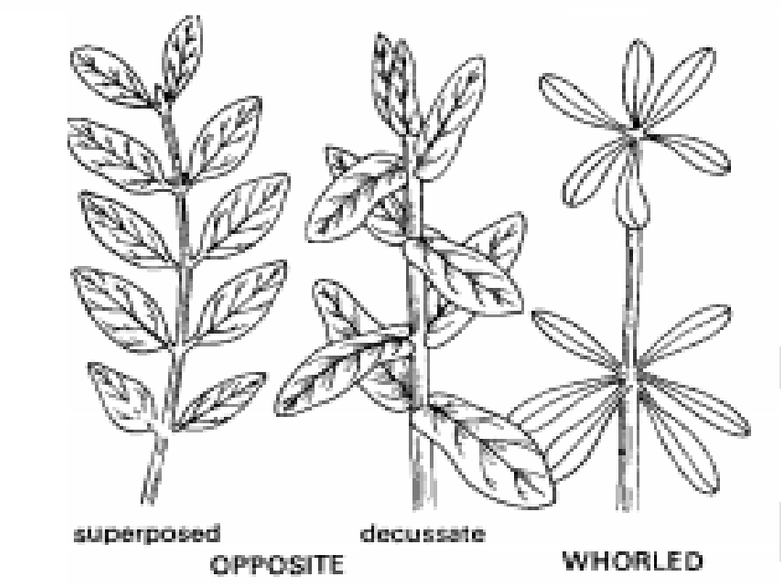
There are three parts in a typical leaf — leaf base, petiole and lamina.

leafbase. :- The leaf remains attached to the stem at node through the leafbase. Sometimes a pair of lateral outgrowths develops from the leaf base. They are small and leaf-like. These are called stipules. In plants like Maize, grasses and banana (monocots). the leafbase expands into a sheath which covers the nodal region. It is called sheathing leaf base. In some plants, leaf base becomes swollen and is called pulvinus which is responsible for sleep movement e.g., Cassia, mimosa, bean.

Petiole:-A stalk-like region connecting the leafbase and the lamina is called petiole. It supports the lamina andarranges it for securing proper light. If a petiole occurs, theleaf is called petiolate. If the petiole is absent, the leaf is called sessile. Generally the petiole is round and cylindrical.

Lamina is the main part of the leaf. It is broad, flat andgreen. Veins are distributed in it. There is a great variation in size, shape, margin incision, etc. of lamina. The arrangementof veins and veinlets in lamina is called venation.





Exercise 5

Object : Leaf:-, Phyllotaxy,

Phyllotaxy. Arrangement of leaves on stem.

1.Alternate or spiral. A single leaf arising at each node; e.g., Ipomoea.
It is of following types.

(a) 1/2 or two-ranked. Third leaf stands over the first and there is one spiral between the two leaves; e.g., Gramineae, Ginger, Ravenala

(b) 1/3 or three-ranked. Fourth leaf stands over the first and ther~ is one spiral between the two leaves; e.g. Cyperns rotundus .

(c) 2/5 or five-ranked. Sixth leaf stands over the first and there are two spirals between the two leaves; e.g. China rose. This is the most common type of alternate phyllotaxy

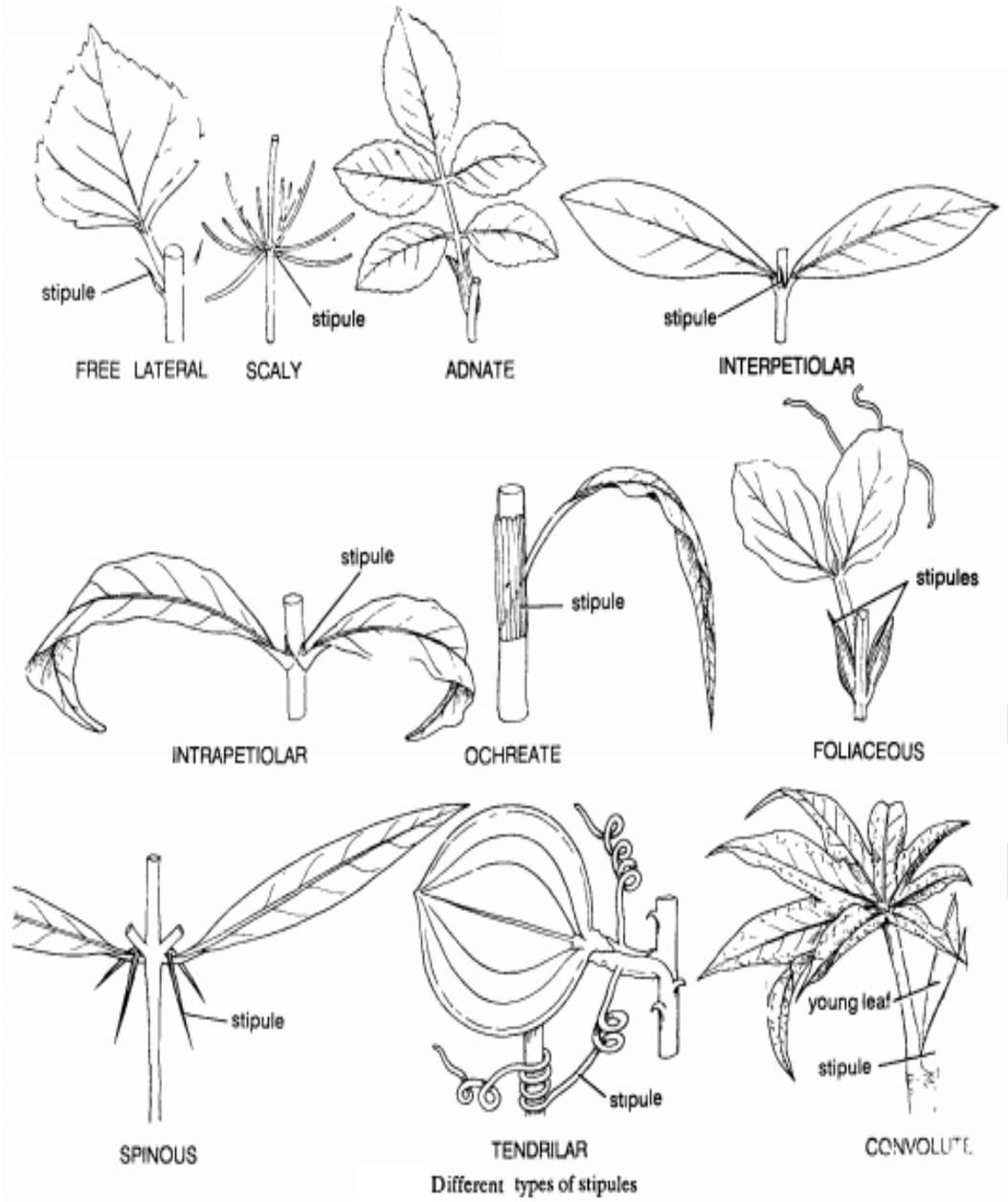
(d) 3/8 or eight-ranked. Ninth leaf stands over the first and there are three spirals between the two leaves; e.g., Papaya.

2. Opposite. Term applied to leaves or buds occurring in pairs at a node; e.g., Ixora.

(a) Decussate. A pair of leaves that stands at right angle to the next upper or lower pair; e.g., Caiotropis, Mussaenda, Tabemaemontana

(b) Superposed. A pair of leaves that stands directly over a pair in the same plane; e.g., Guava, Quisquaiis, Carissa

3. Whorled. More than two leaves at each node arranged in a circle or whorl; e.g., Alstonia .



Different types of stipules

Exercise 6

Object : Leaf:- Stipules

Stipule. An appendage on both the sides of basal part of a leaf.

Stipel. Stipule-like appendage at the base of leaflets of a compound leaf.

1. Extipulate. Stipules absent, e.g., Ipomoea.

2. Stipulate. Stipules present, e.g., Rose.

(a) Free-lateral : Two fee stipules borne on the two sides of leaf base; e.g., China rose .

(**b) Scaly.** Small dry scales, usually two in number, borne on two sides of the leaf base; e.g., Spergula, Desmodium .

(c) Adnate. Two lateral stipules that grow adhering to the petiole up to a certain height thus making it somewhat winged; e.g., Rose .

(**d) Interpetiolar.** Two stipules lying between the petioles of opposite or whorled leaves; e.g., /xora, Mussaenda .

(e) Intrapetiolar. Stipules situated between the petiole and the axis; e.g., Tabemaemontana .

(f) Ochreate. Stipules that form a hollow tube encircling the stem from the node up to a certain height of internode in front of the petiole; e.g. Polygonum .

(g) Foliaceous. Two large green leafy structures; e.g., Lathyrus, Pisum .

(h) Spinous. Stipules modified into spines, one on each side ofthe leaf base; e.g., Zizyphus, Acacia

(i) Tendrillar. Stipules modified into tendriles, one on each side of the petiole; e. g., Smilax

(j) Convolute (Ventral). Stipules occurring on ventral side of the petiole. The margins after meeting serve as bud scales; e.g., Fucus, Magnolia, Ricinus

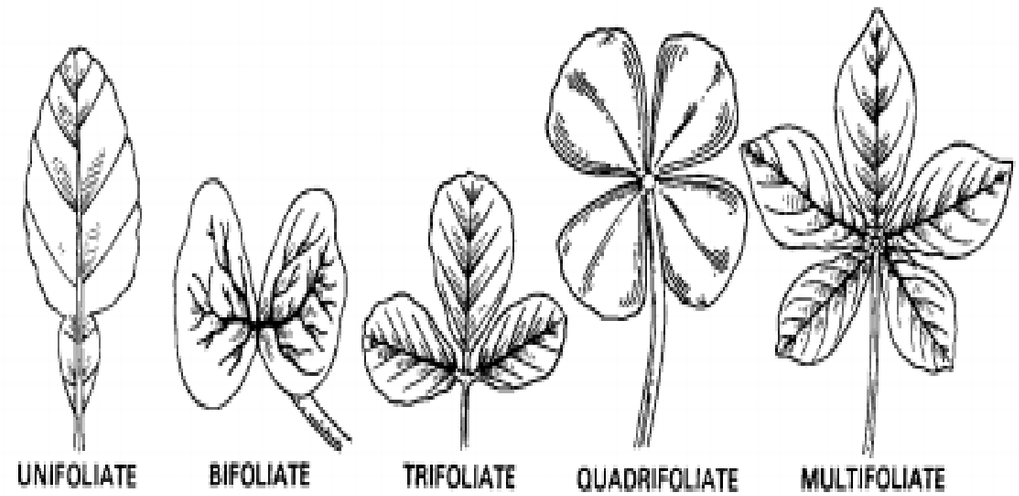
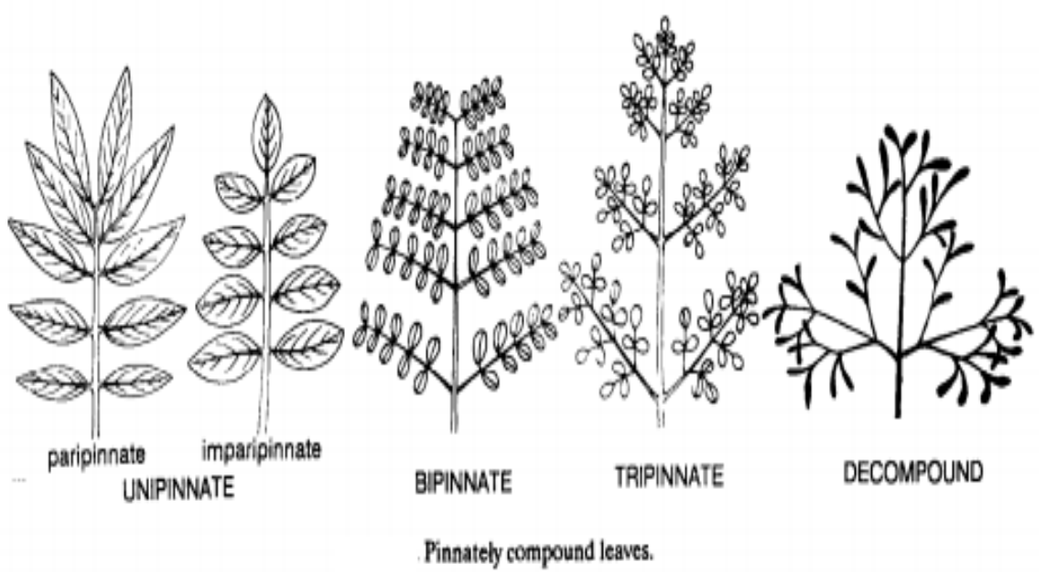


Fig. 12. Palmately compound leaves.



Pinnately compound leaves.

Exercise 7

Object : Leaf:- types of leaves

1. Simple. A leaf which may be entire or incised to any depth, but not down to the midrib or petiole; e.g., Mango

2. Compound. A leaf in which the leaf blade is incised up to the midrib or petiole, thus dividing it into two or more segments, called leaflets; e.g., Sweet pea, Gold mohur.

(a) Palmately Compound. A compound leaf with the leaflets attached at the tip of the petiole and thus seem to be radiating from a common point, like fingers from the palm; e.g., Cleome gynandra

These are of five type.

(i) Ullifoliate. A single leaflet is articulated to the petiole; e.g., Citrus

(ii) Bifoliate. Two leaflets are articulated to the petiole; e.g., Hardwickia binnata, Prinsepia

(iii) Trifoliate. Three leaflets are articulated to the petiole; e.g., Medicago, Aegle, Oxalis

(iv) Quadrifoliate. Four leaflets are articulated to the petiole; e.g., Paris quadrifoUa, Marsilea

(v) MultifoUate (Digitate). Five or more leaflets are articulated to the petiole and spreading like fmgers from the palm; e.g., Cleome (= Gynandropsis), .

(b) Pinnately Compound. A compound leaf with the leaflets arranged along {he sides of common axis, the rachis; e.g., Tamarind

(i) Unipinnate. A pinnately compound leaf bearing the leaflets directly on the rachis; e.g., Cassia

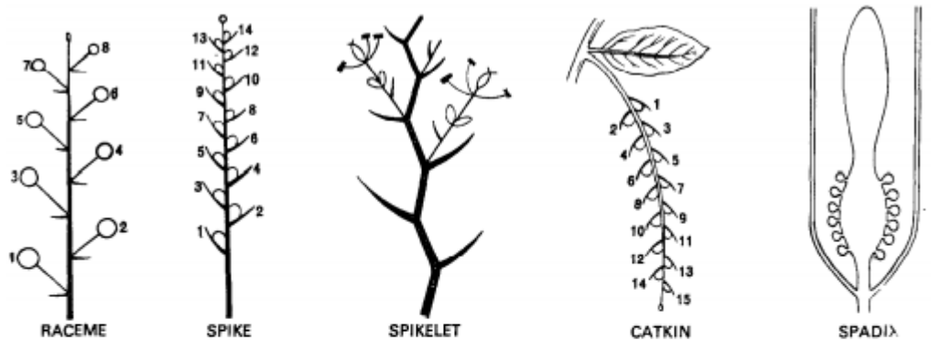
(A) Pari pinnate. A unipinnate leaf with even number of leaflets e.g., Tamarind, Cassia sp.

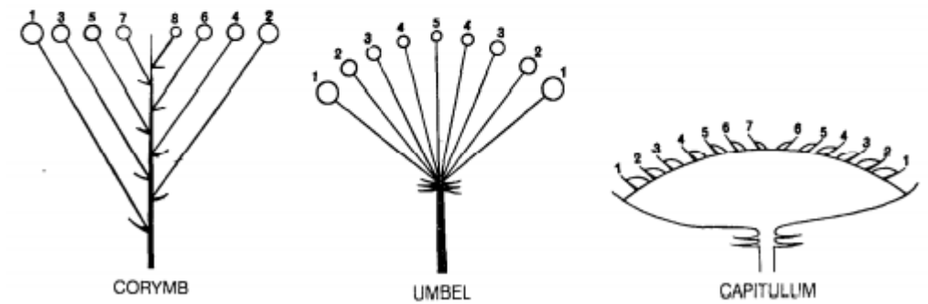
(B) Imparipinnate. A unipinnate leaf with odd number of leaflets, e.g., Rose, Melia .

(ii) Bipinnate. A twice pinnate compound leaf i.e. , the midrib produces secondary axes on which the leaflets are borne; e.g., Acacia, Mimosa plldica

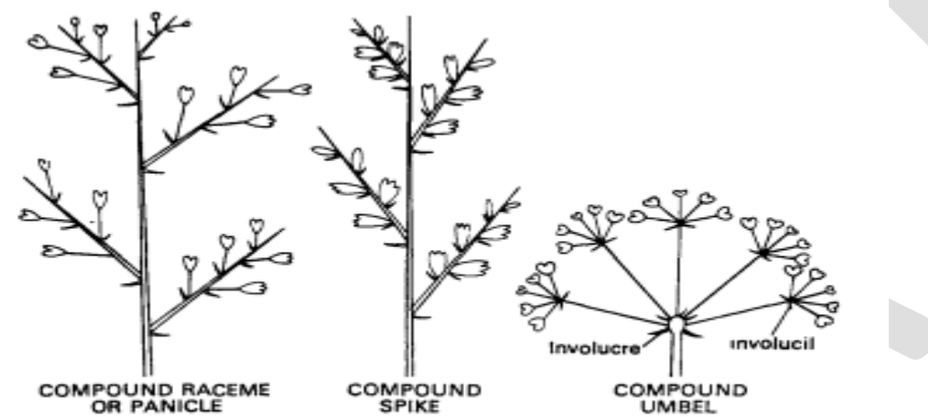
(iii) Tripinnate. A thrice pinnate compound leaf i.e., the secondary axes produce the tertiary axes which bear the leaflets; e.g., Moringa .

(iv) Decompound. A compound leaf which is more than thrice pinnate; e.g., Coriandrnm .





Types of racemose inflorescences.



Compound racemose inflorescences.

Exercise 8

Object : Inflorescence: - Racemose,

Inflorescence. A cluster of flowers or arrangement of flowers on floral axis.

1. Racemose. An inflorescence where the main axis does not terminate in a flower, but it continues to grow and gives off flowers laterally in acropetal succession.

(a) Raceme. A simple, elongated, indeterminate inflorescence with stalked flowers, e.g., Radish, Mustard, Crotalaria, Delphinium, etc.

(b) Panicle. When axis of raceme is branched, it is called a panicle; e.g., Gold Mohur

(c) Spike. Usually unbranched, elongated, simple, indeterminate inflorescence whose flowers are sessile; e.g., Adhatoda, Piper longllm

(d) Compound spike. Axis is branched and the flowers are arranged in a spike-like manner on the branches; e.g., Amaranthus,

(e) Strobile. Type of spike in which each flower is borne in the axil of a persistent membranous bract; e.g., Humulus lupullIS.

(f) Spikelet. The unit of the compound inflorescence of the grasses; composed of a cluster of one or more flowers and their associated bracts; e.g., Grasses

(g) Catkin. A pendant spike of unisexual flowers found only in woody plants; e.g., Moms, Salix,.

(**h) Spadix**. A thick or fleshy spike subtended or surrounded by a spathe; e.g., Maize or Corn

(i) Corymb. Indeterminate inflorescence with shortened main axis, in which the lower flowers have much longer pedicels than the upper so that flowers are brought more or less to the same level e.g., Candytuft.

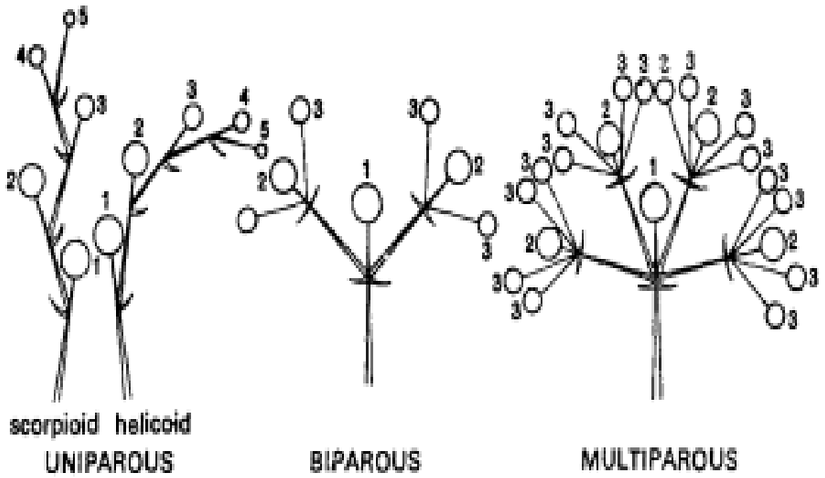
(j) Compound corymb. A branched corymb; e.g., Pyms !onninalis.

(k) Umbel. An inflorescence in which the flower stalks of more or less equal length, arise from the same point, like the ribs of an umbrella at the base of flower stalks, there is whorl of bracts forming an involucre; e.g., Hydrocotyle asiatica .

(I) Compound umbel. An umbel with branched axis and the branches bearing the flowers. These are known as umbellules; e.g., Coriander.

(m) Capitate. When a large number of sessile flowers arise from a suppressed axis forming a globose structure as in Acacia, Mimosa. It differs from capitulum in the absence of a receptacle.

(n) Capitulum. A dense inflorescence comprising an aggregation of usually sessile flowers arranged on a c'onvex receptacle formed by the axis, and having one or more whorls of bracts forming involucre; e.g., Compositae family



Types of cymose inflorescences.

Exercise 9

Object : Inflorescence: - Cymose

2. Cymose. An inflorescence where the growth of the main axis is soon checked by the development of a flower its apex, and the lateral axix which develops below the terminal flower also ends in a Rower, thus its growth is also checked

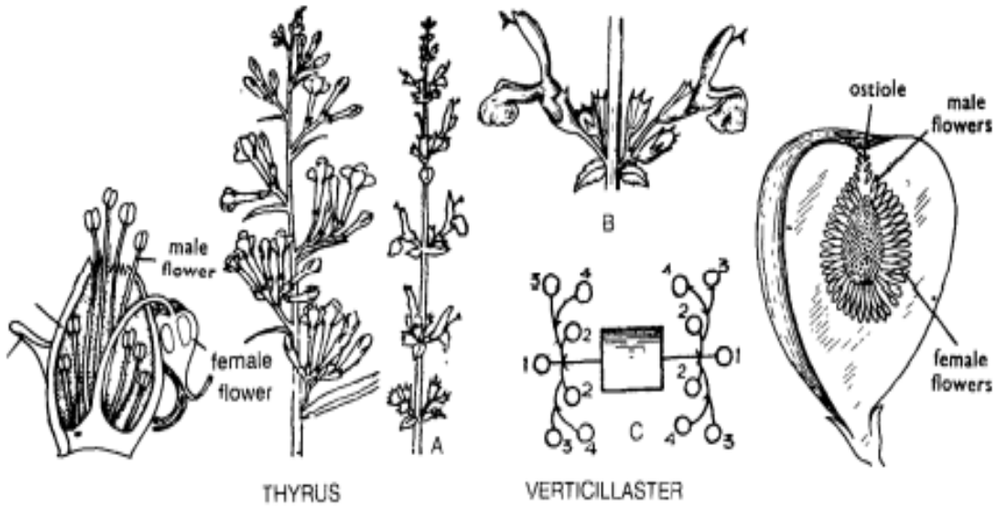
(a) Uniparous. (Monochasial). The main axis ending in a flower producing only one lateral branch at a time ending in a flower

(i) Scorpioid. Uniparous cyme in which the lateral branches develop on alternate sides evidently forming a zigzag; e.g., Rananculus bulbosus

(ii) Helicoid. Uniparous cyme in which the lateral branches develop successively on the same side, evidently forming a sort of helix; e.g., Juncus, Begonia, Heliotropium.

(b) Biparous (Dichasial). A determinate inflorescence in which the main axis ends in a flower after producing two daughter axes of flowers; e.g., Ixora, Saponaria, Mussaenda,

(c) Multiparous (Polychasial). A determinate inflorescence in which the main axis ends in a flower after producing a numbet: of daughter. axes or flowers around. This inflorescence looks like an umbel but can be distinguished from umbel by the opening of the middle flower first; e.g., Calotropis.



Special types of ipflorescences.

Exercise 10

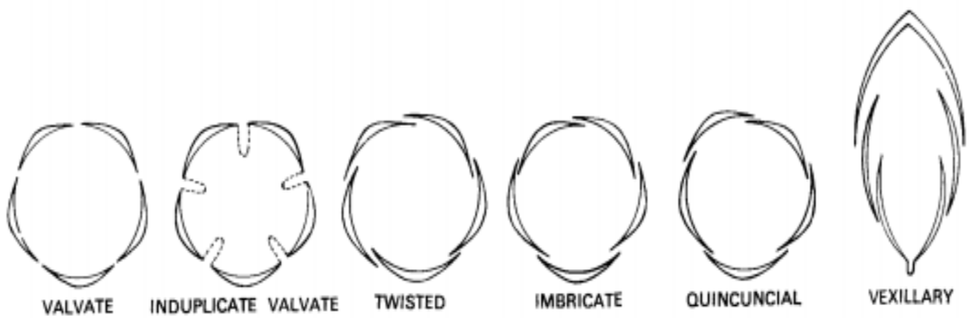
3. Inflorescence**: Special types**

(a) Cyathium. A type of inflorescence characteristic of Euphorbia, in which a cup-shaped involucre, often provided with nectary, encloses a single female flower (reduced to pistil) in the centre and a number of male flowers (each reduced to a solitary stamen) around it .

(b) Thyrsus. A panicle-like cluster with main axis indeterminate and the lateral axes determinate; e.g., Lilacs, .

(c) Verticillaster. It consists of a series of nodes. At each node there is a condensed dichasial cyme with a cluster of almost sessile flowers arranged opposite one another in the axils of opposite bracts or leaves; e.g., Ocimum .

(d) Hypanthodium. The fleshy receptacle forms a cup like cavity with an apical opening (ostiole) guarded by scales and bearing flowers on the inner wall of the cavity; e.g., Fig' Peepal, .



Types of aestivation.

Exercise 11

Object : study types of Aestivation.

Aestivation. The arrangement of petals in a flower bud

1. Valvate. Petals meeting by the edges without overlapping; e.g., Solanum.

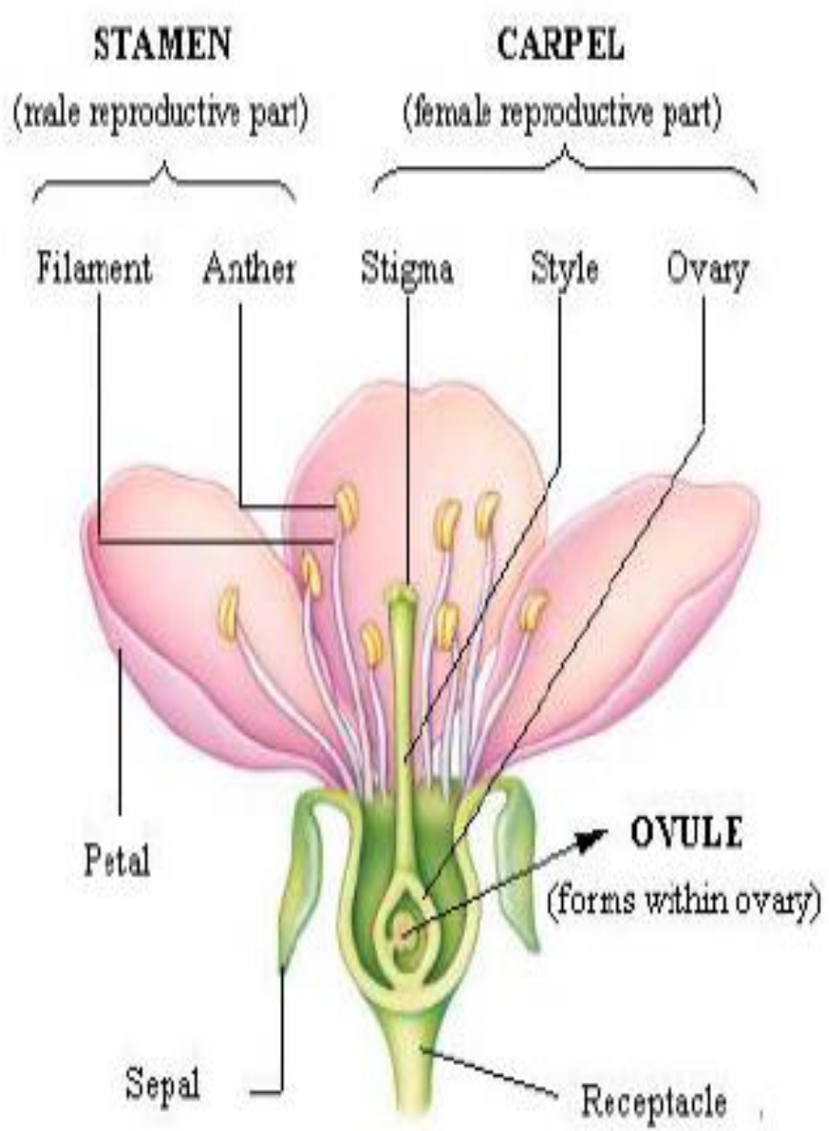
2. Induplicate valvate. A form of valvate in which the margins of the petals are folded inwards on themselves; e.g., Ipomoea

3. Twisted (Contorted). One margin of the petal overlaps that of the next one, and the other margin is overlapped by the third one; e.g., China rose

4. Imbricate. Out of the five petals one is internal, one external and the other three partly internal, partly external; e.g., Callistemon

5**. Quincuncial.** A form of imbricate where there are five petals, two internal, two external, and one partly internal, partly external; e.g., Melia, Murraya

6. Vexillary. Out of the five petals the posterior one is the largest and covers the two lateral petals and the latter in their turn overlap the two anterior and smallest petals; characteristic of papilionaceae



Exercise 12

Aim Study of Morphology of Flower

Flower: reproductive organ of flowering plants (angiosperms)

A modified, determinate shoot bearing sporophylls (stamens and/or carpels), with or without outer modified leaves (the perianth)

1. Bract. A modified, usually reduced leaf-like structure at the base of the flower.

(a) Involucral bracts. Bracts present at the base of an umbel

(b) Involucels. Bracts present at the base of umbellule (secondary umbel).

2. Bracteole. Bracts occurring on secondary axis i.e. pedicel of flower.

3.Calyx. The outer or ftrst whorl of flower, consisting of sepals.

Sepal. One of the separate parts of a calyx, usually green and foliaceous.

4.Corolla. Second whorl of flower made of petals.

Petal. One of the separate parts of corolla usually coloured and more or less showy.

5.Perianth. Sometimes calyx and corolla are not distinguishable from one another and the outer whorl is thus called perianth.

Tepal. One of the separate parts of perianth .

6. Androecium. The third or male whorl of flower; made of stamens.

Stamen. An individual part of an androecium that produces pollen grains, usually composed of anther, connective and filament.

7.Gynoecium. The fourth or female whorl composed of one or more carpels. Pistillode. A sterile Gynoecium or pistil.

Carpels. A leaf-like organ bearing ovules along the margins, the unit structure of a compound pistil.

OUTLINES OF THE SYSTEM OF CLASSIFICATION PROPOSED BY BENTHAM & HOOKER *

SEED PLANTS OR PHANEROGAMS

Class I DICOTYLEDONAE

Sub-class 1. Polypetalae

Series I
Thalamiflorae
Order 1.
Ranales
Families
Ranunculaceae
Magnoliaceae
Anonaceae
(5 other families)
Order 2.
Parietales
Families
Papaveraceae
Cruciferae
Capparidaceae
(6 other families)
Order 3.
Polygalineae
(4 families)
Order 4.
Caryophyllineae
Family
Caryophyllaceae
(3 other families)
Order 5.
Guttiferales
(6 families)
Order 6.
Malvales
Families
Malvaceae
Tiliaceae
(1 more family)

Series II
Disciflorae
Order 1.
Geraniales
Families
Rutaceae
Meliaceae
(9 other families)
Order 2.
Olacales
(3 families)
Order 3.
Celastrales
(4 familes)
Order 4.
Sapindales
(5 families)

Series III
Calyciflorae
Order 1.
Rosales
Families
Leguminosae
Rosaceae
(7 other families)
Order 2.
Myrtales
Family
Myrtaceae
(5 other families)
Order 3.
Passiflorales
Family
Cucurbitaceae
(6 other families)
Order 4.
Ficoidales
(2 families)
Order 5.
Umbellales
Family
Umbelliferae
(2 other families)

Sub-class 2. Gamopetalae

Series I
Inferae
Order 1.
Rubiales
Family
Rubiaceae
(1 more familiy)
Order 2.
Asterales
Family
Compositae
(3 other families)
Order 3.
Campanales
(3 families)

Series II
Heteromerae
Order 1.
Ericales
(6 families)
Order 2.
Primulales
(3 families)
Order 3
Ebenales
(3 families)

Series III
Bicarpellatae
Order 1.
Gentianales
Families
Apocynaceae
Asclepiadaceae
(4 other families)
Order 2.
Polemoniales
Families
Convolvulaceae
Solanaceae
(3 other families)
Order 3.
Personales
Families
Scrophulariaceae
Acanthaceae
(6 other families)
Order 4.
Lamiales
Families
Verbenaceae
Labiatae
(3 other families)

Sub-class 3. Monochlamydeae

Series 1.
Curvembryeae
Family
Amaranthaceae
Chenopodiaceae
Polygonaceae
(4 other families)
Series 2.
Multiovulatae aquaticae
(1 family)
Series 3.
Multiovulatae terrestres
(3 families)
Series 4.
Microembryeae
(4 families)
Series 5.
Daphnales
(5 families)
Series 6.
Achlamydosporeae
(3 families)
Series 7.
Unisexuales
Families
Euphlorbiaceae
Urticaceae
(7 other families)
Series 8.
Ordines anomali
(4 families)

Class II GYMNOSPERMAE

Class III MONOCOTYLEDONAE

Series 1
Microspermae
(3 families)
Family
Orchidaceae
Series 2.
Epigynae
Family
Scitamineae
(6 other families)
Series 3.
Coronarieae
Family
Liliaceae
(7 other families)
Series 4
Calycineae
Family
Palmae
(2 other families)
Series 5.
Nudiflorae
(5 families)
Series 6.
Apocarpae
(3 families)
Series 7.
Glumaceae
Families
Cyperaceae
Gramineae
(4 other families)

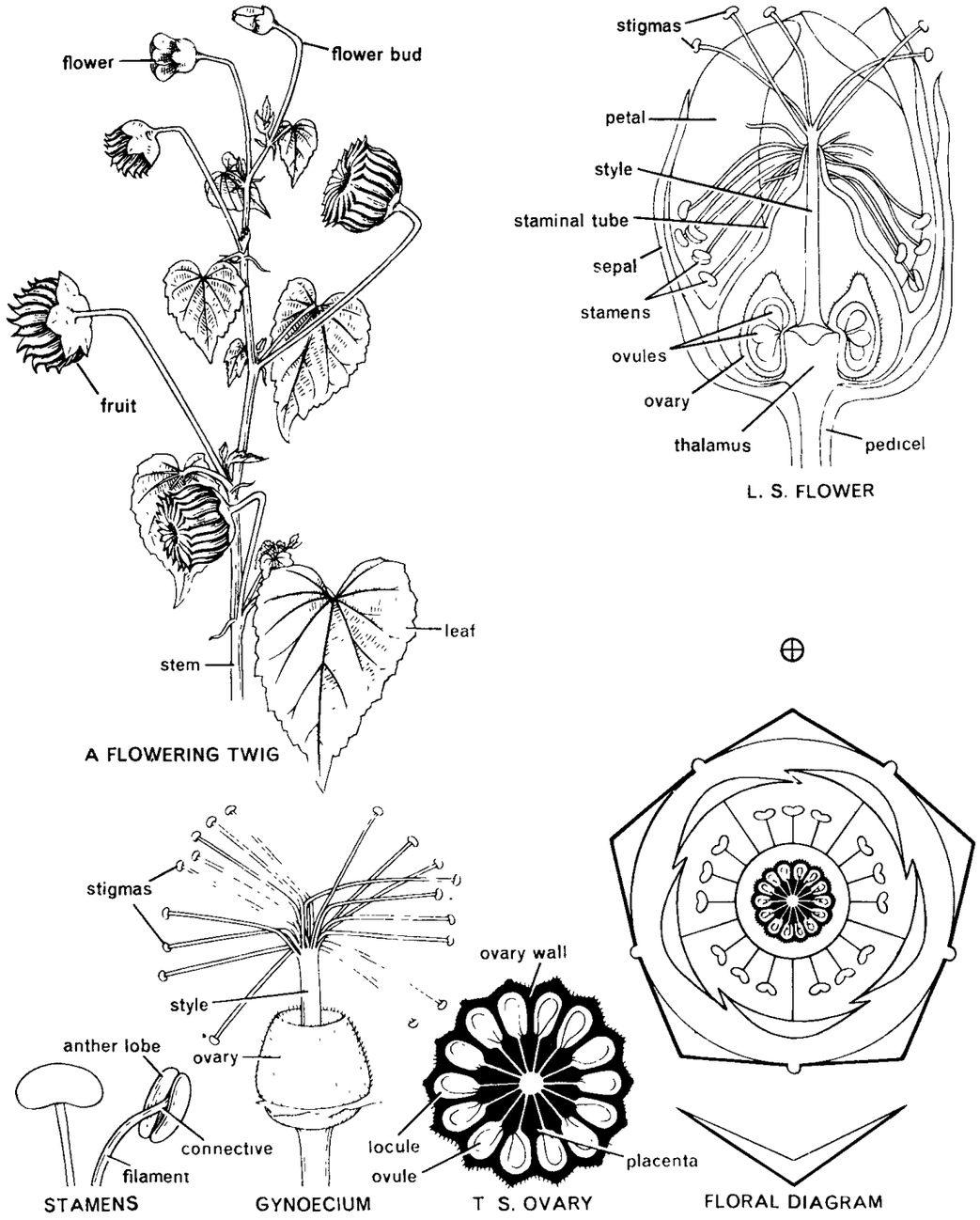


Fig. 19. ***Abutilon indicum.***

Practical No: 13

Object : Study of angiosperm families: Malvaceae,

Plant : Abutilon indicum (Linn.) Sweet.

Stem. Herbaceous, aerial, erect, cylindrical, branched, solid, pubescent and green.

Leaf. Cauline and ramal, alternate, stipulate, simple, petiolate, deltoid, serrate, acute, slightly hairy and rugose above, velvety, multicostate, reticulate, divergent type.

Inflorescence. Solitary axillary.

Flower. Bracteate, pedicellate, complete, actinomorphic, hermaphrodite, pentamerous, hypogynous and cyclic.

Calyx. Sepals 5, gamosepalous, free at the tips, valvate, persistent, green.

Corolla. Petals 5, polypetalous, slightly connate at the base and adnate to staminal tube, twisted.

Androecium. Stamens indefinite, monadelphous forming a tube around the style, the tube being united with the petals (epipetalous). In the upper part of the staminal tube are borne monothecous and extrorse anthers.

Gynoecium. Multicarpellary, syncarpous, ovary superior, multilocular, with one ovule in each locule, placentation axile, style long and stigmas as many as carpels.

Fruit. Capsule. ---.

Floral formula.

$$\mathrm{Br},\ \oplus,\ \mathrm{♀},\ \mathrm{K}_{(5)},\ \overbrace{\mathrm{C}_{5}},\ \mathrm{A}_{(\infty)},\ \underline{\mathrm{G}}_{(5-\infty)}.$$

Object : Study of angiosperm families: Malvaceae,

Classification and identification.

Class. Dicotyledonae

1. Venation reticulate.
2. Flowers pentamerous.

Sub-Class. Polypetalae

1. Petals free.

Series. Thalamiflorae

1. Flowers hypogynous and ovary superior.

Order. Malvales

1. Stamens usually indefinite and monadelphous.
2. Ovary 3 to multicarpellary with axile placentation.

Family. Malvaceae

1. Leaves stipulate.
2. Calyx often With an epicalyx.
3. Stamens monothecous and anthers reniform.
4. Fruit - capsule or schizocarp

Common plants of the family

1. *Althaea rosea* (L.) Cav (Holly-hock Gul khair, Khaini.)
2. *Abutilon indicum* (L.) Sweet, Hort. (Dabli, Kanksi, Asud, Khapat, Khapto)
3. *Hibiscus rosa-sinensis* –(jashud.)
4. *Gossypium* sp.– Cultivated for cotton.
5. *Sida cordifolia* L. (Bala, Baladana, Kharenti)
6. *Malva parviflora* L. (Pranirak,Supra)
7. *Abelmoschus esculentus* (L.) (Moench. Bhinda, Bhindi)
8. *Pavonia odorata* Willd. (Kalavala, Sugandhbala)
9. *Thespesia populnea* (L.) Soland. ex. Corr. (Paras piplo, Pardeshi bhindi)
10. *Hibiscus sabdariffa* L. (Khati Bhindi, Lal Ambadi)

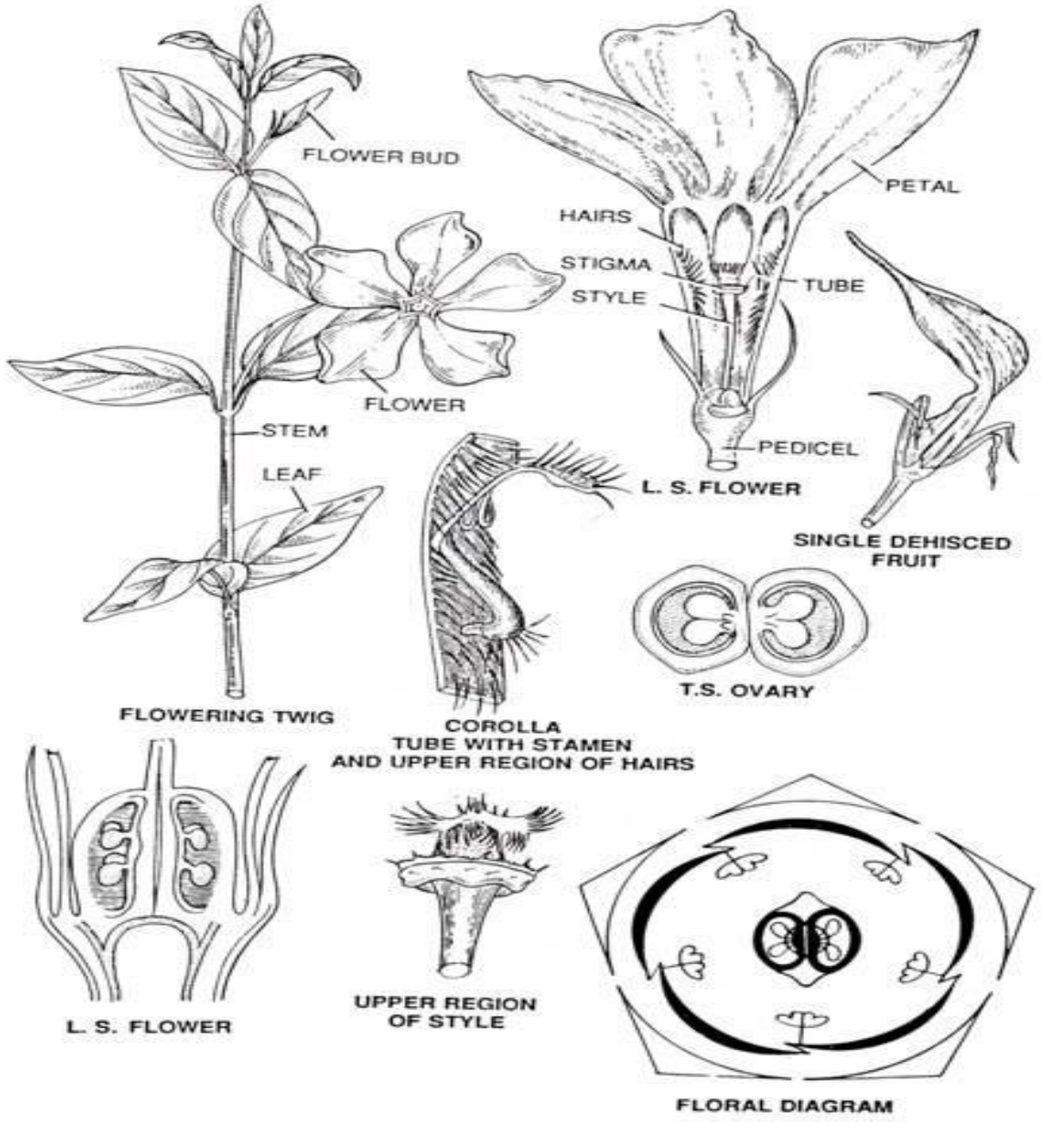


Fig. 19.1. Apocynaceae. *Lochnera rosea;* Syn. *Vinca rosea* Linn.

Practical No: 13

Object : Study of angiosperm families: Apocynaceae,

Plant: ***Catharanthus roseus* (L.) G.Don (= *Vinca rosea* Linn.)**

Stem. Herbaceous, aerial, erect, angular, branched, solid, puberulous, purple-red, milky latex present.

Leaf. Cauline and ramal, opposite decussate, stipulate interpetiolar, simple, elliptic-obovate, entire, mucrollate, puberulous, unicostate reticulate, latex present.

Inflorescence. Axillary dichasial cyme or solitary axillary.

Flower. Ebracteate, pedicellate, complete, actinomorphic, hermaphrodite, pentamerous, hypogynous and cyclic.

Calyx. Sepals 5, polysepalous, valvate, persistent.

Corolla. Petals 5, gamopetalous, twisted, corolla hypocrateriform, purple.

Androecium. Stamens 5, polyandrous, inserted at the mouth of the corolla tube, epipetalous, dithecous, dorsifrxed , introrse.

Gynoecium. Bicarpellary, syncarpous, ovaries are free and superior, placentation marginal, style long, stigma drum- shaped and sticky. Two ligulate hypogynous nectaries are present one on the anterior side and the other on the posterior side of the ovary.

Fruit. Etaerio of follicles.

Flora formula:

$$\text{Ebr},\ \oplus,\ \varphi^{\delta},\ K_5,\ \overbrace{C_{(5)}},\ A_5,\ \underline{G}_{(2)}.$$

Practical No: 13

Object : Study of angiosperm families: Apocynaceae,

Classification and identification.

Class. Dicotyledonae

1. Venation reticulate.
2. Flowers pentamerous.

Sub-Class. Gamopetalae

1. Petals fused.

Series. Bicarpellatae

1. Carpels two
2. Ovary usually superior.

Order. Gentianales

1. Leaves opposite.
2. Flowers actinomorphic.
3. Stamens epipetalous.

Family. Acocynaceae

1. Inflorescence cymose.
2. Stamens not gynandrous.
3. Ovules one or two in each locule.
4. Ovaries two, free, but united by the style.
5. Latex present.

Common plants of the family

1. *Nerium indicum* (syn. N. odorum, Kaner):
2. *Carissa carandus* (Karaunda):
3. *Catharanthus roseus* (Sada Bahar):
4. *Rauwolfia serpentina* (Sarpgandha, Chotachand):
5. *Thevetia peruviana: (* Pili karen)
6. *Plumeria alba* L. *(* Khad Champo)
7. *Wrightia tinctoria* R. Br. (Runchalo Dudhlo, Mitho dudhalo)
8. *Baissea multiflora.*
9. *Allamanda cathartica* L. var. **hendersonii** Bailey
10. *Alstonia scholaris* (L.) R. Br. (Saptaparni)

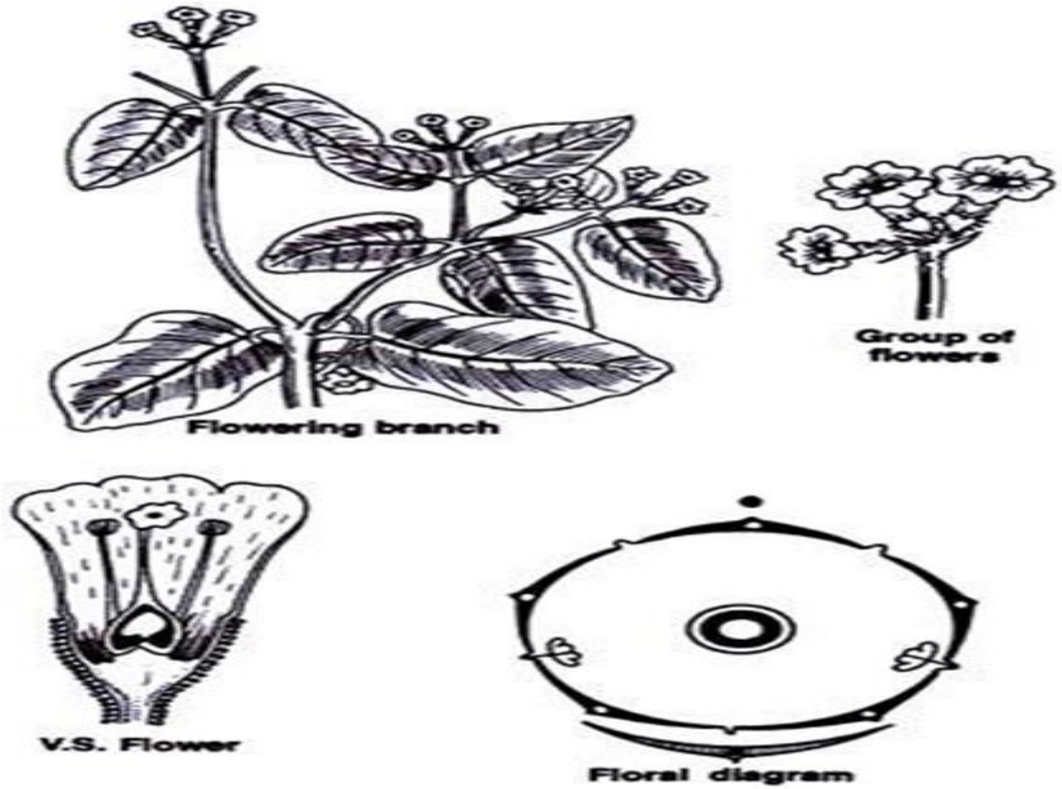


Fig. 89.2. *Boerhaavia diffusa* (Nyctaginaceae)

Practical No: 13

Object : Study of angiosperm families Nyctaginaceae

Plant : . *Boerhaavia diffusa*

Habit – Annual herb. Root – Fusiform.

Stem – A glabrous, prostrate or ascending and diffusely branched.

Leaf: Simple, opposite, unequal, exstipulate, petiolate, ovate with rounded or cordate base, margin entire, apex obtuse, dorsal surface green, lower surface usually silvery white.

Inflorescence: Umbellate clusters.

Flower: Small, bracteate, subsessile, actinomorphic, hermaphrodite, hypogynous.

Perianth: Tepals 5, gamophyllous, pink.

Androecium: Stamens 1-3 slightly exserted, filaments of unequal length.

Gynoecium: Monocarpellary, unilocular superior, simple basal ovule, style simple.

Floral formula: $\mathbf{Br \oplus \varnothing P_{(5)} A_{1-3} G_{\underline{1}}}$

Practical No: 13

Object : Study of angiosperm families: Nyctaginaceae

Classification and identification.

Division: Phanerogams

Class: Dicotyledons

1. Venation reticulate.
2. Flowers pentamerous.

Sub-class: Monachlamydeae (Apetalae)

1. Flowers usually with one whorl of perianth, commonly sepaloid or none.

Series: Curvembryeae

1. Embryo curved.

Family: Nyctaginaceae

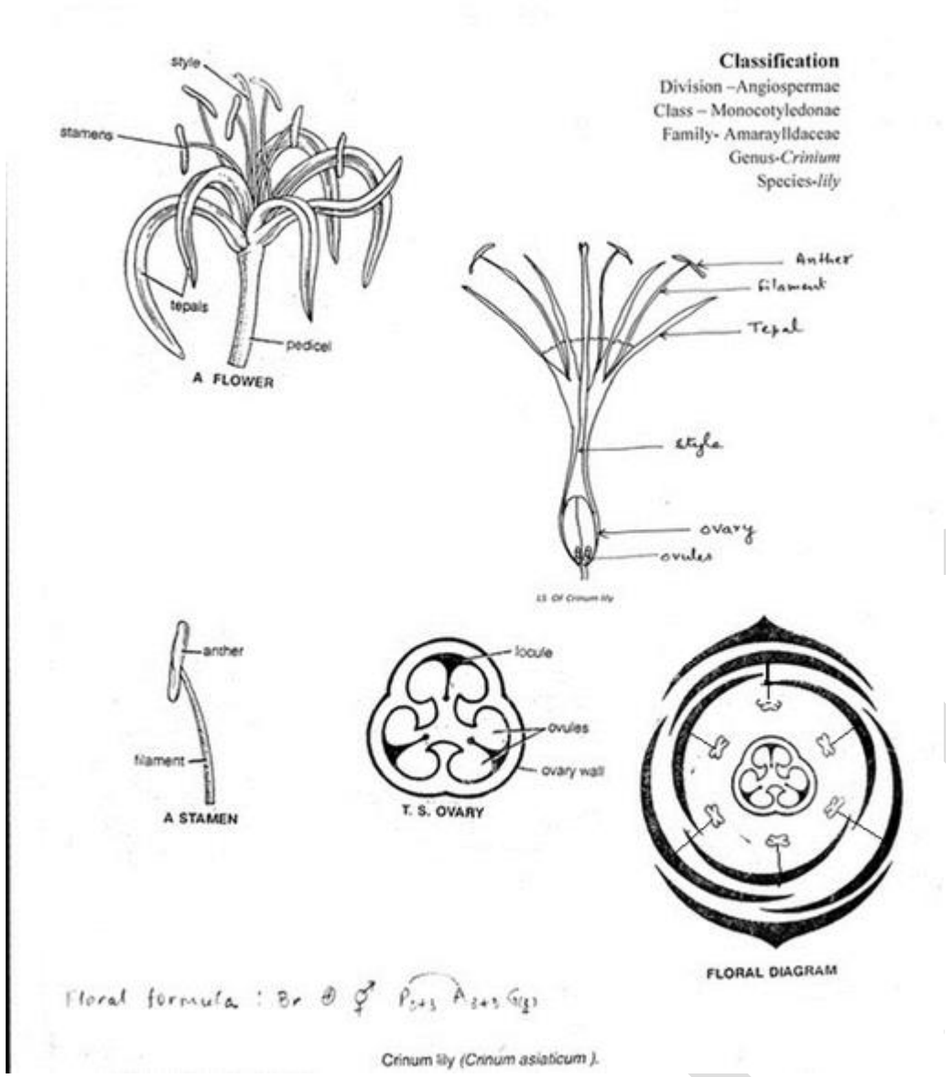
1. Flowers open in late afternoon;
2. flowers mostly hermaphrodite rarely diclinous, actinomorphic,
3. usually subtended by an involucre of separate or united brightly coloured bracts or sepaloid bracts that are often mistaken for sepals;
4. petaloid perianth, tepals 5;
5. stamens 1- ∝;
6. carpel one.

Genus:

Species:

Common plants of the family

1. *Mirabilis jalapa* – Four O'clock plant ,Gule-bas
2. *Boerhaavia diffusa* – ***Common weed after rainy season, medicinal.***
3. *Bougainvillea glabra,*
4. *Boerhavia chinensis* ***(L.) Durce***
5. *Boerhavia elegans* Choisy
6. *Boerhavia verticillata* Poir.
7. *Bougainvillea spectabilis* Willd.



Crinum lily (*Crinum asiaticum*).

Practical No: 13

Aim Study of Taxonomy as per theory

Object : Study of angiosperm families: Amaryllidaceae

Plant: *Crinum asiaticum* L.

Habit : Stout, perennial herbs; bulbs, underground, tunicated, narrowed, clothed with old leaf-sheaths.

Leaves : radical, linear lanceolate, widely spreading, repand, shortly acuminate, flat, narrow, base sheathing, margins bright-green & smooth, glabrous; sheath long & as much broad, membranous.

Inflorescence : terminal simple, 15-20 flowered umbels; scape solid, stout.

Flower : white, sessile, fragrant at night, incomplete, zygomorphic, hermaphrodite; bracts, 2, spathe-like, ovate-lanceolate, membranous; pedicels 0.6-2.5 cm long; bracteoles linear.

Perianth : tepals 6, gamotepalous, tubular, funnel or salver-shaped; tube long, greenish-white, cylindric, slender; lobes nearly as long as tube, linear, recurved or revolute, deflexed.

Androecium : stamens 6, reddish, adnate to bases of the perianth-segments, on the throat of perianth; tube filaments, free, slender, shorter than perianth lobes, filiform; linear, dorsifixed, red-brown.

Gynoecium : Tricarpellary Ovary trilocular, inferior with few or many anatropous 2-seriate, ovules on the inner angles of the cells; style long, filiform, slender; stigma minute, subcapitate.

Fruit : Capsule, ovoid, smooth, globose, 1 (rarely 2) seeded, beaked by fleshy base of perianth, dehiscing irregularly

Seeds : large, rounded, testa thick, albumen fleshy & copious.

Classification

Division: Phanerogams

Class: Monocotyledons

Series: Epigynae

Family: Amaryllidaceae

1. Plants are mostly herbs.
2. Stem rhizome or bulb or corm.
3. Laves exstipulate.
4. Inflorescence umbellate cyme, flowers are protected by spathe.
5. Flowers epigynous rarely zygomorphic.
6. Presence of perianth.
7. Corona present.
8. Gynoecium syncarpous and ovary inferior.
9. Axile placentation.

Common plant of the family:

1. Agave americana (American aloe or century plant):

A fibrous plant and its sap, after fermentation, gives alcoholic drink.

2. Crinum asiaticum:

Cultivated from ornamental purposes.

3. Curculigo orchioides:

A small herb with blue flowers.

4. Galanthus (Snow drop):

Cultivated for beautiful snow-like flowers.

5. Narcissus:

(H. Nargis) ornamental in Garden all over the world.

6. Pancratium:

Herb with tunicated bulb and large flowers.

7. Zephyranthus tubispatha (Zephyr lily):

A bulbous herb with white flowers.