ALLIED BOTANY

PRACTICAL MANUAL - INSTANT NOTES FOR I B.Sc., ZOOLOGY I & II SEMESTERS

(Based on TANSCHE Syllabus)

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PREFACE

This practical manual, "Allied Botany Practical Manual - Instant Notes, for I B.Sc., Zoology I & II Semesters" is meticulously designed to align with the TANSCHE (Tamil Nadu State Council for Higher Education) syllabus. It aims to provide a comprehensive and accessible resource for Allied Botany students.

The creation of this manual is driven by the need to support students in bridging the gap between theoretical knowledge and practical application. By offering clear, concise and systematically organized notes, this manual helps students quickly grasp essential concepts and techniques. Structured to align with the curriculum of introductory botany courses, this manual covers essential topics spanning the first and second semesters. It provides detailed instructions and insightful explanations to ensure that students gain a robust practical grounding in the subject.

Divided into sections that correspond to the syllabus for Semesters I and II, this manual covers a wide range of topics. It is more than just a compilation of laboratory exercises; it is a tool designed to inspire curiosity, foster a deeper understanding of plant sciences and equip students with the skills necessary for future scientific endeavors. We hope that this manual will not only serve as a practical guide but also ignite a passion for botany that will last a lifetime.

Wishing you a productive and enlightening experience in the laboratory.

Authors

ACKNOWLEDGMENT

First and foremost, we would like to express our profound gratitude to God Almighty, whose blessings and guidance have been our source of strength and inspiration throughout the creation of this book, "Allied Botany Semesters I & II Practical Manual: Instant Notes." It is through His grace that we have been able to see this project to completion.

We extend our heartfelt thanks to our Principal Dr. R. Nagarajan for his unwavering support and encouragement. We also wish to express our sincere thanks to the Head of the Department of Botany,Prof. S. Rajasekaran. His visionary leadership, invaluable guidance, and expert insights have significantly enriched the content and quality of this manual. His commitment to advancing botanical education has been a constant source of inspiration.

Our sincere gratitude goes to our esteemed faculty members of the Department of Botany, whose expertise and feedback have been crucial in shaping this manual. Their commitment to nurturing the next generation of botanists and their willingness to share their knowledge have been invaluable. Special thanks to non-teaching staff members and research scholars for their significant contributions. We are also grateful to our friends and colleagues, whose support and encouragement have sustained us throughout this endeavor. Their constructive feedback and moral support have been deeply appreciated.

Finally, we thank all the students, whose enthusiasm and curiosity have been the driving force behind this manual. It is our hope that this manual will serve as a valuable resource in their academic journey and inspire a lasting passion for Botany.

Authors

CONTENTS

SEMESTER II

1. COMPOUND MICROSCOPE

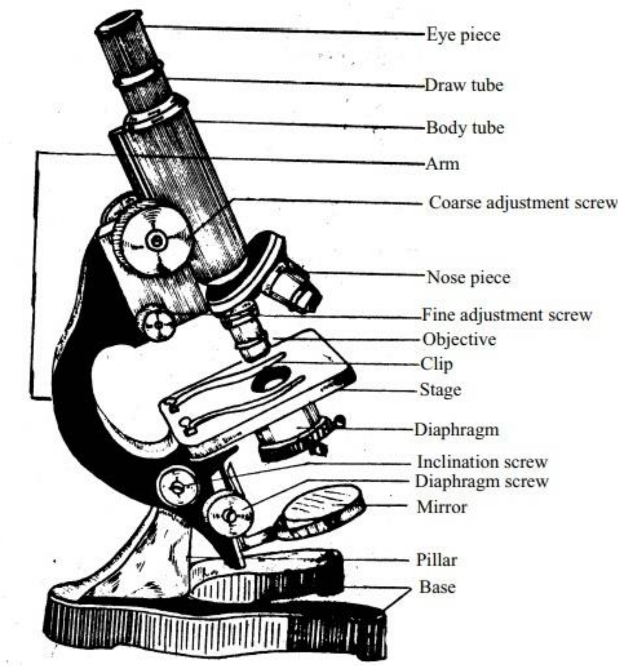
Definition

A compound microscope is an optical instrument used for magnifying small objects. It uses multiple lenses to achieve higher magnification than a simple microscope.

The parts of a compound microscope can be classified into two:

I. Optical

II. Non optical



I. Optical parts

1. **Eyepiece (Ocular Lens)** - The lens you look through, usually with a 10x magnification.
2. **Objective Lenses** - Multiple lenses with different magnifications (e.g., 4x, 10x, 40x, 100x) that can be rotated into position.
3. **Illuminator (Light Source)** - Provides light that passes through the specimen.
4. **Condenser** - Focuses light from the illuminator onto the specimen.
5. **Diaphragm/Iris** - Adjusts the amount of light reaching the specimen.

II. Non-optical parts

1. **Base -** The base is also known as the foot which is either U or horseshoe-shaped. It is a metallic structure that supports the entire microscope.
2. **Pillar -** The connection between the base and the arm are possible through the pillar.
3. **Arm -** The arm is also known as the limb which is a metallic handle forming the connection between the arm to the inclined joint. The stage and the body tube is supported by the arm.
4. **Stage -** It is the metallic platform that is fitted to the lower part of the arm with a hole in the center. The microscopic slides are placed on the stage either by using side clips or by mechanical stage clips.
5. **Fine and Coarse Focus Knobs -** Used to adjust the focus of the microscope.

How it Works

1. **Illumination**: Light from the illuminator passes through the diaphragm and condenser, focusing on the specimen.
2. **Magnification**: Light passes through the objective lens, magnifying the image.
3. **Viewing**: The magnified image is further enlarged by the eyepiece lens, allowing detailed observation.

Magnification Calculation

Total Magnification = Eyepiece Magnification × Objective Lens Magnification Example: If the eyepiece is 10x and the objective lens is 40x, the total magnification is 10 × 40 = 400x.

Applications

1. **Biology**: Studying cells, microorganisms, and tissue samples.
2. **Medicine**: Pathological examinations and diagnostics.
3. **Materials Science**: Analyzing materials at a microscopic level.

Usage Tips

1. **Starting with Low Power**: Always begin with the lowest magnification to locate the specimen.
2. **Proper Lighting**: Adjust the diaphragm and condenser for optimal lighting.
3. **Focusing**: Use coarse focus first, then fine focus to get a clear image.
4. **Cleaning Lenses**: Clean lenses with lens paper to avoid scratches.

Care and Maintenance

1. Keep the microscope covered when not in use.
2. Clean lenses and other parts regularly.
3. Handle with care to avoid damaging the lenses and mechanical parts.

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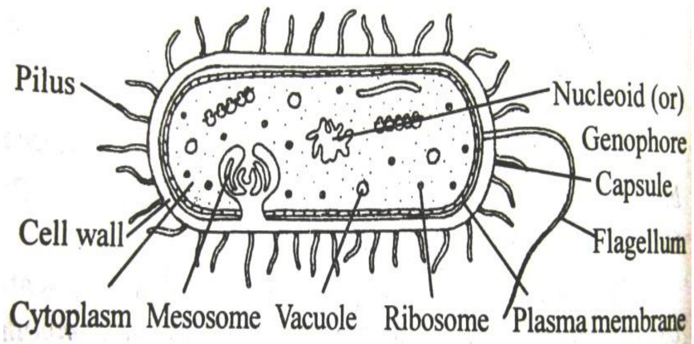
2. BACTERIA



Bacteria are single-celled microorganisms with a relatively simple cell structure. Here is an overview of the main components of a bacterial cell:

1. Cell Wall

- **Function**: Provides shape and protection.
- **Composition**: Mainly composed of peptidoglycan (a polymer of sugars and amino acids).

2. Cell Membrane (Plasma Membrane)

- **Function**: Regulates the movement of substances in and out of the cell.
- **Composition**: A phospholipid bilayer with embedded proteins.

3. Cytoplasm

- **Function**: Contains all the cellular components and is the site for most of the metabolic activities.
- **Composition**: A gel-like substance made up of water, enzymes, nutrients, wastes, and gases.

4. Nucleoid

- **Function**: Contains the bacterial chromosome, which carries genetic information.
- **Composition**: A single, circular DNA molecule not enclosed by a membrane.

5. Ribosomes

- **Function**: Protein synthesis.
- **Composition**: Made of RNA and proteins; they are smaller than eukaryotic ribosomes.

6. Plasmids

- **Function**: Provide additional genetic information that can be beneficial, such as antibiotic resistance.
- **Composition**: Small, circular DNA molecules separate from the chromosomal DNA.

7. Flagella

- **Function**: Provides motility to the bacterium.
- **Composition**: Made of the protein flagellin.

8. Pili (Fimbriae)

- **Function**: Help in attachment to surfaces and in the exchange of genetic material during conjugation.
- **Composition**: Hair-like structures made of protein.

9. Capsule (or Slime Layer)

- **Function**: Provides protection against desiccation and phagocytosis, and helps in adhesion to surfaces.
- **Composition**: A gelatinous layer made of polysaccharides or polypeptides.

10. Endospores

- **Function**: Allow survival in harsh environmental conditions.
- **Composition**: Highly resistant structures containing DNA, ribosomes, and large amounts of dipicolinic acid.

Structural Variations:

- **Gram-Positive Bacteria**: Have a thick peptidoglycan layer in their cell wall, which retains the crystal violet stain used in the Gram staining procedure.
- **Gram-Negative Bacteria**: Have a thin peptidoglycan layer and an outer membrane containing lipopolysaccharides, which does not retain the crystal violet stain but can be counterstained with safranin.

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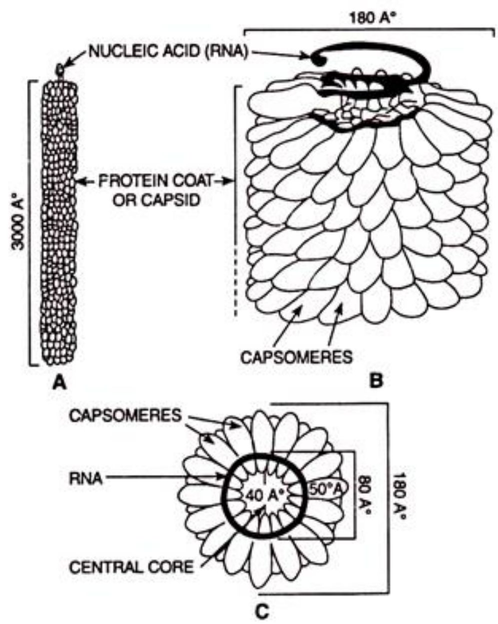
3. TOBACCO MOSAIC VIRUS (TMV)



Tobacco Mosaic Virus (TMV). A. Surface view B. Enlarged portion showing RNA capsomere arrangement C. View in section.

1. Tobacco mosaic virus (TMV) is a typical plant virus. It causes a disease called tobacco mosaic in tobacco plants, hence the name.
2. Infected plants exhibit yellow and green mottling that forms a mosaic pattern.
3. TMV is an RNA virus. It has a helical, rod-shaped structure, measuring approximately 3000 Å in length and 180 Å in diameter.
4. TMV consists of two components: an outer capsid and an inner RNA molecule.
5. The capsid, or outer coat, is made of protein and is composed of small subunits called capsomeres.
6. There are about 2130 capsomeres in a TMV, which are helically arranged around the RNA.
7. There are approximately 129 complete spirals.
8. The RNA forms the core of the virus. It is a single-stranded nucleic acid that is helically coiled, similar to the capsid.

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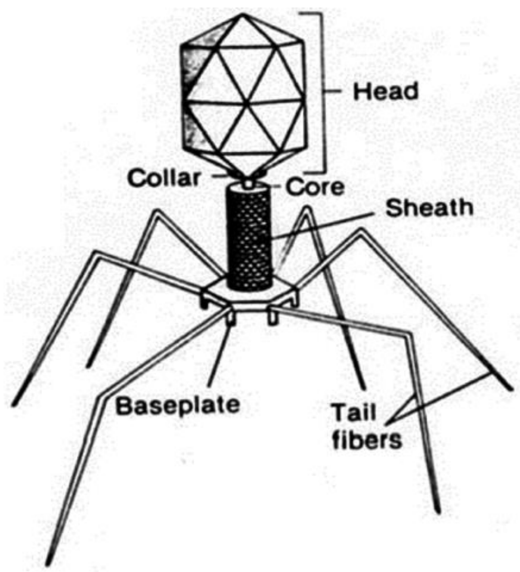
4. T_4 BACTERIOPHAGE



1. A virus that infects bacteria is called a bacteriophage or bacterial virus. Bacteriophage means "bacteria-carrying agent." It infects the bacterium E. coli.

2. Bacteriophages, such as the T4 phage, may have a tadpole shape.
3. It consists of a polygonal head, a short neck, and a tail.
4. The head is a polygonal structure, measuring 1250 Å in length and 850 Å in diameter.
5. The bacteriophage consists of a central core of nucleic acid surrounded by a protein coat called a capsid.
6. The capsid consists of about 2000 subunits called capsomeres.
7. Each capsomere has a molecular weight of 80,000 Daltons.
8. Most bacteriophages contain DNA as their genetic material. The nucleic acid in T4 phage is linear duplex DNA.
9. Inside the capsid, there is a highly coiled DNA molecule, which is about 52,000 nm long and contains approximately 70 genes.

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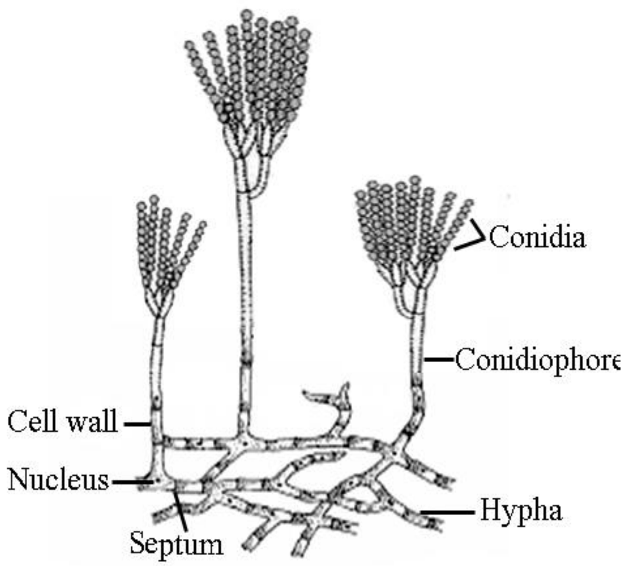
5. PENICILLIUM



Penicillium is a genus of fungi that are known for their distinctive structure, which plays a crucial role in their reproduction and growth. Here is a detailed description of the structure of Penicillium:

1. Mycelium:

- **Structure:** The mycelium is a network of thread-like structures called hyphae that spread throughout the substrate.
- **Function**: It forms the vegetative part of the fungus, anchoring it and absorbing nutrients.

2. Hyphae:

- **Structure:** Hyphae are long, branching filaments that make up the mycelium. They are septate, meaning they have cross-walls.
- **Function:** They grow and penetrate the substrate to absorb nutrients and water.

3. Septa:

- **Structure:** Septa are cross-walls within the hyphae that divide them into individual cells.
- **Function:** They provide structural support and compartmentalize the hyphae, allowing for differentiation and damage control.

4. Nutrient Absorption:

- **Process:** Hyphae secrete enzymes into the substrate to break down complex organic materials into simpler compounds, which are then absorbed through the cell walls and membranes.
- **Function:** Provides essential nutrients for growth and development.

5. Conidiophores:

- **Structure:** Specialized hyphal structures that extend from the mycelium and bear the reproductive spores (conidia).
- **Function:** Involved in asexual reproduction by producing and releasing conidia.

6. Conidia:

- **Structure:** Small, typically unicellular spores that are produced in chains at the tips of the phialides.
- **Function:** Serve as the primary means of asexual reproduction, dispersing to form new colonies when they land on suitable substrates.

7. Cellular Organelles:

- **Structure:** Like other eukaryotic cells, Penicillium cells contain organelles such as nuclei, mitochondria, endoplasmic reticulum, Golgi apparatus, and vacuoles.
- **Function:** Organelles perform various cellular functions, including energy production, protein synthesis, and waste management.

8. Reserve Food:

- **Structure:** Penicillium cells store reserve food materials, such as glycogen and lipids, within their vacuoles and cytoplasm.
- **Function:** Provides energy and carbon sources during periods of nutrient scarcity.

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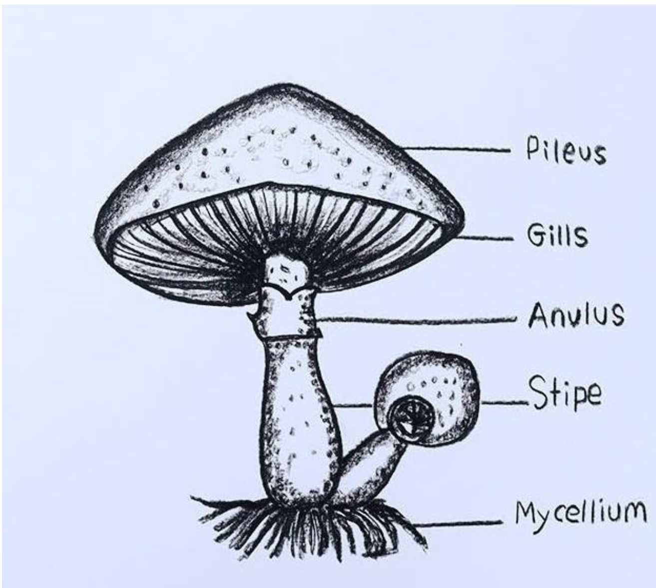
6. AGARICUS - BASIDIOCARP

Agaricus is a genus of mushrooms that includes the common edible mushroom, *Agaricus bisporus*. The term **basidiocarp** refers to the fruiting body of a fungus, which is the structure responsible for producing and dispersing spores.



Here is a detailed description of the structure and features of the basidiocarp in Agaricus species:

Structure of *Agaricus* Basidiocarp

1. **Cap (Pileus)**:
   - **Structure**: The cap is the upper, umbrella-like part of the mushroom. It can vary in size, shape, and color depending on the species and maturity.
   - **Function**: Protects the gills and provides a surface for spore dispersal.

2. **Gills (Lamellae)**:
   - **Structure**: Thin, blade-like structures located on the underside of the cap. They are radiating and closely spaced.
   - **Function**: Contain the basidia, which are the spore-producing cells.
3. **Stipe (Stem)**:
   - **Structure**: The stalk that supports the cap. It varies in length and thickness.
   - **Function**: Elevates the cap to facilitate spore dispersal.

4. **Annulus (Ring)**:
   - **Structure**: A ring-like structure around the stipe, remnants of the partial veil that initially covered the gills.
   - **Function**: Provides a protective covering for the developing gills.
5. **Volva**:
   - **Structure**: A cup-like structure at the base of the stipe, remnants of the universal veil.
   - **Function**: Present in some species of Agaricus, it protects the young mushroom during development.

6. **Basidia**:
   - **Structure**: Microscopic, club-shaped cells located on the gills.
   - **Function**: Produce and release basidiospores.

7. **Basidiospores**:
   - **Structure**: Microscopic, spore-forming structures produced by the basidia.
   - **Function**: Dispersed into the environment to germinate and form new fungal mycelium.

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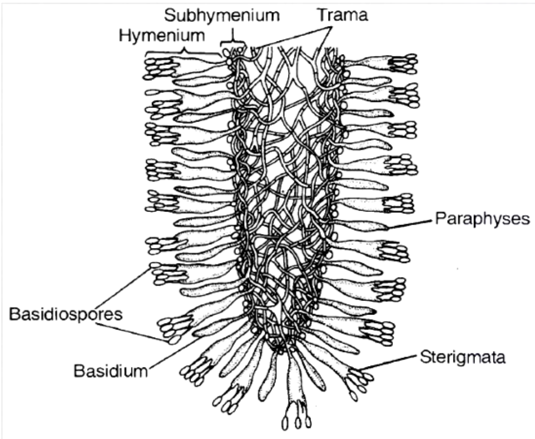
7. AGARICUS – V.S OF GILL



***Agaricus* : Internal structure of gill**

1. The section of an Agaricus gill plate shows a mass of loosely arranged hyphae at the center called the trama.
2. The free ends of the hyphae project out in a parallel layer called the hymenial layer.
3. The hymenial layer consists of club-shaped structures called basidia.
4. Each basidium consists of four sterigmata, and at the end of each sterigma, there is a basidiospore.
5. Between the sterigmata, some sterile structures called paraphyses are present.

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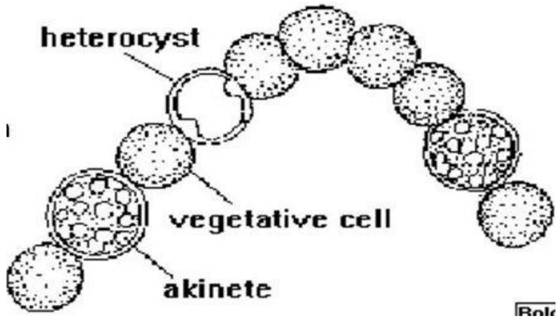
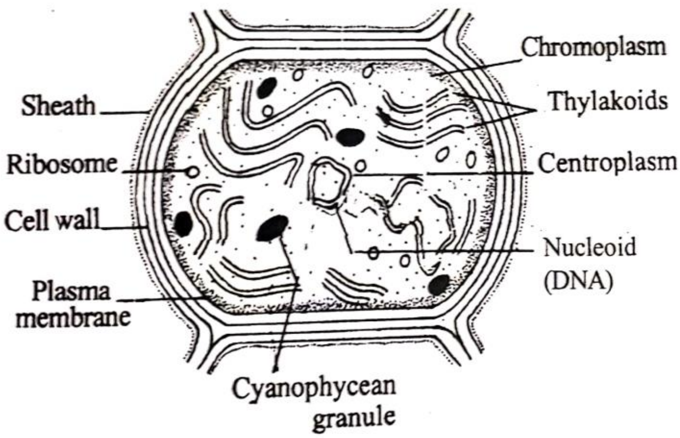
8. ANABAENA





1. Anabaena is blue green algae. It is a filamentous alga. Greek word-anabaino means I will go up.
2. Usually, a few Anabaena filaments aggregate together and occur as a slightly gelatinous mass, floating on the surface of water.
3. The plant is a haploid gametophyte. It is a prokaryote.
4. **Trichome**: Unbranched, filamentous chain of cells.
5. **Vegetative Cells**: Regular, oval, or cylindrical cells. Responsible for photosynthesis and growth. Contain chlorophyll and other pigments.
6. **Heterocyst's**: Specialized, thick-walled cells. Appear at regular intervals along the trichome. Function in nitrogen fixation.

7. **Akinetes**: Enlarged, thick-walled resting cells. Develop from vegetative cells, usually adjacent to heterocyst's. Serve for survival and perennation.
8. **Mucilaginous Sheath**: Gelatinous layer surrounding the trichome. Provides protection and buoyancy.

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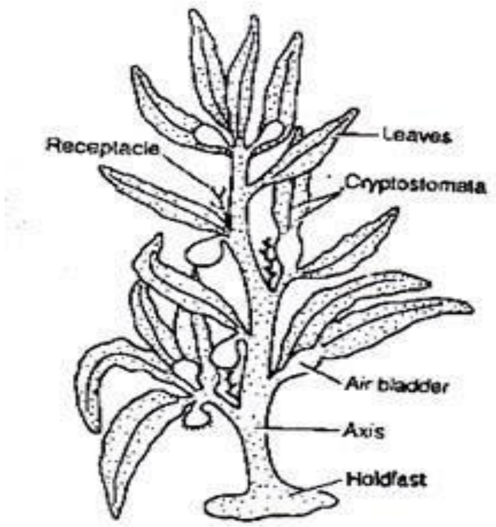
9. SARGASSUM THALLUS STRUCTURE



1. The thallus is multicellular, diploid (2n), and highly organized.
2. The thallus consists of a rhizoidal holdfast, a branched stem-like axis, leaf-like laterals, and fruit-like air bladders.
3. The stem consists of many branches with spirally arranged leaves.
4. The air bladders help with flotation.
5. At the axis of certain leaves, many cylindrical fertile branches are present, and they are called receptacles.

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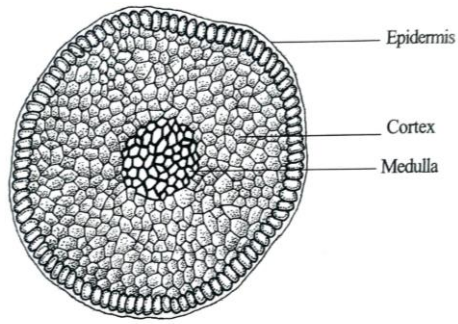
10. SARGASSUM T. S OF AXIS



1. The axis is differentiated into meristoderm, cortex, and medulla.
2. The meristoderm is the outermost layer, made up of closely packed, small cells.
3. The cells are meristematic in nature and filled with chromatophores.
4. It is also covered by a layer of cuticle.
5. This layer is also known as the epidermis, and due to the presence of chromatophores, its function is photosynthetic.
6. Below the meristoderm is the region of the cortex.
7. It is made up of many parenchymatous cells. The cells are polygonal in shape and have intercellular spaces.
8. The cells are filled with reserve food, so it is also known as storage tissue.
9. The center of the axis is occupied by a thick-walled region called the medulla.
10. The cells of the medulla are narrow and elongated.
11. The lateral walls of the medulla bear some scalariform thickenings.
12. The conduction of water and other nutrients is the supposed function of the medulla.

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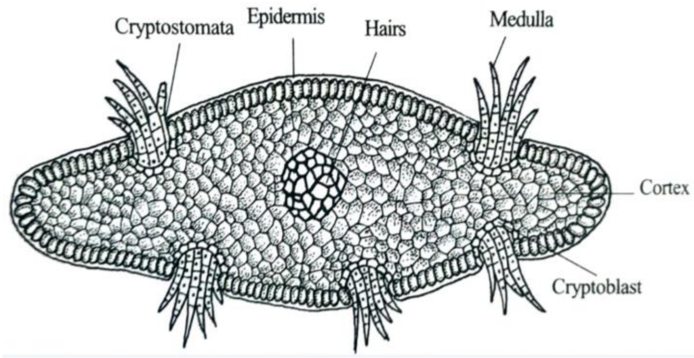
11. SARGASSUM T. S OF LEAF



1. The leaf is essentially similar to the axis, being divided into the epidermis, cortex, and medulla.
2. The leaf is thicker in the midrib region, while the wings are narrow, long, and thin.
3. The epidermis is made up of small cells containing chromatophores. The cortex is mainly distributed in the wings and is a few cells thick in the midrib region.
4. The medulla is present only in the midrib region.
5. Many flask-shaped cryptostomata or sterile conceptacles are also present in the leaf. They contain numerous sterile hairs or paraphyses.
6. Cryptostomata open through a pore known as the ostiole.
7. The epidermis performs photosynthesis, the cortex acts as a storage region, and the medulla serves the function of conduction. Thus, there is a division of labour among the tissues in Sargassum.

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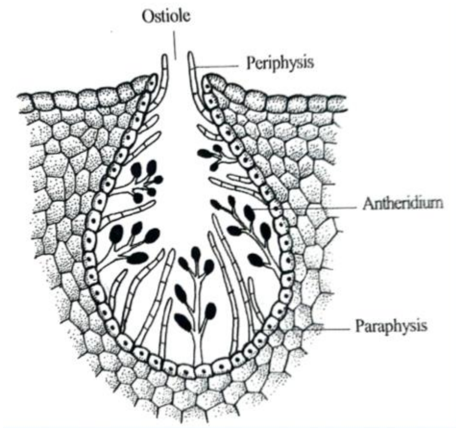
12. SARGASSUM MALE CONCEPTACLE



1. The male conceptacles contain the male reproductive structures called antheridia, which are located on short branches.
2. Between the antheridia, there are many sterile branches called paraphyses.
3. There is an opening in the male conceptacle known as the ostiole.
4. Each diploid antheridium undergoes meiosis followed by mitotic division to produce biflagellate male gametes.

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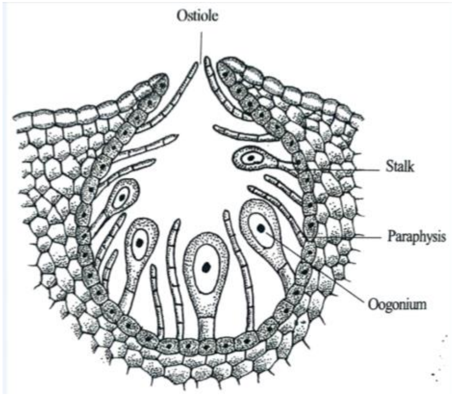
13. SARGASSUM FEMALE CONCEPTACLE



1. The female conceptacle contains the female reproductive structures called oogonia.
2. Between the oogonia, there are many sterile branches called paraphyses.
3. There is an opening in the female conceptacle known as the ostiole.
4. The diploid nucleus of the oogonium undergoes meiotic and mitotic divisions to form 8 haploid daughter nuclei, of which 7 degenerate and one matures into an egg.

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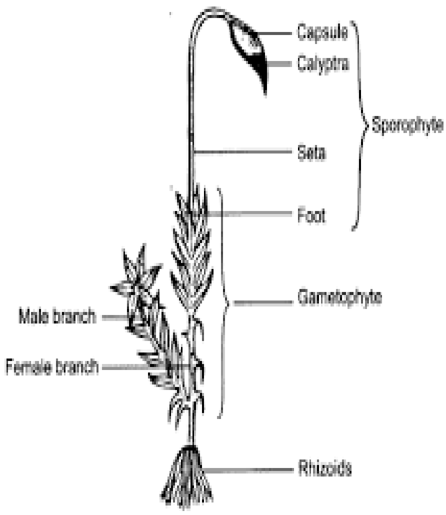
14. FUNARIA (MOSS)



1. Moss is a small plant, usually 2-3 cm in height.
2. The main plant body is a gametophyte consisting of a short axis with spirally arranged minute green leaves.
3. The plant bears a number of thread-like rhizoids that function as roots.
4. The plant is monoecious, meaning it bears both male and female sex organs.
5. The female sex organ, called the archegonium, is located at the apex of the main axis. A lateral branch, called the male shoot, bears antheridia at its tip.
6. The female branch of older plants bears a sporophyte, which comprises the foot, seta, and capsule.

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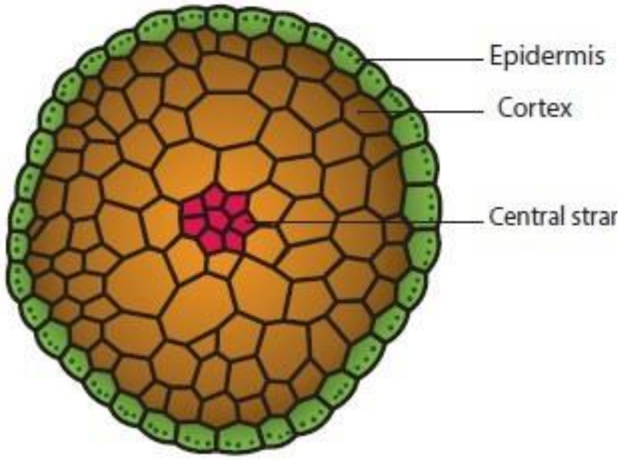
15. C.S OF FUNARIA STEM



1. The cross-section of the stem shows three distinct regions: an outer epidermis, a middle cortex, and an inner central cylinder.
2. The epidermis is a single layer. The epidermal cells contain chloroplasts and can therefore perform photosynthesis. Stomata and a cuticle are absent in the epidermis.
3. The cortex lies between the epidermis and the central cylinder. It is multilayered and parenchymatous.
4. The outer cortical cells of the mature stem are thick-walled, while the inner cortical cells are thin-walled.
5. The cortex functions in storage.
6. The central cylinder is a core of vertically elongated, thin-walled, colorless cells that lack protoplasm.
7. It serves as mechanical tissue, as well as conductive and storage tissue.
8. True vascular bundles are absent.

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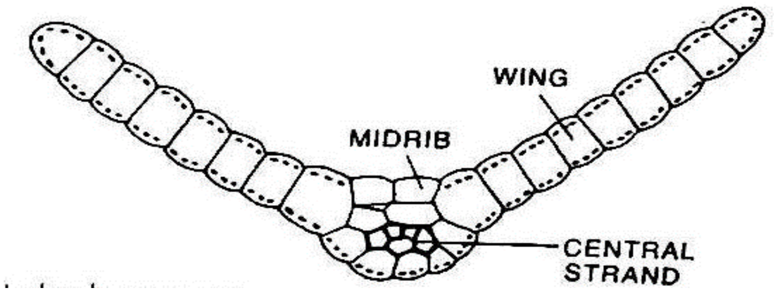
16. T.S OF FUNARIA LEAF



1. The cross-section of a Funaria leaf shows a single-layered wing or lamina and a midrib.
2. The cells of the wing are large and chlorenchymatous.
3. The marginal cells are smaller in size.
4. All cells of the wing are photosynthetic.
5. The midrib is located in the center of the wing. It is several cells thick and bounded by the upper and lower epidermis.
6. The cells of the midrib are thick-walled. In the center of the midrib, there is a small central cylinder.
7. The central cylinder is composed of elongated, thick-walled cells. It provides mechanical support to the leaf and serves as a conducting strand.

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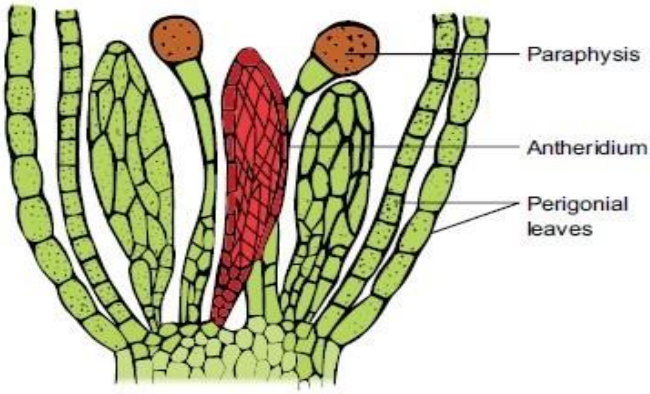
17. FUNARIA- ANTHERIDIAL HEAD



1. The antheridium is the male sex organ of Funaria.
2. It is produced in clusters at the tip of the male branch of the gametophyte. This branch is called the antheridial branch.
3. The antheridia are surrounded by a rosette of perichaetial leaves.
4. The antheridia are intermingled with numerous uniseriate filaments called paraphyses.
5. The paraphyses store water and secrete mucilage to protect the antheridia.
6. The mature antheridium is club-shaped.
7. It consists of a stalk, a body, and an operculum.
8. The antheridium is attached to the antheridial branches by the stalk.
9. The body of the antheridium consists of an outer sterile envelope called the jacket and an inner mass of androcyte mother cells.
10. The distal end of the jacket has an operculum, which helps in the dehiscence of the antheridium.
11. Each androcyte mother cell divides to form two androcytes.
12. Each androcyte gives rise to a single, elongated, biflagellate sperm.

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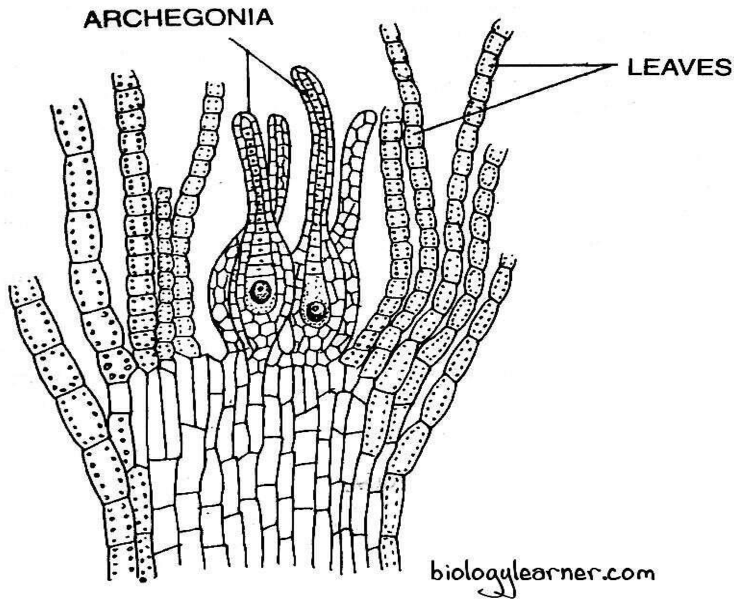
18. FUNARIA- ARCHEGONIUM HEAD



1. The archegonium is the female sex organ of Funaria.
2. It is produced by the haploid gametophyte.
3. It develops on the female branch, with archegonia produced in clusters at the convex tip.
4. They are intermingled with multicellular, sterile, uniseriate filaments called paraphyses.
5. The archegonia are surrounded by green perichaetial leaves.
6. The mature archegonium is a flask-shaped structure.
7. The archegonium consists of a stalk, a venter, and a neck.
8. The stalk attaches the archegonium to the female branch.
9. The venter contains a venter cavity.
10. The venter cavity houses an egg and a ventral canal cell.
11. The neck consists of an axial row of 8-12 neck canal cells. The tip of the neck is closed by four cover cells.

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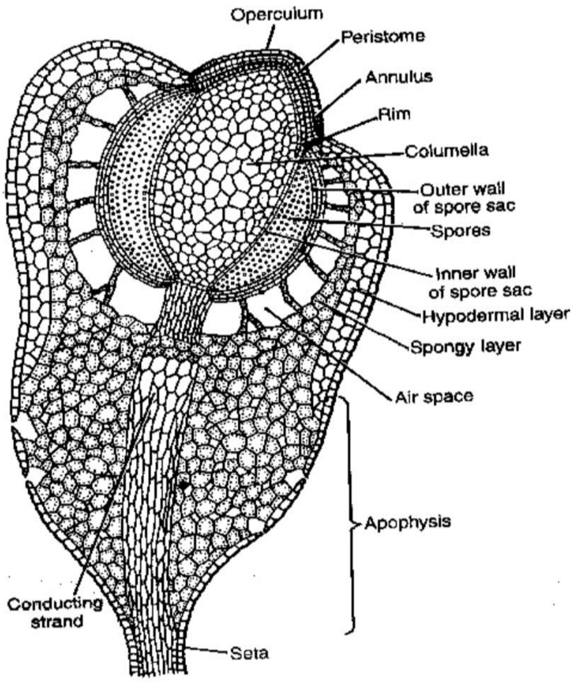
19. L.S OF FUNARIA CAPSULE



1. The capsule is the part of the sporophyte where spores develop. It is pear-shaped and can be either erect or pendent, with colors ranging from green to yellow to orange.
2. It is the fertile region of the sporophyte.
3. The Funaria transverse section of the capsule is the reproductive part and consists of the following regions:
   - Paraphyses
   - Theca
   - Operculum
4. The apophyse is the basal region.
5. Stomata are present in the epidermis.
6. The theca region is the actual spore-producing area.
7. It contains a central columella.
8. The upper region consists of the operculum and peristome.

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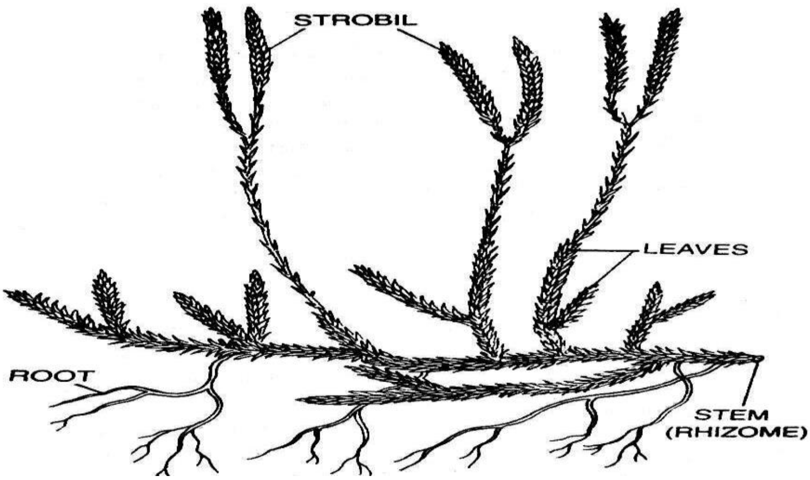
20. LYCOPODIUM – HABIT



The habit of Lycopodium, or clubmosses, is characterized by several distinct features:

1. **Growth Form**:
   - **Creeping or Spreading**: Lycopodium plants typically have a creeping or spreading habit. They grow horizontally along the ground, forming dense mats or carpets.
   - **Upright or Erect**: In some species, the stems can grow upright or slightly ascending, giving a more bushy appearance.
2. **Stems**:
   - **Branching**: The stems are often branched, with lateral branches extending from the main stem. In some species, the branching can be quite complex.
   - **Rhizomes**: Lycopodium plants have underground rhizomes that help them spread and establish new growth.
3. **Leaves**:
   - **Small and Scale-like**: The leaves are typically small, scale-like, and arranged in a spiral or alternate pattern along the stems.

   - **Lycopodium Leaves**: They are usually simple, without veins, and often have a distinct, overlapping arrangement that gives a "club-shaped" appearance.
4. **Reproductive Structures**:
   - **Strobili**: Lycopodium plants produce strobili (cone-like structures) at the tips of some branches. These strobili contain the spores and are important for reproduction.
5. **Habitats**:
   - **Forest Floor**: They are commonly found growing on the forest floor, where they form dense mats.
   - **Moist and Shaded Areas**: Lycopodium species thrive in moist and shaded environments, such as under the canopy of trees or in boggy areas.

Overall, Lycopodium exhibits a habit that allows it to thrive in a variety of moist and shaded environments, with a growth form that can cover large areas and adapt to different substrates.

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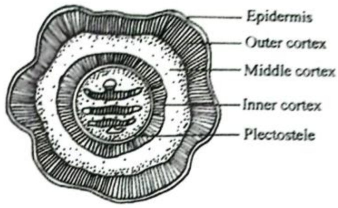
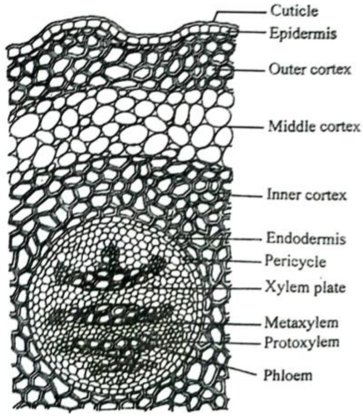
21. T.S OF LYCOPODIUM STEM



A. Ground plane



The transverse section (T.S.) of a Lycopodium stem reveals several distinct structural features:

1. **Epidermis**:
   - **Outer Layer**: The outermost layer of the stem.
   - **Cell Structure**: Composed of a single layer of small, tightly packed cells.
   - **Function**: Provides protection and may have a cuticle to prevent water loss.
2. **Cortex**:
   - **Location**: Lies beneath the epidermis.
   - **Cell Structure**: Consists of several layers of parenchymatous cells.
   - **Function**: Often involved in storage and support.

3. **Endodermis**:
    - **Inner Layer of Cortex**: A distinct layer that separates the cortex from the central cylinder.
    - **Cell Structure**: Composed of a single layer of cells that may be slightly thicker than those in the cortex.
4. **Central Cylinder**:
    - **Structure**: The central core of the stem.
    - **Components**:
        - **Stele**: Contains vascular tissues organized in a distinct pattern.
        - **Xylem**: The vascular tissue responsible for water transport. In Lycopodium, xylem cells are typically arranged in a ring or scattered within the central cylinder.
        - **Phloem**: The vascular tissue responsible for nutrient transport. It is often found adjacent to the xylem.
5. **Pith**:
    - **Location**: Central region within the central cylinder.
    - **Cell Structure**: Composed of parenchymatous cells.
    - **Function**: Functions in storage and may provide support.
6. **Vascular Bundles**:
    - **Arrangement**: Lycopodium typically has a protostelic arrangement, meaning that the xylem is central and surrounded by phloem.
    - **Structure**: Vascular bundles are generally not organized into a ring but are dispersed throughout the central cylinder.

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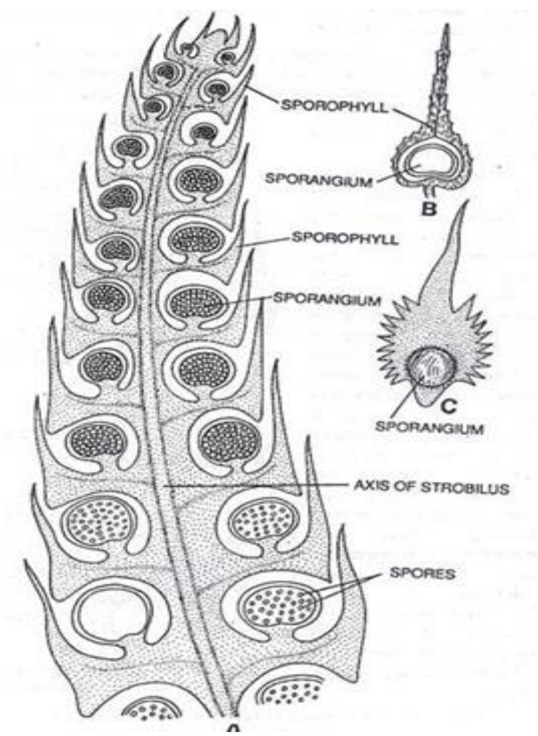
22. L.S OF LYCOPODIUM CONE

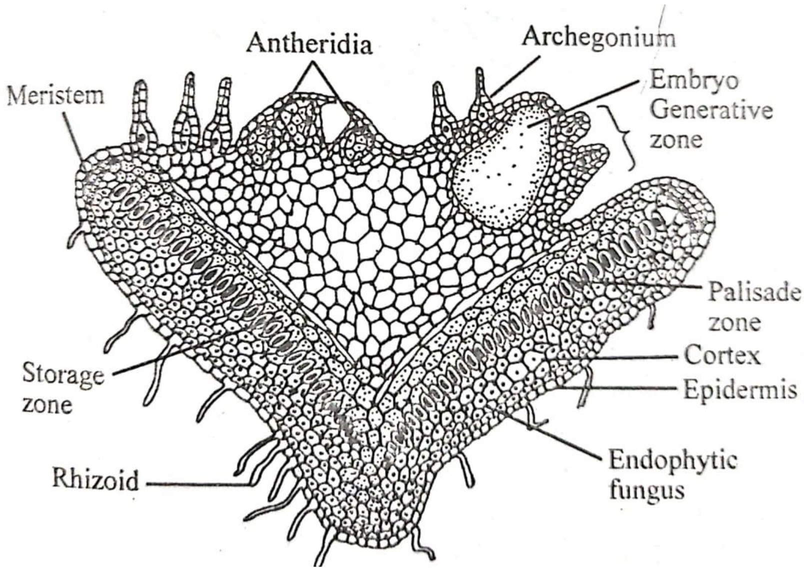
The longitudinal section (L.S.) of a Lycopodium cone (or strobilus) reveals its reproductive structures and their arrangement. Here are the key features:

1. **Strobilus Structure**:
   - **Cone Shape**: The strobilus is cone-shaped or cylindrical, with a series of spirally arranged microsporophylls or sporophylls
2. **Sporophylls**:
   - **Arrangement**: The sporophylls are modified leaves that bear the sporangia. They are arranged in a spiral pattern around the central axis of the cone.
   - **Structure**: Each sporophyll has a central vein and may have a leaf-like appearance.



3. **Sporangia**:
    - o **Location**: Located on the upper or lower surface of each sporophyll.
    - o **Appearance**: Sporangia are usually rounded or oval and contain spores.
    - o **Development**: Inside the sporangia, meiosis occurs to produce haploid spores.
4. **Microsporophyll's**:
    - o **Type**: In Lycopodium, the microsporophyll's are the male reproductive structures that produce microspores.
    - o **Arrangement**: They are arranged in a spiral pattern around the central axis of the cone.
5. **Meiotic Spore Production**:
    - o **Microspores**: Produced within the sporangia through meiosis. These are the male gametes that eventually develop into male gametophytes.
6. **Central Axis**:
    - o **Structure**: The central axis of the strobilus supports the sporophylls and houses the reproductive structures.
7. *******

23. LYCOPODIUM PROTHALLUS



1. The prothallus grows up to 12 mm in height. It may be top-shaped or inverted conical, with an irregularly fluted margin.
2. It is differentiated into a lower conical region and an upper broad generative region.
3. The conical region consists of an outer epidermis, cortex, palisade zone, and a central storage zone.
4. The epidermis is a single layer of cells.
5. Many rhizoids arise from the epidermal cells and anchor the prothallus to the substratum.
6. The cortex is composed of densely packed parenchymatous cells.
7. The cortical cells are infected with endophytic mycorrhizae.
8. Inner to the cortical zone is a layer of closely packed columnar cells called the palisade zone.

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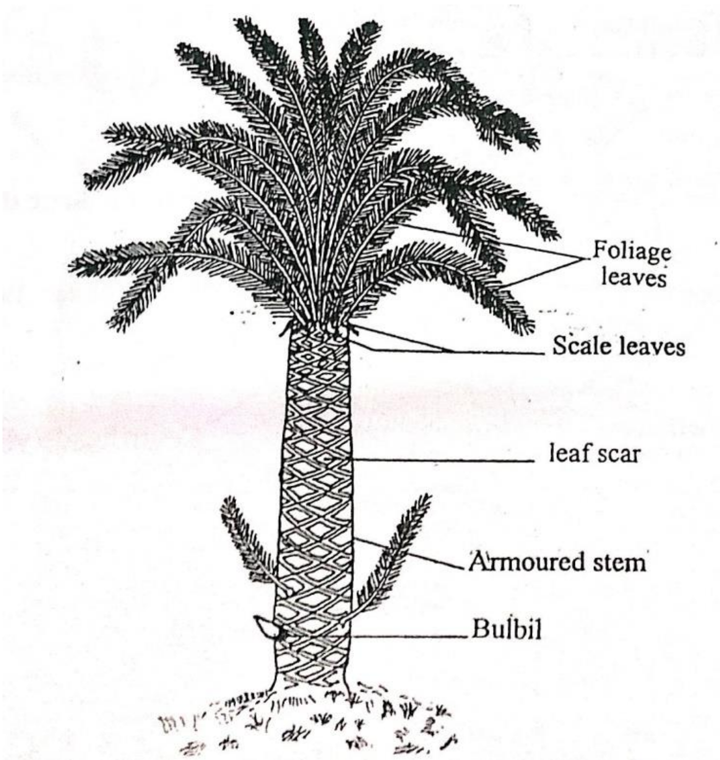
24. CYCAS HABIT



1. It is an evergreen, perennial plant. Some species can grow up to 40 feet in height.
2. It is a dioecious plant, meaning that male and female reproductive parts are borne on separate trees.
3. It possesses two types of roots: tap roots and coralloid roots.
4. The primary roots are tap roots. Their main functions are anchorage and the absorption of water and minerals.
5. The coralloid roots develop from the normal roots and are associated with cyanobacteria that perform biological nitrogen fixation.
6. The stem, or caudex, is mostly unbranched, thick, and woody. Its surface is rough due to persistent leaf bases.
7. Leaves form a crown at the top of the stem. There are two types of leaves found in Cycas: foliage leaves and scaly leaves.

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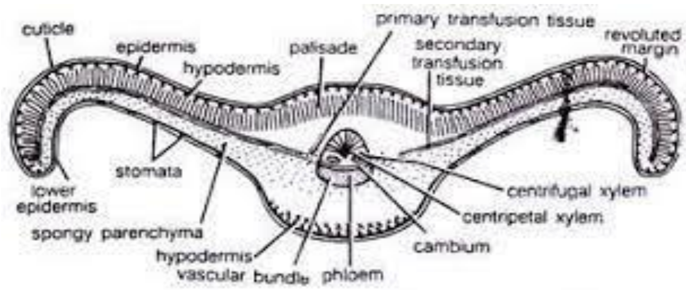
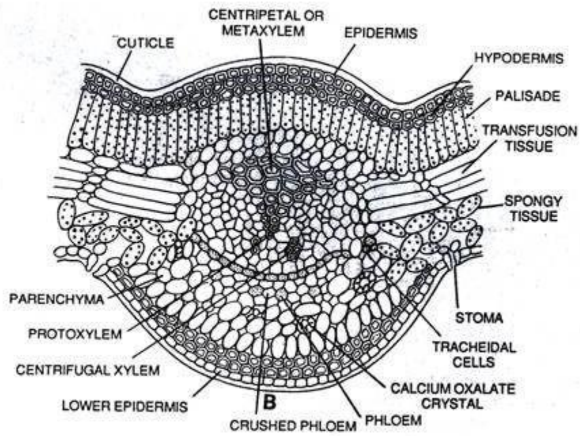
25. CYCAS LEAFLET





The internal structure of a Cycas leaflet, observed in a transverse section (T.S.), includes several key tissue types that contribute to its function. Here's a detailed overview of each component:

1. **Epidermis**:
   - **Upper Epidermis**:
     - **Structure**: A single layer of cells.
     - **Features**: Covered by a thick cuticle to minimize water loss. Continuous across the surface.
   - **Lower Epidermis**:
     - **Structure**: Also a single layer of cells.
     - **Features**: Covered by a thick cuticle. Interrupted by sunken stomata that facilitate gas exchange.
2. **Hypodermis**:
   - **Structure**: Composed of sclerenchymatous cells (thick-walled, supportive cells).

  - **Function**: Provides protection against overheating and excessive transpiration.
3. **Mesophyll**:
   - **Palisade Parenchyma**:
     - **Structure**: A single layer of elongated, columnar cells located just beneath the upper epidermis.
     - **Features**: Rich in chloroplasts, aiding in photosynthesis.
   - **Spongy Parenchyma**:
     - **Structure**: Several layers of loosely arranged, oval or irregular cells beneath the palisade layer.
     - **Features**: Contains large intercellular spaces to facilitate gas exchange.
4. **Transfusion Tissue**:
   - **Structure**: Consists of two groups of short, wide tracheid-like cells with wall thickenings or pits.
   - **Function**: Assists in the internal transport of water and nutrients.
5. **Accessory Transfusion Tissue**:
   - **Structure**: Consists of several layers of transversely elongated cells located between the palisade and spongy parenchyma cells.
   - **Function**: Enhances internal transport and support.
6. **Vascular Bundle**:
   - **Location**: Found in the midrib region of the leaflet.
   - **Structure**:
     - **Conjoint, Collateral, Open, and Diploxylic**: Features both xylem and phloem.
     - **Xylem**: Triangular and centrifugal with endarchprotoxylem.
     - **Phloem**: Arc-shaped, separated from xylem by cambium. Contains sieve tubes and phloem parenchyma.
     - **Companion Cells**: Absent in the phloem.

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26. CYCAS- T.S OF RACHIS

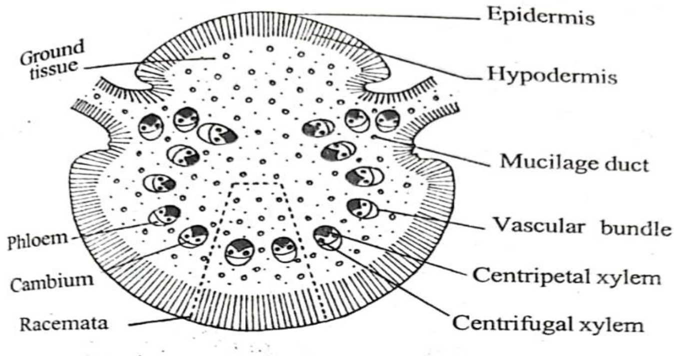
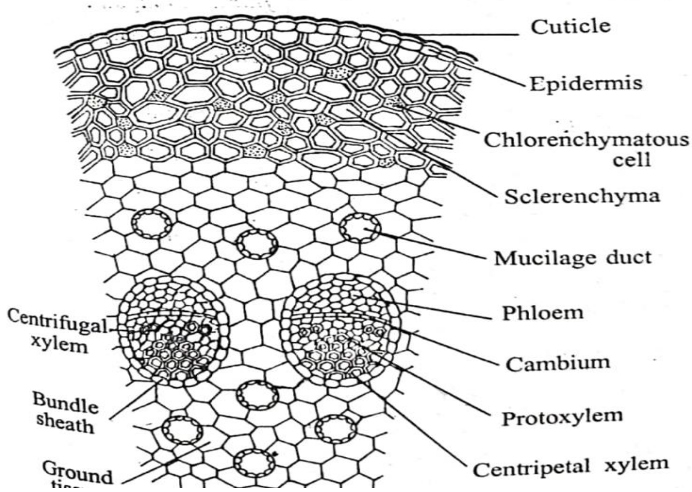


Fig. 11.11: Cycas. T.S. of rachis outline (diagrammatic).



The transverse section (T.S.) of the rachis of a Cycas leaflet shows a complex arrangement of tissues that facilitate its various functions, including support, transport, and photosynthesis. Here is a detailed description of the internal structure of the Cycas rachis:

1. **Epidermis**:
   - **Structure**: The outermost layer, consisting of a single layer of cells.
   - **Features**: Covered with a thick cuticle that helps in reducing water loss. Stomata may be present on the lower surface.
2. **Hypodermis**:
   - **Structure**: Located just below the epidermis, composed of several layers of sclerenchymatous cells.

   - **Function**: Provides mechanical strength and protection to the rachis.
3. **Cortex**:
   - **Structure**: A region of parenchymatous cells located beneath the hypodermis.
   - **Features**: The cells are often thin-walled and may contain chloroplasts. The cortex is divided into two parts:
     - **Outer Cortex**: Contains chloroplasts for photosynthesis.
     - **Inner Cortex**: Mainly serves as storage tissue.
4. **Transfusion Tissue**:
   - **Structure**: Present in patches near the vascular bundles, composed of tracheid-like cells.
   - **Function**: Assists in the lateral conduction of water and nutrients.
5. **Vascular Bundles**:
   - **Structure**: Numerous vascular bundles are arranged in a ring or scattered throughout the cortex.
   - **Features**:
     - **Conjoint, Collateral, and Open**: Each bundle has both xylem and phloem.
     - **Xylem**: Located towards the inner side of the bundle, typically endarch (protoxylem is towards the center).
     - **Phloem**: Located towards the outer side of the bundle, containing sieve cells and phloem parenchyma.
     - **Cambium**: Present between xylem and phloem, indicating secondary growth potential.
6. **Pith**:
   - **Structure**: The central region of the rachis, composed of large, parenchymatous cells.
   - **Function**: Provides support and stores nutrients.

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27. CYCAS T.S OF COROLLOID ROOT

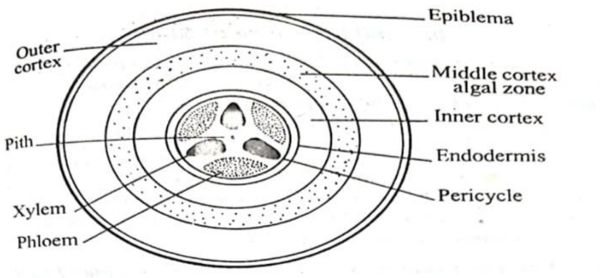
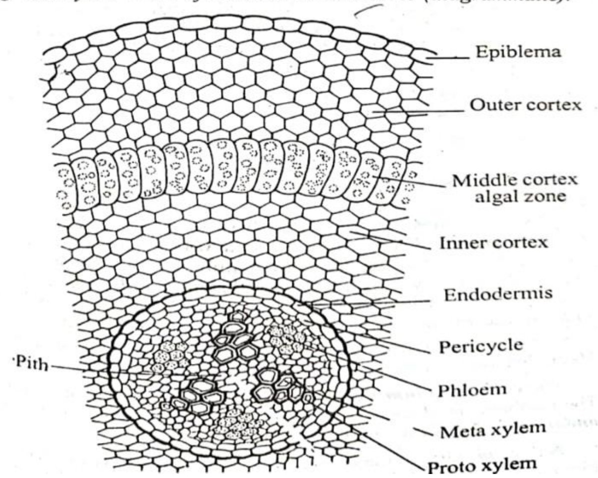


Fig. 11.8: Cycas - T.S. of coralloid root outline (diagrammatic).



The transverse section (T.S.) of a coralloid root in Cycas exhibits a unique structure that supports its symbiotic relationship with nitrogen-fixing cyanobacteria. Here is a detailed description of the internal structure of a Cycas coralloid root:

1. **Epidermis**:
   - **Structure**: The outermost layer, consisting of a single layer of cells.
   - **Features**: The cells are thin-walled and may have root hairs for absorption.
2. **Cortex**:
   - **Structure**: A broad region beneath the epidermis, composed of multiple layers of parenchymatous cells.
   - **Features**: The cortex is typically divided into two distinct zones:

        - **Outer Cortex**: Contains loosely arranged parenchymatous cells with intercellular spaces.
        - **Inner Cortex**: Characterized by the presence of algal zones, which house cyanobacteria (Nostoc or Anabaena) for nitrogen fixation.
3. **Algal Zones**:
    - **Structure**: Located in the inner cortex, these zones consist of specialized cells that harbour cyanobacteria.
    - **Function**: Facilitate the symbiotic relationship with cyanobacteria, aiding in biological nitrogen fixation.
4. **Endodermis**:
    - **Structure**: A single layer of tightly packed cells that forms the innermost layer of the cortex.
    - **Features**: The cells often have Casparian strips, which are band-like thickenings of suberin on the radial and transverse walls, helping to regulate the movement of water and solutes into the vascular tissue.
5. **Stele**:
    - **Structure**: The central vascular cylinder inside the endodermis.
    - **Features**:
        - **Pericycle**: A layer of cells just inside the endodermis.
        - **Vascular Tissue**: Contains both xylem and phloem arranged in a radial pattern.
        - **Xylem**: Typically located at the center, responsible for water conduction.
        - **Phloem**: Located between the xylem arms, responsible for transporting nutrients.
6. **Pith**:
    - **Structure**: The central region of the stele, consisting of parenchymatous cells.
    - **Function**: Provides storage and structural support.

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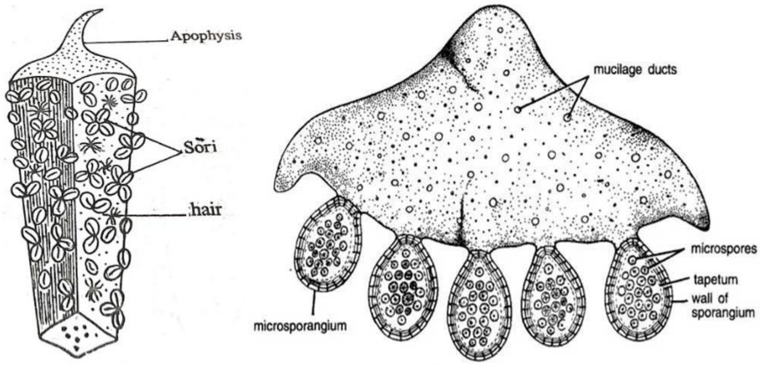
28. CYCAS – MICROSPOROPHYLL ENTIRE AND T.S



1. It shows the microsporangia on the axial side.
2. The microsporangium shows three regions: the outer thick exothecium, the inner endothecium, and the tapetum.
3. The microspore is present inside the microsporangium.
4. It is terminal, shortly stalked, compact, large, and colonial.
5. It consists of numerous microsporophylls around the central axis.

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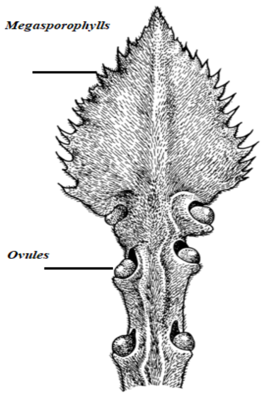
29. CYCAS – MEGASPOROPHYLLS



Cycas – Megasporophylls

1. **Structure**:
   - The megasporophylls in Cycas are large and pinnate, resembling leaves.
   - Each megasporophyll is divided into a sterile upper portion and a fertile lower portion.
2. **Sterile Region**:
   - The upper part of the megasporophyll is sterile and resembles the foliage leaves of Cycas.
   - It is composed of leaf-like segments, which are photosynthetic in function.
3. **Fertile Region**:
   - The lower portion of the megasporophyll bears ovules.
   - Ovules are typically arranged in two rows on either side of the rachis (central axis) of the megasporophyll.
   - Each ovule is large, orthotropous (straight), and integumented (covered by protective layers).
4. **Ovules**:
   - The ovules are naked, meaning they are not enclosed within an ovary.
   - Each ovule consists of a nucellus surrounded by integuments.
   - The micropyle, a small opening at the apex of the ovule, allows for the entry of pollen.

5. **Development**:
    - The megasporophylls develop at the apex of the plant in a spiral arrangement.
    - They are produced in large numbers during the reproductive phase of the plant.
6. **Function**:
    - The primary function of the megasporophylls is to produce and bear the ovules, which will develop into seeds after fertilization.
    - The sterile part performs photosynthesis, supporting the plant's nutritional needs.

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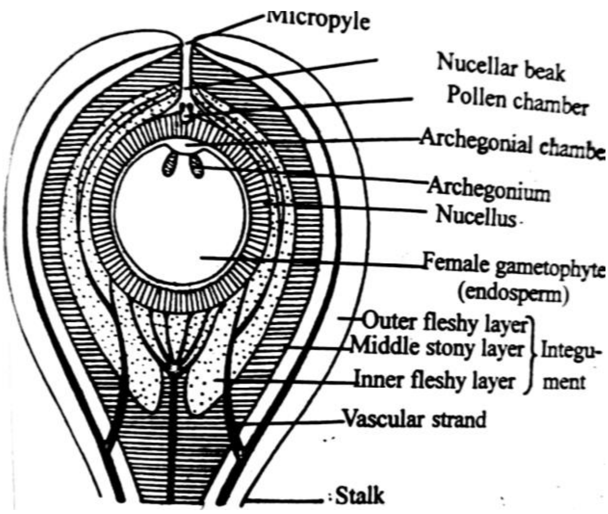
30. CYCAS – L.S OF OVULE



1. Orthotropous type of ovule.
2. The integument has three layers: an outer fleshy layer, a middle stony layer, and an inner fleshy layer.
3. The outer and inner layers are supplied with vascular structures.
4. The nucellus is just below the integument and forms a nucellar beak.
5. The innermost structure of the ovule is the female gametophyte.

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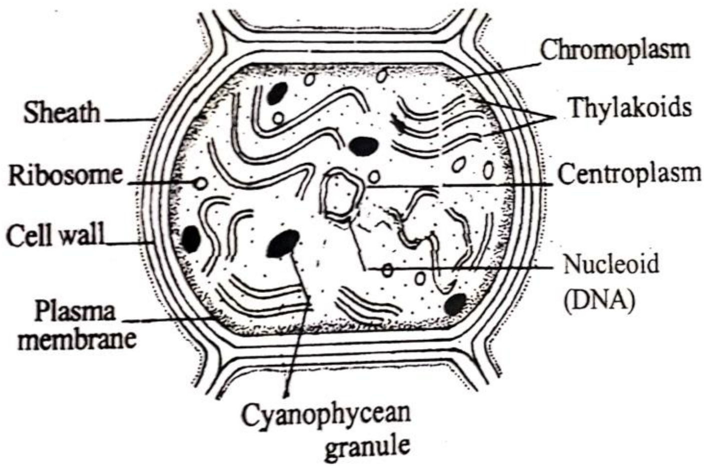
31. PROKARYOTIC CELL STRUCTURE



1. Prokaryotic cells are single-celled microorganisms believed to be the earliest life forms on Earth.
2. They lack a nuclear membrane.
3. Mitochondria, Golgi bodies, chloroplasts, and lysosomes are absent.
4. The genetic material is present on a single chromosome.
5. The cell wall is made up of carbohydrates and amino acids.
6. The plasma membrane functions like the mitochondrial membrane, carrying respiratory enzymes.

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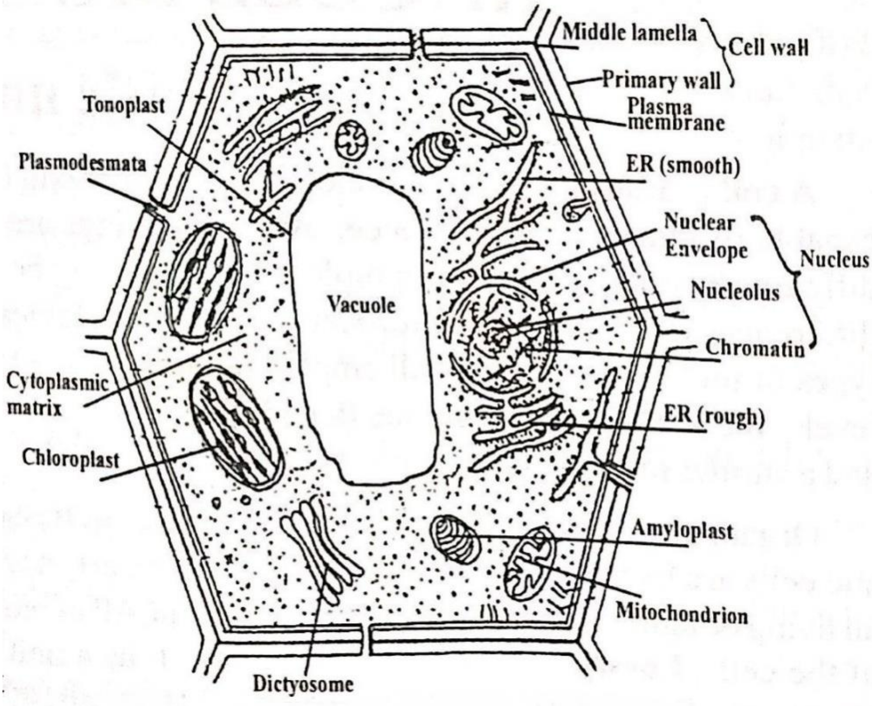
32. EUKARYOTIC CELL STRUCTURE



1. The cell was first discovered and named by Robert Hooke in 1665.
2. Plant cell has a distinct and definite shape because of the rigid cell wall, made up of cellulose.
3. Plant cell has nucleolus, nucleus, rough ER, smooth ER, ribosomes, golgi apparatus, cytoskeleton, mitochondrion, peroxisome, and plasma membrane.
4. Golgi complex is dispersed throughout the cytoplasm. Vacuoles are very fewer and larger.
5. The following are organelles that can be found in typical plant cells:
   - **Cell Wall** - outer covering of the cell that protects the plant cell and gives it shape.The cell wall is a rigid layer that surrounds the plant cells. It is made up of cellulose.
   - **Chloroplast** - the sites of photosynthesis in a plant cell. They contain chlorophyll, a green pigment that absorbs energy from sunlight.

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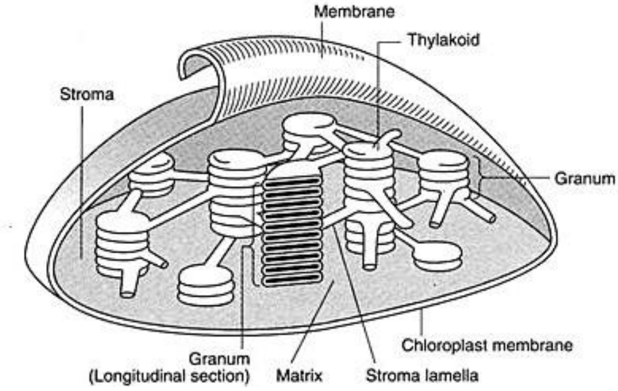
33. ULTRA STRUCTURE OF CHLOROPLAST



1. Chloroplasts are the site of photosynthesis in eukaryotic cells.
2. Each chloroplast is enclosed (surrounded by) a chloroplast envelope consisting of three layers:
   i. The outer membrane is a phospholipid membrane
   ii. The intermembrane space
   iii. The inner membrane is a phospholipid membrane
   Overall, the chloroplast envelope is semi-permeable. It is permeable to glucose molecules and certain ions including Fe2+ and Mg2+, and oxygen and carbon dioxide.
3. The chloroplast matrix is called the stroma and contains enzymes that catalyse the light-independent reactions of photosynthesis.
4. Thylakoids are also referred to as thylakoid membranes. They are disc-shaped structures that are the sites of light absorption at which the light-dependent reactions of photosynthesis take place.
5. Thylakoids are arranged in stacks called grana (plural).

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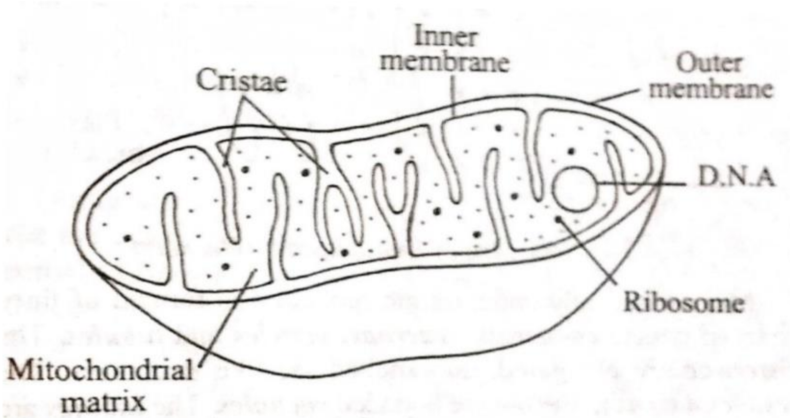
34. ULTRA STRUCTURE OF MITOCHONDRIA



1. Mitochondria are known as the powerhouses of the cell.
2. Mitochondria have a distinctive oblong or oval shape and are bounded by a double membrane. The inner membrane is folded creating structures known as cristae.
3. Mitochondria have characteristic morphologies despite variable appearance. Typical mitochondria are bean shaped organelles but may be round or threadlike.
4. The size and number of mitochondria reflect the energy requirements of the cell.
5. Inner and outer mitochondrial membranes enclose two spaces: the matrix and Inter membrane space.

   The outer mitochondrial membrane serves as its outer boundary.

   • The inner mitochondrial membrane is subdivided into two interconnected domains:

   • Inner boundary membrane

   • Cristae – where the machinery for ATP is located.

5. The outer membrane is about 50%; the inner membrane is more than 75% protein.
6. The inner membrane contains cardiolipin but not cholesterol, both are true of bacterial membranes.

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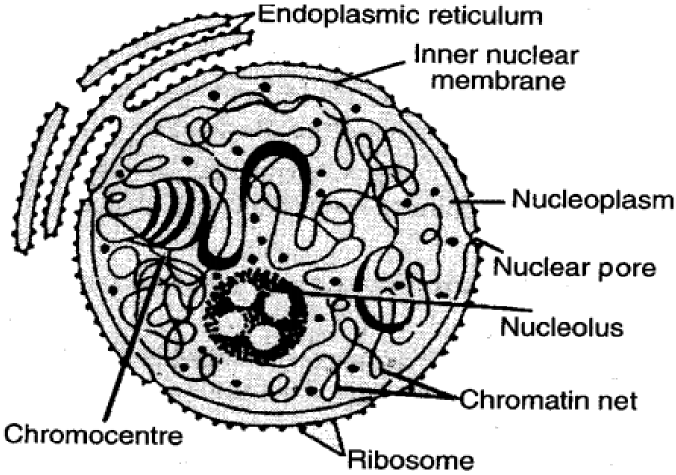
35. ULTRA STRUCTURE OF NUCLEUS



1. The cell nucleus is a membrane bound structure that contains the cell's hereditary information and controls the cell's growth and reproduction. It is the command center of a eukaryotic cell and is commonly the most prominent organelle in a cell.
2. The cell nucleus is bound by a double membrane called the nuclear envelope. This membrane separates the contents of the nucleus from the cytoplasm.
3. Like the cell membrane, the nuclear envelope consists of phospholipids that form a lipid bilayer. The envelope helps to maintain the shape of the nucleus and assists in regulating the flow of molecules into and out of the nucleus through nuclear pores.
4. The nuclear envelope is connected with the endoplasmic reticulum (ER) in such a way that the internal compartment of the nuclear envelope is continuous with the lumen of the ER.

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36. STAGES OF MITOSIS

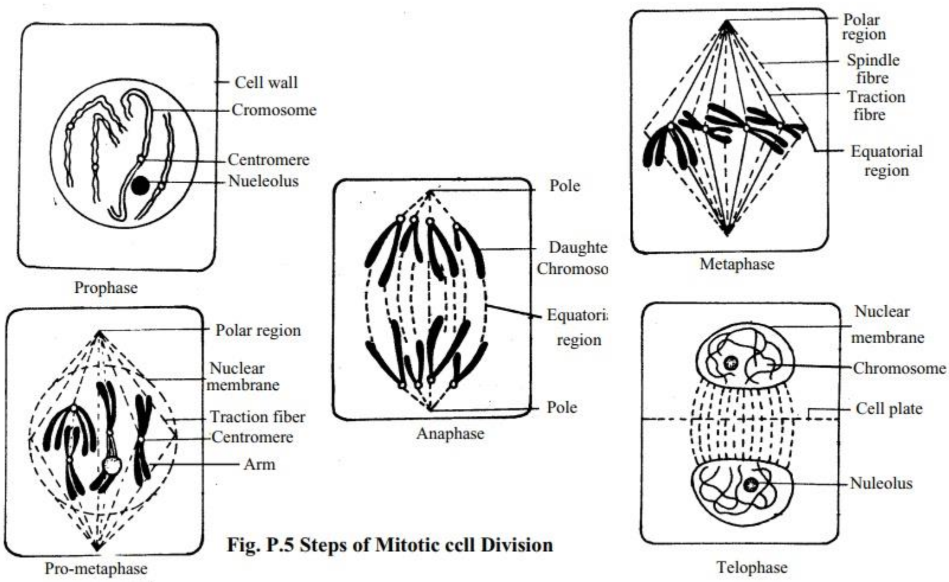

Fig. P.5 Steps of Mitotic ccll Division

PROPHASE:

- Prophase is the beginning stage of the mitotic phase. During prophase, the chromatin reticulum condenses into shorter and thicker structures called chromosomes.
- The chromatin reticulum appears as a definite, constant number of chromosomes.
- Each chromosome splits into two chromatids. The chromatids are in very close association with each other along their length.
- The chromatids are held together by the centromere or kinetochore.

METAPHASE:

- The disappearance of the nuclear membrane marks the beginning of metaphase.
- During this stage, the chromosomes are arranged on the equatorial plane in the middle of the spindle.
- Each chromosome gets attached to the spindle at the centromere region. The chromatids with their centromeres are clearly visible. It is a very short stage.

ANAPHASE:

- Anaphase starts with the division of the centromere. The two chromatids of each chromosome move apart.
- They move towards the opposite poles, caused by the reduction of spindle fibers.
- During anaphase, two identical sets of chromatids or daughter chromosomes move and group at opposite poles of the cell.

TELOPHASE:

- Telophase is more or less a reversal of prophase. The spindle disappears.
- The chromatids, which have moved to opposite poles, uncoil and lengthen into slender threads called chromatin fibers once again.

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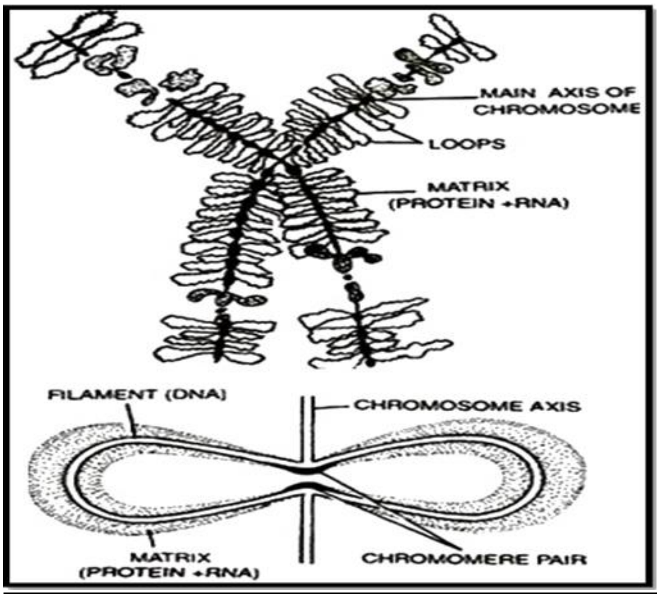
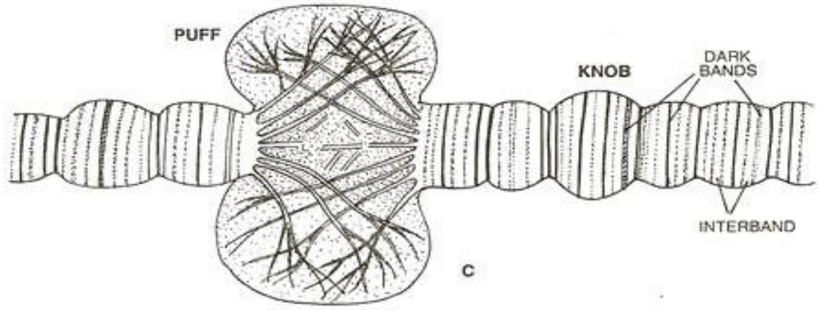
37. GIANT CHROMOSOMES





When the demand of any particular amino acid in a cell or organism increases, then amplification in the gene takes place i.e., there is an increase in copy number of genes to fulfil the demand of amino acid, making the chromosome giant.

Types of Giant Chromosome:

1. Lamp brush chromosome:

- Found in primary oocytes of vertebrates and invertebrates.
- They have master gene (regulates the function of slave gene), slave gene, loop hair (they contain newly formed RNA or nascent RNA).

2. Polytene/ Salivary gland chromosome:

- Found in the cell salivary gland of Drosophila.
- Chromosome with many chromatids.
- Formed as a result of non- disjunction of chromosomes during anaphase.

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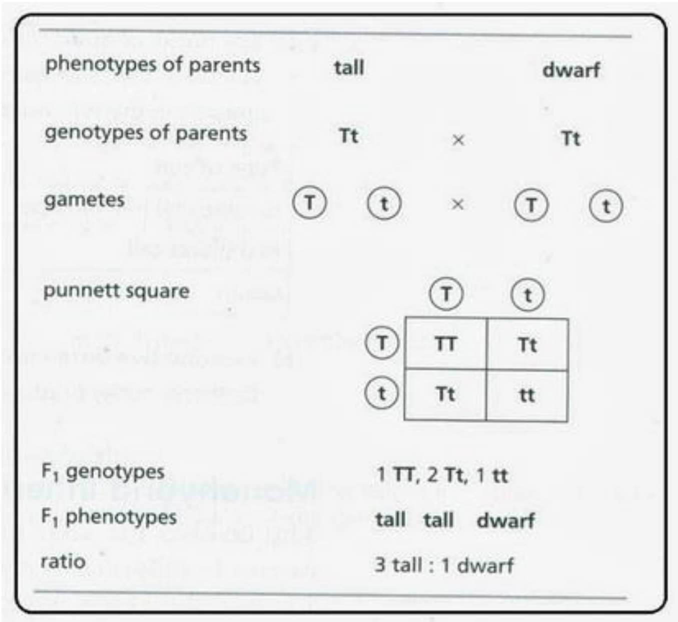
38. MONOHYBRID CROSS

1. A monohybrid cross is the hybrid of two individuals with homozygous genotypes which result in the opposite phenotype for a certain genetic trait.
2. The cross between two monohybrid traits (TT and tt) is called a Monohybrid Cross.
3. Monohybrid cross is responsible for the inheritance of one gene. It can be easily shown through a Punnett Square.

4. Monohybrid cross is used by geneticists to observe how homozygous offspring express heterozygous genotypes inherited from their parents.



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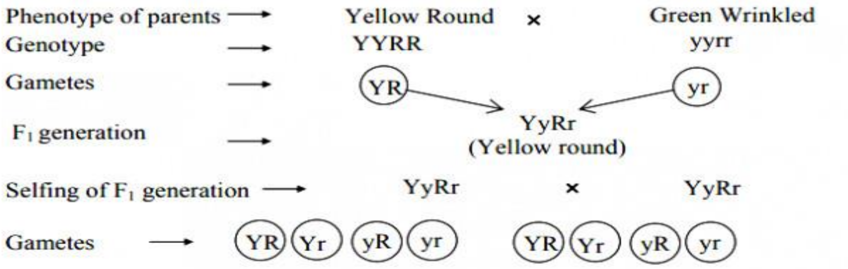
<u>39. DIHYBRID CROSS</u>

1. Dihybrid cross is the cross between two different genes that differ in two observed traits.
2. Mendel took a pair of contradicting traits together for crossing, for example colour and the shape of seeds at a time. He picked the wrinkled-green seed and round-yellow seed and crossed them.
3. He obtained only round-yellow seeds in the F1 generation. This indicated that round shape and yellow colour of seeds are dominant in nature.
4. Meanwhile, the wrinkled shape and green colour of seeds are recessive traits. Then, F1 progeny was self-pollinated.

5. This resulted in four different combinations of seeds in the F2 generation. They were wrinkled-yellow, round-yellow, wrinkled-green seeds and round-green in the phenotypic ratio of 9:3:3:1.



F2 generation →

♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

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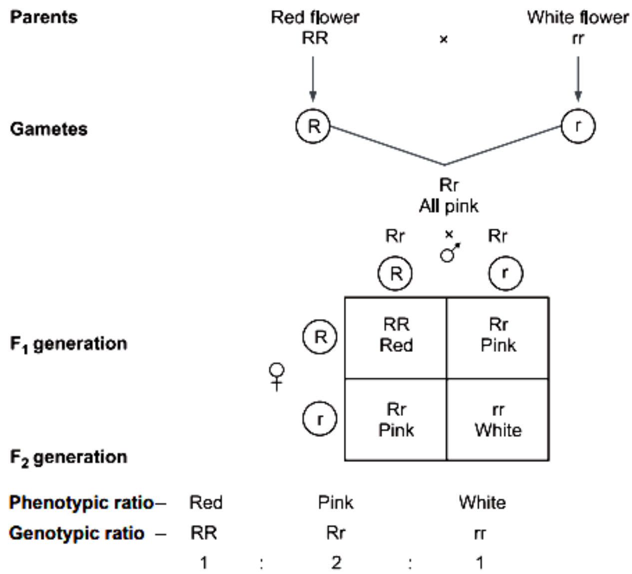
40. INCOMPLETE DOMINANCE

1. Incomplete dominance is a form of intermediate inheritance in which one allele for a particular trait is not expressed completely over its paired allele.
2. Incomplete dominance is a form of Gene interaction in which both alleles of a gene at a locus are partially expressed, often resulting in an intermediate or different phenotype. It is also known as partial dominance.
3. When none of the factors of a gene is dominant, the phenotype of a heterozygous dominant individual is a blend of dominant and recessive traits.This is called as incomplete dominance. For example, flower colour in Mirabilis jalapa.
4. The red flower is the dominant character and the white flower is recessive character. There is blending of the two alleles.

5. The flowers in the F1 generation will be pink in colour due to mixing of the alleles.



Monohybrid cross in Snapdragon, where one allele is incompletely dominant over the other allele

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41. EXPLANTS

1. Explant culture is a technique used for the isolation of cells from a piece or pieces of tissue. Tissue harvested in this manner is called an explant. It can be a portion of the shoot, leaves or some cells from a plant.
2. Explant is referred to as the cell or tissue which is taken from a particular body and then placed in a culture medium for growth.
3. In terms of plants, the explant is the small pieces of plant part and issues that are aseptically cut and then they are kept in a nutrient medium.
4. For the culture, this can be taken from different plant parts which can dedifferentiate into totipotent cells.
5. The explants are placed in the aseptic condition and the nutrient medium.

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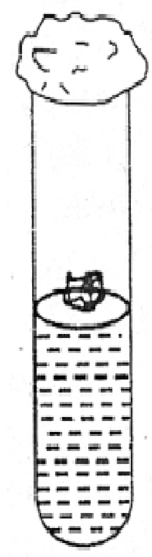
42. CALLUS



1. Callus is a group of undifferentiated cells that is formed from the explant in a sterilised nutrient medium during tissue culture.

2. The mitotic divisions of the explant result in callus formation.

3. Callus is unorganized actively dividing the mass of cells maintained in culture.

4. It has a meristematic cell which has ample amount of cytoplasm to trigger cell division.

5. It is treated with the growth hormones to allow the cell division and differentiation.

6. Callus when treated with auxin it promotes rooting and when it is treated with cytokinin it stimulates cell maturation, differentiation and finally, promotes the development of stem.

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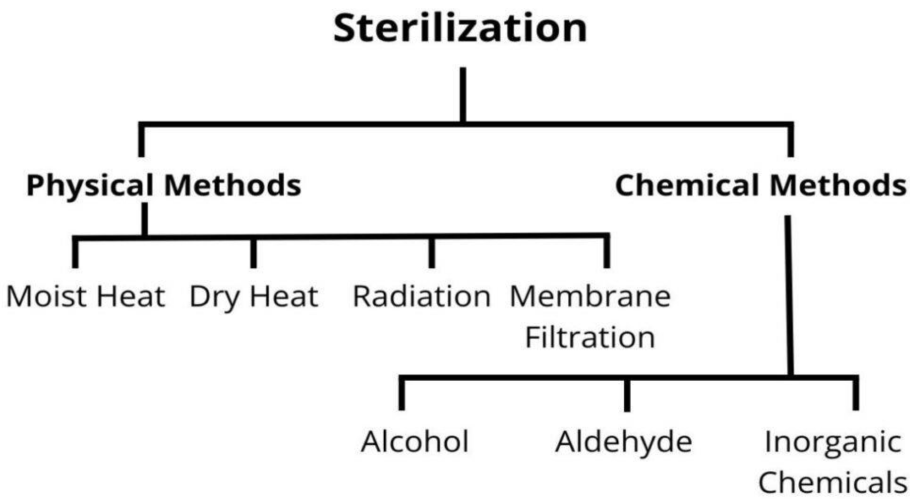
43. STERILIZATION



1. Sterilization is the process of inactivating or removing all living organisms from a substance or surface. Different kinds of sterilization procedures were adapted in plant tissue culture.

2. Heating: Dry heat (e.g., Hot air oven) is used for glassware and Steam or moist or wet heat (e.g., Autoclave) is used for sterilization of media and fermenter vessels.

3. Radiation: UV radiation and high efficiency particulate air (HEPA) filter in laminar air-flow chamber used for sterilization of transfer area.

4. Chemicals: 95 % ethanol used for sterilizing forceps, scalpels, needles etc., Hypochlorite solutions (sodium or calcium) and antibiotics are used as sterilizing agents to disinfect plant tissues.

5. Ultra-filtration: The solution of thermolabile compounds (e.g., vitamins, antibiotics etc.) is sterilized by membrane filtration.

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44. M.S MEDIA

Macronutrients	mgL^{-1}
KNO_3	1900
NH_4NO_3	1650
$CaCl_2 . 2H_2O$	440
$MgSO_4$	370
KH_2PO_4	170
Micronutrients	
$MnSO_4 . H_2O$	16.9
H_3BO_3	6.2
Kl	0.83
$ZnSO_4 . 4H_2O$	8.6
$NaMoO_4 . 2H_2O$	0.25
$CuSO_4 . 5H_2O$	0.025
$CoCl_2 . 6H_2O$	0.025
FeNa/EDTA	36.8
Vitamins	
Myo-inositol	100
Nicotinic acid	0.5
Pyridoxine	0.5
Thiamine	0.1
Glycine	2.0
Carbon source	
Sucrose	30,000
Solidifying agent	
Agar	6,000
pH	5.8

1. Murashige and Skoog medium (or MSO or MS0 (MS-zero)) is a plant growth medium used in the laboratories for cultivation of plant cell culture.
2. MS0 was invented by plant scientists Toshio Murashige and Folke K. Skoog in 1962 during Murashige's search for a new plant growth regulator.
3. A number behind the letters MS is used to indicate the sucrose concentration of the medium.
4. Since then, it is widely used for micro propagation, organ culture, callus culture and suspension culture.
5. The formulation is a nutrient blend of inorganic salts, vitamins and amino acid.

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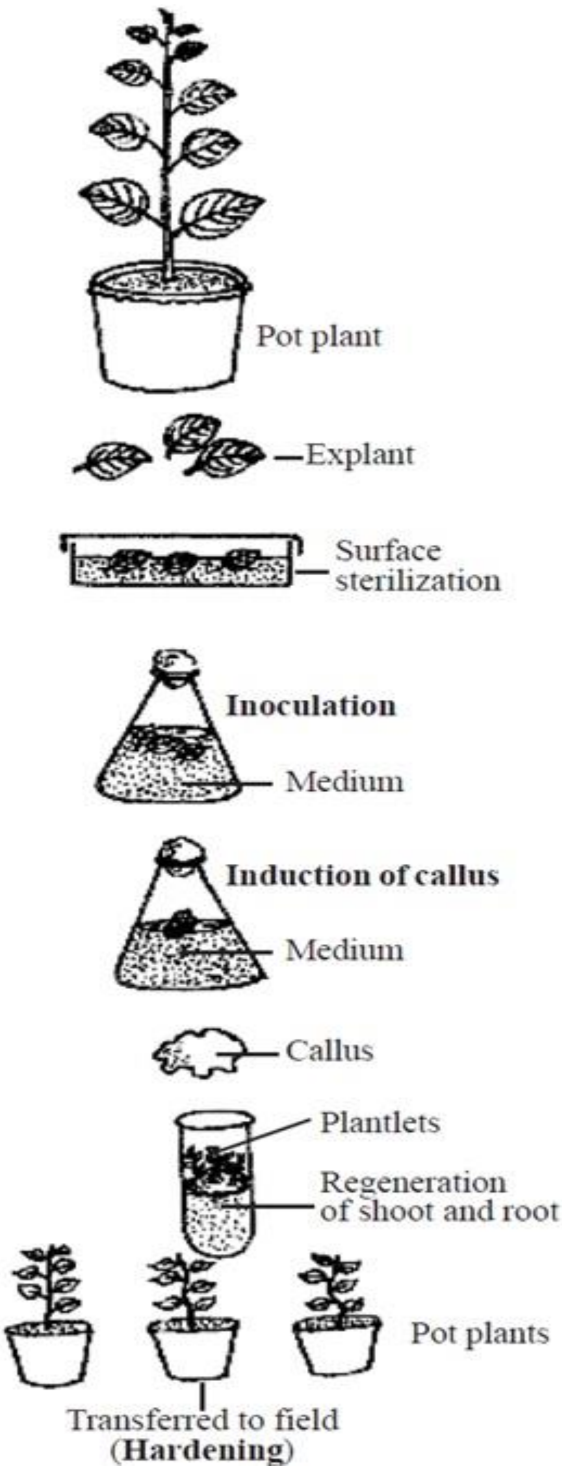
45. HARDENING

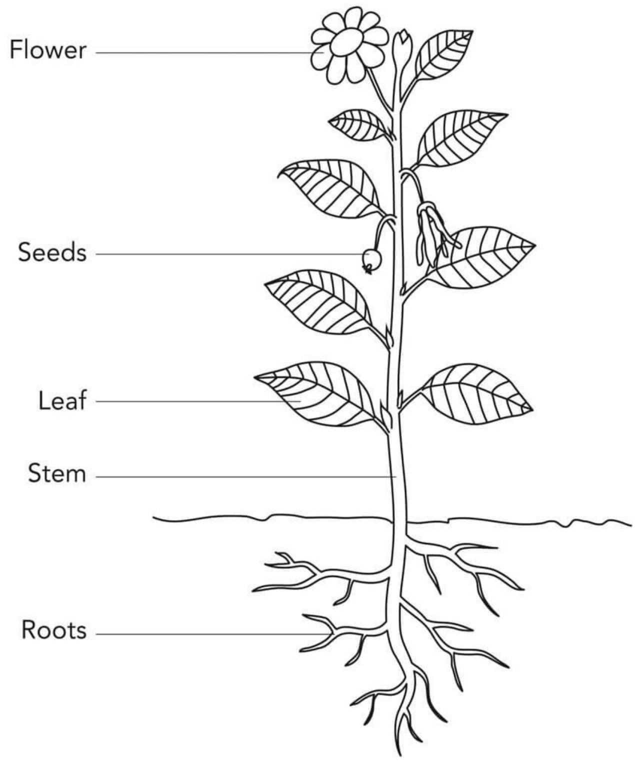
1. Gradual exposure of plantlets to outdoor environment for acclimatization is called hardening.
2. It enables the plantlets to tolerate the natural environments in which they have to be grown.
3. If the regenerated plantlets are transplanted in the field without hardening, they wilt and die off very soon because of susceptibility to the environment.
4. The regenerated plants plantlets are transferred to large bottles containing nutrient medium and kept in constant temperature room with illumination.
5. It helps for growth of roots and shoots within a week. This step is called first stage hardening.


Pot plant
Explant
Surface
sterilization
Inoculation
Medium
Induction of callus
Medium
Callus
Plantlets
Regeneration
of shoot and root
Pot plants
Transferred to field
(Hardening)

SEMESTER - II

ALLIED BOTANY - II

1. PARTS OF A DICOT PLANTS



1. Morphology- (Morphe = form + logos = study). It deals with the study of forms and features of different plant organs like roots, stems, leaves, flowers, seeds, fruit etc.
2. The body of a typical angiosperm plant is differentiated into:
    a. an underground
    b. an aerial shoot system
3. The shoot system consists of stem (including branches), leaves, flowers and fruits.
4. The roots, stems and leaves are vegetative parts, while flowers constitute the reproductive part.

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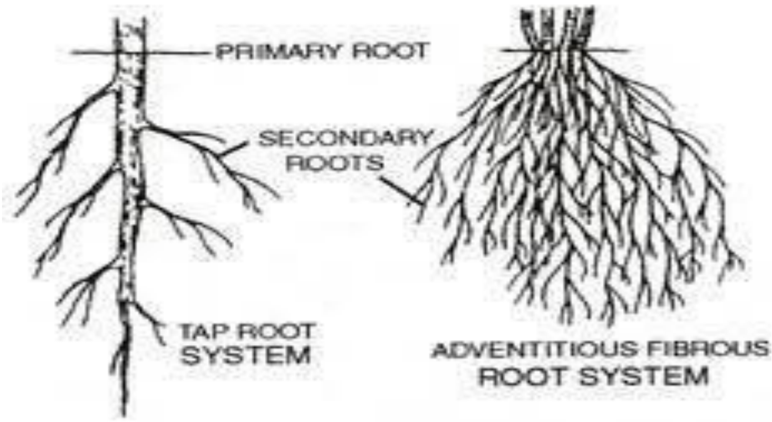
2. ROOT SYSTEM - TAP ROOT AND FIBROUS ROOT



TAP ROOT:

- It develops from radicle and made up of one main branch and other sub branches.
- The primary roots and its branches constitute tap root system.
  E.g: Dicot roots.

FIBROUS ROOT:

- The fibrous root is fibre- like, developing as a cluster from the base of the stem and it is characteristic of monocot plant.
- In monocot plants the primary root developing from the radicle is shoot lived and it is replaced by the fibrous roots.

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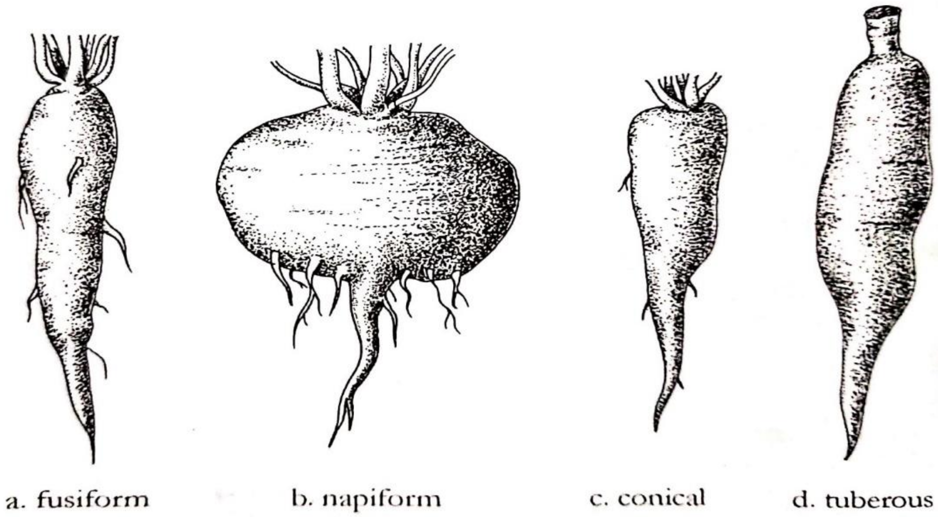
3. ROOT MODIFICATION



1. **Conical:** Base is broad and tapers gradually towards apex; Example - carrot
2. **Fusiform:** Swollen in middle, tapering toward both ends; Example - radish
3. **Napiform:** Spherical at base tapering sharply towards the tip; Example - turnip, beetroot
4. **Tuberous:** Thick and fleshy with no definite shape; Example: Mirabilis jalapa (4 O'clock plant).

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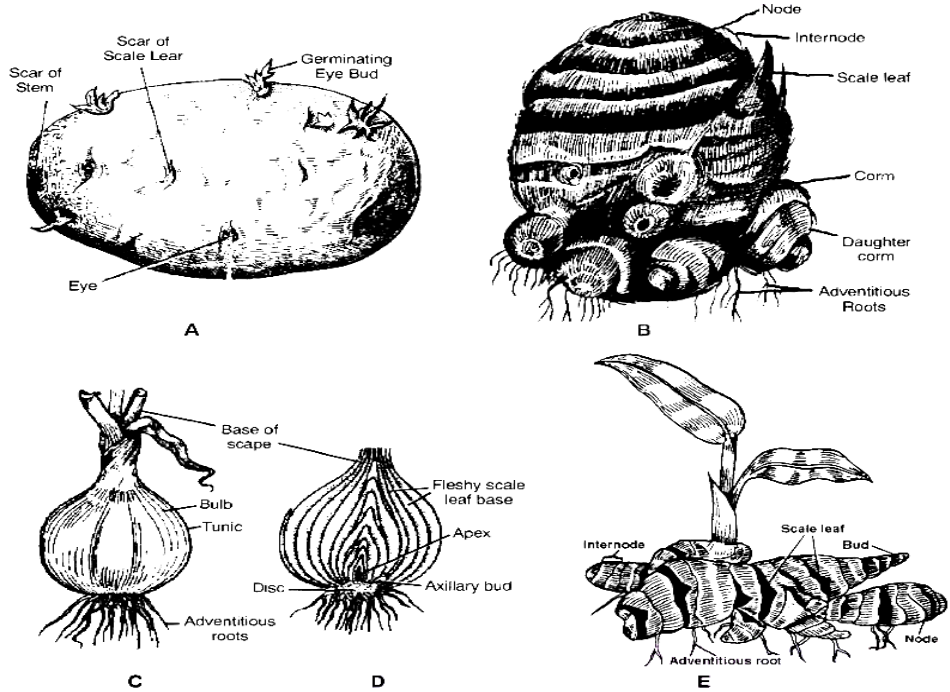
4. UNDER GROUND STEM MODIFICATION



1. **Rhizome**- is a thickened underground stem that has distinct nodes and internodes and scaly leaves at the nodes. Example: Ginger.
2. **Tuber**- is a horizontal underground stem that becomes enlarged at its growing tips due to the accumulation of stored food, commonly starch. E.g. Potato.
3. **Bulb**- It is a short underground stem with a fleshy base with leafy scales. The stem is actually reduced to form a disc-like structure. The nodes bear fleshy scales. On the upper side, the disc bears a terminal bud surrounded by a number of leaves. E.g. Onion.
4. **Corm**- is a short, vertical, swollen underground stem of a plant that serves as a food storage organ to enable the plant to survive adverse conditions. E.g*Colocasia*.

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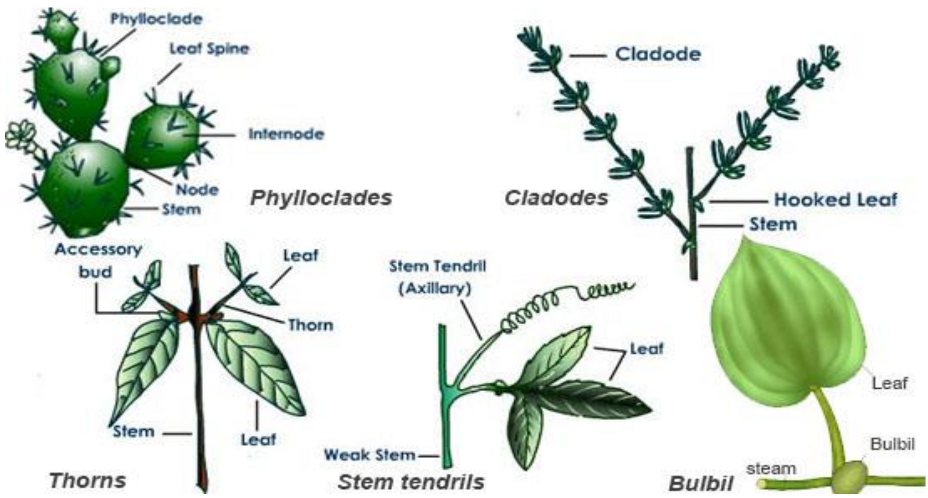
5. AERIAL STEM MODIFICATION



Whole stem or its part (axillary or terminal bud) gets modified to perform definite functions. You can recognize them as stems by following features:

(i) Arise in the axil of leaf
(ii) Bear nodes and internodes
(iii) may bear leaves, buds, flowers

Stem tendrils:

Thread like, spirally coiled, leafless structures (tendrils) which twine around neighboring objects and help weak plants to climb. Example: Grape vine

Thorns:

Straight, pointed, hard structures; modifications of axillary (Citrus) or terminal (Carissa) bud; act as defense organs or as climbing organs. Examples: Citrus, Duranta Carissa

Phylloclade:

Green, flattened or cylindrical fleshy stem, with nodes and internodes; bears spines (modified leaves to check evaporation); carries out photosynthesis, stores water. Found in plants growing in dry regions. Example: Opuntia

Cladode:

It is a phylloclade with limited growth i.e. with only one or two internodes; help in photosynthesis. Example: Asparagus

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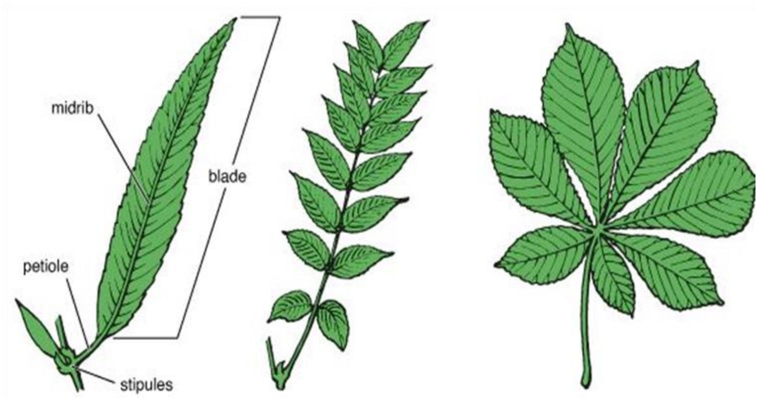
6. LEAVES



- The leaf is a lateral generally flattened structure borne on the stem.
- The leaves develop from the nodes.
- Their main function is photosynthesis and food making, axillary buds are found in its axil.
- All the leaves of a plant are known as phyllome.
- Axillary bud later develops into a branch. Leaves originated from shoot apical meristem and are arranged in acropetal order.

Types of Leaf:

1. **Simple leaf:**
   A leaf which may be incised to any depth, but not down to the midrib or petiole, then this type of leaf called simple leaf E.g: mango, Ficus
2. **Compound leaf:**
   A leaf in which the leaf blade is incised up to the midrib or petiole, thus dividing it into several small parts, known as leaflets. This type of leaf is known as compound leaf.

Types:

1. **Pinnately compound leaf:** In this type of leaf midrib is known as rachis. Leaflets are arranged on both sides of rachis. E.g: Neem

2. **Palmate compound leaf:** In this type incision of leaf are directed from leaf margin to apex of petiole and all leaflets are attached on the upper end of petiole.

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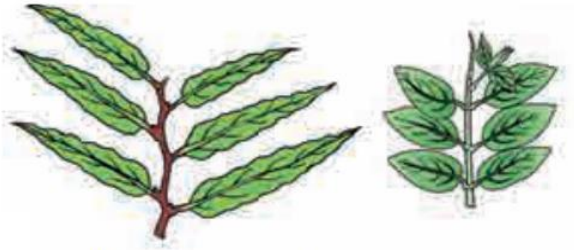
7.PHYLLOTAXY



Alternate *Polyalthia* Opposite Superposed *Guava*

Opposite Decussate *Calotropis* Ternate *Nerium* Whorled *Allamanda*

The patterns of arrangement of leaves on the stem are called Phyllotaxy. Plants show three types of phyllotaxy- alternate, opposite and whorled types of phyllotaxy.

- When only a single leaf develops at each node alternatively, it is an alternate type of phyllotaxy. E.g. China rose.
- When a pair of leaves develops at each node opposite to each other, it is called opposite phyllotaxy. E.g. Guava plants.
- When more than two leaves develop at the nodes to form a whorl of leaves, it is called whorled phyllotaxy. E.g. Alstonia.

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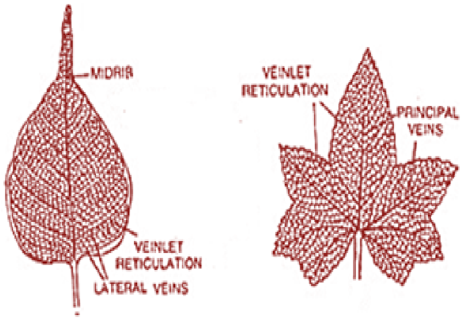
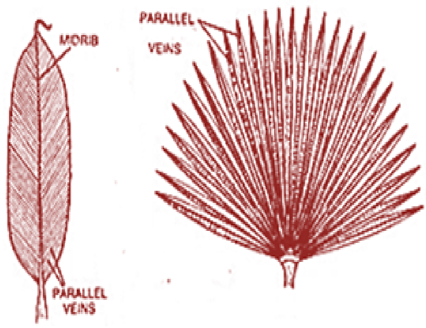
8. VENATION



Reticulate venation; unicostate and multicostate



Parallel venation; unicostate and multicostate

1. Leaf venation is the arrangement of veins in lamina of the leaf.
2. The veins are composed of vascular tissues which are vital for the transport of food and water.
3. Leaf veins connect the blade to the petiole, and lead as of the petiole to the stem.
4. The two main vascular tissues in leaf veins are xylem, which is important for transport of water and soluble ions into the leaf, and phloem which is vital for transport of carbohydrates made by photosynthesis from the leaf to the rest of the plant.
5. Two types of venations are reticulate venation and parallel venation.
6. When the veins are irregularly distributed to form a channel, it is known as reticulate venation.
7. When the veins are parallel and do not form a network, it is known as parallel venation.

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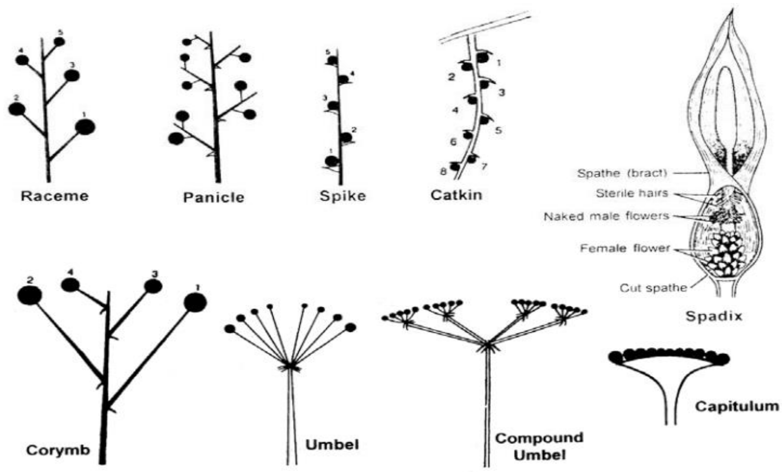
9. INFLORESCENCE - RACEMOSE



1. In this type of inflorescence, the main axis continues to grow and does not terminate in a flower and give off flower laterally in acropetal manner where old flowers are arranged towards base and young flowers are at tip.
2. When peduncle is broad then flowers are centripetally arranged.

Types:

1. **RACEME:** when peduncle is elongated and flowers are pedicellate
2. **Spike:** In its peduncle is elongated but flowers are bisexual and sessile.
3. **Catkin:** In its peduncle is thin, long and weak, and flowers are sessile and unisexual. Peduncle is pendulus.
4. **Spadix:** In its peduncle is thick, long and fleshy and have small sessile and unisexual male and female flowers covered with one or more green colourful bracts known as spathe.
5. **Corymb:** in its peduncle is short and all flowers are present at same level because the lower has much long pedicle than the upper one

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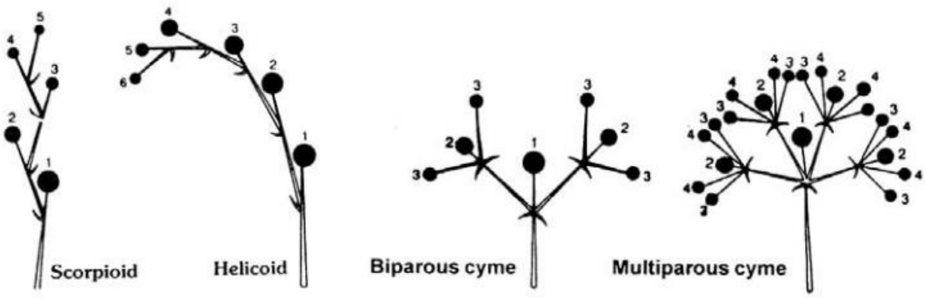
10. INFLORESCENCE - CYMOSE



1. In this type of inflorescence, the peduncle terminates in a flower. In it the older flowers are present at tip and young buds are arranged towards base. This arrangement is called basipetal succession.

Types:

a) **Uniparous cyme/ monochasial cyme:**
The peduncle ending in a flower producing lateral branch at the time of ending in flower. It is two types
Helicoid cyme: When all lateral branches developed on the same side on peduncle then it is called helicoid cyme.
Scorpioid cyme: In it the lateral branch is alternately develop on left and right side.
Riphidium: in monochasial cyme all flower is borne on same plane.

b) **Dichasial or biparous cyme:**
In its peduncle ends in a flower, from the basal part of peduncle two lateral branches arise, which also end in a flower, now this same arrangement occurs on these lateral branches.

c) **Multiparous cyme/ polychasial:**
In its peduncle ends in a flower and from the base of it many lateral branches arise which also terminates in flower, this arrangement now also occurs on these lateral branches.

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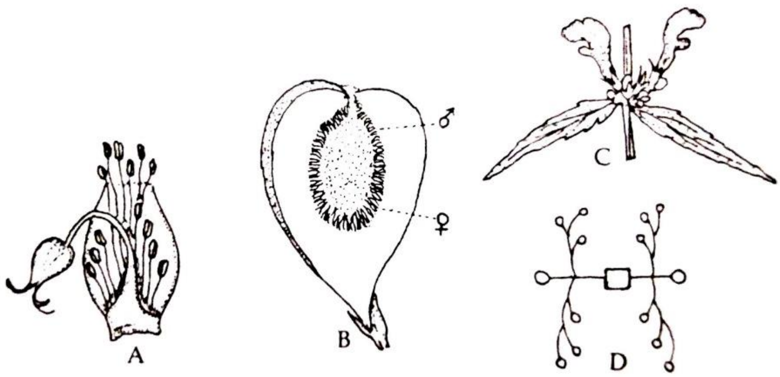
11. SPECIAL TYPES OF INFLORESCENCES



1. Cyathium:

It contains a cup-shaped involucre provided with nectar-secreting glands. A female flower is enclosed within the involucre. A number of male flowers surround the female flowers.

2. Hypanthodium:

The receptacle forms a hollow cavity and has an apical opening protected by scales.

3. Verticillaster:

It is a condensed form of a dichasial cyme with a cluster of sessile and sub-sessile flowers.

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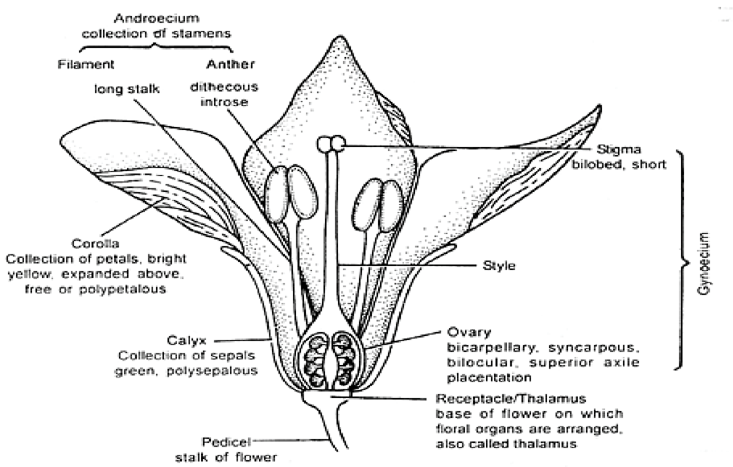
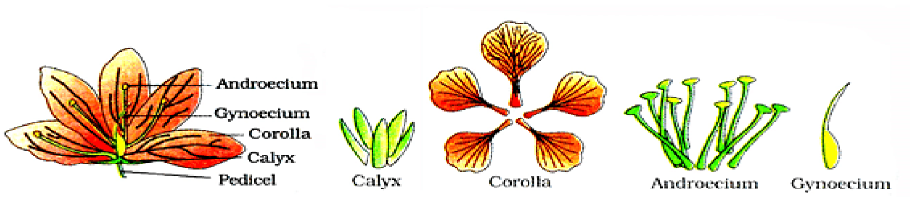
12. PARTS OF THE FLOWERS





Parts of a flower

1. Flower is defined as highly condensed and modified reproductive shoot.
2. The part from where flower arise is called bract.
3. Flower has short or long flower stalk which is called pedicel.
4. The upper part of pedicel is swollen, spherical or conical which is called thalamus/receptacle.
5. The outermost whorl of the flower is called calyx.
6. Inner to the calyx, the next whorl of the flower is called corolla.
7. Androecium lies next to the corolla. The androecium is the male reproductive structure of the flower and is composed of a number of stamens.
8. The innermost essential whorl is the gynoecium or pistil. It is situated in the centre of the flower.
9. The gynoecium is the female reproductive structure of the flower.

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13. RUTACEAE

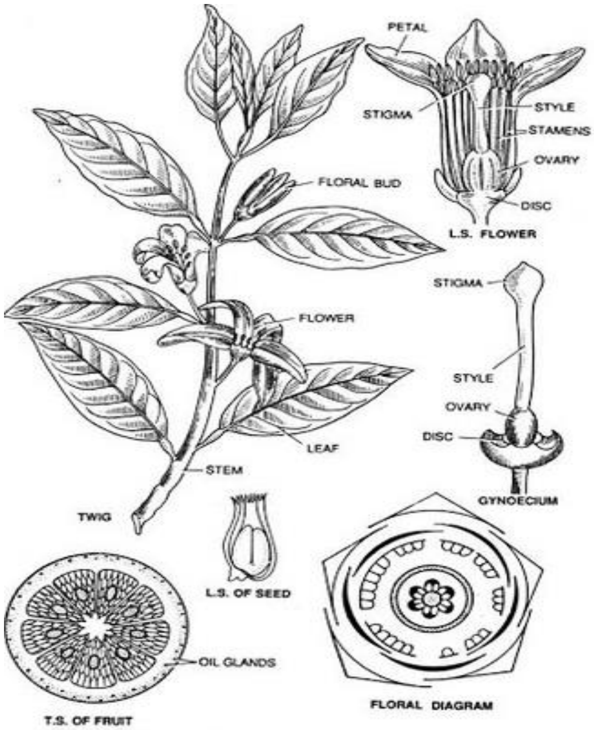

Fig. 18.1. Rutaceae, *Citrus aurantium* Linn., Orange; Verna, Narangi.

Systematic Position

Class: Dicotyledons
Sub-class: Polypetalae
Series: Disciflorae
Order: Geraniales
Family: Rutaceae

The family Rutaceae is commonly called orange family. The common plants are Orange, Lime, Vilvam, Vilampalam, Curry leaf.

Distinguishing Characters of the Family Rutaceae

1. The plants are shrubs or trees, rarely herbs.
2. Leaves are simple or compound, ex-stipulate and gland-dotted (pellucid punctate)
3. The inflorescence is cyme or panicle.
4. The flowers are bisexual, bracteate, bracteolate, actinomorphic and hypogynous.
5. Calyx consists of 5 sepals, gamosepalous with imbricate or valvate aestivation.
6. Corolla consists of 5 petals, polypetalous with valvate or imbricate aestivation.
7. Androecium consists of 8-10 obdiplostemonousstamens.
8. Gynoecium consists of five carpels, ovary superior, ovules are placed on axile placentation. Style is simple and the stigma is capitate. A large honey. Secreting disc is present below the ovary.
9. Fruit is a berry, capsule or hesperidium.
10. **Floral Formula:** Br, $\oplus$, ⚥, $K_{(5)}$, C_5, A_{5+5}, $G_{(2-5)}$

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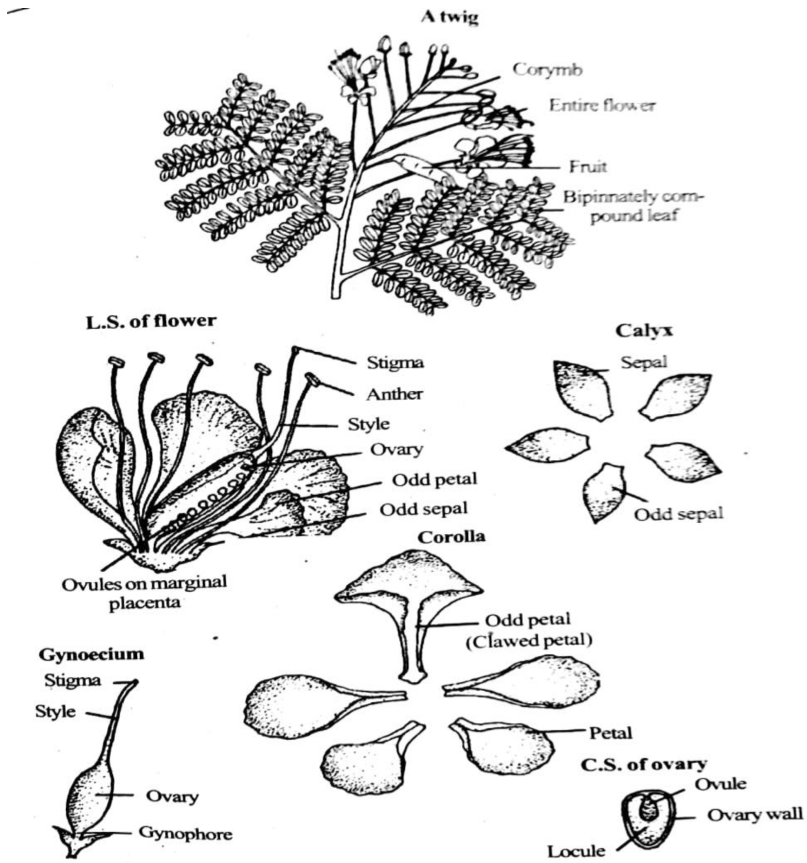
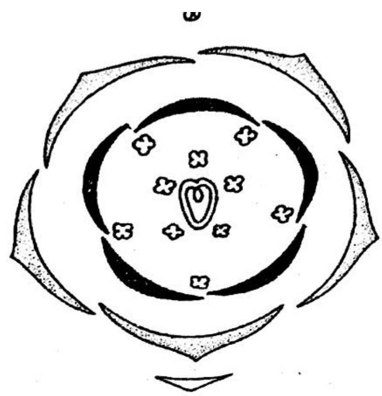
14. CAESALPINIOIDEAE

Systematic Position

Class: Dicotyledons
Sub-class: Polypetalae
Series: Calyciflorae
Order: Rosales
Family: Fabaceae
Sub-family: Caesalpinioideae

The sub-family Caesalpinioideae belongs to the family Fabaceae (Leguminosae). Hutchinson raised it to the rank of the family Caesalpiniaceae. It is popularly known as Cassia family





F.F: Br, ⚥, ⦶, K_5, C_5, A_{5+5}, G_1-

Distinguishing Characters of Caesalpinioideae

1. The plants are mostly trees, rarely shrubs.
2. The leaves are compound and alternate.
3. The inflorescence is a corymb or panicle.
4. Flowers are bisexual, irregular (zygomorphic) and perigynous.
5. The calyx consists of 4-5 sepals, polysepalous with imbricate aestivation.
6. The corolla consists of 4-5 petals, polypetalous with ascendingly imbricate aestivation.
7. The androecium consists of 10 free stamens, diplostemonous.
8. The gynoecium is monocarpellary, unilocular, ovules on marginal placentation. Ovary is half-inferior
9. Fruit is a legume.
10. Seeds are with or without endosperm.
11. **Floral formula:** Br, %, **⚥**, K_5, C_5, A5+5, G_{1-}

****

15. ASCLEPIADACEAE

Systematic Position

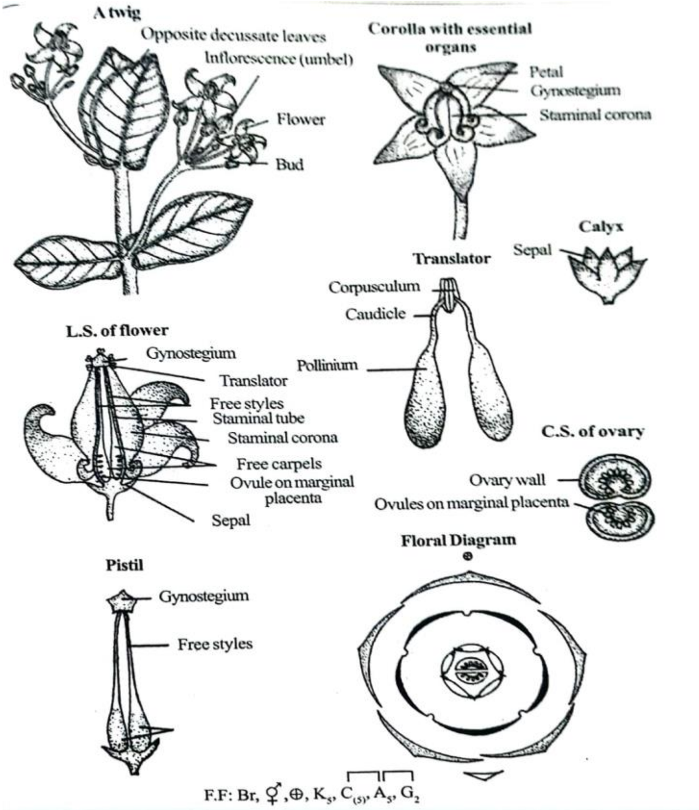
Class: Dicotyledons
Sub-class: Gamopetalae
Series: Bicarpellate
Order: Gentianales
Family: Asclepiadaceae

The family Asclepiadaceaeis popularly known as Milk – weed family.

Distinguishing Characters of Caesalpinioideae

1. The plants are herbs or shrubs or woody climbers with milky latex.
2. The leaves are simple, opposite, decussate and exstipulate.
3. The inflorescence is terminal or axillary. It is racemose or cymose type.
4. The Flowers are bisexual, hypogynous, actinomorphic, bracteate and bracteolate.
5. The calyx consists of 5 sepals, polysepalous with imbricated aestivation.

6. The corolla consists of 5 petals, gamopetalous with valvate or twisted aestivation. Corolla is provided with coralline corona.



7. The androecium consists of 5 stamens that alternate with the petals, epipetalous. The filaments form a tube around gynoecium. The anthers are dithecous and are attached to the stigma to form the gynostegium or gynostemium. Pollen grains are present in the form of translators.
8. The gynoecium consists of 2 carpels, bicarpellary, sub – apocarpous, superior ovary, ovules on marginal placentation.
9. Pollination is brought about by the agency of insects (entomophily). Pollination mechanism is termed as clip mechanism or translator mechanism.
10. The fruit is a pair of follicles.
11. Seeds are endospermous with comose hairs.
12. **Floral formula:** Br, $\oplus$, ⚥, K_5, $C_{(5)}$, A_5, $\underline{G}_{2}$.

****

16. EUPHORBIACEAE

Systematic Position

Class: Dicotyledons

Sub-class: Monochlamydeae

Series: Unisexuales

Family: Euphorbiaceae

The family Euphorbiaceae is commonly called "Spurge family"

Distinguishing Characters of Euphorbiaceae:

1. The plants are mostly herbs, shrubs or trees.
2. The leaves are simple, rarely compound, stipulate. Milky latex is present in the stem and leaves.
3. The inflorescence is racemose or cymose or special type called cyathium.
4. The flowers are unisexual, monoecious or dioecious, actinomorphic or zygomorphic, monochlamydeous or dichlamydeous.
5. The perianth consists of one or two whorls of perianth lobes. They are sepaloid or petaloid, free or united. Aestivation is valvate or imbricate.
6. Androecium of male flowers consists of one-to-many stamens.
7. Gynoecium of female flowers consists of 3 carpels, (tricarpellary) syncarpous, ovary superior with three terminal styles that are forked. One or two ovules are present on axile placenta.
8. Pollination is by insects (entomophily).
9. Fruit is a capsule.
10. **Floral formula:** Male flower: Br,**⊕,** ♂, K_5, C_5, A_∞, $\underline{G_0}$.

Female flower: Br,**⊕,** ♀, K_5, C_0, A_0, $\underline{G}$

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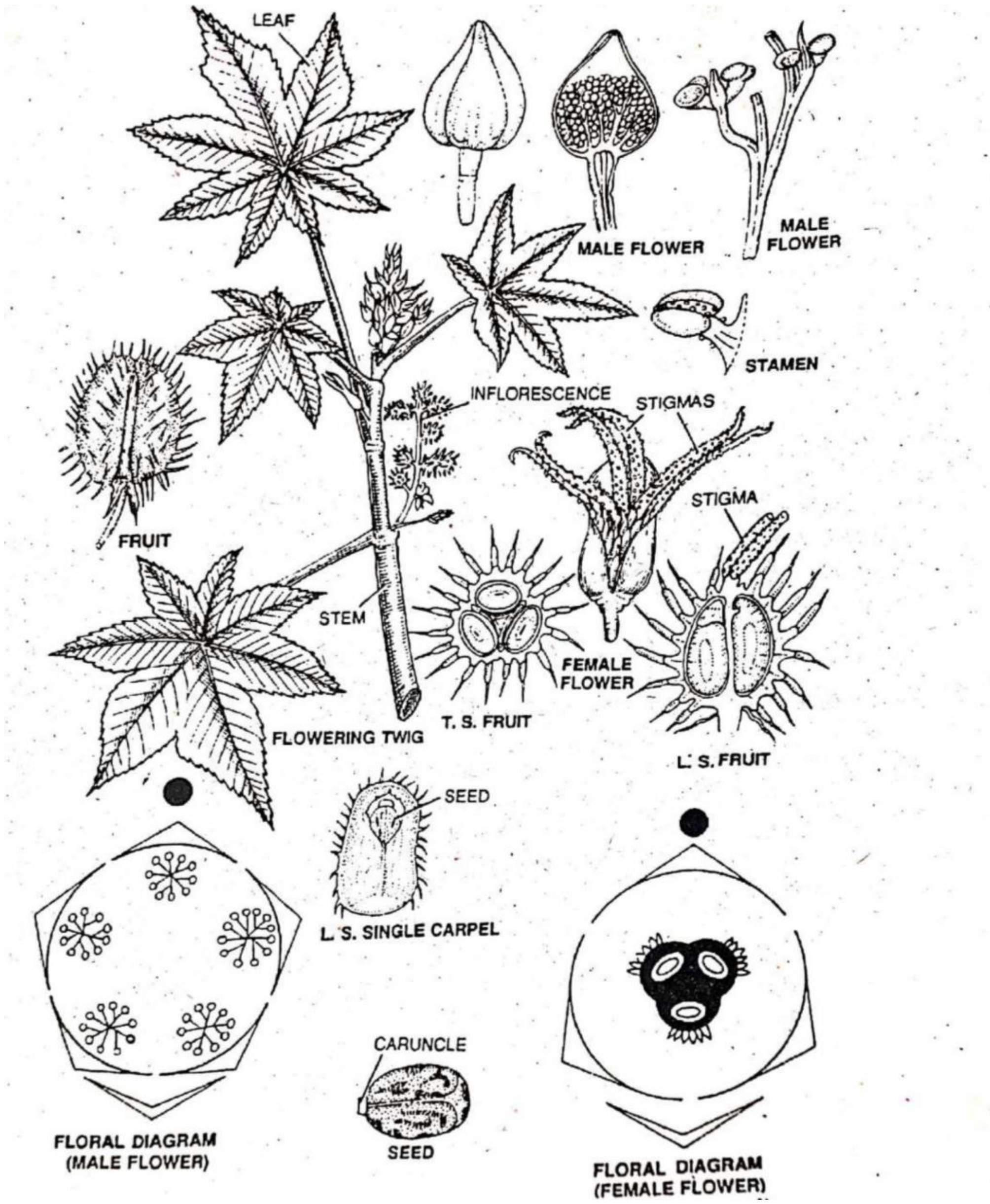


LEAF
MALE FLOWER
MALE FLOWER
STAMEN
INFLORESCENCE
STIGMAS
FRUIT
STIGMA
STEM
FEMALE FLOWER
T. S. FRUIT
FLOWERING TWIG
L. S. FRUIT
SEED
L. S. SINGLE CARPEL
CARUNCLE
SEED
FLORAL DIAGRAM (MALE FLOWER)
FLORAL DIAGRAM (FEMALE FLOWER)

17. CANNACEAE

Systematic Position

Class: Monocotyledons

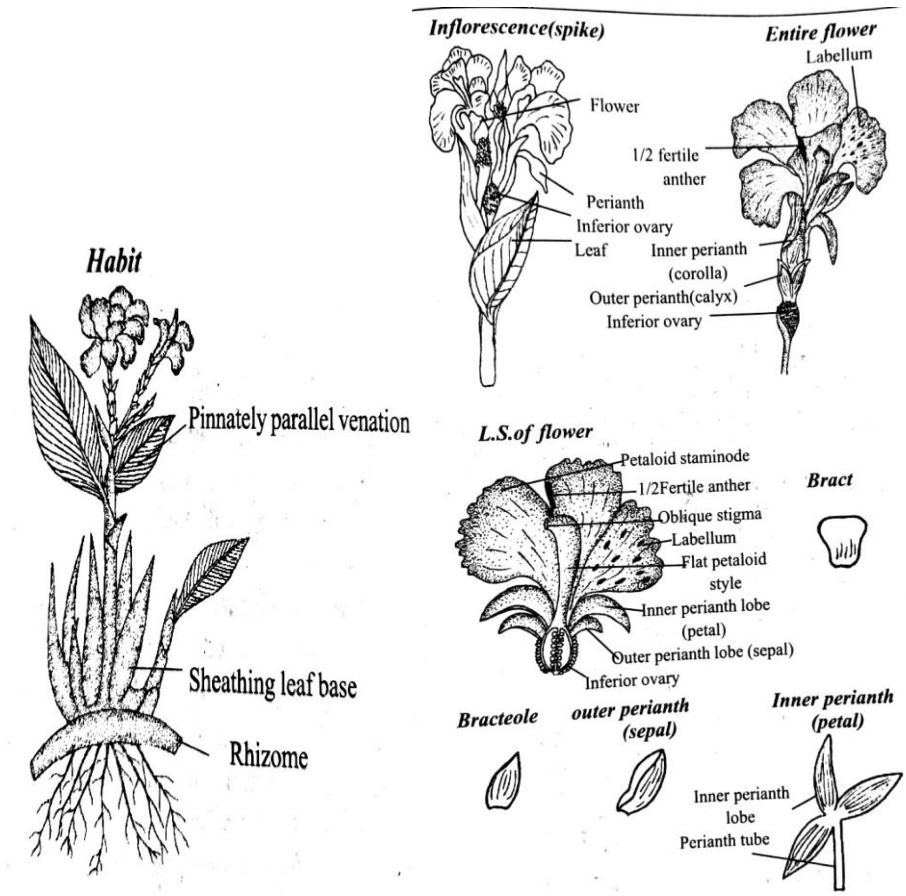
Series: Epigynae

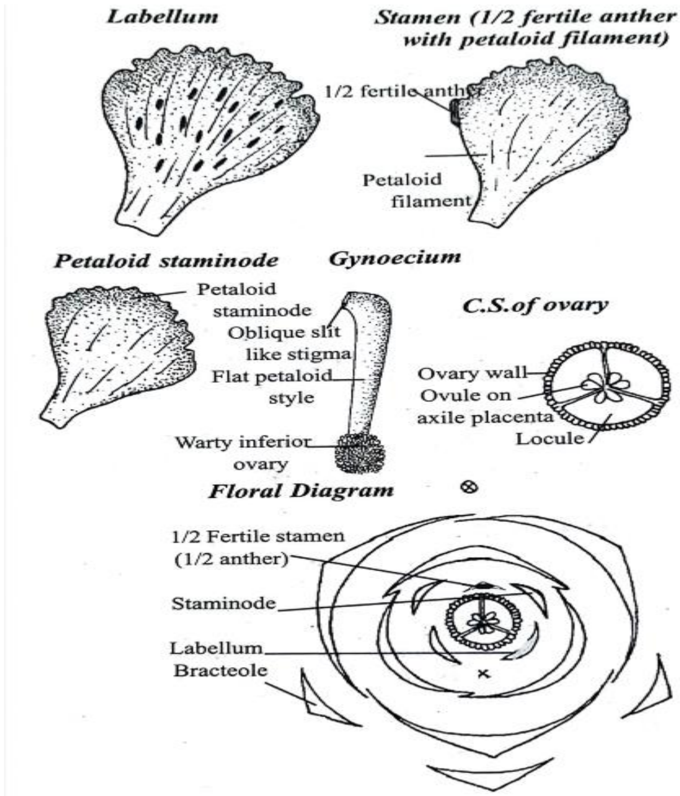
Family: Cannaceae

The family Cannaceae is commonly called “the canna family”. The common plant is kalvazhi

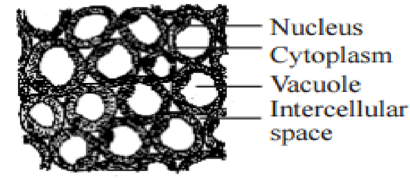
Distinguishing characters of the family Cannaceae.

1. Cannaceae is anunigeneric family with a single genus Canna.
2. They are perennial herbs with underground rhizome.
3. Leaves are simple with leaf sheath without ligule.
4. Inflorescence is a spike.
5. Flowers are bisexual, asymmetrical, epigynous and trimerous.
6. Perianth, consists of 6 lobes, arranged in two whorls (3+3).
7. They have single fertile stamen with half – anther.
8. Others stamens are modified into petaloidstaminodes.
9. One of the sterile staminodes is modified into labellum.
10. Style is petaloid and the stigma is oblique.
11. The gynoecium is tricarpellary, syncarpous, inferior, trilocular with many ovules on axile placenta.
12. The fruit is a warty, many seeded, loculicidal capsule.
13. The seeds are endospermic.
14. **Floral formula:** Br, Brl%**, ⚥**, $P_{3+(3)}$ C_5, $A_{1/2+5\ \text{Staminodes}}$, $G_{(3)}$-

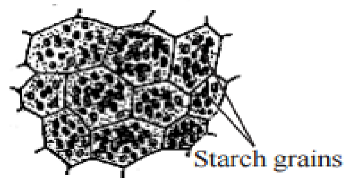

Inflorescence(spike)
Flower
Perianth
Inferior ovary
Leaf
Entire flower
Labellum
1/2 fertile anther
Inner perianth (corolla)
Outer perianth(calyx)
Inferior ovary
Habit
Pinnately parallel venation
Sheathing leaf base
Rhizome
L.S.of flower
Petaloid staminode
1/2Fertile anther
Oblique stigma
Labellum
Flat petaloid style
Inner perianth lobe (petal)
Outer perianth lobe (sepal)
Inferior ovary
Bract
Bracteole
outer perianth (sepal)
Inner perianth (petal)
Inner perianth lobe
Perianth tube


Labellum
Stamen (1/2 fertile anther with petaloid filament)
1/2 fertile anther
Petaloid filament
Petaloid staminode
Gynoecium
Petaloid staminode
Oblique slit like stigma
Flat petaloid style
Warty inferior ovary
C.S.of ovary
Ovary wall
Ovule on axile placenta
Locule
Floral Diagram
1/2 Fertile stamen (1/2 anther)
Staminode
Labellum
Bracteole

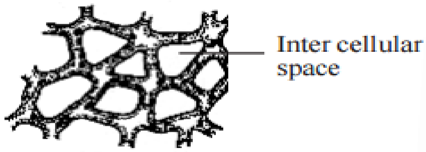
18. SIMPLE PERMANENT TISSUES
PARENCHYMA



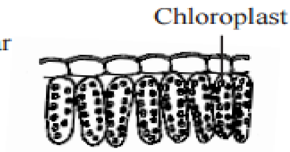
Parenchyma tissue



Storage parenchyma



Aerenchyma



Palisade parenchyma

1. It is the most common type of permanent tissue, found in almost all plant parts.
2. It is living tissue and made up of thin-walled cells. The cell wall consists of cellulose and pectin materials.
3. Parenchyma cells may be oval, spherical, rectangular, cylindrical or stellate.
4. The cells are usually polyhedral with 10-12 facets.
5. Parenchyma is different types as follows,

   Aerenchyma: In hydrophytes, the parenchyma found in the cortex region possesses well developed large intercellular spaces called air spaces. This air-filled parenchyma tissue is called aerenchyma. It helps the plant to float in water.

   Chlorenchyma: in green parts of plants, the parenchyma cells have chloroplasts and are called chlorenchyma. It does the function of photosynthesis.

   Storage parenchyma: the parenchyma cells that are stored with starch grains. Eg: stem and root tubers.

   Stellate parenchyma: in the petioles of Canna and Banana, star shaped parenchyma cells are found, and are called stellate parenchyma.

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19. SIMPLE PERMANENT TISSUES
COLLENCHYMA

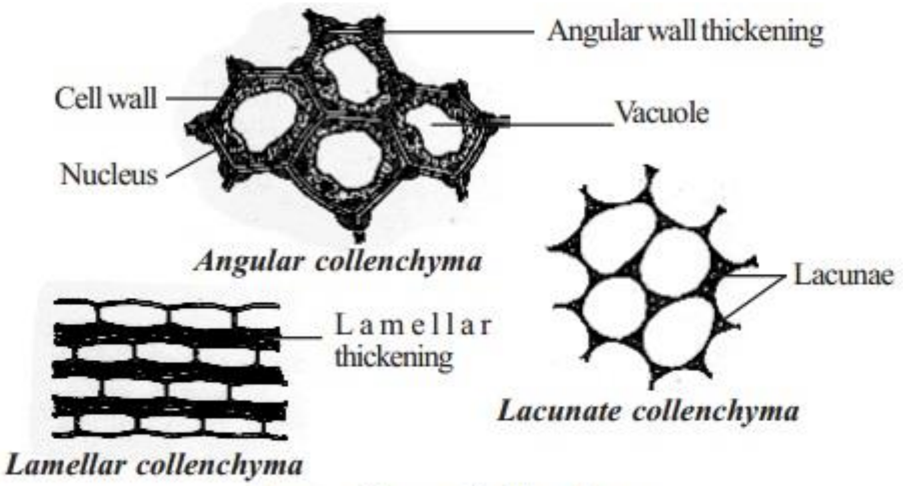

Fig.   Types of collenchyma

1. Collenchyma is a special type of parenchyma with somewhat elongated cells, which are polygonal in cross section.
2. The most characteristic feature of the collenchyma's is the uneven thickness of their walls which is confined to the corners of the cells.
3. The cell wall contains cellulose, high amounts of hemicelluloses and pectin.
4. Simple pits occur on their walls.
5. Collenchyma's cells are living and often contain chloroplasts.
6. Based on the thickening of the walls, collenchyma is of three types
    a. Angular collenchyma
    b. Lamellar collenchyma
    c. Lacunar collenchyma

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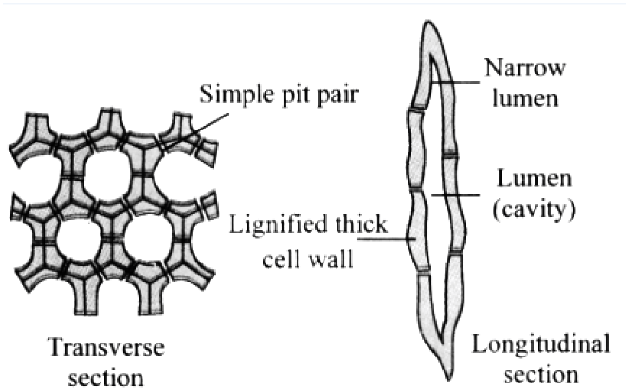
20. SIMPLE PERMANENT TISSUES: SCLERENCHYMA – FIBRES



Sclerenchyma

1. Sclerenchyma is a dead tissue. The cells have lignified secondary walls. It possesses simple pits.
2. The fibres are very much elongated and narrow cells with pointed ends.
3. In cross section the fibres are polygonal with narrow lumen.
4. Fibres are supporting tissues. They provide mechanical strength to the plants and protect them from the strong winds.
5. Fibres are two types,
    a. Xylem fibres or wood fibres
    b. Phloem fibres or bast fibres

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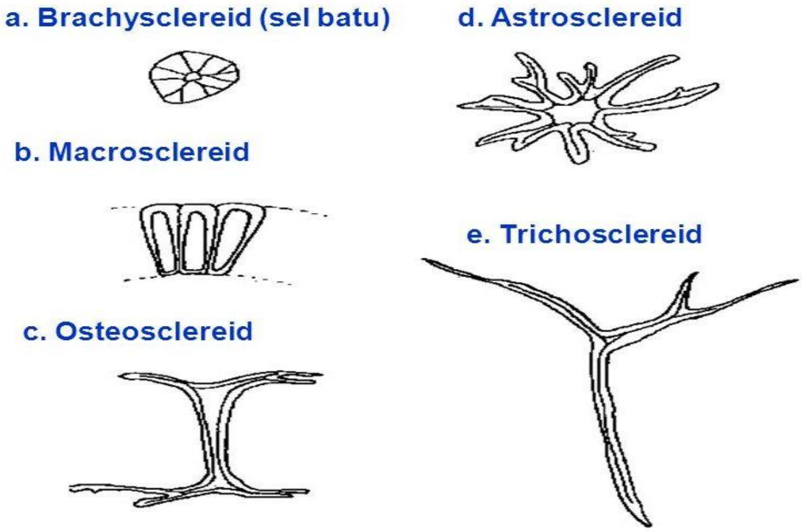
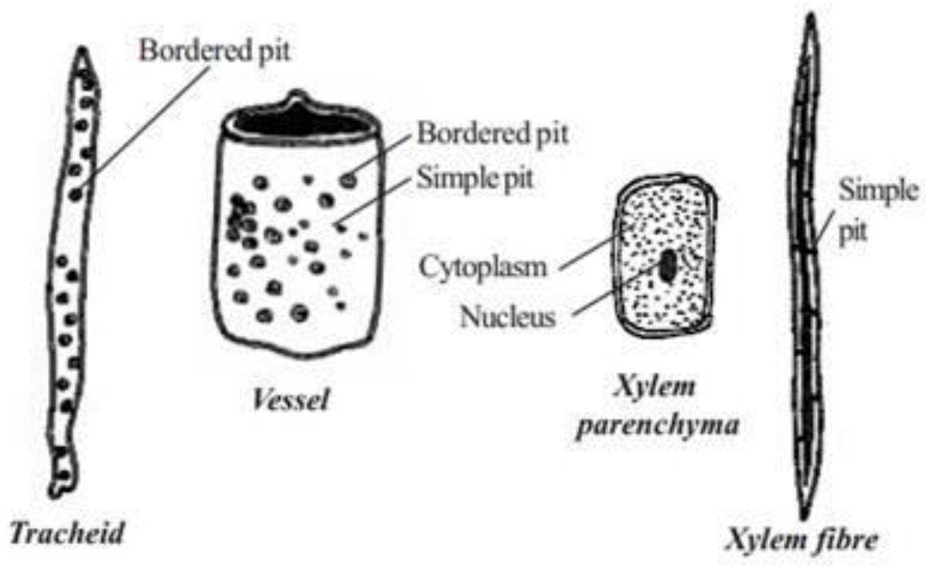
21. SIMPLE PERMANENT TISSUES: SCLERENCHYMA- SCLEREIDS



1. Sclereids are called stone cells. The cell wall is very thick and hard due to lignification's.
2. They are dead cells.
3. The pits in the walls are simple and reduced. Lumen is very much reduced.
4. The sclereids occur in groups in the cortex and pith of the stems of gymnosperms and dicots.
5. On the basis of shape, sclereids are of five types,
   a. Brachysclereids
   b. Macroscelereids
   c. Osteosclereids
   d. Astroscelereids
   e. Trichsclereids

****

22. COMPLEX PERMANENT TISSUES - I. XYLEM



1. It is the principal water conducting tissue of the vascular plants.
2. Xylem is made up of 4 kinds of cells – Tracheids, vessels or tracheae, xylem fibre and xylem parenchyma.
3. The tracheids are long elongated, tapering cells with blunt ends. Their secondary wall is lignified. They have large lumen (cell cavity). They're devoid of protoplast and hence dead.
4. The vessels are long pipeline like structures. They are composed of a row of cells placed end to end.
5. The scelerenchyma fibres associated with the xylem are known as xylem fibres or wood fibres.
6. The parenchyma cells associated with the xylem are known as xylem parenchyma. It is the only living tissue amongst the constituents of xylem.

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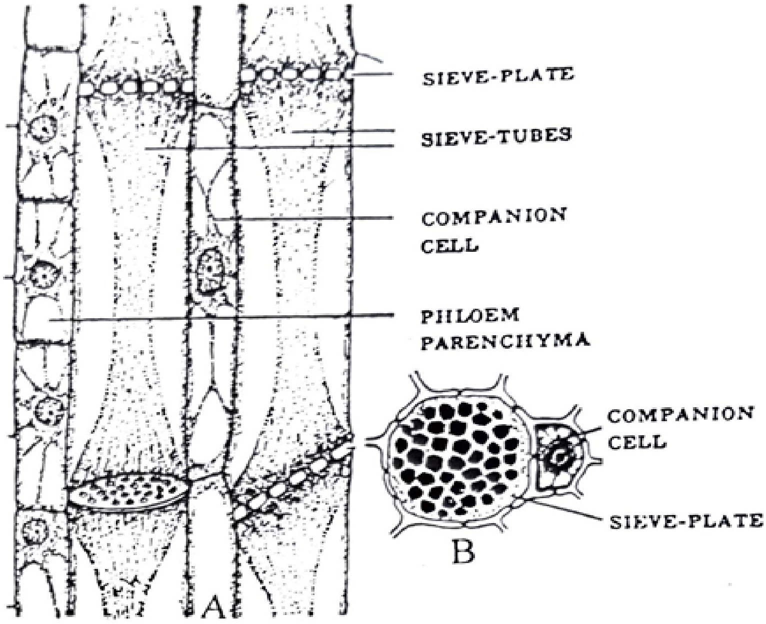
23. COMPLEX PERMANENT TISSUES - II. PHLOEM



1. Phloem is the food conducting tissue of the vascular system.
2. It is composed of 4 kinds of cells – sieve elements, companion cells, phloem parenchyma and phloem fibres.
3. The sieve elements are the conducting elements in phloem. They have only thick primary walls. Their end walls contain a number of pores which look like a sieve and are called sieve plates.
4. The sieve elements are attached end to end forming vertical sieve tubes.
5. The sieve tube elements contain a lining layer of cytoplasm but no nucleus.
6. The thin walled, elongated, specialized parenchyma cells, which are associated with the sieve elements, are called companion cells. They have cytoplasm and a prominent nucleus.
7. The parenchyma cells associated with the phloem are called phloem parenchyma.
8. The sclerenchyma cells associated with phloem are called phloem fibres.

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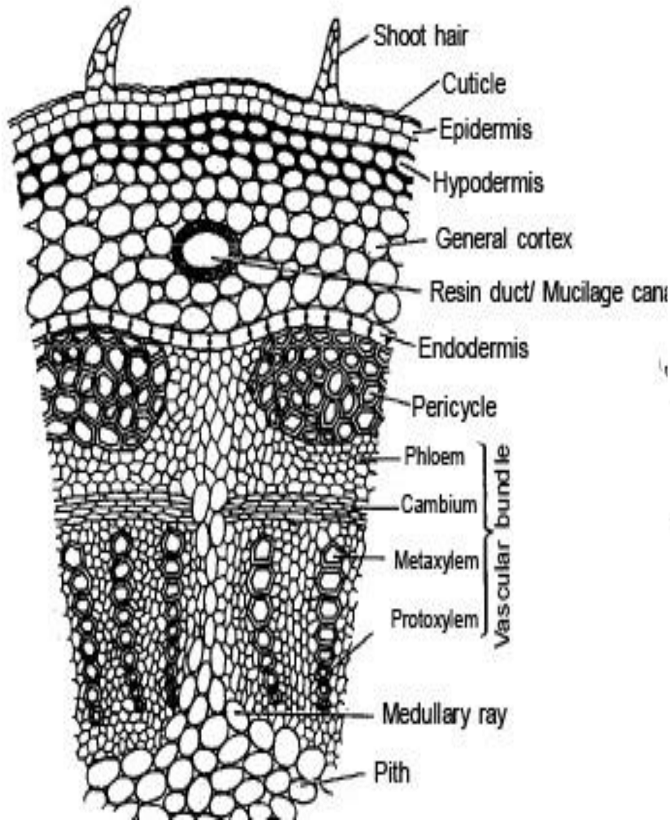
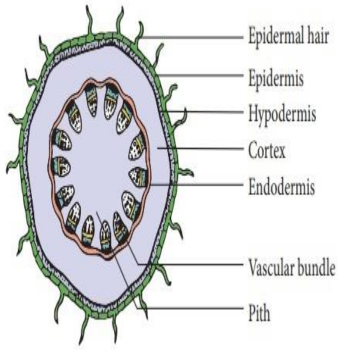
24. ANATOMY OF DICOT STEM
PRIMARY STRUCTURE

E.g. Sunflower Stem





The transverse Section of a dicot stem shows three main parts, known as epidermis, cortex and vascular bundles.

Epidermis:

This is the outermost layer, consists of a single layered barrel shaped parenchyma cells. A layer of cuticle is present on the outer side of the epidermis. Multicellular hairs and stomata are present.

Cortex:

The cortex is made up of 3 regions called hypodermis, general cortex and endodermis. Hypodermis is made up of 3 or 4 layers of collenchyma cells. General cortex is centrally placed and made up few layers of parenchyma cells with intercellular spaces. The innermost layer of cortex is known as endodermis.

Vascular bundles:

The vascular bundles are arranged in the form of a ring. They are conjoint (xylem and phloem are in same radius), collateral (inner xylem and outer phloem) and open (presence of cambium in between xylem and phloem). The protoxylem faces towards the centre and known as endarch xylem. Each vascular bundle is wedge shaped.

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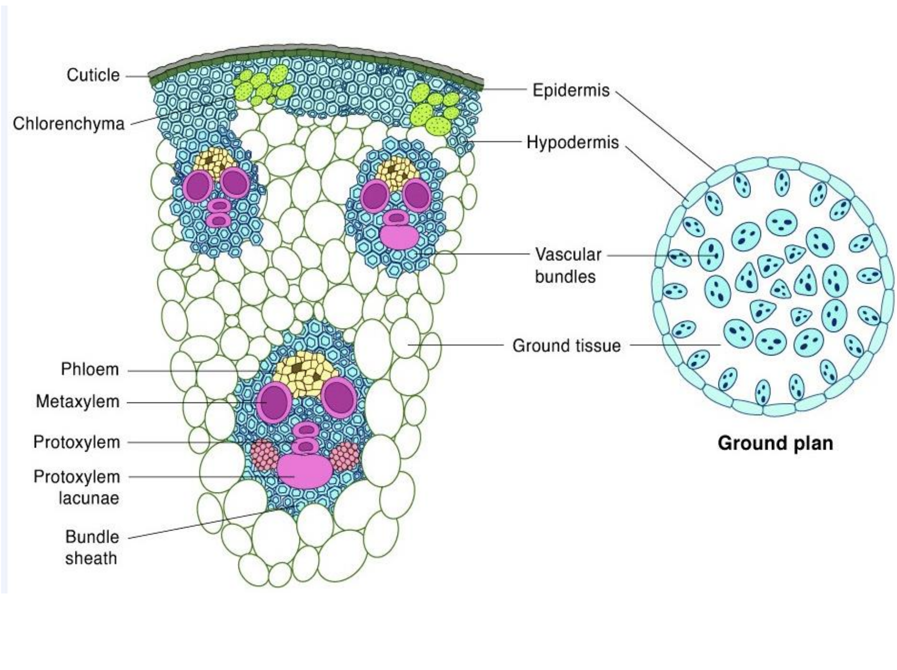
25. ANATOMY OF MONOCOT STEM- PRIMARY STRUCTURE - Eg. Maize Stem



The transverse section of a monocot stem shows three main parts, known as epidermis, ground tissue and vascular bundles.

Epidermis:

This is the outermost layer of stem. It is single layered and made up of cutinized cells. The epidermal hairs are absent and stomata may be present.

Ground tissue:

The tissue of region below the epidermis is called hypodermis. It is made up of 2 or 3 layered sclerenchyma cells. From just below the hypodermis and up to the centre, the region is known as ground tissue, made up of thin-walled parenchyma cells.

Vascular bundles:

Many vascular bundles are irregularly arranged on the ground tissue. Less number of larger sized bundles is arranged at the centre, whereas large number of smaller sized bundles is arranged at the periphery.

The vascular bundles are conjoint (xylem and phloem are in same radius), collateral (inner xylem and outer phloem) and closed (absence of cambium in between xylem and phloem). Each bundle is surrounded by sclerenchymatous sheath (bundle sheath).

Each vascular bundle is skull shaped and surrounded by a sclerenchymatous sheath (bundle sheath). Xylem in each bundle is arranged in 'Y' shaped manner. Metaxylem is present in the outer side and protoxylem at the inner side. The protoxylem faces towards the centre and known as endarch xylem. Phloem is present above the xylem.

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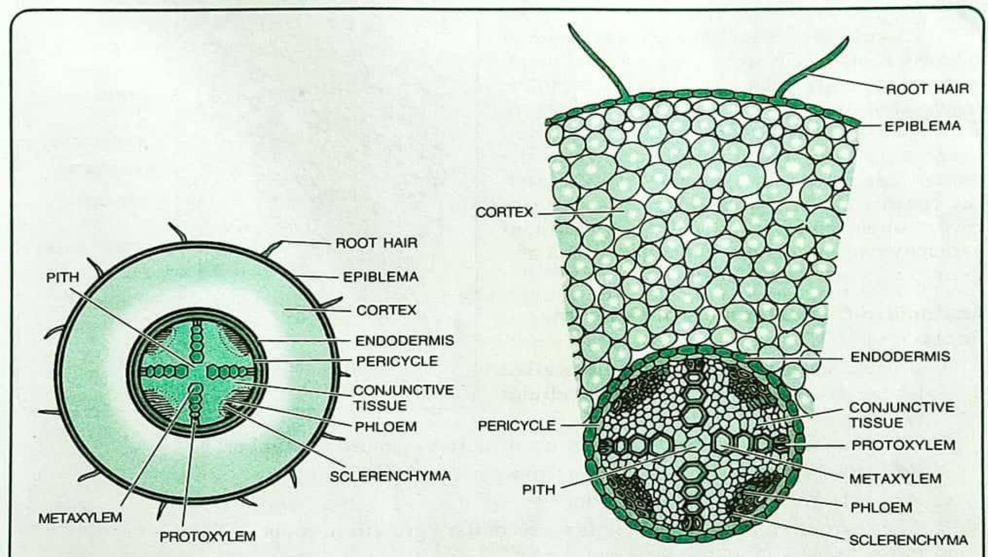
26. INTERNAL STRUCTURE OF DICOT ROOT



T.S. Portion of young dicot root of *Cicer*

The transverse section of a dicot root reveals the following the structures.

Epiblemma or rhizodermis:

It is a single layer of thin-walled cells. Unicellular root hairs are formed from the epiblemma.

Cortex:

Below the epiblemma there are many layers of parenchyma cells with intercellular spaces. (homogenous cortex). The cells contain leucoplast and starch.

Endodermis:

This is the innermost layer of cortex. It forms a ring of compact, barrel shaped cells around the stele. The cells of the endodermis have a thickening called Casparian thickening, made up of Suberin. But the cells opposite to the protoxylem lack the thickenings and called as passage cells.

Stele:

The stele includes pericycle, xylem and phloem. The outermost layer of stele is pericycle, lying just below the endodermis. The vascular bundles are radial. Four rows of xylem and phloem are alternate with each other.

This condition is known as tetrarch. The protoxylem faces outwards and known as exarch.

The pith is generally absent. However, in some plants, scanty pith may be present.

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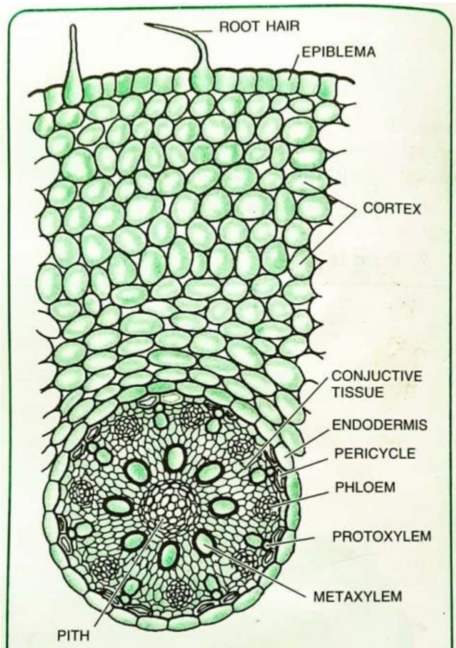
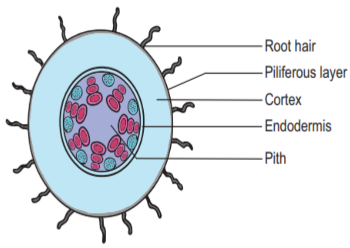
27. INTERNAL STRUCTURE OF MONOCOT ROOT



T.S. Monocot root of *Zea mays* (A part magnified)



Ground plan

The transverse section of a dicot root reveals the following the structures.

Epiblema (or) Rhizodermis:

It is a single layer of thin-walled cells. Unicellular root hairs are formed from the epiblemma.

Cortex:

Below the epiblemma there are many layers of parenchyma cells with intercellular spaces. (homogenous cortex). The cells contain leucoplast and starch.

Endodermis:
This is the innermost layer of cortex. It forms a ring of compact, barrel shaped cells around the stele. The cells of the endodermis have a thickening called Casparian thickening, made up of Suberin. But the cells opposite to the protoxylem, lack the thickenings and called as passage cells.
Stele:
The stele includes pericycle, xylem and phloem. The outermost layer of stele is pericycle, lying just below the endodermis. The vascular bundles are radial. The xylem and phloem bundles are numerous (more than 6). Xylem bundles are alternate with phloem bundles. This condition is known as polyarch. The protoxylem faces outwards and known as exarch.
The central thin-walled parenchyma cells from the pith.

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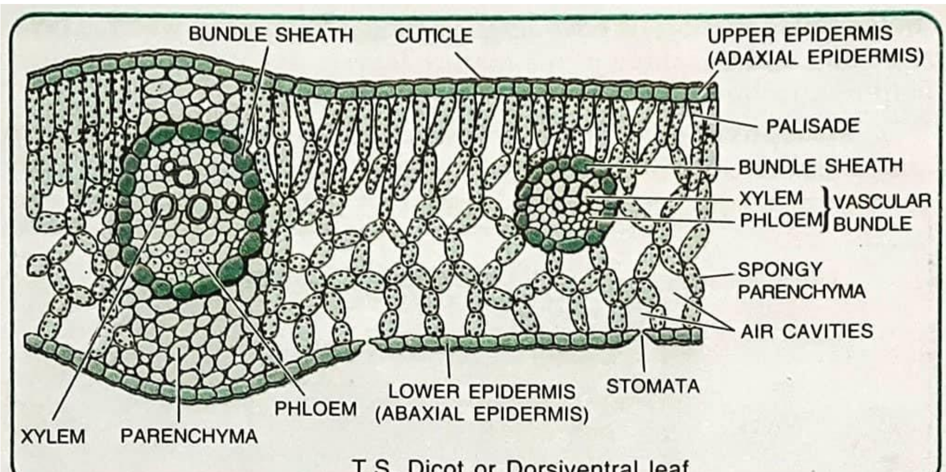
28. INTERNAL STRUCTURE OF A DICOT LEAF (DORSIVENTRAL LEAF)



T.S. Dicot or Dorsiventral leaf

Most of the dicotyledonous leaves are dorsiventral or bilateral leaves. They can be differentiated into a dorsal region and ventral region. In transverse section, the dicot leaf shows the following structures.

1. Epidermis:

The upper and lower epidermis is made up of a single layer of cells. The outer wall is generally cutinized. Numerous stomata are present in the lower epidermis.

2. Mesophyll:

The entire tissue between the upper and lower epidermis is called the mesophyll. It is differentiated into two regions.

Palisade tissue:

It is composed of one or two layers of closely arranged columnar cells. Large numbers of chloroplasts are present in each cell. The palisade parenchyma is present just below the upper epidermis and is meant for photosynthesis.

Spongy tissue:

Just below the palisade tissue there are loosely arranged parenchyma cells are present. They are irregularly arranged with intercellular spaces. They help in storage and exchange of gases.

3. Vascular bundle:

The vascular bundles are present in the veins of the leaf. Each vascular bundle is conjoint, collateral and closed. Xylem is present towards the upper epidermis and the phloem towards the lower side. The entire bundle is surrounded by a layer of compact parenchymatous cells called bundle sheath or border parenchyma.

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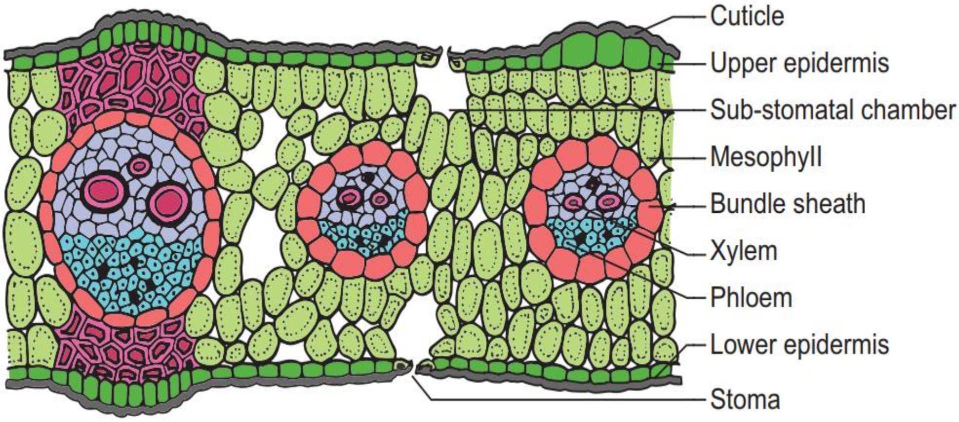
29. INTERNAL STRUCTURE OF A MONOCOT LEAF (ISOBILATERAL LEAF)



The monocot leaves are not differentiated into two regions internally. The structure on both the surfaces is quite similar.

1. **Epidermis:**

The upper and lower epidermis in monocot leaves is almost similar in structure. It is usually made up of thin walled cells. The stomata are present on both the epidermis. In maize, bamboo and grasses, bulliform cells or motor cells are present.

2. Mesophyll:

The mesophyll consists of spongy parenchyma cells. They are filled with chloroplasts. They have arranged with intercellular spaces.

3. Vascular bundles:

The vascular bundles in monocots are arranged in parallel manner. All the vascular bundles are of equal in size. They are conjoint, collateral and enclosed by bundle sheath (made up of scelerenchyma). The xylem is towards the upper side and the phloem lower side.

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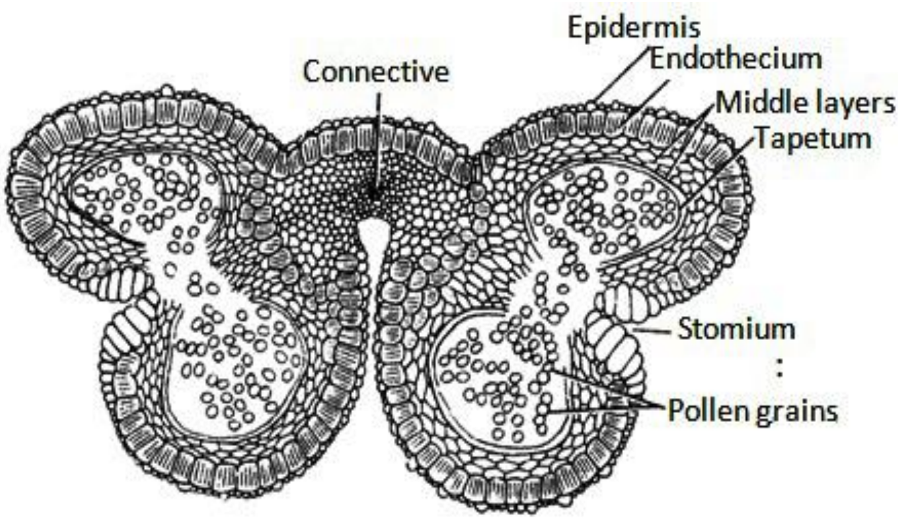
30. T.S OF MATURE ANTHER



1. An organized anther is four chambered in a transaction.
2. Its wall consists of an outer epidermis, an endothecium, one to three middle layers and an inner most tapetum.
3. The tapetum at maturity is multinucleate and contains dense cytoplasm which is finally used up by the developing microspores.
4. Microspores or pollen grains are at first arranged in tetrads. Later these separate and occur as individual pollen grains, dispersed throughout the chamber.

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31. L.S 0F MATURE OVULE

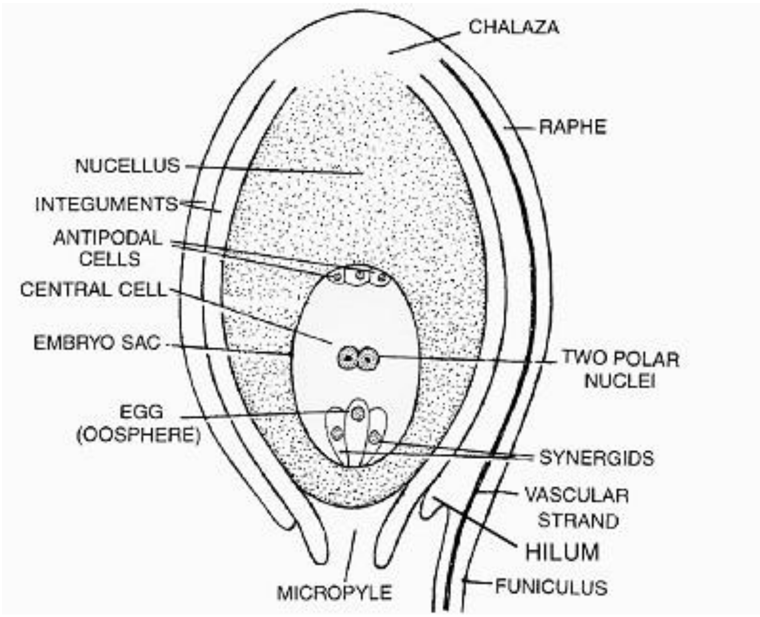

Fig. L.S of Mature Ovule

1. Ovule is the fertile part of Pistil. Morphologically it is called megasporangium.
2. The ovule consists of the stalk and the body.
3. It is protective outer coat are called integuments and the stalk called funicle.
4. The ovule may have either one or two integuments.
5. Ovule with one integument is called unitegmic ovules and those have with two integuments are bitegmic.
6. The integuments envelop the inner nucellus except at one place which is the opening known as micropyle.
7. This micropyle is the main passage area for the entry of pollen tube.
8. Nucellus is the fertile part that form the female gametophyte (embryo sac).
9. Basal region of the ovule is called chalaza.

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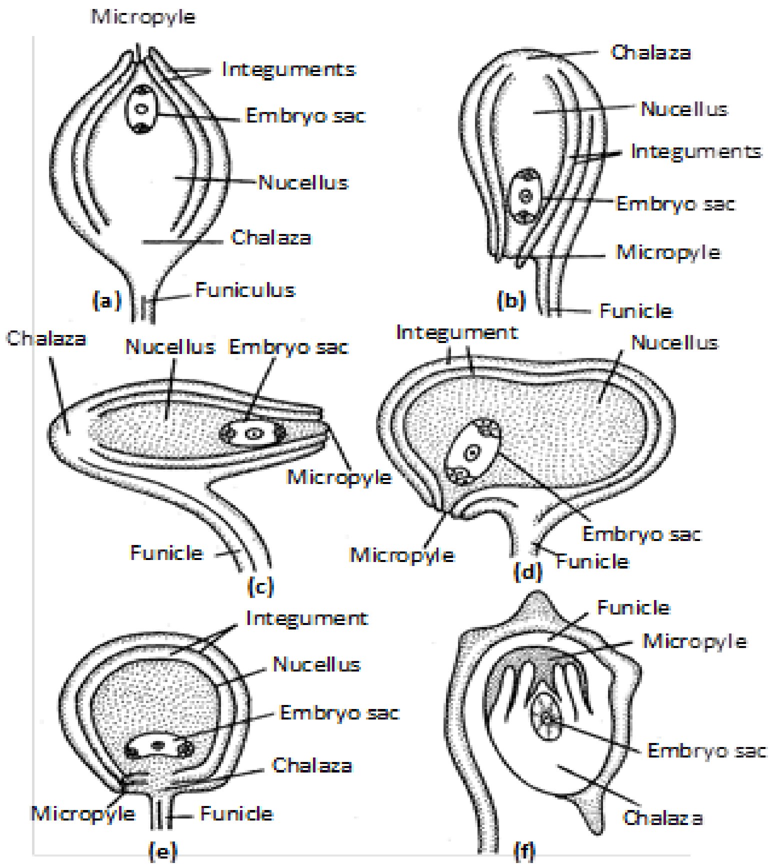
32. TYPES OF OVULES

The position of the microphyll and the funicle of the ovules are classified in to six different types.



1. **Orthotropous:** It is the erect ovule. The body of the ovule is upright the funicle, chalaza, hilum lies on the same vertical line. Ex. Polygonum.
2. **Anatropous:** It is an inverted ovule, the microphyle comes nearer to the funicle. Ex. Nymphaea.
3. **Campylotropous:** This is a curved ovule. The microphyle and funicle lies in parallel lines. Ex. Crotalaria.
4. **Hemianatropous:** This is a T shaped ovule. The microphyle and chalaza remains at angles to the funicle. Ex. Rannuncules.

5. **Amphitropous ovule:** this ovule like to horse shou shaped. The curvature of the ovule affects the embryo sac and bends like a horse shoe. Ex. Alisma.
6. **Circinotropous ovule:** this is a peculiar type of ovule in which the funicle is very long and form a complete circle. Ex. Opuntia.

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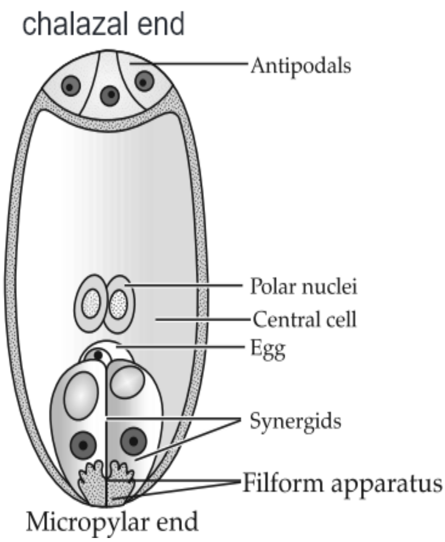
33. STRUCTURE OF EMBRYO SAC



1. It is the fully developed female gametophyte.
2. It is multicellular and haploid.
3. It consists of eight nuclei.
4. Of the eight nuclei, four are at the micropylar end while the other four are at the chalazal end.
5. The components of the embryo sac are egg apparatus, antipodal cells, and central nuclei.

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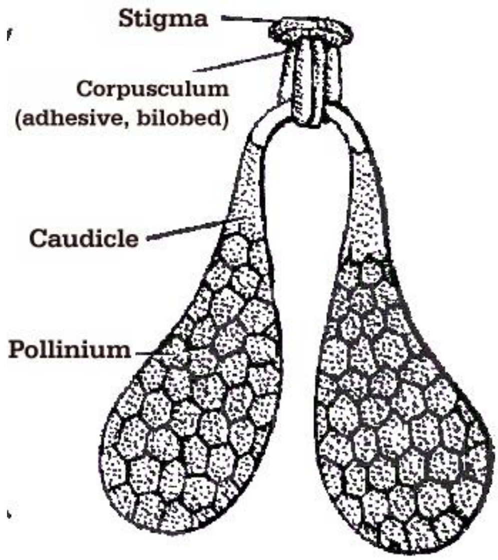
34. STRUCTURE OF POLLINIA



1. The stamens of Calotropis produce pollinium.
2. Two pollinia are found attached to a glandular adhesive disc called corpusculum by a thread like structure called retinaculum.
3. The whole structure looks like inverted letter 'Y' and is called translator.
4. The sticky disc gets attached with the legs of pollinator (bees or butterflies) and is carried to the stigma of another flower, thus ensuring pollination.

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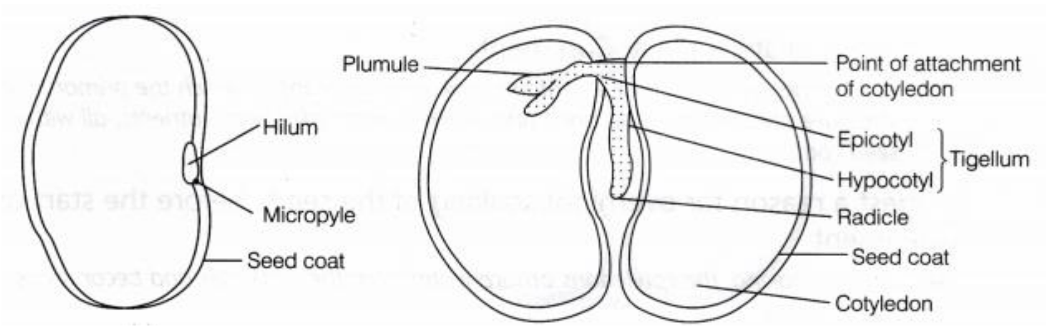
35. STRUCTURE OF DICOT SEEDS



1. Seeds of gram have two cotyledons and an embryonal axis.
2. Each seed is covered by two seed coats (a) Testa – outer coat and (b) Tegmen – inner coat.
3. The embryonal axis consists of radicle and plumule.
4. The portion of the embryonal axis above the level of cotyledons is called epicotyl. It terminates into the plumule.
5. The portion of the embryonal axis below the level of cotyledons is called hypocotyl. It terminates into the radicle or root tip.

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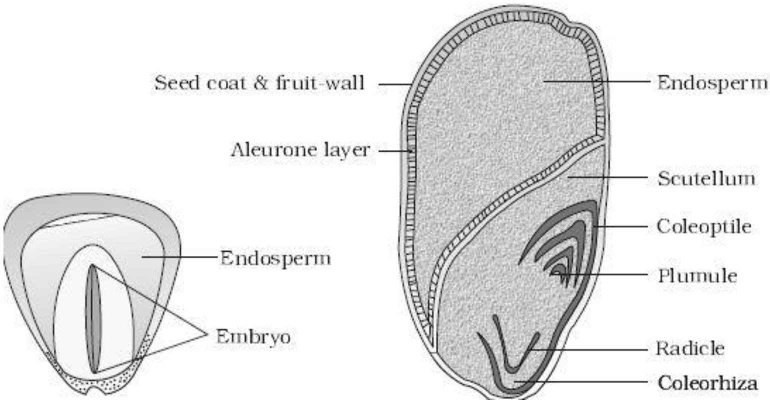
36. STRUCTURE OF MONOCOT SEEDS



1. The monocot seeds are mostly endospermic.
2. The seed coat is thin and fuses with pericarp.
3. It contains one cotyledon called scutellum and shoot axis.
4. The lower part of the axis is the radicle, covered by a sheath called coleorhiza.
5. The upper part of an axis is called plumule, covered by a sheath called coleoptile.
6. Aleurone layer is a proteinaceous layer that separates endosperm from the outer covering.

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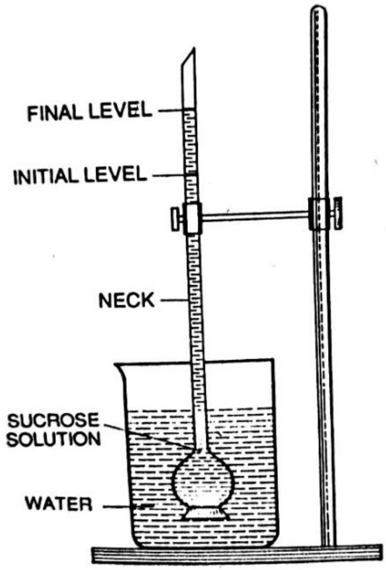
37. OSMOSIS- THISTLE FUNNEL EXPERIMENT



Aim:

To demonstrate osmosis by thistle funnel experiment.

Requisites:

Thistle funnel, sheep's bladder, water, beaker, sugar solution and stand.

Procedure:

- ❖ Take a Thistle funnel is tied with sheep's bladder.
- ❖ The thistle funnel is filled with concentrated sugar solution and the initial level is marked.
- ❖ The thistle funnel is placed in a beaker of water with the help of the stand.
- ❖ Note the levels of water in the beaker and move importantly, the level of the sugar solution in the thistle funnel.
- ❖ Leave the apparatus undisturbed, let the osmosis take place.

Observation and Conclusion:

- ❖ Water and sugar solution of two different solute concentrations are separated by semi permeable membrane (sheep's blader) enables the process of osmosis.

- The level of sugar solution rises up in the setup of the thistle funnel thereby gives the conclusion of the movement of solvent from a region of low concentration to high.

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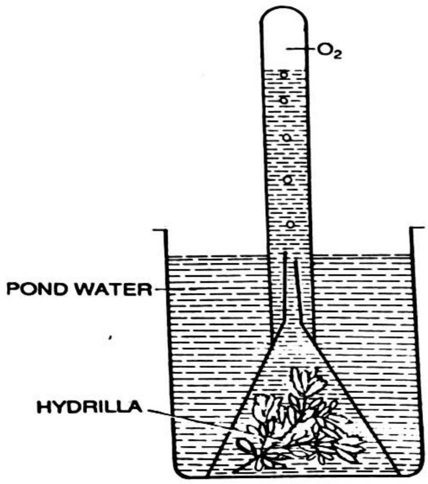
38. PHOTOSYNTHESIS – BEAKER AND FUNNEL EXPERIMENT



Aim:

To demonstrate the evalution of oxygen during photosynthesis in aquatic plant.

Material required:

Beaker, funnel, test tubes, few twigs of hydrilla plant, water and glowing splinter.

Procedure:

- Fill up the 3/4 of the beaker with water
- Take a glass funnel and insert few twigs of hydrilla plant into the mouth (wider) part of the funnel and place it in the beaker in the inverted position.
- Take a test tube, fill it with water and carefully keep it above the setup of the glass funnel without air space on the top.
- Place the entire setup in the direct sunlight for a period of time.

Observation and conclusion:

- As photosynthesis takes place in the direct sunlight, few air bubbles comes out of the twigs and goes up in the test tube.

- After a period of time, air space is observed in the test tube.
- When the gas in the air space of the test tube is introduced with the glowing splinter, it burns with a flame.
- This shows that oxygen is liberated during photosynthesis.

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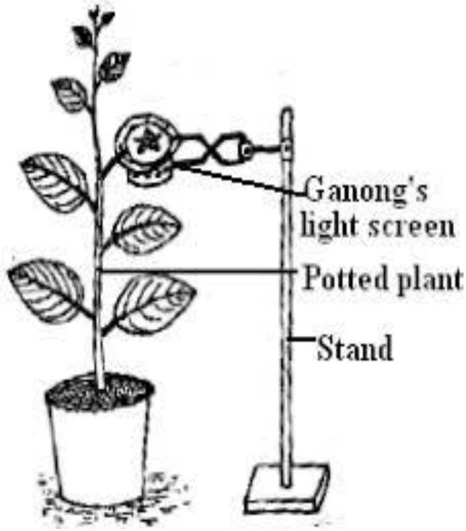
39. GANONG'S LIGHT SCREEN EXPERIMENT



Aim:

To demonstrate that light is necessary for photosynthesis.

Material required:

Ganong's light screen, a potted plant, iodine solution and stand.

Procedure:

- Take a potted plant, Ganongs light screen test clip is specially designed with iron and has a partly mould area with star shaped cut.
- Take a healthy potted plant with fresh leaves clip the selected leaf with the light screen apparatus and leave it is undistrubed with the help of stand.
- Place the setup in the direct sunlight and keep it for one hour.

Observation and conclusion:

- Detach the leaf taken for observation and dip it in the iodine solution.
- The leaf has partly exposed surface and closed too.

- The closed or hidden area of the leaf does not show positive result for iodine solution, rest of the exposed area turns blue, indicates that the starch prepared area reacts with iodine.
- This shows that the light is necessary for photosynthesis.

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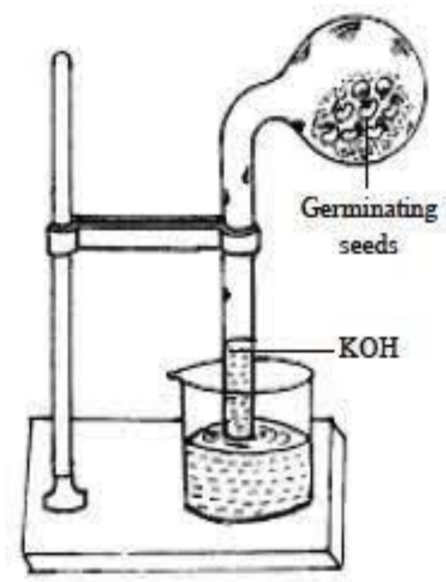
40. GANONG'S RESPIRESCOPE EXPERIMENT



Aim:

To prove that carbon dioxide is released during respiration by using Ganong'srespiroscope.

Requisites:

Ganong'srespiroscopes, potassium hydroxide solution (KOH), stand, beaker and germinating seeds.

Procedure:

- The respiroscope is a specially designed glass bulb with a tube attachment giving a bend appearance.
- Put few germinating seeds into the glass bulb area of the apparatus.
- Place the setup of the apparatus in the beaker filled with KOH solution.
- Fix the setup undisturbed help of a stand.

Observation and Conclusion:

- The level of KOH solution keeps increasing in a period of time.
- The KOH solution is capable of absorbing the carbon di oxide gas liberated by the germinating seeds in the bulb by the process of respiration.
- As the absorption takes place a vacuum is farmed, thereby causing the increase is KOH level.
- This shows that $Co_{2\ is}$ liberated during respiration.

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