

Brahmavart P.G. College, Mandhana, Kanpur

Department of Botany

Question Bank

Section-A

B.Sc. 3rd Semester

*Title: Flowering Plants Identification
&
Aesthetic Characteristics*

Course Code: B040301T

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Department of Botany
B.Sc. 3rd Semester
(Flowering Plants Identification & Aesthetic Characteristics: B040301T)
Question Bank (Section-A)

Q. 1. Write a note on plant nomenclature and its significance.

Ans: Plant nomenclature is the system of naming plants according to internationally accepted rules and principles. It is governed by the International Code of Nomenclature for algae, fungi, and plants (ICN). The system used is Binomial Nomenclature given by **Carolus Linnaeus** (1753). Every plant gets a scientific name with two parts:

Genus - first letter capital

Species epithet - all small letters

Ex: *Mangifera indica* L. for Mango, *Solanum tuberosum* for Potato.

Main Principles / Rules:

- Each plant has only one correct scientific name.
- Name is in Latin and printed in italics.
- Priority of publication - the first validly published name is accepted.
- Type method - each name is attached to a type specimen.

Significance / Importance:

- **Universal:** One scientific name is same all over the world, avoids confusion of local common names.
- **Indicates Relationship:** Genus shows closeness between species.
- **Stability and Communication:** Helps scientists worldwide to communicate accurately about plants.
- **Basis for Classification:** It is the foundation for taxonomy, biodiversity study, and conservation.

In short, nomenclature provides a stable, universal, and scientific language for identification of plants.

Q. 2. Define plant classification. Explain its major objectives.

Ans: Plant classification or Plant Taxonomy is the science of identifying, naming and grouping plants into different categories on the basis of their similarities, dissimilarities and evolutionary relationships. It is a core subfield of plant taxonomy and systematics that helps botanists organize the vast diversity of the plant kingdom into a structured, manageable framework.

It places plants into a hierarchy: Kingdom > Division > Class > Order > Family > Genus > Species.

Major Objectives of Plant Classification:

1. **Identification:** To correctly identify unknown plants by comparing them with already known plants.
2. **Nomenclature:** To give every plant a proper scientific name according to ICN rules, so that there is one universal name.
3. **To show Relationships:** To understand natural and evolutionary (phylogenetic) relationships among different plant groups. Ex: which plants are primitive and which are advanced.
4. **To make study easy:** There are more than 4 lakh plant species. Classification arranges them into groups, so studying one or two plants from a group gives an idea about the whole group.
5. **Economic and Practical Importance:** It helps in knowing the uses of plants - medicinal, food, timber, etc. If a plant in a family has medicinal properties, other plants of the same family may also show similar properties.

In short, classification provides order and system to the vast diversity of plants.

Q. 3. Differentiate between artificial, natural and phylogenetic systems of classification.

Ans: Biological classification systems are grouped into three main types based on the number and type of traits used to categorize organisms.

Artificial System of Classification

Basis: Uses one or very few easily seen superficial traits, like leaf shape, plant habit, or number of stamens.

Evolutionary Link: Ignores evolutionary history.

Key Example: Carolus Linnaeus's sexual system of plant classification.

Pros & Cons: Simple and fast to use, but places unrelated species together.

Natural System of Classification

Basis: Uses a large number of natural traits, including internal anatomy, embryology, and external morphology.

Evolutionary Link: Shows natural affinities and structural similarities, but does not trace direct evolutionary descent.

Key Example: The Bentham and Hooker system of plant classification.

Pros & Cons: More stable and reliable than artificial systems, but can still separate closely related groups.

Phylogenetic System of Classification

Basis: Based on evolutionary descent, ancestral relationships, and genetic/DNA data.

Evolutionary Link: Explicitly reflects the evolutionary history and branching lineages of organisms.

Key Example: The Angiosperm Phylogeny Group (APG) system.

Pros & Cons: Accurately depicts true biological relationships, but requires complex molecular data that may be incomplete for extinct species.

Q. 4. Write a note on APG IV classification system

Ans: The APG IV (Angiosperm Phylogeny Group IV) system, published in 2016, is the fourth and most recent version of the modern, DNA-based classification standard for flowering plants (angiosperms). It recognizes 64 orders and 416 families, utilizing a conservative phylogenetic approach to update plant taxonomy.

Key Features of APG IV

1. **Molecular Basis:** Built primarily on DNA sequencing data (chloroplast and nuclear genes) combined with morphological traits.
 2. **Informal Clades:** Avoids formal botanical names above the rank of order, using unranked clades like monocots, eudicots, rosids, and asterids.
 3. **New Additions:** Reinstated or added 5 new orders (including Boraginales and Dilleniales) and several new families from recent splits and DNA insights.
 4. **Lumping and Splitting:** Refined family boundaries, such as expanding Amaryllidaceae to include onion genera (*Allium*) and updating names like Asphodelaceae.
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Q. 5. Describe the Bentham and Hooker system of classification.

Ans: Given by George Bentham and Joseph Dalton Hooker in their book *Genera Plantarum* (1862-1883). It is a Natural System of classification based on natural affinities. It is the most famous and practical system, based on De Candolle's system. They classified 97,205 species in 202 families.

Outline of Classification:

They divided Seed Plants (Phanerogams) into 3 Classes:

1. **Dicotyledons:** Divided into 3 Sub-classes
 - **Polypetalae:** Petals free. Example: Order Thalamiflorae (Family Ranunculaceae), Disciflorae, Calyciflorae.
 - **Gamopetalae:** Petals united. Example: Order Inferae, Heteromerae, Bicarpetallatae.
 - **Monochlamydeae:** Flowers incomplete, perianth in one whorl. 8 Orders.
2. **Gymnospermae:** 3 Families - Gnetaceae, Coniferae, Cycadaceae. Placed between Dicots and Monocots.
3. **Monocotyledons:** 7 Series - Epigynae, Coronarieae, Calycinae, Nudiflorae, Apocarpae, Glumaceae.

Merits:

- Very practical and easy for identification in field as it is based on morphological characters.

- Every family description is complete and accurate.

Demerits:

- It is not evolutionary. It places Monochlamydeae as most advanced dicot group but it is actually primitive.
- Gymnosperms kept between Dicots and Monocots which is unnatural.
- Some closely related families are kept apart.

Despite demerits, it is still used in many herbaria of India and UK for arrangement of plants.

Q. 6. Define herbarium. Explain its preparation and importance.

Ans: A herbarium is a collection of dried, pressed, and preserved plant specimens arranged systematically according to a classification system, and kept for future reference and study.

Preparation of Herbarium - Steps:

- 1. Collection:** Healthy, flowering plant with root, stem, leaves, flowers and fruits is collected. Field data like date, place, habit is noted.
- 2. Pressing and Drying:** Specimen is spread between blotting papers and pressed in a herbarium press with iron frames. Papers are changed daily for 7-10 days till completely dry.
- 3. Poisoning:** Dried specimen is treated with 2% Mercuric chloride or formalin to protect from insects and fungi.
- 4. Mounting:** Dried specimen is mounted on a thick herbarium sheet (42 x 28 cm) with glue or stitches.
- 5. Labelling:** Label is pasted on right lower corner of sheet. It contains - Scientific name, Family, Local name, Place of collection, Date, Collector's name, and Description.
- 6. Storage:** Sheets are arranged according to Bentham and Hooker system and kept in steel cupboards with naphthalene balls.

Importance:

- **Reference:** It is a permanent record of flora of a region.
 - **Identification:** Helps in correct identification of unknown plants.
 - **Taxonomic Research:** Type specimens are preserved for nomenclature.
 - **Conservation:** Provides information about rare and extinct plants.
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Q. 7. What is a botanical garden? Explain its major functions.

Ans: A botanical garden is a place where living plants from different parts of the world are grown outdoors or indoors for scientific, educational, conservation and ornamental purposes. The plants are labelled with their scientific name and family.

Examples: Indian Botanical Garden, Howrah; National Botanical Garden, Lucknow.

Major Functions:

- 1. Conservation (Ex-situ):** Rare, endangered and economically important plants are conserved outside their natural habitat. Germplasm collection is maintained.
- 2. Taxonomic Research:** Serves as a living laboratory for botanists. Helps in identification, classification and research on plant morphology.
- 3. Education:** Provides practical knowledge to students, researchers and common people about plant diversity and uses.
- 4. Recreation and Aesthetics:** Provides a place for recreation and increases public interest towards plants.
- 5. Supply of Material:** Supplies seeds, living plants, cuttings and herbarium specimens to other institutions and research centers. Also helps in introduction of new economic plants.
- 6. Library and Herbarium:** Most botanical gardens have a library and herbarium attached to them.

Q. 8. Differentiate between a herbarium and botanical garden.

Ans: A herbarium is a collection of dried, pressed, and preserved plant specimens mounted on paper, while a botanical garden is a large outdoor area dedicated to the cultivation and display of living plants.

Differences:

Feature	Herbarium	Botanical Garden
Plant State	Dead, dried, pressed, and preserved.	Living and growing.
Primary Purpose	Taxonomic studies, historical records, and quick plant identification.	<i>Ex-situ</i> conservation, public education, and recreation.
Physical Setup	Indoor facility with storage cabinets, sheets, and labels.	Outdoor open land, often with greenhouses and research labs.
Scope	Stores preserved flora from wide geographic ranges over centuries.	Displays living collections suited to local or managed climates.

Q. 9. Write a short note on aesthetic characteristics of plants.

Ans: Aesthetic characteristics are the visual and sensory qualities of plants that make them beautiful and valuable for landscaping, gardening and human well-being.

Main Aesthetic Characters:

- 1. Form / Habit:** Shape of the plant decides its look.
 - ❖ Columnar – Polyalthia
 - ❖ Weeping - Weeping Willow
 - ❖ Round / Spreading - Mangifera, Ficus
- 2. Foliage and Texture:** Leaves are most important.

- ❖ **Colour** - Green, variegated, reddish (*Coleus*)
- ❖ **Texture** - Fine (*Fern*), Coarse (*Monstera*)
- ❖ **Seasonal change** - Deciduous plants give colour change.

3. **Flowers:** Most attractive part due to colour, size, fragrance and blooming time. Ex: Rose, Gulmohar, Bougainvillea.

4. **Colour:** Provides visual contrast. Green gives soothing effect, bright flowers attract attention. Seasonal colour of new leaves, autumn colour is also important.

5. **Fragrance and Other Senses:** Sweet smell of Jasmine, Rose, Night-blooming Cestrum adds aesthetic value.

6. **Bark and Stem:** Attractive bark pattern in Eucalyptus, thorny sculpture of Cactus.

Importance:

These characters are used in landscape architecture, interior decoration, avenue planting and to create parks and gardens that give mental peace and recreation.

Q. 10. Describe the importance of greenhouses in plant cultivation.

Ans: Greenhouses are specialized structures covered with transparent materials that trap solar heat to create a regulated microclimate for optimizing plant growth.

Importance and Benefits

- **Climate and Temperature Control:** Greenhouses protect crops from extreme weather conditions, including frost, heavy rain, harsh winds, and scorching heatwaves. They allow growers to maintain stable internal temperatures and humidity levels tailored to specific plant needs.
- **Year-Round Production and Season Extension:** By shielding plants from seasonal changes, greenhouses enable farmers to grow crops outside their natural growing seasons and harvest fresh produce 12 months a year.
- **Pest and Disease Management:** The enclosed physical barrier restricts access by insects, rodents, and airborne weeds. This controlled environment significantly lowers infection rates and reduces reliance on heavy chemical pesticides.
- **Resource and Water Efficiency:** Greenhouses trap moisture and house precise drip or closed-loop irrigation systems, cutting down water use drastically compared to traditional open-field farming.
- **High-Value and Exotic Crop Cultivation:** Growers use protected structures to successfully cultivate delicate seedlings, high-value vegetables (like capsicum and tomatoes), medicinal plants, and export-quality flowers.

Q. 11. Describe the important characters and economic importance of Malvaceae.

Ans: The [Malvaceae family](#), commonly known as the mallow or cotton family, is a diverse group of flowering plants containing over 4,200 species valued globally for agriculture, textiles, and industry.

Important Characters of Malvaceae

Vegetative Characters

- **Habit:** Mostly herbs, shrubs, or occasionally soft-wooded trees.
- **Stellate Hairs:** Young stems and leaves feature characteristic star-shaped (stellate) hairs.
- **Mucilage:** Plant parts contain a sticky, mucilaginous sap or cavities.
- **Leaves:** Alternate, simple, often palmately lobed or veined, with stipules present.

Floral Characters

- **Inflorescence:** Solitary axillary or cymose.
- **Epicalyx:** A whorl of bracteoles lying below the calyx, often present.
- **Flower:** Bisexual (having both male and female parts) and actinomorphic (radially symmetrical).
- **Calyx:** 5 sepals, usually fused at the base (gamosepalous) with valvate aestivation.
- **Corolla:** 5 petals, distinct or slightly connate at the base, often attached to the staminal tube.
- **Androecium:** Numerous stamens that are **monadelphous** (united into a single tube surrounding the style) with 1-celled (monothecous) anthers.
- **Gynoecium:** Syncarpous (fused carpels) with a superior ovary containing multiple locules.

Economic Importance of Malvaceae

- **Fiber Crops:**
 - [Cotton](#) (*Gossypium* species) provides seed-hair fibers that form the backbone of the global textile industry. Cottonseed also yields edible oil and livestock feed.
 - Jute (*Corchorus* species like *C. capsularis*) supplies strong bast fibers used for making burlap, rope, and sacking.
 - **Food Crops:**
 - Cacao (*Theobroma cacao*) yields cocoa beans, the essential raw material for producing chocolate.
 - Okra / Lady's finger (*Abelmoschus esculentus*) is widely cultivated for its edible, nutritious green seed pods.
 - Durian (*Durio zibethinus*) provides a popular tropical fruit.
 - **Medicinal Plants:**
 - Species like *Abutilon* and *Hibiscus* are rich in mucilage, making them useful in traditional medicine to soothe inflammation, coughs, and respiratory irritation.
 - **Ornamental Plants:**
 - Genera such as *Hibiscus* (rose mallow), *Alcea* (hollyhock), and *Malva* (mallow) are widely planted in gardens for their large, showy flowers.
 - **Timber:**
 - Arborescent (tree-like) members like balsa (*Ochroma pyramidale*) produce extremely lightweight timber used for specialized construction, crafts, and insulation.
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Q. 12. Write a short note on the family Fabaceae.

Ans: The third largest family of flowering plants. Also called Pea family.

Systematic Position:

Order – Fabales

Distribution: Cosmopolitan, 730 genera and 19,400 species.

Habit: Herbs, shrubs, trees, climbers. Mostly cultivated.

Vegetative Characters:

- **Root:** Tap root with root nodules containing nitrogen-fixing bacteria Rhizobium.
- **Stem:** Erect or climber.
- **Leaf:** Alternate, pinnately compound, stipulate. Pulvinus leaf base.

Floral Characters:

- **Inflorescence:** Raceme
- **Flower:** Zygomorphic, bisexual, complete, perigynous.
- **Calyx:** 5 sepals, gamosepalous, odd sepal anterior.
- **Corolla:** 5 petals, papilionaceous - 1 large Standard, 2 lateral Wings, 2 inner fused Keel. Vexillary aestivation.
- **Androecium:** 10 stamens, diadelphous - 9 united + 1 free, or monadelphous.
- **Gynoecium:** Monocarpellary, ovary superior, marginal placentation.
- **Fruit:** Legume / Pod
- **Floral Formula:** $\% \square K_{(5)} C_{1+2+(2)} A_{(9)+1} G_1$

Divided into 3 sub-families: Papilionoideae, Caesalpinioideae, Mimosoideae.

Economic Importance:

- **Pulses:** Gram (*Cicer*), Pea (*Pisum*), Arhar (*Cajanus*)
- **Oil:** Groundnut (*Arachis*), Soybean (*Glycine*)
- **Timber:** Sheesham (*Dalbergia*), Kikar (*Acacia*)
- **Dye:** Indigo (*Indigofera*)
- **Fodder:** Alfalfa, Berseem

Example: *Pisum sativum* (Pea)

Q. 13. Describe the diagnostic characters and economic importance of Cucurbitaceae.

Ans: The Cucurbitaceae family—commonly known as the gourd, melon, or pumpkin family—consists of mostly herbaceous, climbing or prostrate plants famous for specialized fleshy fruits called pepos.

Characters of Cucurbitaceae

- **Habit:** Mostly annual or perennial herbaceous climbers, trailers, or twiners, utilizing specialized climbing structures.
- **Tendrils:** Distinctive extra-axillary or stem-modified tendrils are present, helping the plant climb.

- **Leaves:** Alternate, simple, often deeply palmately lobed or palmately compound, and exstipulate (without stipules) with long petioles.
- **Vascular Bundles:** Characterized by bicollateral vascular bundles (phloem located on both the outer and inner sides of the xylem).
- **Flowers:** Unisexual (plants are monoecious or dioecious), regular (actinomorphic), and pentamerous.
- **Calyx & Corolla:** 5 sepals (usually connate/united) and 5 petals (free or united, bell-shaped or wheel-shaped, typically yellow or white).
- **Androecium:** 5 stamens that are frequently highly modified or connate in complex, twisted patterns (syngenesious or distinct).
- **Gynoecium:** Inferior ovary, syncarpous with 3 carpels (tricarpellary), unilocular with parietal placentation (often appearing multilocular due to protruding placentae).
- **Fruit:** Typically a specialized fleshy, many-seeded berry known as a **pepo**, featuring a tough or hard outer rind.
- **Seeds:** Dicotyledonous and exalbuminous (lacking endosperm).

Economic Importance of Cucurbitaceae

- **Major Food Crops & Vegetables:** Yields globally consumed vegetables and fruits like *Cucumis sativus* (cucumber), *Citrullus lanatus* (watermelon), and various squashes, pumpkins, and melons (*Cucurbita* and *Cucumis* species), supplying essential vitamins, minerals, and hydration.
- **Edible Seeds:** Many species are cultivated for nutrient-rich, edible seeds packed with oils and proteins (such as pumpkin seeds).
- **Medicinal Uses:** Certain species possess active compounds like cucurbitacins used in traditional or herbal medicine; for example, *Momordica charantia* (bitter melon) helps regulate blood sugar levels, while *Citrullus colocynthis* has historical purgative applications.
- **Utensils and Instruments:** The hard, woody outer pericarp of mature *Lagenaria siceraria* (bottle gourd) is dried and crafted into water containers, pipes, and traditional musical instruments.
- **Natural Sponges:** The dried internal fibrous vascular network of mature *Luffa* fruits serves as the commercial loofah scrubbing sponge.
- **Ornamental Value:** Genera like *Ecballium*, *Cyclanthera*, and ornamental gourds are widely grown in gardens for decorative and landscaping purposes.

Q. 14. Write a note on the family Lamiaceae and its important members.

Ans: Also called Mint family. 236 genera and 7200 species.

Distribution: Cosmopolitan, mostly in Mediterranean region.

Habit: Mostly aromatic herbs or shrubs, stem quadrangular.

Vegetative Characters:

Stem: Quadrangular (square), hairy, contains essential oils.

Leaf: Opposite decussate, simple, exstipulate, with oil glands giving aroma.

Floral Characters:

Inflorescence: Verticillaster - a cluster of sessile flowers in axils of opposite leaves.

Flower: Zygomorphic, bisexual, hypogynous.

Calyx: 5 sepals, gamosepalous, bilabiate, persistent.

Corolla: 5 petals, gamopetalous, bilabiate (2/3), upper lip 2-lobed, lower lip 3-lobed.

Androecium: 4 stamens, didynamous (2 long + 2 short), rarely 2.

Gynoecium: Bicarpellary, syncarpous, ovary superior but 4-lobed, becomes tetralocular due to false septum, gynobasic style, axile placentation.

Fruit: Carcerulus - 4 nutlets.

Floral Formula: $\% \square K_{(5)} C_{(5)} A_4 G_{(2)}$

Important Members and Economic Importance:

- **Mint (*Mentha* species):** Includes peppermint and spearmint. Grown for flavoring foods, candies, teas, and extracting cooling menthol oils.
 - **Basil (*Ocimum basilicum* & *Ocimum tenuiflorum*):** Includes sweet basil and holy basil (Tulsi). Widely used in global cuisine and traditional medicine for their healing properties.
 - **Lavender (*Lavandula* species):** Famous for fragrant purple blooms. Used heavily in perfumes, cosmetics, aromatherapy, and relaxing herbal teas.
 - **Rosemary (*Salvia rosmarinus*):** A woody, perennial herb used as a savory culinary spice and for fragrant essential oils.
 - **Sage (*Salvia officinalis*):** A popular garden herb valued for cooking and medicinal gargles.
 - **Thyme (*Thymus vulgaris*):** A low-growing culinary and antiseptic herb rich in healing thymol.
 - **Oregano & Marjoram (*Origanum* species):** Essential savory herbs in Mediterranean cooking.
 - **Patchouli (*Pogostemon cablin*):** Grown for its rich, earthy oil used in the perfume and incense industries.
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Q. 15. Describe the important characteristics of Solanaceae.

Ans: Commonly called Potato or Nightshade family. 90 genera and 2800 species.

Distribution: Cosmopolitan, more abundant in tropical and temperate regions.

Habit: Herbs, shrubs, small trees, climbers. Many with stellate hairs.

Vegetative Characters:

- **Stem:** Erect, branched, herbaceous or woody.
- **Leaf:** Alternate, simple, exstipulate, often pinnately lobed.

Floral Characters:

- **Inflorescence:** Cymose - axillary or extra-axillary cyme.
- **Flower:** Actinomorphic, bisexual, complete, hypogynous.
- **Calyx:** 5 sepals, gamosepalous, persistent, often enlarged in fruit.
- **Corolla:** 5 petals, gamopetalous, rotate or funnel-shaped, valvate or twisted aestivation.
- **Androecium:** 5 stamens, polyandrous, epipetalous, alternate to petals.

- **Gynoecium:** Bicarpellary, syncarpous, ovary superior, bilocular but becomes tetralocular due to false septum, obliquely placed, swollen placenta, axile placentation.
- **Fruit:** Berry or Capsule
- **Floral Formula:** $\oplus \square K_{(5)} C_{(5)} A_5 G_{(2)}$

Economic Importance:

1. **Vegetables:** *Solanum tuberosum* - Potato, *S. melongena* - Brinjal, *Lycopersicon esculentum* - Tomato, *Capsicum* - Chilli.
2. **Medicinal:** *Atropa belladonna* - Belladonna, *Datura* - Datura, *Withania somnifera* - Ashwagandha.
3. **Tobacco:** *Nicotiana tabacum*
4. **Ornamental:** *Petunia*, *Cestrum*, *Brunfelsia*.

Q. 16. Write a note on the family Poaceae and its economic importance.

Ans: The Poaceae family, commonly known as the grass family, is the single most economically important and widely distributed plant family to humans.

Characteristics of Poaceae:

- **Classification:** A massive family of monocotyledonous flowering plants belonging to the order Poales.
- **Diversity:** It includes roughly 12,000 species distributed across more than 770 genera.
- **Habit and Habitat:** Mostly annual or perennial herbs, though some species like bamboos can grow into tree-like structures. Grasses thrive globally on all continents—from deserts and tundras to freshwater and marine habitats—covering nearly a quarter of the Earth's vegetation.
- **Key Features:** Characterized by fibrous adventitious roots, jointed hollow stems called culms, parallel-veined leaves with sheathing bases, and unique reduced flowers arranged in spikelets. The fruit is typically a one-seeded *caryopsis*.

Economic Importance

The economic value of grasses touches almost every aspect of human life, agriculture, and industry.

1. Staple Food and Cereals

- Poaceae provides the primary caloric intake and staple diet for a majority of the global human population.
- Major cereal and grain crops include **rice** (*Oryza sativa*), **wheat** (*Triticum aestivum*), **maize/corn** (*Zea mays*), **barley** (*Hordeum vulgare*), **oats** (*Avena sativa*), and various millets (such as pearl millet or *bajra*).

2. Livestock Fodder and Forage

- Vast areas of natural grasslands (savannas and prairies) and cultivated grass species supply essential grazing forage for livestock, cattle, sheep, and horses.
- Dried straw and leaves from harvested cereal crops are extensively repurposed as dry cattle feed.

3. Sugar Production

- **Sugarcane** (*Saccharum officinarum*), a prominent member of this family, is cultivated globally on a massive scale. Its sweet stalk juice is extracted and processed to produce commercial sugar and related byproducts like molasses.

4. Construction and Timber (Bamboo)

- Bamboos (subfamily Bambusoideae) act as a fast-growing, highly sustainable substitute for traditional timber.
- They are heavily utilized in scaffolding, rural housing construction, fencing, furniture, ladders, and weaving into mats and baskets.

5. Alcohol, Beverages, and Biofuel

- Fermentation and distillation of grains (like corn, rye, and barley) yield alcoholic beverages such as whiskey, beer, and neutral spirits.
- Molasses derived from sugarcane is fermented to produce rum and industrial ethanol.
- Corn and other grasses serve as critical feedstocks for renewable biofuels.

6. Paper, Fibers, and Thatching

- Certain coarse grasses and bamboos are processed into pulp for the paper industry.
- Leaves and stems of species like *Saccharum spontaneum* (Kans) and *Erianthus munja* (Munj) yield strong natural fibers utilized for making ropes, mats, and traditional thatched roofing.

7. Aromatic and Essential Oils

- Aromatic grasses belonging to the genus *Cymbopogon* (such as lemon grass and citronella grass) yield valuable essential oils. These oils are widely used in the perfume, cosmetic, soap, and insect-repellent industries.
- **Khus oil** (vetiver) is extracted from the roots of *Vetiveria zizanoides* for high-end perfumery and cooling mats.

8. Lawns and Landscaping (Ornamentals)

- Turf grasses—such as Bermuda grass (*Cynodon dactylon*) and meadow grass (*Poa annua*)—form the basis of residential lawns, public parks, golf courses, and sports stadiums, offering significant aesthetic and recreational value.
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Q. 17. Differentiate between Liliaceae and Poaceae.

Ans: Liliaceae and Poaceae are both monocotyledonous plant families, but they differ significantly in their floral structure, stem morphology, and economic use.

Difference between Liliaceae and Poaceae:-

Feature	Liliaceae (Lily Family)	Poaceae (Grass Family)
Common Name	Lily family	Grass family
Habit / Stem	Mostly perennial herbs with underground bulbs, corms, or rhizomes.	Annual or perennial herbs with jointed culms and hollow internodes.
Flower Symmetry	Actinomorphic (regular and radially symmetrical).	Zygomorphic (bilaterally symmetrical) or irregular.
Perianth (Tepals)	6 distinct tepals arranged in two whorls of 3 (often brightly colored).	Reduced to tiny, membranous scales called lodicules .
Androecium (Stamens)	6 stamens, arranged in two whorls of 3.	Usually 3 stamens (sometimes 6 in bamboos).
Gynoecium (Ovary)	Tricarpellary, syncarpous, trilocular with axile placentation .	Monocarpellary, superior ovary, unilocular with basal placentation (single ovule).
Pollination	Mostly entomophilous (pollinated by insects via showy, fragrant flowers).	Mostly anemophilous (pollinated by wind via feathery stigmas).
Fruit Type	Capsule or berry.	Caryopsis (grain) or rarely a nut.
Economic Importance	Grown mainly for ornamentals (tulips, lilies) and some food/spices (onion, garlic, asparagus).	Dominates global agriculture as staple food crops (wheat, rice, maize, and bamboo).

Q. 18. Write a short note on the importance of monocot families in human welfare.

Ans: Monocotyledons (monocots) are among the most economically and ecologically vital groups of flowering plants. Several monocot families play an indispensable role in human welfare, forming the backbone of global agriculture, nutrition, and industry.

1. Poaceae (The Grass Family)

The Poaceae family is arguably the most important plant family for human survival. It includes major cereal crops such as **rice, wheat, maize, barley, oats, and millet**. These grains serve as the primary staple food for the vast majority of the world's population, providing essential carbohydrates and calories. Additionally, sugarcane is a primary source of global sugar production, while bamboo is widely used as a sustainable material for construction, paper manufacturing, and crafts. Grasses also provide crucial forage and fodder for livestock.

2. Arecaceae (The Palm Family)

The palm family is a critical source of food, oil, and shelter, particularly in tropical and subtropical regions. **Coconut palms (*Cocos nucifera*)** are known as the "tree of life" because every part of the plant is usable—providing coconut water, oil, coir, and wood. Other vital members include the oil palm, which supplies a significant portion of the world's vegetable oil, and the date palm, which yields highly nutritious fruit.

3. Liliaceae and Amaryllidaceae (The Lily and Onion Families)

These families contribute significantly to human diet, medicine, and aesthetics. The genus *Allium* (often classified under Amaryllidaceae) includes **onions, garlic, leeks, and chives**, which are essential culinary ingredients globally. Garlic and onion also possess well-documented antimicrobial and cardiovascular health benefits. On the ornamental side, lilies and tulips represent major commercial sectors in the global floriculture industry.

4. Musaceae (The Banana Family)

This family includes **bananas and plantains**, which rank among the most important fruit crops in the world. They serve as a primary food source and a major export commodity for many developing nations, providing vital nutrients like potassium and vitamin B6.

5. Orchidaceae (The Orchid Family)

While orchids are primarily celebrated for their immense value in the global ornamental plant and flower trade, they also have direct economic uses. The genus *Vanilla* yields **vanilla pods**, which are the source of one of the world's most popular and expensive natural flavoring agents used in the food and cosmetic industries.

Conclusion

Monocot families are foundational to human civilization. From providing global food security through staple grains to driving multi-billion-dollar industries in timber, oil, and floriculture, these plants are central to sustaining human life, health, and economic development.

Q. 19. Define plant morphology and explain its importance in plant identification.

Ans: **Plant morphology** is the scientific study of the physical form, external structure, and visual appearance of plants, encompassing both vegetative structures (such as roots, stems, and leaves) and reproductive structures (such as flowers, fruits, and seeds).

Importance of Plant Morphology in Plant Identification

Plant morphology serves as the primary foundation for recognizing, naming, and categorizing plant species. Its role in identification is vital for several reasons:

- **Visual Recognition:** It provides immediate, accessible visual cues—such as leaf shape, flower color, stem arrangement, and root type—allowing botanists and amateurs alike to distinguish one species from another in the field.
 - **Taxonomic Classification:** Taxonomists group plants into hierarchical categories like families, genera, and species by comparing shared external structural traits. For example, cereal crops are grouped in the *Poaceae* family because they share common growth habits and floral characteristics.
 - **Cultivar and Variety Differentiation:** Subtle variations in morphological features help experts identify specific sub-varieties or cultivars within the same species, which is essential for cereal breeding and agriculture.
 - **Ecological and Practical Insight:** External features often indicate how a plant interacts with its environment, helping researchers identify medicinal qualities, ecological adaptations (like drought resistance), or conservation needs for endangered species.
-

Q. 20. Describe the different types of root modifications with examples.

Ans: Roots are modified in shape and structure to perform vital functions other than normal absorption and anchorage, such as food storage, mechanical support, and respiration. These modifications occur in both taproot and adventitious root systems.

1. Taproot Modifications for Food Storage

The primary taproot becomes thick, fleshy, and swollen with stored nutrients. They are categorized by their distinct shapes:

- **Conical Roots:** Broad at the base and tapering gradually toward the apex, forming a cone-like structure.
 - *Example:* Carrot (*Daucus carota*)
- **Fusiform Roots:** Swollen in the middle and tapering gradually toward both ends (spindle-shaped).
 - *Example:* Radish (*Raphanus sativus*)
- **Napiform Roots:** Significantly swollen and spherical at the top, and sharply tapering below like a top.
 - *Example:* Turnip (*Brassica rapa*) and Beetroot
- **Tuberous Roots:** Thick and fleshy without any definite, regular shape.

- *Example: Mirabilis (4 o'clock plant)*

2. Adventitious Root Modifications for Food Storage

These adventitious roots arise from non-root parts (like stems or nodes) and become swollen to store reserve food:

- **Tuberous Roots:** Fleshy and swollen without a fixed shape.
 - *Example: Sweet potato (*Ipomoea batatas*)*
- **Fasciculated Roots:** Swollen, fleshy storage roots that occur in clusters from the base of the stem.
 - *Example: Dahlia and Asparagus*
- **Moniliform (Beaded) Roots:** Swollen at regular intervals, giving a bead-like appearance.
 - *Example: Bitter gourd (*Momordica*) and grasses*
- **Nodulose Roots:** Swollen and knob-like specifically at their distal tips.
 - *Example: Turmeric (*Curcuma longa*) and arrowroot*
- **Annulated Roots:** Feature a series of ring-like swellings stacked on top of each other like discs.
 - *Example: Ipecac (*Cephaelis*)*

3. Modifications for Mechanical Support

These roots provide extra stability and structural balance to heavy plants or weak stems:

Prop Roots: Thick, pillar-like roots that grow downward from horizontal tree branches into the ground to bear heavy loads.

- *Example: Banyan tree (*Ficus benghalensis*)*
- **Stilt Roots:** Short, stout support roots that grow obliquely/slantingly outward from the lower nodes of the stem into the soil.
 - *Example: Maize (corn) and sugarcane*
- **Buttress Roots:** Horizontally compressed, plank-like vertical extensions spreading outward from the base of tall trunk bases.
 - *Example: Silk cotton tree (*Bombax*) and tropical rain forest trees*
- **Climbing and Clinging Roots:** Arise from nodes to latch onto supports, walls, or host bark.
 - *Example: Money plant (*Pothos*) and black pepper*

4. Specialized Physiological Modifications

- **Pneumatophores (Respiratory Roots):** Vertically upward-growing aerial roots that emerge out of waterlogged, oxygen-deficient swamp soils to absorb atmospheric oxygen through tiny pores called lenticels.
 - *Example: Mangroves (*Rhizophora* and *Avicennia*)*
- **Epiphytic Roots:** Hanging aerial roots covered with a spongy moisture-absorbing tissue (*velamen*) to absorb humidity directly from the air.
 - *Example: Orchids (*Vanda*)*
- **Parasitic (Haustorial) Roots:** Specialized sucking roots that penetrate the host plant's vascular tissues to withdraw water and nutrients.
 - *Example: Dodder (*Cuscuta*)*
- **Nodulated Roots:** Swollen structures housing symbiotic nitrogen-fixing bacteria (*Rhizobium*) that convert atmospheric nitrogen into usable nitrates.

- *Example:* Pea, gram, and groundnut
- **Assimilatory (Photosynthetic) Roots:** Green, chlorophyll-containing hanging roots that manufacture food via photosynthesis when exposed to light.
- *Example:* *Tinospora*

Q. 21. What are phylloclade, cladode and phyllode? Differentiate between them.

Ans: Phylloclade, cladode, and phyllode are specialized plant structures that turn green and make food through photosynthesis when regular leaves are reduced or absent.

- **Phylloclade:** A flattened or fleshy green **stem** with multiple nodes and internodes that has unlimited growth. True leaves are often turned into spines. Example: *Opuntia* (cactus).
- **Cladode:** A green, flattened **branch** of limited growth that typically consists of only one or two internodes. Example: *Asparagus* or Butcher's broom (*Ruscus*).
- **Phyllode:** A flattened, green **petiole** (leaf stalk) or rachis that takes over the job of a leaf, while the real leaf blade is reduced or vanishes. Example: Australian *Acacia*.

Differences Between Them:

Feature	Phylloclade	Cladode	Phyllode
Plant Part Modified	Stem (main axis or large branch)	Branch (limited portion of a stem)	Petiole or leaf rachis (leaf part)
Growth Type	Unlimited growth	Limited growth (usually 1–2 internodes)	Limited growth
Nodes and Internodes	Many nodes and internodes present	Very few (often a single internode)	Absent
Leaf/Bud Status	Leaves are often reduced to spines/scales	Bears small scale leaves or spiny tips	An axillary bud is present at its base
Main Examples	<i>Opuntia</i> (Prickly Pear), <i>Euphorbia</i>	<i>Asparagus</i> , <i>Ruscus</i>	Australian <i>Acacia</i>

Q. 22. Describe the different types of inflorescences.

Ans: An inflorescence is the arrangement of flowers on the main floral axis (peduncle) of a plant.

1. Racemose (Indeterminate)

In a racemose inflorescence, the main axis keeps growing indefinitely and does not end in a flower. Flowers grow on the sides in an acropetal order, meaning older flowers are at the bottom and younger buds are at the top.

- **Simple Raceme:** Flowers have short stalks (pedicels) and line an unbranched main axis (e.g., radish, mustard).
- **Spike:** Flowers lack stalks and attach directly to the main axis (e.g., chaff flower).
- **Corymb:** Flower stalks are different lengths; lower stalks are longer so all flowers sit at the same flat level (e.g., candytuft).
- **Umbel:** Stalks of equal length rise from a single common point, like an umbrella (e.g., carrot, coriander).
- **Capitulum (Head):** The main axis flattens out into a base holding many tiny, stalkless flowers (e.g., sunflower).
- **Spadix:** A spike with a thick, fleshy main axis wrapped in a large protective leaf called a spathe (e.g., banana, palm).

2. Cymose (Determinate)

In a cymose inflorescence, the main axis stops growing because it ends in a flower. Flowers grow in a basipetal order, meaning the oldest flower is at the top and newer flowers grow on side branches below.

- **Uniparous (Monochasial) Cyme:** The main axis ends in a flower, and only one lateral branch grows from below it (e.g., Cotton).
- **Biparous (Dichasial) Cyme:** The main axis ends in a flower, and two lateral branches grow from below it at the same time (e.g., Jasmine).
- **Multiparous (Polychasial) Cyme:** The main axis ends in a flower, and three or more lateral branches grow from below it (e.g., *Nerium*).

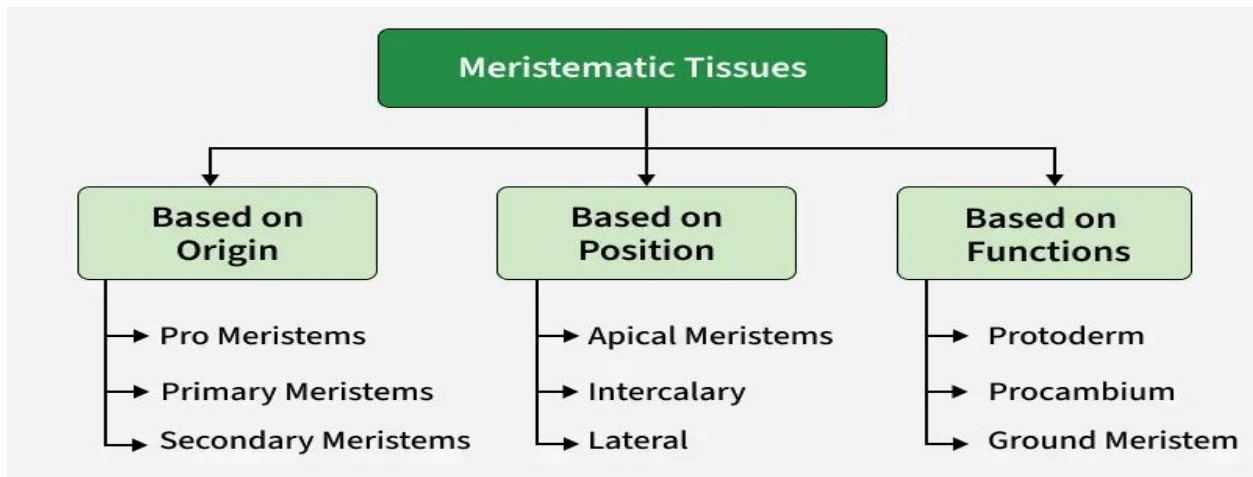
3. Special Types

Some plants form unique, highly modified structures that combine or alter these basic patterns:

- **Cyathium:** A small cup-shaped structure holding one central female flower surrounded by multiple single male flowers (e.g., *Poinsettia*).
- **Hypanthodium:** A closed, flask-shaped structure with a hollow inside cavity that holds tiny flowers accessed through a small pore (e.g., Fig).
- **Verticillaster:** A tight cluster of sessile flowers that looks like a ring around the stem, common in the mint family (e.g., Tulsi).

Q. 23. Define meristematic tissue. Describe its different types.

Ans: Meristematic tissues are a type of plant tissue that plays an important role in the growth and development of plants. These tissues consist of undifferentiated cells that can divide and differentiate into various types of specialised cells. The term "meristem" was given by Carl Wilhelm von Nägeli. Meristematic tissues are mainly found in that part of the plant where active growth occurs, such as at the tips of roots and shoots.



Characteristics of Meristematic Tissue

The characteristics of the meristematic tissues are as follows:

- Meristematic tissues consist of cells that have not yet differentiated into specific cell types.
- These tissues undergo rapid and frequent [cell division](#), contributing to the growth of the plant.
- Meristematic tissues are responsible for primary growth, which leads to an increase in the length of plant structures.
- These tissues are commonly found at the tips of roots, shoots, and other growing regions of the plant.
- Meristematic tissue exhibits totipotency.
- Secondary meristems such as vascular cambium and cork cambium are responsible for [secondary growth](#).

Classification of Meristematic Tissue

Meristematic tissue is classified based on its origin, position, and functions. The classification of meristematic tissue is as follows:

Classification Based on Origin

The meristematic tissue is divided based on origin as follows:

1. Pro Meristems

- Pro meristems are the earliest stage of undifferentiated cells in plant development and are the precursors to specialised meristematic tissues.
- Found in growing regions, such as root and shoot tips, it contributes to primary and secondary growth in plants.
- It is responsible for the growth and development of apical, lateral, and intercalary meristems.

2. Primary Meristems

- Derived from pro meristems, they are the first set of differentiating meristematic cells.

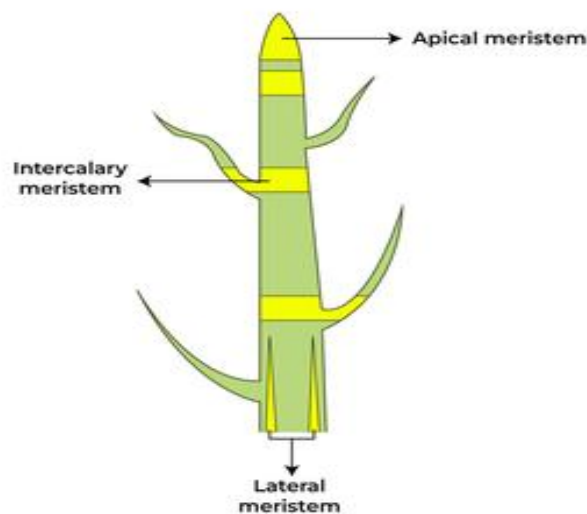
- Primary meristems are of three types: protoderm, ground meristem, and procambium.
- Protoderm forms the outer layer, ground meristem produces internal tissues, and procambium differentiates into vascular tissues.
- Primary meristem gives rise to specific plant tissues—epidermis, ground tissues, and vascular tissues (xylem and phloem).
- Primary meristems contribute to primary growth, which is elongation in plants.

3. Secondary Meristems

- Secondary meristems develop in the later stages of a plant's life from primary meristems or cambium cells.
- It is of two main types—vascular cambium and cork cambium (phellogen).
- Vascular cambium gives rise to secondary xylem and secondary phloem, leading to an increase in girth in woody plants (secondary growth).
- Cork cambium produces protective outer bark, helping in plant protection and growth.
- Vascular cambium is present between the primary xylem and the primary phloem in stems and roots. Cork cambium is found in the outer bark.

Classification Based on Position

The meristematic tissue is divided based on position as follows:



1. Apical Meristems

- Apical meristems are present at the tips of roots and shoots in plants.
- It is responsible for primary growth, which leads to the elongation of plant structures.
- It is of two main types—root apical meristem (at root tips) and shoot apical meristem (at shoot tips).
- Apical meristems ensure continuous growth and renewal throughout a plant's life.

2. Intercalary Meristems

- Intercalary meristems are present at the base of leaves or internodes at the intercalary position.
- Intercalary meristems enable rapid growth and regeneration in response to injury.
- It helps in regrowing plant parts like leaves and stems after they have been removed.

- It helps in the elongation of stems and leaves.
- More commonly found in monocot plants, such as grasses and bamboo.

3. Lateral Meristems

- Lateral meristems form in mature plants from primary meristems.
- It is of two main types—vascular cambium and cork cambium (phellogen).
- It is responsible for secondary growth, adding girth by producing secondary xylem and phloem.
- Vascular cambium is present between the primary xylem and phloem in both stems and roots. Cork cambium is present in the outer bark.
- Lateral meristems help plants to adapt to changing conditions.

Classification Based on Functions

The meristematic tissue is divided based on function as follows:

1. Protoderm

- Protoderm is a primary meristem that forms the epidermis, the outermost layer of plant tissues.
- It acts as a barrier against physical damage, pathogens, and water loss.
- Protoderm is important as it forms the epidermal layer in both root and shoot tissues.

2. Procambium

- Procambium is a primary meristem that produces vascular tissues (xylem and phloem).
- Procambium differentiates into primary xylem and primary phloem, which are essential for fluid and nutrient transport.

3. Ground Meristem

- Ground meristem is a primary meristem that produces ground tissues.
- It differentiates into various types of ground tissues like parenchyma, collenchyma, and sclerenchyma.
- Parenchyma stores nutrients, collenchyma gives support, and sclerenchyma provides structural strength.

Functions of Meristematic Tissue

Meristematic tissues are important for plants as they contribute to growth, development, and adaptation. Some of the important functions of meristematic tissue are as follows:

- Meristematic tissues for both primary and secondary growth in plants, allowing them to increase in both length and girth.
 - It produces various types of specialised cells, which then differentiate into different plant tissues such as epidermal, vascular, and ground tissues.
 - Meristematic tissues start the formation of new leaves, stems, roots, and other plant structures.
 - Vascular tissues that originate from meristematic tissues are responsible for the movement of water, nutrients, and minerals throughout the plant.
 - Meristematic tissues allow plants to adapt to changing environmental conditions by forming new tissues and structures.
 - Intercalary meristems result in the repair and regrowth of the injured plants, especially after grazing or cutting off plants.
-

Q. 24. Differentiate between meristematic and permanent tissues.

Ans: The main difference is that [meristematic tissue](#) consists of actively dividing cells that cause a plant to grow, while permanent tissue consists of mature cells that have stopped dividing and perform dedicated tasks.

Differences Between Meristematic and Permanent Tissues

Aspect	Meristematic Tissue	Permanent Tissue
Capacity to Divide	Can divide	Cannot divide
Cell Composition	Undifferentiated cells	Differentiated cells
Simple/Complex Tissues	Simple tissues, composed of one type of cell	Can be simple or complex
Nature of Cells	Always living cells	Can be living (parenchyma) or non-living (sclerenchyma)
Cytoplasm in Cells	Dense cytoplasm	May or may not contain cytoplasm
Prominent Nucleus	Always present	Prominent in parenchyma, absent in sclerenchyma
Size and Shape of Cells	Small, isodiametric cells	Large cells with varied shapes
Cell Arrangement	Compactly arranged, no intercellular spaces	Loose (parenchyma) or compact (sclerenchyma)
Vacuoles	Usually absent	Present in living cells, absent in dead cells
Metabolic Rate	Very high	Very low or no metabolism

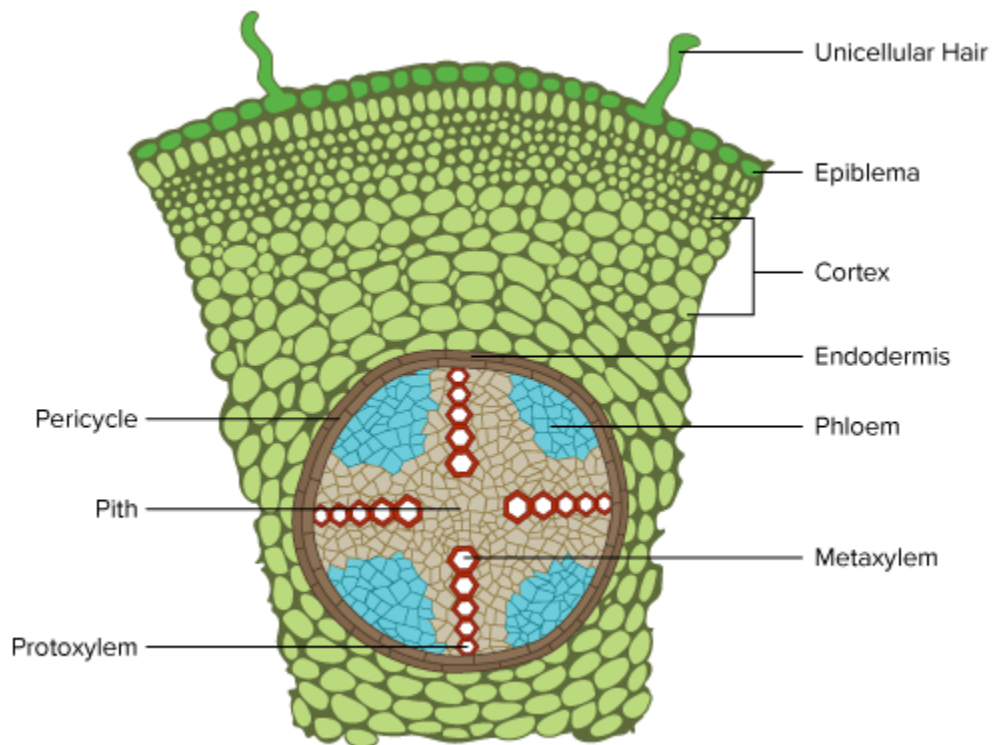
Q. 25. Describe the anatomy of a dicot root.

Ans: The internal structure of a primary dicot root consists of distinct layers from the outside to the center, characterized by a radial vascular arrangement and a very small or absent pith.

Anatomy of a Dicot Root:

- **Epiblema (Epidermis):** The outermost single layer of thin-walled parenchymatous cells. It lacks a cuticle and stomata. Many of these cells extend into single-celled **root hairs** to absorb water and minerals.
- **Cortex:** A wide zone beneath the epiblema made of multiple layers of thin-walled parenchyma cells with intercellular spaces for gas and water movement.
- **Endodermis:** The innermost layer of the cortex. It is a single layer of barrel-shaped cells without intercellular spaces. Its cell walls feature waxy thickenings called **Casparian strips** made of suberin, which regulate water flow into the center.
- **Pericycle:** A single layer of thick-walled parenchyma cells just inside the endodermis. It initiates lateral roots and forms the vascular cambium during secondary growth.
- **Vascular Bundles:** Arranged in a **radial** pattern where xylem and phloem lie on alternate radii. Dicot roots typically contain **two to four** (tetrarch) vascular bundles. The xylem is **exarch**, meaning the smaller protoxylem points outward and the larger metaxylem points inward.

- **Conjunctive Tissue:** Parenchyma cells located between the xylem and phloem bundles.
- **Pith:** Very small, poorly developed, or completely absent in the center of a dicot root.



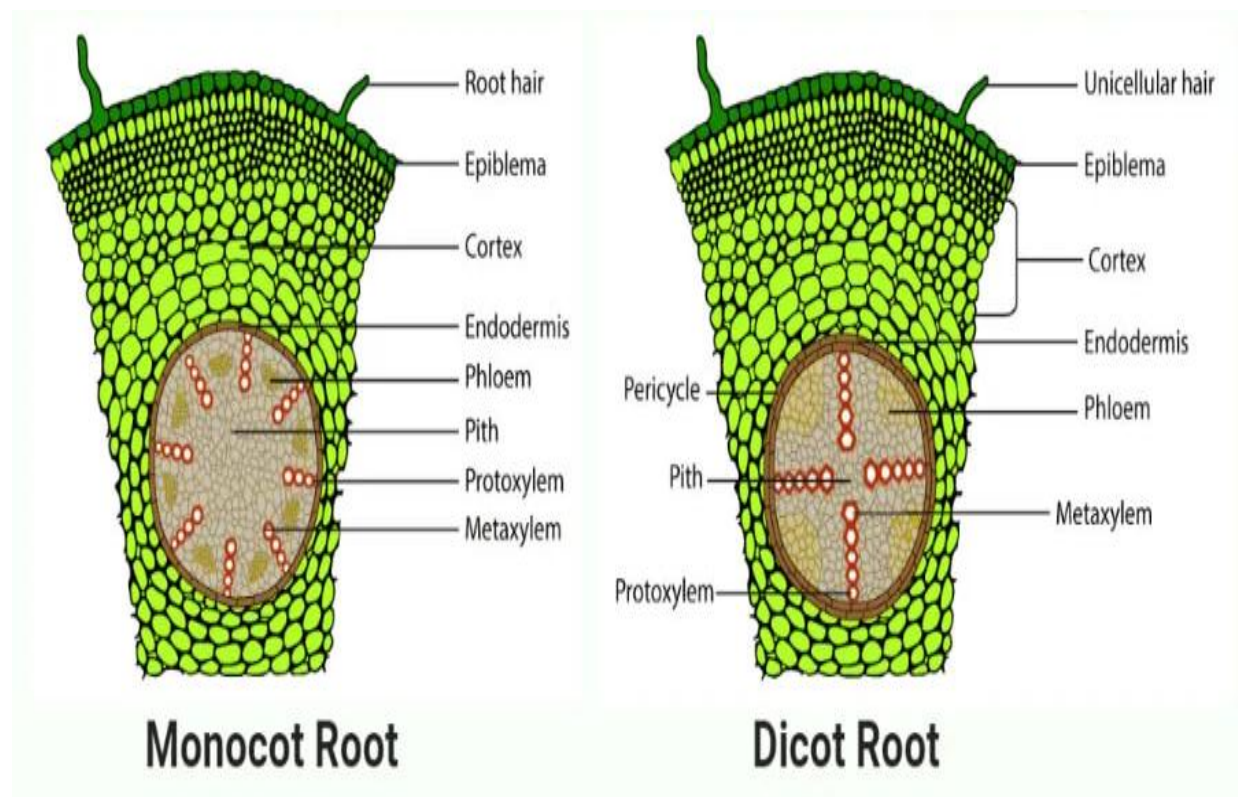
Q. 26. Compare the anatomy of dicot and monocot roots.

Ans: The main difference between dicot and monocot roots is that dicot roots have fewer xylem and phloem groups (usually diarch to tetrarch) with a small or absent pith, while monocot roots have many xylem and phloem groups (polyarch) with a large, well-developed pith.

Comparison Table

Feature	Dicot Root	Monocot Root
Root System	Taproot system (main vertical root)	Fibrous root system (many thin, equal roots)
Vascular Bundles (Xylem & Phloem)	Limited in number (usually 2 to 4, diarch to tetrarch)	Numerous / multiple (6 or more, polyarch)
Xylem Shape	Angular or star-shaped in the center	Round or oval-shaped
Pith	Small, indistinct, or completely absent	Large and very prominent /

		well-developed
Secondary Growth	Present (has cambium for thickness and wood growth)	Absent (no cambium, does not get thicker over time)
Pericycle Role	Gives rise to lateral roots, cork cambium, and part of vascular cambium	Produces lateral roots only
Cortex	Narrower compared to monocot roots	Wider and more extensive
Examples	Sunflower, bean, pea, mango	Maize, grass, rice, wheat, onion



Q. 27. Explain the process of root–shoot transition.

Ans: The root–shoot (or root–stem) transition is the process where a plant's internal vascular system changes its arrangement and orientation as it moves from the radial bundles of the root to the conjoint/collateral bundles of the stem.

This change typically happens in a narrow zone located at the hypocotyl, the base of the stem, or near the root-stem junction.

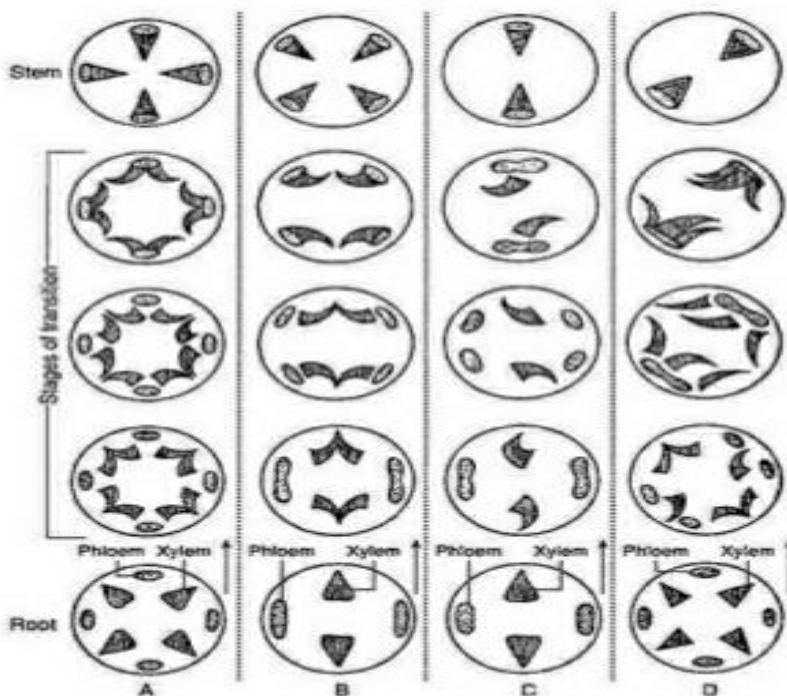
Changes During the Transition

- **Vascular Bundle Arrangement:** Roots have **radial** vascular bundles where xylem and phloem lie on alternating radii. Stems have **conjoint or collateral** bundles where xylem and phloem sit together on the same radius.
- **Xylem Maturation Orientation:** Root xylem is **exarch** (protoxylem develops toward the outside/periphery). Stem xylem is **endarch** (protoxylem develops toward the inside/center)

Steps in the Process

The structural rearrangement happens through specific organizational phases within the [Root-Stem Transition](#) zone:

1. **Division of Strands:** The alternating xylem and phloem strands in the root stele split or fork.
2. **Twisting and Inversion:** Xylem strands twist and rotate 180 degrees so that the outer (exarch) protoxylem re-orient toward the inner (endarch) position.
3. **Displacement of Phloem:** Phloem bundles shift their physical positions to align alongside the rotated xylem strands.
4. **Conjoinment:** The repositioned xylem and phloem fuse or connect into unified collateral vascular bundles characteristic of the stem.



Q. 28. Define secondary growth and explain its significance.

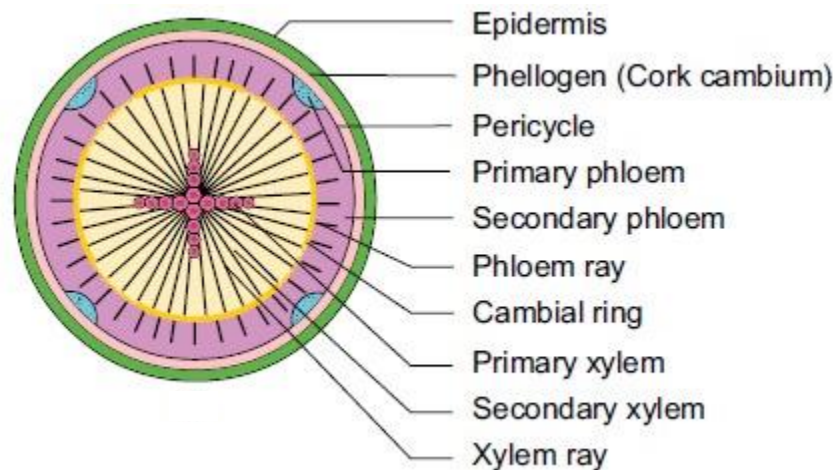
Ans: Secondary growth is the increase in the thickness or girth of stems and roots in plants, caused by cell division in lateral meristems.

Definition

- **Process:** Unlike primary growth (which increases length via apical meristems at the tips), secondary growth increases width.
- **Tissues Involved:** It is driven by two main lateral meristems:
 - **Vascular cambium:** Produces secondary xylem (wood) on the inside and secondary phloem (inner bark) on the outside.
 - **Cork cambium (phellogen):** Produces protective cork cells (phellem) on the outside and phelloderm on the inside, forming the periderm (outer bark).
- **Occurrence:** Common in gymnosperms and most dicots (eudicots), but typically absent in monocots.

Significance

- **Structural Support:** Generates wood, allowing plants to grow tall, support heavy branches, and withstand strong winds.
- **Enhanced Transport:** Expands the vascular system (xylem and phloem) to efficiently transport water, minerals, and sugars across longer distances in large plants.
- **Protection:** Replaces fragile epidermis with tough, waterproof bark that prevents water loss and guards against pests, diseases, and fire.
- **Longevity:** Enables perennial woody plants and trees to live for decades, centuries, or even millennia.



Q. 29. Describe the structure and function of vascular cambium.

Ans: The [vascular cambium](#) is a thin, cylindrical lateral meristem tissue in woody plants that drives secondary growth, increasing the girth or diameter of stems and roots.

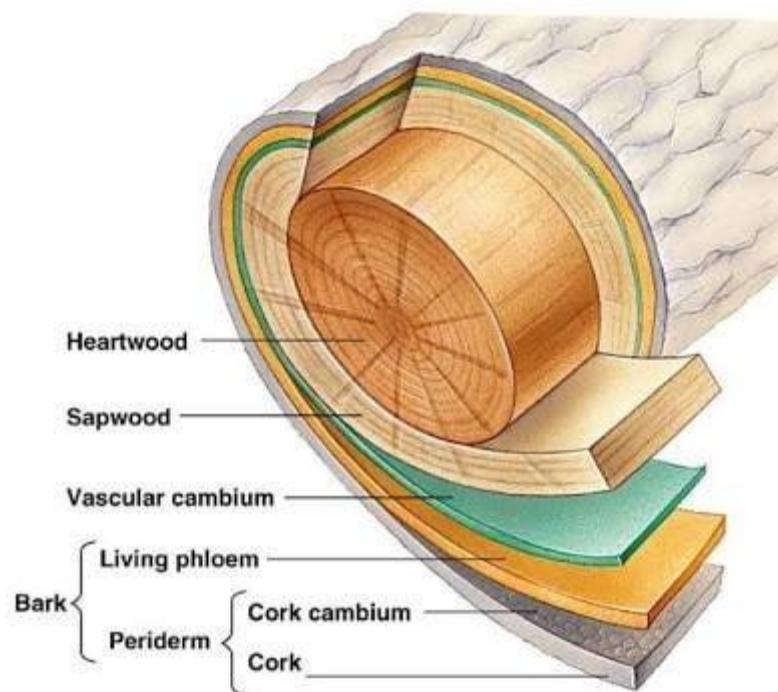
Structure of Vascular Cambium

- **Location:** It forms a continuous ring (or cylinder) situated directly between the primary xylem (inside, toward the pith) and the primary phloem (outside, toward the bark).
- **Cell Types:** It consists of two primary types of actively dividing meristematic cells:

- **Fusiform initials:** Tall, vertically elongated cells aligned with the axis of the stem or root; they produce the vertical (axial) conducting tissues like tracheids, vessel elements, and axial parenchyma.
- **Ray initials:** Short, horizontally oriented, and more isodiametric (equidimensional) cells; they produce vascular rays that transport water and nutrients horizontally across the stem.
- **Ring Formation:** In dicot stems, it develops by combining the *fascicular cambium* (inside vascular bundles) and the *interfascicular cambium* (formed from cells of medullary rays between bundles).

Function of Vascular Cambium

- **Secondary Xylem Production:** It divides inwards to generate **secondary xylem** (commonly known as wood), which provides structural support and bulk transport of water and minerals.
- **Secondary Phloem Production:** It divides outwards to generate **secondary phloem**, which distributes sugars and organic nutrients produced during photosynthesis.
- **Annual Ring Formation:** Seasonal shifts in cambial activity (fast growth in spring, slow growth in autumn) create visible growth rings used to calculate a tree's age.
- **Wound Healing:** It triggers the proliferation of callus tissue to repair injured bark and seal damaged plant surfaces.



Q. 30. Explain the process of secondary growth in roots.

Ans: Secondary growth in roots is the process that increases the thickness or diameter (girth) of the root axis in dicots and gymnosperms. It provides extra structural support and improves the transport of water and minerals.

This growth happens through the activity of two lateral meristems (tissues that divide to make the plant wider): the **vascular cambium** and the **cork cambium**.

Step 1: Formation of the Vascular Cambium Ring

- **Origin:** Unlike in stems, the vascular cambium in roots is completely secondary in origin. It develops from the conjunctive parenchyma tissue (cells located just below the primary phloem bundles) and a portion of the pericycle tissue lying outside the protoxylem.
- **Shape:** This division creates separate strips of meristematic tissue that eventually join together to form a complete, continuous, but wavy ring around the primary xylem.
- **Circular Shift:** As the cambium starts producing new cells, the pressure from the inner tissues pushes the wavy ring outward, making it circular.

Step 2: Activity of the Vascular Cambium

- **Secondary Tissues:** The cells of the vascular cambium ring divide actively.
 - Cells produced on the **inner side** differentiate into **secondary xylem** (wood).
 - Cells produced on the **outer side** differentiate into **secondary phloem**.
- **Proportion:** The cambium is much more active on the inside than the outside, producing a large amount of secondary xylem and a much narrower band of secondary phloem.
- **Medullary Rays:** At certain points, the cambium produces parenchymatous cells radially, forming secondary medullary (vascular) rays for lateral conduction.

Step 3: Formation of the Periderm (Cork Cambium / Bark)

- As the inner secondary tissues expand and increase the root's girth, the outer primary layers (epidermis, cortex, and endodermis) rupture and die.
- **Cork Cambium (Phellogen):** To replace the protective outer layer, cells in the [pericycle](#) become meristematic and form a new layer called the cork cambium.
- **Phellem and Phelloderm:**
 - The cork cambium cuts off cells on the outside that become **cork (phellem)**, which becomes waterproof due to a substance called suberin.
 - It cuts off cells on the inside that become the secondary cortex or **phelloderm**.
- **Periderm:** The phellem, phellogen, and phelloderm together form the periderm, which protects the inner root from mechanical damage and water loss.

Significance of Secondary Growth in Roots

- **Support:** Strengthens the root system to securely anchor tall, heavy woody plants.
- **Transport:** Expands the conducting channels (xylem and phloem) to handle higher volumes of water, minerals, and nutrients.
- **Protection:** Forms tough bark layers that guard against soil pathogens, pests, and physical injury.

Q. 31. What are annual rings? Explain their formation and significance.

Ans: Annual Rings

Annual rings are the concentric rings seen in the secondary xylem (wood) of the stem of a woody plant. Each ring usually represents **one year of secondary growth**.

Formation of Annual Rings

Annual rings are formed due to the **seasonal activity of the vascular cambium**.

1. During the **favourable season (spring)**, the cambium is highly active and produces a large number of **large, thin-walled xylem vessels and cells**. This lighter part is called **spring wood or early wood**.
2. During the **unfavourable season (autumn/winter)**, cambial activity decreases and it produces **small, thick-walled xylem cells**. This darker part is called **autumn wood, winter wood, or late wood**.
3. One layer of early wood together with one layer of late wood forms **one annual ring**.
4. The boundary between the late wood of one year and the early wood of the next year appears as a distinct ring.

Significance of Annual Rings

- They help in determining the **approximate age of a tree**.
- They provide information about the **rate of growth** of the plant.
- They help in studying **past climatic conditions**, such as rainfall and temperature.
- They can reveal the effects of **drought, disease, fire, and other environmental stresses**.
- The study of annual rings is called **dendrochronology** and is useful in studying the growth history and age of trees.

Annual rings are produced by the seasonal variation in cambial activity and are important for determining the age and growth history of woody plants.

Q. 32. Describe the structure of microsporangium.

Ans: Structure of Microsporangium

A **microsporangium** is the structure present in the **anther** of a flowering plant in which **microspores or pollen grains are produced**. It is commonly called the **pollen sac**.

1. Shape and position

A typical anther is **bilobed and ditheous**. Each lobe contains **two microsporangia**, so a young typical anther has **four microsporangia** arranged at its four corners.

2. Wall layers

The wall of a young microsporangium consists of **four layers**:

- **Epidermis**: The outermost protective layer.
- **Endothecium**: Lies below the epidermis. At maturity, its cells develop fibrous thickenings and help in the **dehiscence of the anther**.
- **Middle layers**: Usually consist of 2–3 layers of cells. They provide support and nourishment but generally degenerate at maturity.
- **Tapetum**: The innermost wall layer. Its cells are rich in cytoplasm and provide **nutrition to developing microspores/pollen grains**. It also helps in the formation of pollen wall materials.

3. Sporogenous tissue

Inside the wall is a mass of **sporogenous tissue**. The cells of this tissue develop into **microspore mother cells (pollen mother cells)**.

4. Formation of pollen grains

The microspore mother cells undergo **meiosis** and produce **haploid microspores**, usually arranged in groups of four called **tetrads**. These microspores later develop into **pollen grains**.

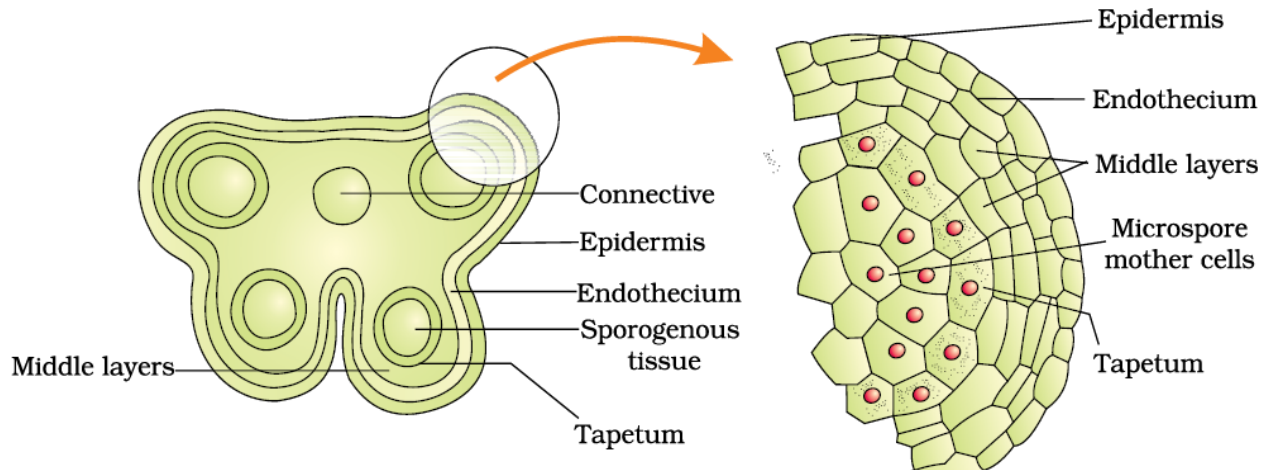


Diagram of T.S. of a typical microsporangium:

Epidermis → Endothecium → Middle layers → Tapetum → Sporogenous tissue

Thus, a microsporangium consists of **four wall layers surrounding sporogenous tissue**, and its main function is the **production and development of pollen grains**.

Q. 33. Write a note on the development of male gametophyte.

Ans: Development of Male Gametophyte

The **male gametophyte** of angiosperms is represented by the **pollen grain**. It develops from a **haploid microspore** produced in the microsporangium.

1. Formation of Microspores

The **microspore mother cell (MMC)** undergoes **meiosis** and forms a group of four haploid microspores called a **microspore tetrad**.

2. Development of Pollen Grain

The microspores separate from the tetrad and develop into pollen grains. Each young pollen grain has a prominent nucleus and dense cytoplasm.

3. First Mitotic Division

The nucleus of the microspore undergoes **mitosis** and forms two unequal cells:

- **Vegetative cell:** Large, with abundant cytoplasm and a large nucleus. It forms the **pollen tube**.
- **Generative cell:** Smaller and lies within the cytoplasm of the vegetative cell. It gives rise to the **two male gametes**.

Thus, at this stage the pollen grain is generally **two-celled**.

4. Formation of Male Gametes

The generative cell undergoes another **mitotic division** to form **two haploid male gametes**. This division may occur before or after pollen germination, depending on the plant species.

5. Mature Male Gametophyte

A mature male gametophyte therefore consists of a **vegetative cell and two male gametes**. The vegetative cell forms the pollen tube, through which the two male gametes are carried towards the embryo sac for fertilization.

Flow Chart

Microspore mother cell → Meiosis → Microspore tetrad → Single microspore → Mitosis → Vegetative cell + Generative cell → Generative cell divides → Two male gametes

Q. 34. Describe the structure of megasporangium (ovule).

Ans: **Structure of Megasporangium (Ovule)**

The **ovule** is the **megasporangium of a seed plant**. In angiosperms, it is present inside the **ovary** and develops into a seed after fertilization.

A typical angiosperm ovule consists of the following parts:

1. Funicle

The **funicle** is a stalk that attaches the ovule to the placenta. It supplies nutrients to the developing ovule.

2. Nucellus

The **nucellus** is the central mass of tissue enclosed by the integuments. It contains the **megaspore mother cell**, which undergoes meiosis to produce megaspores.

3. Integuments

The ovule is generally surrounded by **one or two integuments**. They protect the nucellus and leave a small opening called the **micropyle**.

4. Micropyle

The **micropyle** is a small opening in the integuments. It provides an entry passage for the **pollen tube** during fertilization and later helps in the entry of water during seed germination.

5. Chalaza

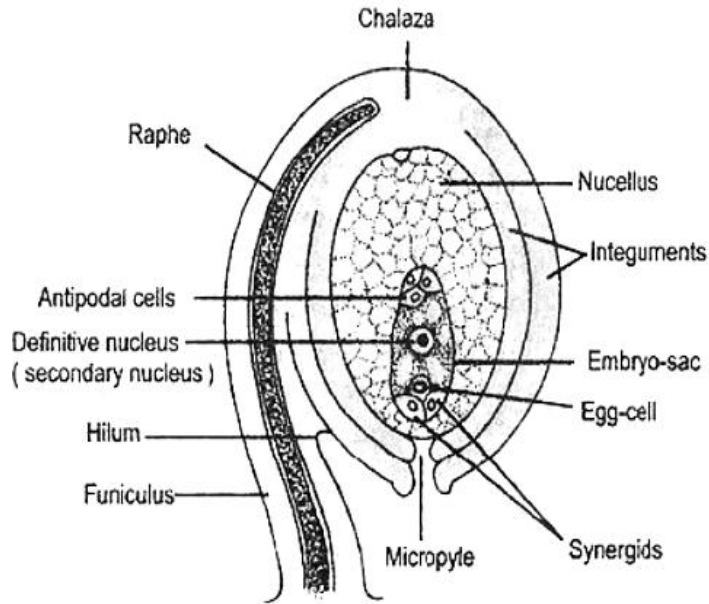
The **chalaza** is the basal region of the ovule where the integuments and nucellus meet. It lies opposite to the micropyle.

6. Embryo Sac

The **embryo sac** is the female gametophyte present within the nucellus. A typical mature embryo sac is **7-celled and 8-nucleate**. It contains:

- One **egg cell**
- Two **synergids**
- Three **antipodal cells**
- One central cell containing **two polar nuclei**

Thus, the ovule or megasporangium consists mainly of **funicle, integuments, nucellus, micropyle, chalaza and embryo sac**. It protects and nourishes the female gametophyte and, after fertilization, develops into a **seed**.



Q. 35. Describe the different types of ovules.

Ans: Different Types of Ovules

Ovules are classified mainly on the basis of the **orientation of the ovule with respect to the funicle, micropyle, and chalaza**. The main types are as follows:

1. Orthotropous Ovule

The ovule is **straight**. The micropyle, chalaza and funicle lie in the **same straight line**.

Examples: *Polygonum*, *Piper*.

2. Anatropous Ovule

The ovule becomes **completely inverted** during development, so that the micropyle comes close to the funicle. The funicle becomes fused with the ovule body forming a ridge called the **raphe**.

Examples: *Solanaceae*, *Leguminosae*. **It is the most common type of ovule in angiosperms.**

3. Hemianatropous Ovule

The ovule is placed at approximately a **right angle (90°)** to the funicle, due to a slight curvature of the ovule.

Example: *Ranunculus*.

4. Campylotropous Ovule

The ovule is **curved**, and as a result the micropyle and chalaza are not in the same straight line. The embryo sac also becomes somewhat curved.

Examples: *Caryophyllaceae*, *Chenopodiaceae*.

5. Amphitropous Ovule

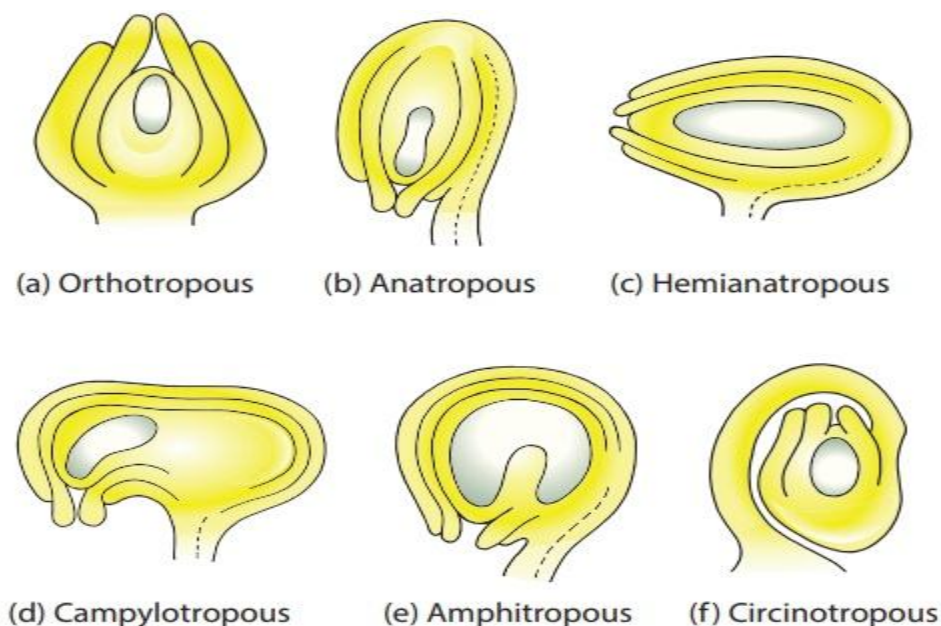
The ovule is strongly curved, and the **embryo sac is also curved or horseshoe-shaped**.

Example: *Alisma*.

6. Circinotropous Ovule

The funicle grows actively and becomes **coiled around the ovule**, often making the ovule appear to rotate almost completely.

Example: *Opuntia*.



Q. 36. Write a note on the significance of pollination in flowering plants.

Ans: Pollination is the transfer of pollen grains from the anther to the stigma of a flower. It is an essential process for sexual reproduction in flowering plants.

Significance of Pollination in Flowering Plants:

1. **Essential for fertilization:** Pollination brings the pollen grains to the stigma, allowing the pollen tube to develop and carry the male gametes to the ovule for fertilization.
2. **Formation of seeds and fruits:** Successful pollination followed by fertilization leads to the development of **seeds and fruits**, which are essential for reproduction and propagation of plants.
3. **Genetic variation:** **Cross-pollination** brings pollen from genetically different plants and promotes **genetic variation** in the offspring.
4. **Evolution and adaptation:** Genetic variation produced through cross-pollination helps plants **adapt to changing environmental conditions** and contributes to evolution.
5. **Maintenance of species:** Pollination ensures **sexual reproduction and continuity of plant species** from one generation to the next.
6. **Agricultural importance:** Efficient pollination increases **fruit and seed production** in many crop and horticultural plants. Insects such as bees play an important role in pollinating many crops.

Thus, pollination is a vital step in the sexual reproduction of flowering plants. It facilitates fertilization, promotes genetic variation, and contributes to the **formation of seeds, fruits and continuation of plant species**.

Q. 37. Define double fertilization and explain the process.

Ans:

Double

Fertilization:

Double fertilization is a characteristic feature of angiosperms in which two fertilization events occur in the same embryo sac. One male gamete fuses with the egg to form the zygote, while the other male gamete fuses with the two polar nuclei to form the primary endosperm nucleus.

Process of Double Fertilization

1. **Pollen germination:** After pollination, the pollen grain germinates on the stigma and produces a **pollen tube**.
2. **Entry of pollen tube:** The pollen tube grows through the style and reaches the ovule, usually entering through the **micropyle**. It enters one of the synergids and releases **two male gametes**.
3. **Syngamy:** One male gamete fuses with the **egg cell**. This fusion is called **syngamy** and results in the formation of a **diploid zygote (2n)**.
 $\text{Male gamete (n)} + \text{Egg (n)} \rightarrow \text{Zygote (2n)}$
4. **Triple fusion:** The second male gamete fuses with the **two polar nuclei** present in the central cell. This fusion is called **triple fusion** and produces the **triploid primary endosperm nucleus (3n)**.
 $\text{Male gamete (n)} + \text{Two polar nuclei (n + n)} \rightarrow \text{Primary endosperm nucleus (3n)}$
5. **Formation of embryo and endosperm:** The zygote develops into the **embryo**, while the primary endosperm nucleus develops into the **endosperm**, which provides nourishment to the developing embryo.

Significance

- It is a **unique feature of flowering plants (angiosperms)**.
- It results in the simultaneous formation of the **embryo and endosperm**.
- The endosperm provides **nutrition to the developing embryo**.
- It ensures that nutritive tissue is formed only after successful fertilization.

Flow Chart

Pollen tube $\rightarrow$ Two male gametes

Male gamete + Egg $\rightarrow$ Zygote (2n) $\rightarrow$ Embryo

Male gamete + Two polar nuclei $\rightarrow$ Primary endosperm nucleus (3n) $\rightarrow$ Endosperm

Thus, syngamy + triple fusion = double fertilization.

Q. 38. Explain the significance of double fertilization in angiosperms.

Ans: **Significance of Double Fertilization in Angiosperms**

Double fertilization is a characteristic feature of angiosperms in which one male gamete fuses with the egg (**syngamy**) and the other fuses with the two polar nuclei (**triple fusion**).

Its major significance is as follows:

1. **Formation of embryo:**
Syngamy produces a **diploid zygote (2n)**, which develops into the embryo of the seed.
2. **Formation of endosperm:**
Triple fusion produces the **triploid primary endosperm nucleus (3n)**, which develops into the endosperm.
3. **Nutrition of embryo:**
The endosperm acts as a **nutritive tissue** and supplies food to the developing embryo.

4. **Efficient use of resources:**
Endosperm formation generally begins **only after fertilization**, so the plant does not invest heavily in nutritive tissue without successful fertilization.
5. **Development of seed and fruit:**
Double fertilization initiates the development of the **embryo, endosperm and seed**, while the ovary develops into the fruit.
6. **Unique feature of angiosperms:**
The occurrence of two fusions—**syngamy and triple fusion**—in the same embryo sac is a distinctive feature of flowering plants.

Thus, double fertilization is biologically important because it results in the formation of both the **embryo and nutritive endosperm**, ensuring proper development of the seed and continuation of the species.

Q. 39. Differentiate between dicot and monocot embryos.

Ans: **Difference Between Dicot and Monocot Embryos**

The embryo of a seed plant develops from the zygote after fertilization. Dicot and monocot embryos differ in the number of cotyledons and the arrangement of their embryonic parts.

Feature	Dicot Embryo	Monocot Embryo
1. Cotyledons	Has two cotyledons .	Has one cotyledon , called scutellum .
2. Shape	Usually heart-shaped at the two-cotyledon stage.	Usually single, shield-shaped cotyledon.
3. Plumule	Lies between the two cotyledons.	Lies laterally near the base of the scutellum.
4. Radicle	Forms the primary root and is present at the lower end of the embryonal axis.	Protected by a sheath called the coleorhiza .
5. Plumule protection	Usually not enclosed by a special sheath.	Plumule is enclosed by a protective sheath called the coleoptile .
6. Food storage	Food may be stored in the cotyledons .	Food is generally stored mainly in the endosperm ; the scutellum absorbs nutrients from it.

7. Examples	Pea, gram, bean, sunflower.	Maize, wheat, rice, grasses.
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Thus, the main difference is that a **dicot embryo has two cotyledons**, whereas a **monocot embryo has a single cotyledon (scutellum)**. Monocot embryos also possess specialized protective structures, **coleoptile and coleorhiza**, around the plumule and radicle respectively.

Q. 40. Explain the process of endosperm development.

Ans: Endosperm Development

Endosperm is a nutritive tissue formed in the embryo sac of angiosperms after **triple fusion**. It provides nourishment to the developing embryo. The primary endosperm nucleus is generally **triploid (3n)**.

Process of Endosperm Development

After double fertilization, the **primary endosperm nucleus (3n)** undergoes repeated divisions. Depending upon the pattern of nuclear and cellular divisions, endosperm development is mainly of **three types**:

1. Nuclear Type

- The primary endosperm nucleus undergoes repeated **mitotic divisions**.
- The daughter nuclei are not immediately separated by cell walls.
- Thus, a large number of free nuclei are formed in the cytoplasm.
- Later, cell walls may develop around the nuclei.
- **Examples:** *Cocos, maize, wheat*.

2. Cellular Type

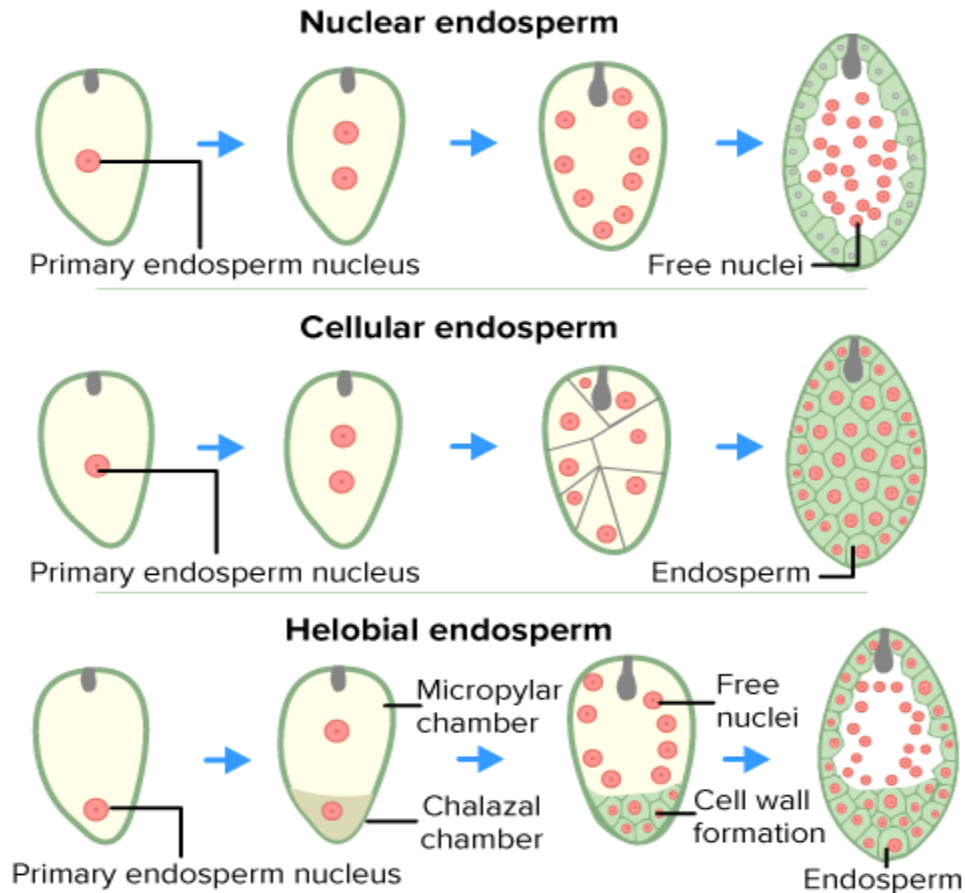
- Each nuclear division is followed immediately by the formation of a **cell wall**.
- Therefore, the endosperm becomes cellular from the beginning.
- **Example:** *Petunia, Datura*.

3. Helobial Type

- The first division of the primary endosperm nucleus is followed by the formation of a **cell wall**, producing two chambers:
 - **Micropylar chamber**
 - **Chalazal chamber**
- Subsequent divisions in these chambers are generally free-nuclear.
- **Examples:** *Eremurus, Asphodelus*.

Significance of Endosperm

1. It provides **nutrition to the developing embryo**.
2. It stores food materials such as **starch, proteins and oils**.
3. It supports the growth and development of the embryo.
4. In many seeds, the endosperm remains as the **main food-storage tissue**.



Thus, endosperm develops from the **primary endosperm nucleus after triple fusion** and may develop by **nuclear, cellular or helobial patterns**. It plays an important role in nourishing the developing embryo.

Q. 41. Didynamous Condition of stamens.

Ans: Didynamous Condition of Stamens

Didynamous is a condition in which a flower has **four stamens arranged in two pairs**, with **two stamens being longer and the other two being shorter**.

Characteristics

1. The flower contains **four stamens**.
2. The stamens occur in **two unequal pairs**.
3. **Two stamens are long** and **two are short**.
4. The stamens are usually attached to the corolla and may extend beyond it.
5. This condition is commonly found in members of the family **Lamiaceae** and some members of **Scrophulariaceae**.

Examples

- **Ocimum** (Tulsi)
- **Salvia**
- **Mentha**
- **Leucas**



Significance

The unequal length of stamens may help in **effective pollen placement and pollination**, particularly in flowers pollinated by insects.

Didynamous = 4 stamens → 2 long + 2 short.

Example: *Ocimum*.

Q. 42. Describe Binomial System.

Ans: Binomial System of Nomenclature

The **Binomial System of Nomenclature** is a system of scientific naming in which every species is given a **two-word name**. It was introduced and popularized by **Carolus Linnaeus**. The scientific name consists of the **genus name and specific epithet**.

Components of Binomial Name

A scientific name has two parts:

1. Genus:

The first word represents the **genus**. Its first letter is always written in **capital form**.

2. Specific epithet:

The second word is the **specific epithet** and is written in **small letters**.

For example, in *Mangifera indica*:

- *Mangifera* → Genus
- *indica* → Specific epithet

Rules of Binomial Nomenclature

1. Every species should have a **two-word scientific name**.
2. The **genus name is written first**, followed by the specific epithet.
3. The first letter of the genus is **capitalized**, while the specific epithet begins with a **small letter**.
4. Scientific names are written in **italics** in printed material.
5. When written by hand, the two words are **underlined separately**.
6. The name of the **author who described the species** may be written after the scientific name.
7. Scientific names are generally derived from **Latin or Latinized words**.
8. The same scientific name is used **universally**, irrespective of the local language.

Examples

Common name	Scientific name
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Mango	<i>Mangifera indica</i>
Wheat	<i>Triticum aestivum</i>
Rice	<i>Oryza sativa</i>
Potato	<i>Solanum tuberosum</i>
Pea	<i>Pisum sativum</i>

Importance

- Provides a **universal and standardized name** for each species.
- Avoids confusion caused by different **common or regional names**.
- Helps in the **identification and classification** of organisms.
- Makes scientific communication easy among scientists throughout the world.
- Indicates the **relationship of a species with its genus**.

Thus, the binomial system provides a **simple, universal and scientific method of naming organisms**, in which each species is identified by a two-word name consisting of its **genus and specific epithet**.

Q. 43. Define herbarium. Explain its preparation and importance.

Ans: Herbarium:

A herbarium is a collection of dried, pressed and properly preserved plant specimens mounted on sheets and arranged systematically for study, identification and reference.

Preparation of Herbarium

The preparation of a herbarium specimen involves the following steps:

1. **Collection:**

Healthy and representative plant specimens are collected from their natural habitat. As far as possible, specimens should include **leaves, flowers and fruits**.

2. **Pressing:**

The collected specimen is placed between sheets of paper and pressed using a **plant press** so that it becomes flat.

3. **Drying:**

The pressed specimen is dried properly by changing the sheets of paper at regular intervals to prevent **fungal growth and decay**.

4. **Mounting:**

The dried specimen is fixed on a standard **herbarium sheet**, usually with glue, adhesive tape or suitable stitching.

5. **Labelling:**

A label is attached to the sheet containing important information such as:

- Scientific name
- Family
- Local/common name
- Place and date of collection
- Name of collector
- Other relevant details

6. **Preservation and Arrangement:**

Herbarium sheets are stored in **dry, protected cupboards** and arranged systematically according to a suitable classification system.

Importance of Herbarium

1. It helps in the **identification of plants**.
2. It provides permanent **reference material** for botanical studies.
3. It is useful in the study of **plant taxonomy and classification**.
4. It helps researchers compare **different plant species and specimens**.
5. It provides information about the **distribution and occurrence of plants**.
6. It is useful for **teaching and research** in botany.
7. It preserves a record of plants collected from particular **localities and periods**.

Thus, a herbarium is an important **reference collection of preserved plant specimens** and is widely used in **plant identification, taxonomy, research and education**.

Q. 44. What is a botanical garden? Explain its major functions.

Ans: **Botanical Garden**

A **botanical garden** is a specially designed place where a large variety of **living plants are collected, cultivated, maintained and labelled** for scientific study, education and conservation. Plants are generally arranged according to their **families, genera or other systematic groups**.

Major Functions of a Botanical Garden

1. **Plant identification:** Botanical gardens provide living specimens that help in the **identification and study of plants**.
2. **Conservation of plants:** They help in the **conservation of rare, endangered and economically important plant species**.
3. **Scientific research:** They provide plant material for research in **taxonomy, morphology, physiology, ecology and other branches of botany**.
4. **Education and teaching:** Botanical gardens are useful for **practical teaching** of students and provide an opportunity to observe living plants directly.
5. **Introduction and acclimatization:** Plants from different geographical regions can be **introduced, cultivated and studied** under suitable conditions.
6. **Exchange of plant material:** Botanical gardens may exchange **seeds, living plants and other plant material** with other botanical institutions.
7. **Public awareness:** They create awareness about **plant diversity, conservation and environmental protection** among the general public.
8. **Germplasm preservation:** They help maintain living collections that can serve as a source of **genetic material** for future research and conservation.

Examples

Important botanical gardens include **Royal Botanic Gardens, Kew (England)** and **Indian Botanical Garden, Howrah (India)**.

Thus, a botanical garden is not only a collection of living plants but also an important centre for **plant conservation, research, education, identification and public awareness**.

Q. 45. Write a note on indoor gardens and their importance.

Ans: **Indoor Gardens**

An **indoor garden** is a garden in which plants are grown and maintained **inside an enclosed building or protected space** such as a house, office, classroom, hotel, greenhouse or atrium. The plants are selected according to the available **light, temperature, humidity and space**. Indoor gardening is also called **interior landscaping** when plants are used mainly for decorating indoor spaces.

Suitable Plants for Indoor Gardens

Plants suitable for indoor conditions generally tolerate **low or indirect light** and require comparatively less maintenance. Common examples include:

- **Money plant** (*Epipremnum*)
- **Snake plant** (*Dracaena trifasciata*)
- **Spider plant** (*Chlorophytum*)
- **Peace lily** (*Spathiphyllum*)
- **Ferns**
- **Areca palm**
- **Dieffenbachia**

Requirements of an Indoor Garden

1. **Suitable light:** Plants should receive adequate natural or artificial light.
2. **Proper watering:** Overwatering should be avoided, and watering should depend on the plant's requirement.
3. **Good drainage:** Pots should have drainage holes to prevent waterlogging.
4. **Temperature and humidity:** Suitable temperature and humidity should be maintained.
5. **Fertilization:** Plants should receive appropriate nutrients for healthy growth.
6. **Regular care:** Removal of dead leaves, cleaning and protection from pests are necessary.

Importance of Indoor Gardens

1. **Aesthetic value:** Indoor plants add **beauty, colour and greenery** to buildings.
2. **Improves the indoor environment:** Plants participate in **photosynthesis** and contribute to oxygen production and carbon dioxide uptake when conditions permit.
3. **Creates a pleasant atmosphere:** Green plants can make indoor spaces appear **fresh, attractive and comfortable**.
4. **Educational importance:** Indoor gardens provide opportunities to study **plant growth, morphology and basic plant-care practices**.
5. **Efficient use of space:** Plants can be grown in **small areas, pots, containers and hanging baskets**, making gardening possible where outdoor space is unavailable.
6. **Promotes interest in plants:** Indoor gardening develops **awareness and interest in plant cultivation and conservation**.
7. **Useful for interior decoration:** Plants are widely used in **homes, offices, hotels, hospitals and educational institutions** for interior landscaping.
8. **Conservation of plant diversity:** Growing suitable plant species indoors can help maintain **living collections** and promote awareness about plant diversity.

Thus, indoor gardens are an important form of gardening in which plants are cultivated within enclosed spaces. They have **aesthetic, educational, environmental and recreational importance** and are especially useful where outdoor gardening space is limited.

Q. 46. Define topiary and describe its significance in ornamental horticulture.

Ans: **Topiary**

Topiary is the horticultural art of **training and trimming living plants into decorative shapes and forms**. Plants are pruned regularly to produce shapes such as **geometrical figures, animals, birds, arches and other ornamental designs**.

Method of Topiary

1. A suitable **evergreen, dense and easily pruned plant** is selected.
2. The plant is trained and pruned regularly using **garden shears or other pruning tools**.
3. Unwanted branches are removed to maintain the desired shape.
4. Frequent trimming is done to maintain the **size, outline and symmetry** of the design.
5. Sometimes a **wire or metal framework** is used as a guide for producing complicated shapes.

Plants Commonly Used

Some plants suitable for topiary are:

- **Duranta**
- **Murraya**
- **Ficus**
- **Myrtle**
- **Boxwood**

Significance in Ornamental Horticulture

1. **Enhances beauty:**
Topiary adds **artistic and decorative value** to gardens and landscapes.
2. **Creates attractive garden designs:**
Plants can be shaped into **balls, cones, pyramids, arches, animals and other forms**.
3. **Landscape decoration:**
It is widely used in **parks, gardens, hotels, resorts and institutional landscapes**.
4. **Improves garden structure:**
Topiary can act as a **focal point** and gives a formal and organized appearance to a garden.
5. **Efficient use of space:**
Properly trained plants can be maintained in **compact forms**, making them useful in smaller gardens.
6. **Commercial value:**
Specially shaped plants have **ornamental and commercial value** and are sold as decorative nursery plants.

Thus, topiary is an important technique of ornamental horticulture in which plants are **trained and pruned into attractive shapes**. It combines **horticultural skill with artistic design** and greatly enhances the ornamental value of landscapes.

Q. 47. Write a short note on Bonsai and its important characteristics.

Ans: Bonsai:

Bonsai is the art of growing and training a **woody plant as a miniature tree in a shallow container**. The plant is kept small by controlling its roots and shoots through **pruning, training and other horticultural techniques**. Bonsai originated as an ancient art in **East Asia**, especially associated with Japanese and Chinese traditions.

Important Characteristics of Bonsai:

1. **Miniature form:**

The plant resembles a **mature natural tree but is maintained in a small size**.

2. **Shallow container:**

Bonsai plants are generally grown in **shallow pots or containers**, which restrict excessive root growth.

3. **Root pruning:**

Roots are periodically pruned to **control root growth** and maintain the desired plant size.

4. **Shoot pruning:**

Regular pruning of shoots and branches maintains the **shape and compact growth** of the plant.

5. **Training:**

Branches and stems are trained into desired forms using **wires, ties or other supports**.

6. **Strong trunk:**

A good bonsai generally has a **well-developed, proportionate and attractive trunk**, giving it the appearance of an old tree.

7. **Proportion and balance:**

The leaves, branches, trunk and roots are maintained in **proper proportion** to create a natural appearance.

8. **Long-term maintenance:**

Bonsai requires regular **watering, pruning, repotting, fertilization and protection from pests and diseases**.

Common Bonsai Plants:

Examples include **Ficus, Juniper, Pine, Bougainvillea, Azalea and Maple**.

Bonsai is a specialized form of ornamental horticulture that combines **plant cultivation, training and artistic design** to create miniature trees with a natural and aesthetically pleasing appearance.

Q. 48. Describe the important features of famous gardens of India.

Ans: Famous Gardens of India

India has many famous historical and ornamental gardens that represent different styles of **landscape gardening and horticulture**. Some important gardens are:

1. *Mughal Gardens, Srinagar*

- Located in **Srinagar, Jammu and Kashmir**.
- Famous for the **Mughal style of garden design**.
- Important gardens include **Shalimar Bagh, Nishat Bagh and Chashme Shahi**.
- Characterized by **terraces, fountains, waterfalls, channels and beautiful views of the surrounding mountains and Dal Lake**.
- A strong feature is the use of **symmetrical layouts and flowing water**.

2. *Lalbagh Botanical Garden, Bengaluru*

- One of the important botanical gardens of India.
- Famous for its **large collection of tropical and subtropical plants**.
- Contains beautiful lawns, flower beds, trees and a famous **glasshouse**.
- It is important for **plant conservation, education and horticultural exhibitions**.

3. *Indian Botanical Garden, Howrah*

- Located at **Shibpur, Howrah, West Bengal**.
- It is known for its extensive collection of **living plants and trees**.
- Famous for the **Great Banyan Tree**, one of the major attractions of the garden.
- It has great importance in **botanical research, education and plant conservation**.

4. *Acharya Jagadish Chandra Bose Indian Botanic Garden*

- Located in **Howrah, West Bengal**.
- Contains a large diversity of **plants from different regions**.
- Important collections include **palms, orchids, bamboos and aquatic plants**.
- It serves as an important centre for **botanical studies and conservation**.

5. *Brindavan Gardens, Mysuru*

- Located near **Krishna Raja Sagara Dam, Karnataka**.
- Famous for its **terraced lawns, ornamental plants, fountains and colourful flower beds**.
- The garden is especially known for its **musical and illuminated fountains**.
- It is an important example of **formal ornamental landscaping**.

The famous gardens of India show a variety of **Mughal, botanical and formal garden styles**. They are important not only for their **beauty and recreation**, but also for **plant conservation, education, research and horticultural development**.

Q. 49. Explain the role of taxonomic resources in plant identification.

Ans: Role of Taxonomic Resources in Plant Identification

Taxonomic resources are the materials, collections and references used by botanists for the **identification, classification and naming of plants**. They provide reliable information about plant characters and help in comparing unknown specimens with known species.

Major Taxonomic Resources and Their Role

1. Herbarium

A herbarium contains **dried, pressed and labelled plant specimens**. An unknown plant can be compared with preserved specimens to determine its identity.

2. Botanical Gardens

Botanical gardens maintain **living collections of identified plants**. They provide an opportunity to observe important morphological characters such as leaves, flowers, fruits and growth habits.

3. Museums

Botanical museums preserve **plant specimens, fruits, seeds, wood and other plant materials**. These collections are useful for studying and comparing plant structures.

4. Flora

A **flora** is a systematic account of plants occurring in a particular **geographical region**. It usually provides descriptions, distribution details and identification keys.

5. Manuals and Monographs

Manuals provide information and keys for identifying plants of a particular area, while **monographs** give detailed information about a particular family, genus or group of plants.

6. Taxonomic Keys

Keys provide a series of **contrasting statements or choices** based on plant characters. By following the correct choices, an unknown plant can be identified.

7. Botanical Literature and Databases

Scientific publications, catalogues and databases provide information about **accepted scientific names, synonyms, classification and distribution** of plants.

Importance in Plant Identification

- Provide **authentic reference material** for comparison.
- Help determine the **correct scientific name** of a plant.
- Provide information about **morphological characters and geographical distribution**.
- Help distinguish between **closely related species**.
- Support **research, teaching and conservation** of plant diversity.

Thus, taxonomic resources such as **herbaria, botanical gardens, museums, floras, manuals, monographs and taxonomic keys** are essential tools for accurate plant identification and classification.

Q. 50. Differentiate between a herbarium and botanical garden.

Ans: Difference Between Herbarium and Botanical Garden

A **herbarium** is a collection of preserved plant specimens, whereas a **botanical garden** is a collection of living plants maintained for study, education and conservation.

Basis	Herbarium	Botanical Garden
1. Definition	A collection of dried, pressed and preserved plant specimens mounted on sheets.	A place where living plants are collected, cultivated and maintained.
2. Nature of plants	Contains dead/preserved specimens.	Contains living plants.
3. Preservation	Specimens are dried, pressed, mounted and labelled.	Plants are maintained by regular watering, pruning, fertilization and other care.
4. Main purpose	Mainly used for plant identification, taxonomy and reference.	Mainly used for plant conservation, education, research and display.
5. Study of characters	Provides preserved morphological characters for comparison.	Allows observation of living characters, growth habit, flowers and fruits.
6. Space required	Specimens are stored in herbarium sheets and cabinets.	Requires land or garden space for cultivation of plants.
7. Labelling	Each specimen is accompanied by a detailed herbarium label.	Plants are generally identified by labels or name plates placed near them.
8. Examples	Herbarium of a university or botanical institution.	Lalbagh Botanical Garden, Bengaluru; Indian Botanic Garden, Howrah.

Thus, a **herbarium preserves plants in dried form for reference and identification**, while a **botanical garden maintains living plants for observation, conservation, education and research.**
