

Practical Manual
Forest Botany

FBS-144 2(1+1)

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College of Horticulture & Forestry
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Syllabus Forest Botany FBS 144 2(1+1): Morphology of root, stem and leaves with special emphasis on underground and aerial modifications in root and stem; simple and compound leaves; types of phyllotaxy and venation (live specimens); typical structure of bisexual flower; types of inflorescence (live specimens); types of tissues with the aid of permanently mounted slides; Tissue organization in Dicot root, stem and leaves; Tissue organization in Monocot root, stem and leaves with the aid of permanent slides or study charts.

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CERTIFICATE

This is to certify that Shri./Km. ID No.....has completed the practical of course.....course No. as per the syllabus of B.Sc. (Hons.) Forestry semester in the year.....in the respective lab/field of College.

Date:

Course Teacher

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Objective: To study the plants root

1. Write down morphology of root

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2. Draw neat and clean diagrams of cross section of root



Objective: To study morphology of leaves

1. Write down morphology of leaves

Leaf blade

Leaf lamina

Mid rib

Tip

Leaf margin

Vein

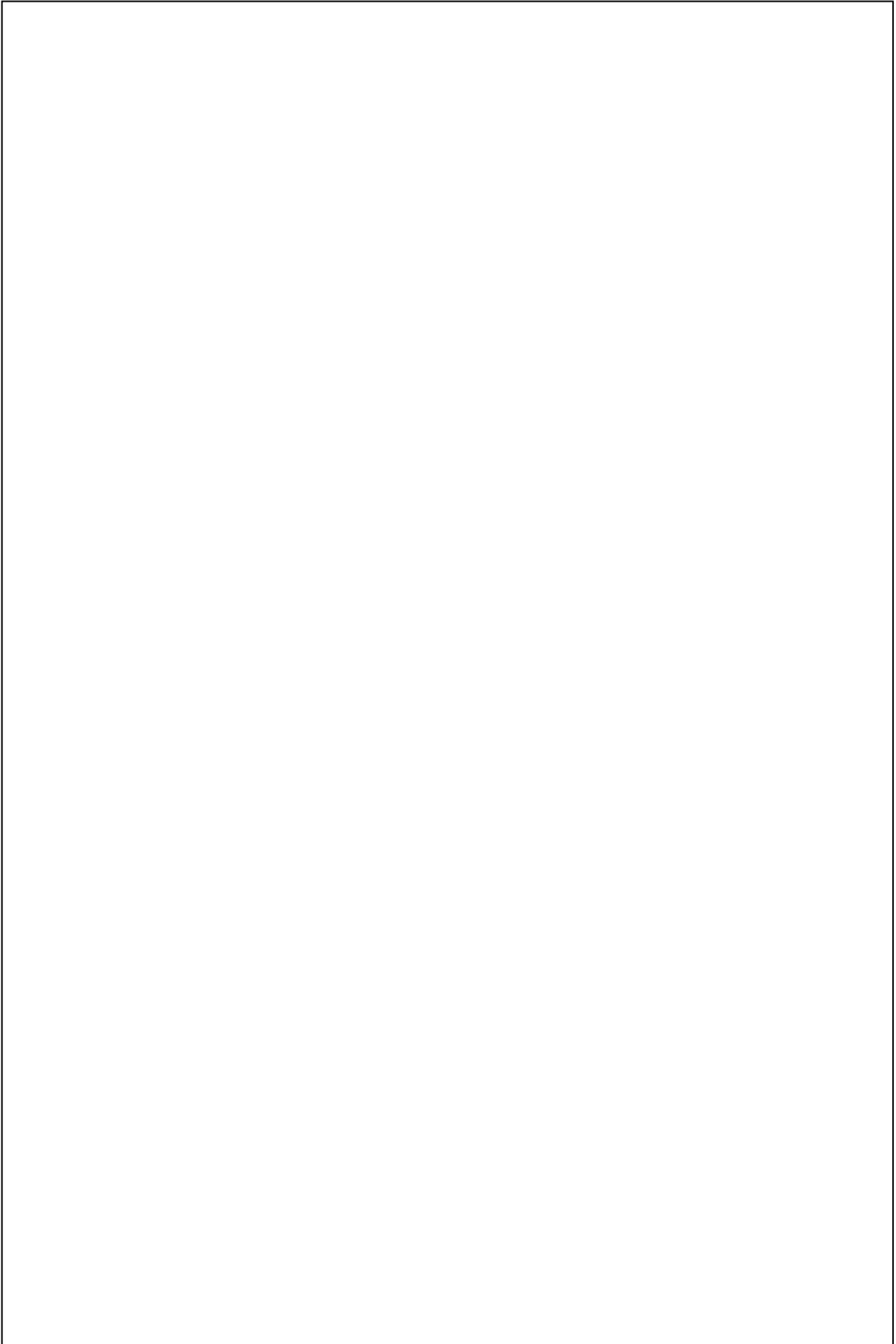
Petiole

Total leaf

Maximum width of leaf

Stipule

2. Draw neat and clean diagram of leaf



Objective: To study the types of simple and compound leaves

1. Write down types of leaves

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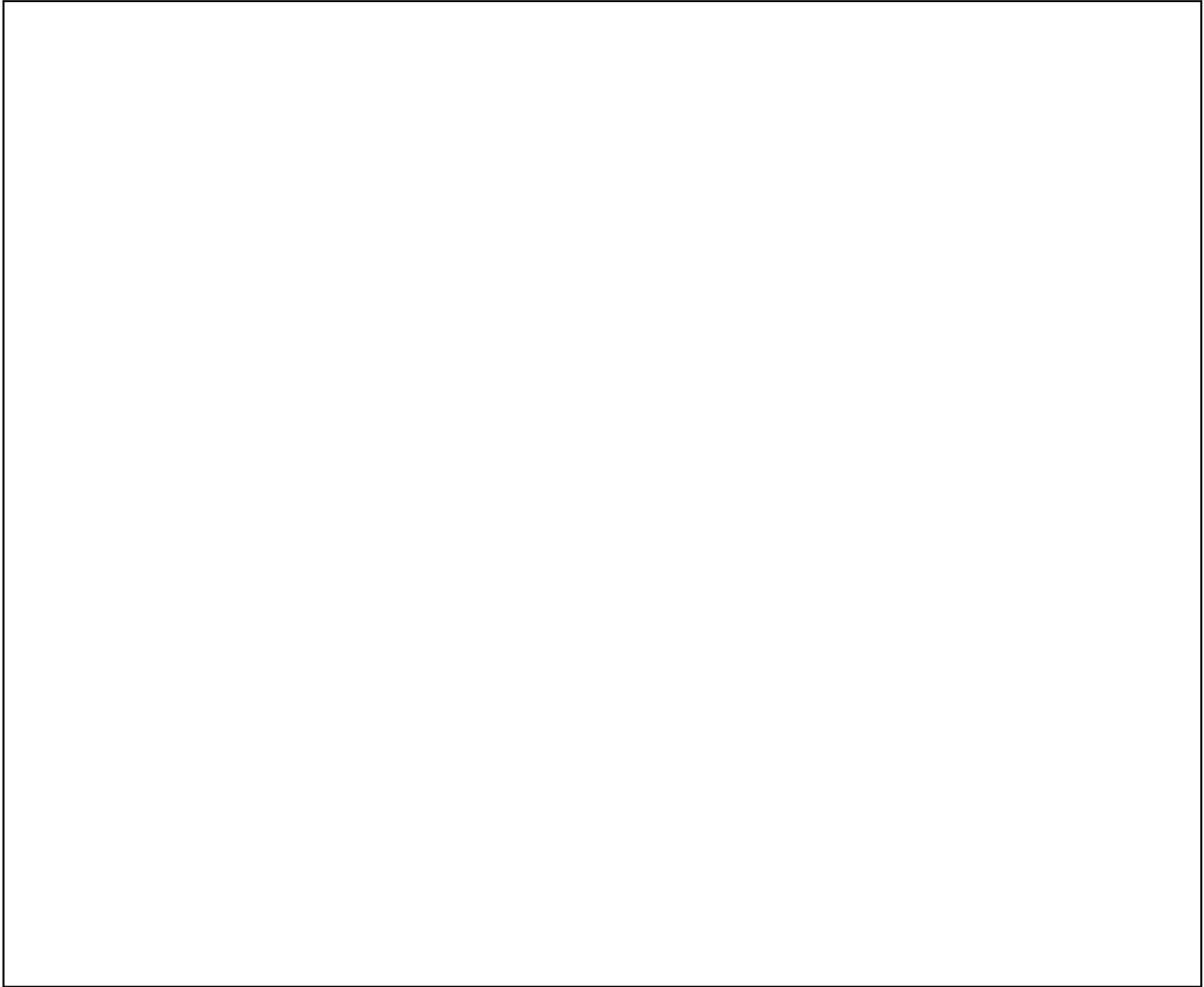
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Objective: To study the types of phyllotaxy and venation

1. Write down types of phyllotaxy

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2. Write down types of venation

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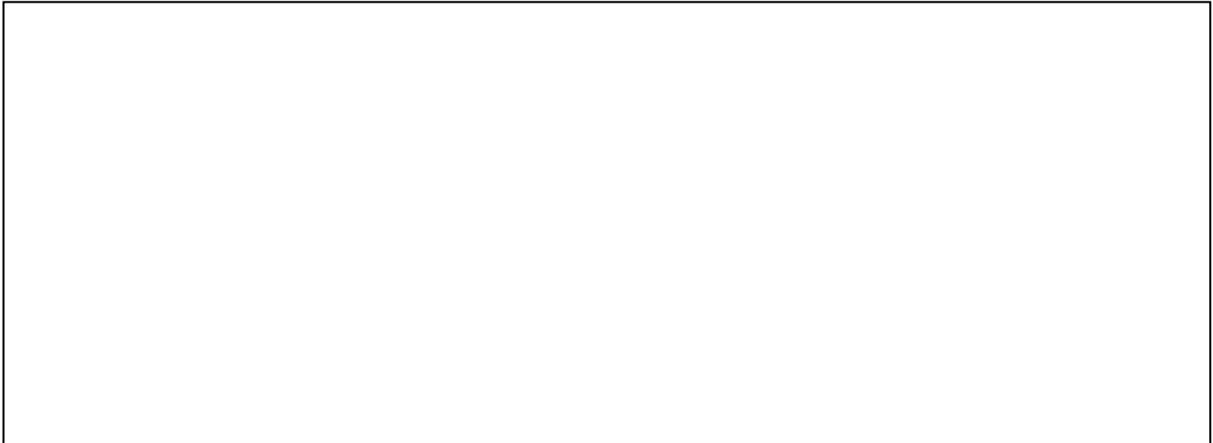
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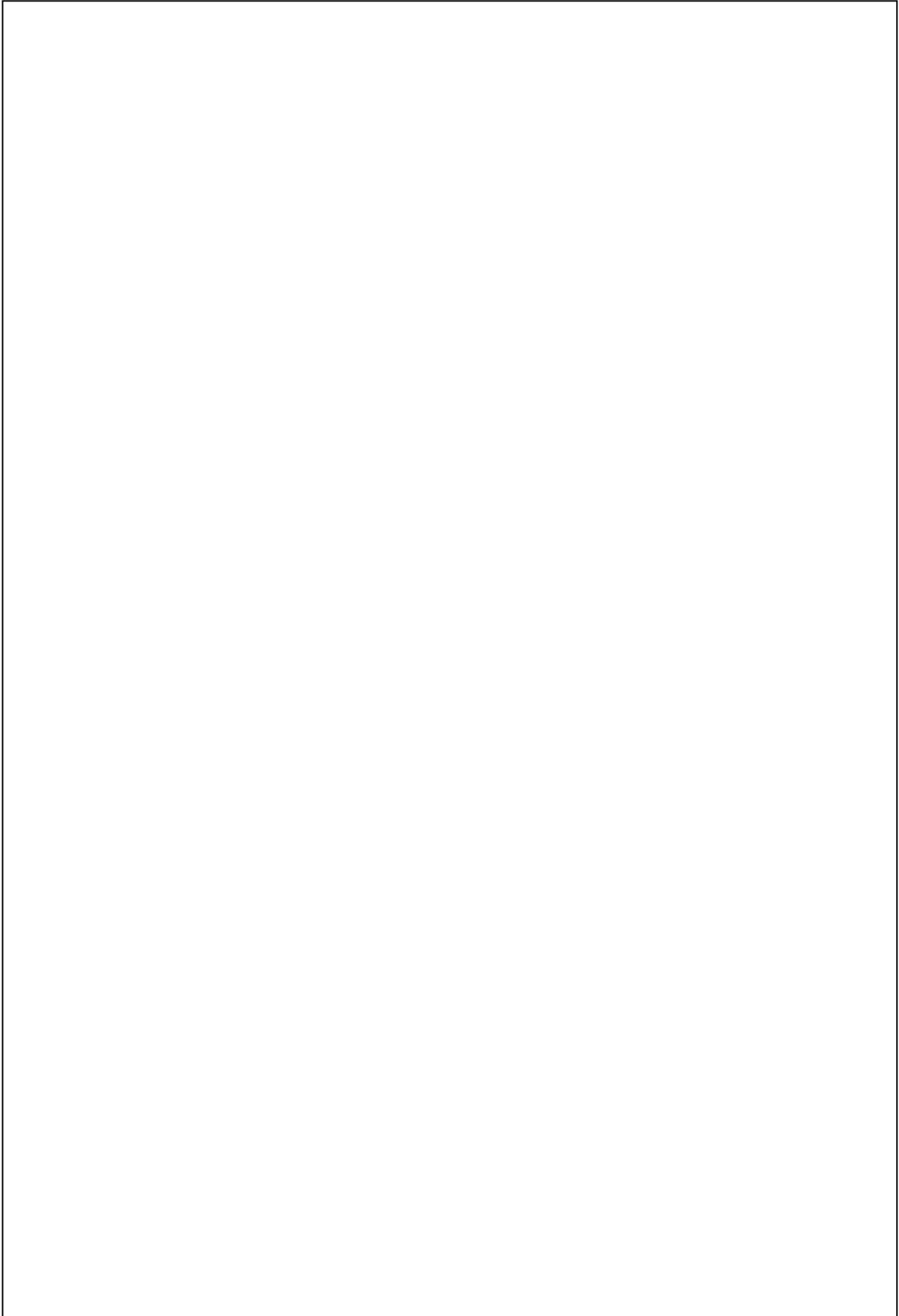
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3. Draw diagram of phyllotaxy and venation



2. Draw diagram of flower



2. Draw diagram of different types of inflorescence



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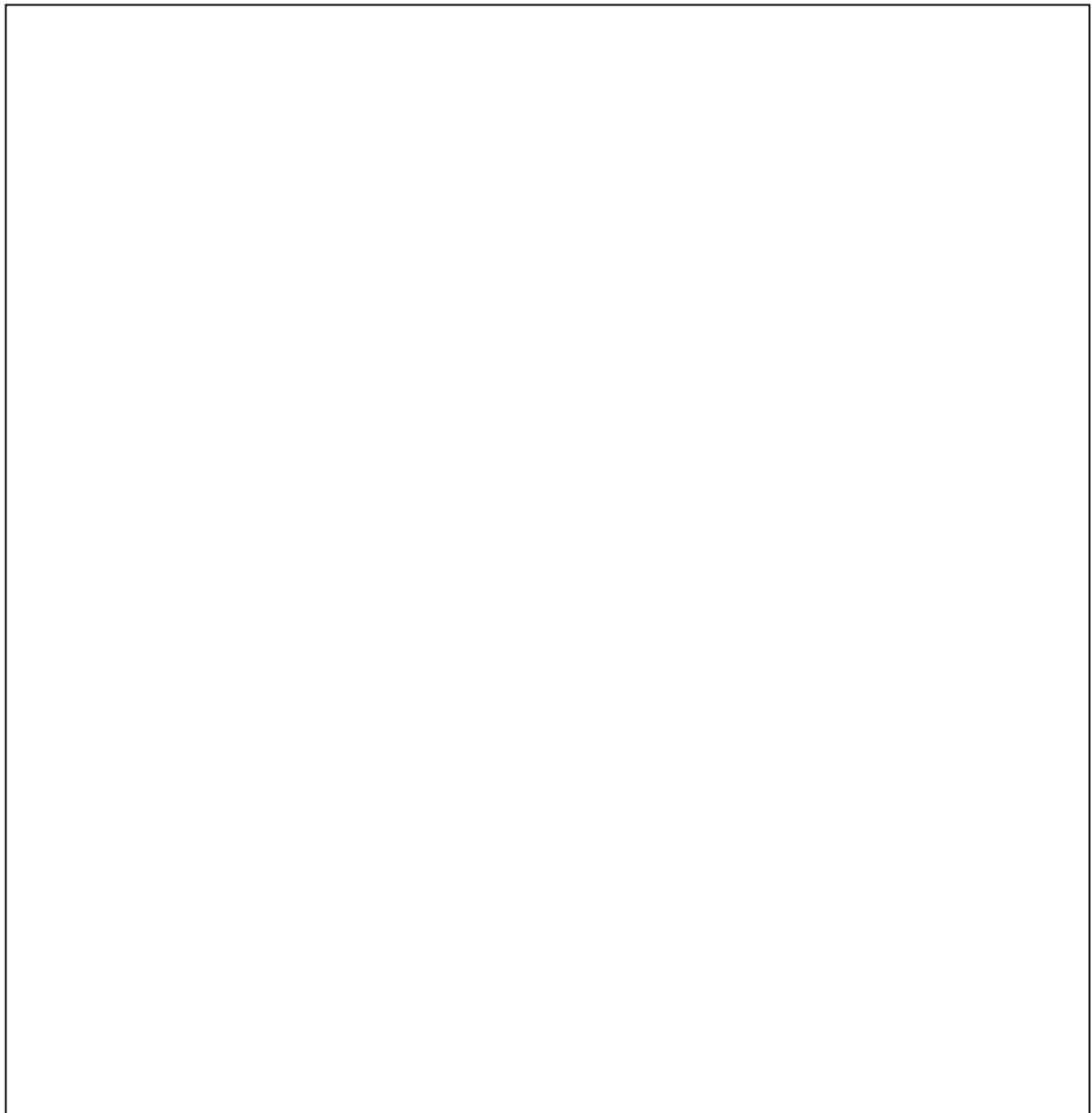
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2. Draw diagram of tissues present in root, stem and leaf



2. Draw diagram of vascular bundles



Objective: To study field Identification of trees

1. Visit nearby plantation for field identification of trees

Name of plantation

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Spacing

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Year of planting

2. List out species identified with scientific name

S. N.	Name of tree	Scientific name	Shape of leaf	Phyllotaxy
1				
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CLASSIFICATION OF PLANTS

All living organisms in the ecosystem are classified into kingdoms and sub-kingdoms based on their characteristics. Similarly, plants are also classified into different sub-kingdoms based on certain characteristic features.

Classification based on Life Cycle

Plant species can be classified based on their life cycle.

Annuals: These are plants that complete their life cycle during a single season. They are normally herbaceous. Examples are annuals plant.

Biennials: These are plants that require two years to complete their life cycle.

Perennials: These are plants that have a long-life span. They are characteristically woody or herbaceous.

Taxonomic Classification of Plants

Taxonomy is a system for classifying plants based on their genetic and evolutionary relationship. Plants are classified into a separate kingdom called the **Kingdom Plantae**. This current system of classification of plants is based on the evolutionary relationship amid other plants.

Coniferophyta (Gymnosperms): It is a group of plants which is primarily evergreen and is native to the temperate zone. They are vascular, non-flowering plants which produce seeds without the production of flower and fruits. Some common examples of gymnosperm include pines, cycads, cedars, etc.

Anthophyta (Angiosperms): They can grow into big trees as well as small shrubs, bushes and herbs. They are subdivided into Monocotyledonous and Dicotyledonous. Some common examples of angiosperms include mango trees, roses, jasmine, marry gold, etc.

Monocotyledons: Monocotyledonous plants are commonly referred to as monocot plants. They are flowering plants with seed containing one cotyledon. The venation pattern of their leaves is parallel-veined. Some common examples of monocot plants are rice, corn, sugarcane, tulips, onion, etc.

Dicotyledons: Dicotyledonous plants are commonly referred to as dicot plants. They are flowering plants, mostly grown as herbs, shrubs, and trees with the seed containing two cotyledons. Some common examples are figs, eucalyptus, potato, tomato, hibiscus, etc.

MORPHOLOGY OF ROOTS

Root: Root is a part of a vascular plant normally underground. Its primary functions are anchorage of the plant, absorption of water and dissolved minerals and conduction of these to the stem, and storage of reserve foods. The root differs from the stem mainly by lacking leaf scars and buds, having a root cap, and having branches that originate from internal tissue rather than from buds. There are two types of root systems. The first is a **fibrous root system** which has multiple big roots that branch and form a dense mass which does not have a visible primary root and other is the **tap root system** which has one main root that has branching into lateral roots. There are different types of roots: **primary root** originated from the root of the seedling, **secondary (lateral) roots** originate from the primary roots and **adventitious roots** originate on stems (some-times also on leaves), the example are prop roots of screw pine (*Pandanus*). Roots employ many different modifications which help to protect, interact and storage.

Pneumatophores: Roots of mangroves (plants growing in ocean coastal swamps) are frequently modified into *supportive aerial roots* ("legs"). Since these swamp plants need oxygen to allow cell respiration in underground parts, there are **pneumatophores**, specialized roots which grow upward and passively catch the air via multiple pores. Plants which grow on sand (psammophytes) have another problem: their substrate constantly disappears. To avoid this, plants developed **contractile roots** which may shorten and pull plant body deeper into the sand.

Root nodules present on the roots of nitrogen-fixing plants, they contain **dia-zotrophic** bacteria capable to deoxidize atmospheric nitrogen into ammonia.

Mycorrhiza is a root modification started when fungus penetrates root and makes it more efficient in mineral and water absorption: it will exchange these for organic compounds. In addition to mycorrhizal fungi, **endophytic fungi** inhabit other plant organs and tissues.

MORPHOLOGY OF STEMS

The Stem: The stem is an axial organ of shoot. It has functions of support, transportation, photosynthesis, and storage. Stem has radial structure, no root hairs and grows continuously. Its components are nodes (places where leaves are/were attached) and internodes, long or short (in the last case, plant some-times appears to be stemless, rosette-like).

MORPHOLOGY OF LEAF

Structure of a Leaf: Leaves are thin, flat organs responsible for photosynthesis in the plants. It develops laterally at the node. It is an important part of the shoot system and it originates from shoot apical meristems.

Parts of a Leaf: Leaf Blade Shape:

Acicular (*acicularis*) – slender and pointed, needle-like.

Acuminate (*acuminata*) – tapering to a long point.

Aristate (*aristata*) – ending in a stiff, bristle-like point.

Bipinnate (*bipinnata*) – each leaflet also pinnate.

Cordate (*cordata*) – heart-shaped, stem attaches to cleft.

Cuneate (*cuneata*) – triangular, stem attaches to point.

Deltoid (*deltoidea*) – triangular, stem attaches to side.

Digitate (*digitata*) – divided into finger-like lobes.

Elliptic (*elliptica*) – oval, with a short or no point.

Falcate (*falcata*) – sickle-shaped.

Flabellate (*flabellata*) – semi-circular, or fan-like.

Hastate (*hastata*) – shaped like a spear point, with flaring pointed lobes at the base.

Lance-shaped, lanceolate (*lanceolata*) – long, wider in the middle.

Linear (*linearis*) – long and very narrow.

Lobed (*lobata*) – with several points.

Obcordate (*obcordata*) – heart-shaped, stem attaches to tapering point.

Ob lanceolate (*oblanceolata*) – top wider than bottom.

Oblong (*oblongus*) – having an elongated form with slightly parallel sides.

Obovate (*obovata*) – teardrop-shaped, stem attaches to tapering point.

Obtuse (*obtusus*) – with a blunt tip.

Orbicular (*orbicularis*) – circular.

Ovate (*ovata*) – Oval, egg-shaped, with a tapering point.

Palmate (*palmata*) – divided into many lobes.

Pedate (*pedata*) – palmate, with cleft lobes.

Peltate (*peltata*) – rounded, stem underneath.

Perfoliate (*perfoliata*) – stem through the leaves.

Pinnate (*pinnata*) – two rows of leaflets.

Odd-pinnate – pinnate with a terminal leaflet.

Paripinnate, even-pinnate – pinnate lacking a terminal leaflet.

Pinnatisect (*pinnatifida*) – cut, but not to the midrib (it would be pinnate then).

Reniform (*reniformis*) – kidney-shaped.

Rhomboid (*rhomboidalis*) – diamond-shaped.

Round (*rotundifolia*) – circular.

Sagittate (*sagittata*) – arrowhead-shaped.

Spatulate, spathulate (*spathulata*) – spoon-shaped.

Spear-shaped (*hastata*) – pointed, with barbs.

Subulate (*subulata*) – awl-shaped with a tapering point.

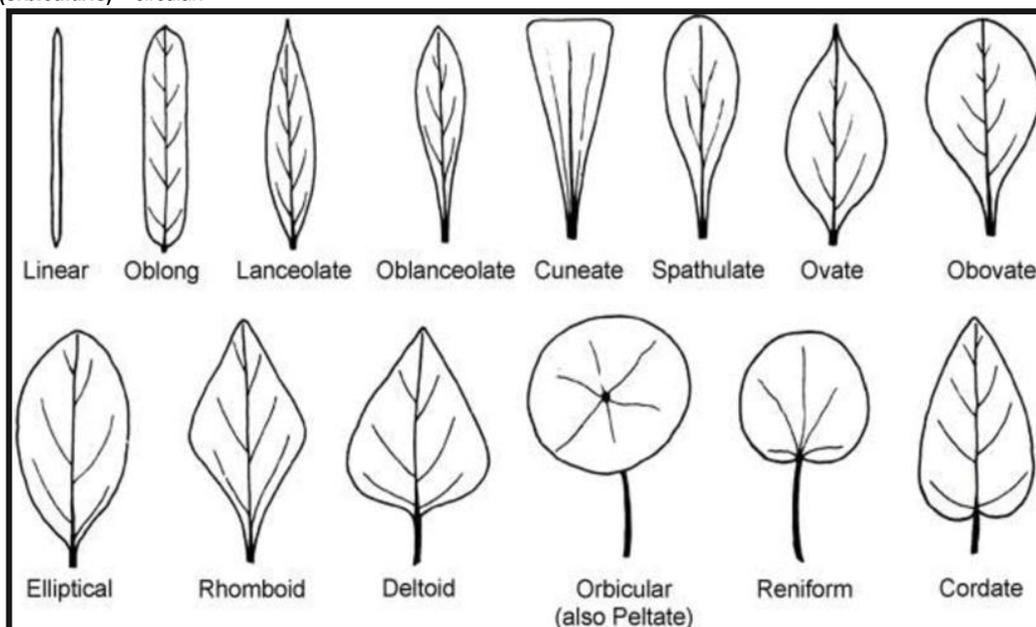
Sword-shaped (*ensiformis*) – long, thin, pointed.

Trifoliate, ternate (or trifoliate) (*trifoliata*) – divided into three leaflets.

Tripinnate (*tripinnata*) – pinnately compound in which each leaflet is itself bipinnate.

Truncate (*truncata*) – with a squared off end.

Unifoliate (*unifoliata*) – with a single leaf.



Leaf Parts: – A complete leaf is composed of a blade, petiole, and stipules, but in many plants one or more might be lacking or highly modified.

Blade – see lamina.

Lamina – the flat and laterally-expanded portion of a leaf blade.

Leaflet – a separate blade, among others, of a compound leaf

Ligule – a projection from the top of the sheath on the adaxial side of the sheath-blade joint in grasses.

Midrib – the central vein of the leaf blade.

Midvein – the central vein of a leaflet.

Petiole – a leaf stalk supporting a blade and attaching to a stem at a node.

Petiolule - the leaf stalk of a leaflet.

Pulvinus – the swollen base of a petiole or petiolule, usually involved in leaf movements and leaf orientation.

Rachilla – a secondary axis of a multiply compound leaf.

Rachis – main axis of a pinnately compound leaf.

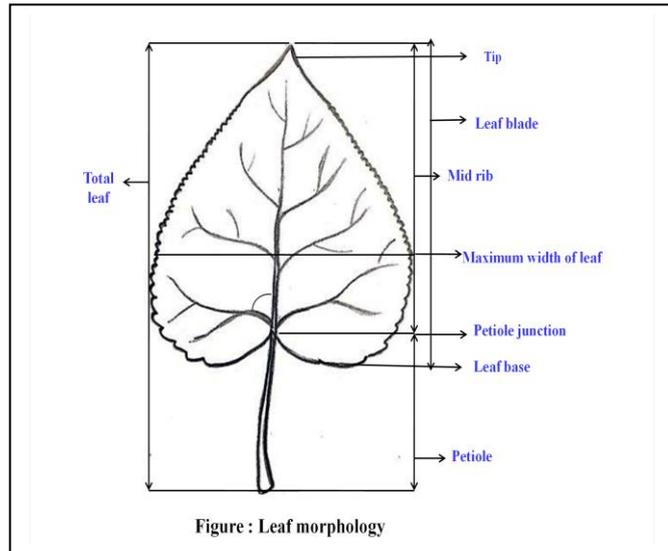
Sheath – the proximal portion of a grass leaf, usually surrounding the stem

Types of simple and compound leaves

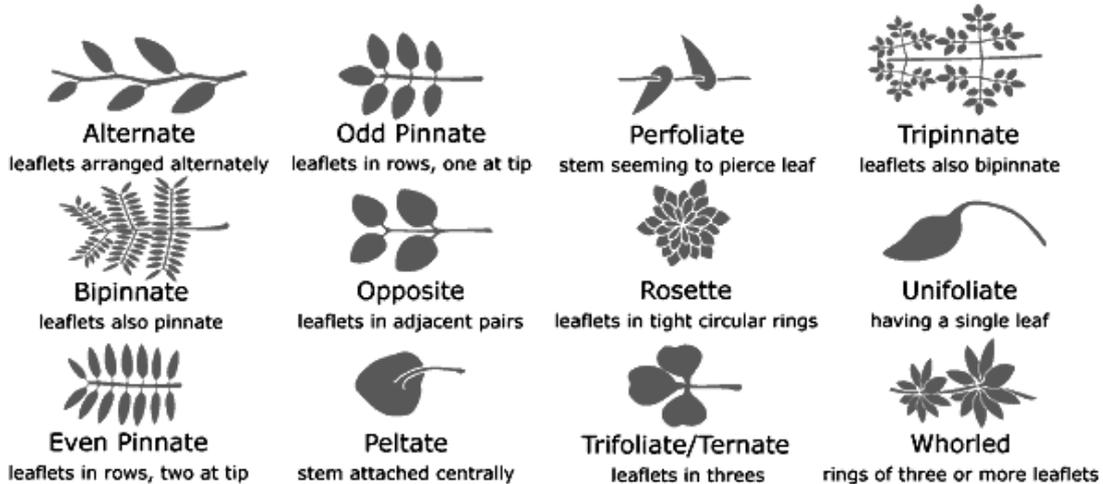
Types of Leaves: There are two broad categories of leaves – simple and compound, which are further classified into different groups based on their shape, size, their arrangements on the stem, leaves of flowering and non-flowering plants, and various other physical attributes.

Simple Leaf: When a single lamina is connected to the main stem by a petiole, the leaf is said to be simple. A simple leaf may be incised to any depth but not down to the midrib or petiole.

Compound Leaf: A compound leaf is a leaf made up of two or more leaflets. In a compound leaf, the midrib of the leaf is branched into different leaflets and is connected by a single petiole.



LEAF TYPE:



Abruptly pinnate – a compound leaf without a terminal leaflet.

Stipels – paired scales, spines, glands, or blade-like structures at the base of a petiolule.

Stipules – paired scales, spines, glands, or blade-like structures at the base of a petiole.

Stipuloid – resembling stipules.

DURATION OF LEAVES:

Deciduous – leaves are shed after the growing season.

Evergreen – leaves are retained throughout the year, sometimes for several years.

Fugacious – lasting for a short time: soon falling away from the parent plant.

Marcrescent – dead leaves, calyx, or petals are persistent and retained.

VENATION:

Acrodromous – the veins run parallel to the leaf edge and fuse at the leaf tip.

Actinodromous – the main veins of a leaf radiate from the tip of the petiole.

Brochidodromous – the veins turn away from the leaf edge to join the next higher vein.

Campylodromous – secondary veins diverge at the base of the lamina and rejoin at the tip.

Craspedodromous – secondary veins run straight to the leaf edge and end there.

Furcate – forked, dividing into two divergent branches.

Reticulate – veins interconnected to form a network. Net-veined.

Vein – the externally visible vascular bundles found on leaves, petals, and other parts.

Veinlet – a small vein.

Leaf Arrangement or Phyllotaxy:

Alternate: A single leaf arises at each node in alternate manner.

Opposite: A pair of leaves arise at each node and lie opposite each other

Whorl – three or more leaves or branches or pedicels arising from the same node.

Modifications in root and stem

Modification of Roots

Storage Roots: Storage roots become fleshy by the accumulation of stored up food.

Roots: Plants, with regard to identification and classification, are not often characterized by their roots, which are important in determining plant duration. However, in some groups, including the grasses, roots are important for proper identification.

Adventitious: Roots that form from other than the hypocotyl or from other roots. Roots forming on the stem are adventitious.

Aerial: Roots growing in the air.

Root crown: The place where the roots and stem meet, which may or may not be clearly visible.[10]

Fibrous: Describes roots that are thread-like and normally tough.

Fleshy: Describes roots that are relatively thick and soft, normally made up of storage tissue. Roots are typically long and thick but not thickly rounded in shape.

Haustrorial: specialized roots that invade other plants and absorb nutrients from those plants.

Lignotuber: Root tissue that allows plants to regenerate after fire or other damage.

Primary: root that develop from the radicle of the embryo, and is normally the first root to emerge from the seed as it germinates.

Root Hairs – very small roots, often one cell wide, that do most of the water and nutrient absorption.

Secondary – roots forming off of the primary root; often called branch roots.

Taproot: A primary root that more-or-less enlarges and grows downward into the soil.

Tuberous: Roots that are thick and soft with storage tissue, and are typically thick and round in shape.

Conical root – Storage root that is broad at its base (upper portion) and gradually tapers to its apex (lower portion): e.g., Carrot.

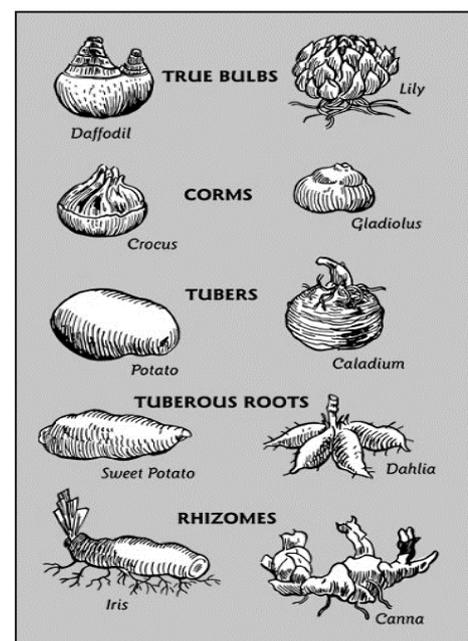
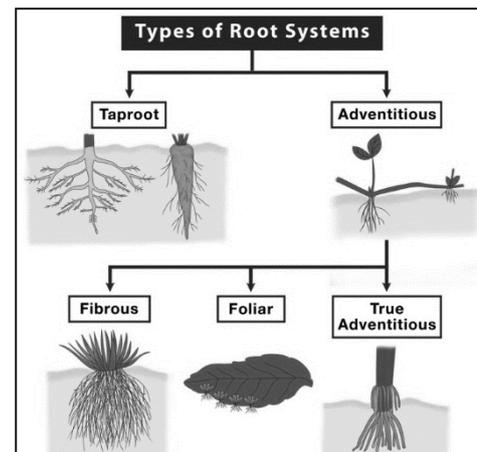
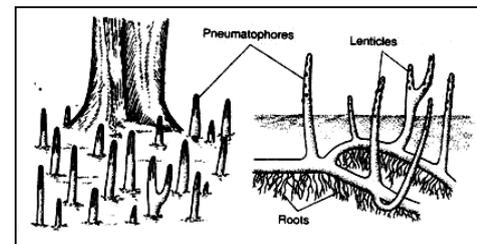
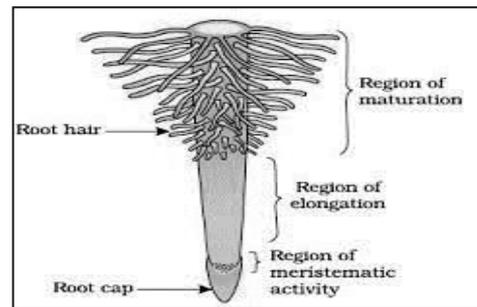
Fusiform root – Storage root that is swollen in the centre and tapers towards both apex and base: e.g., radish (*Raphanus satvus*).

Napiform root: Root who's upper (basal) portion is heavily swollen but who's lower (apical) portion is narrow and tapering: e.g., beet, turnip.

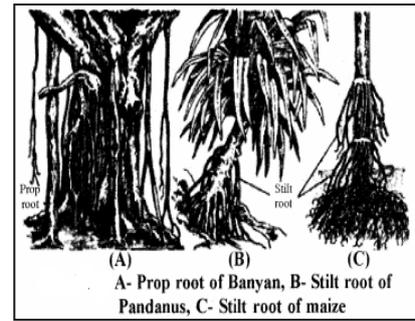
Tuberous or tubercular tap-root: In its narrow sense, a tap-root that is thick and fleshy (due to storage) but that does not conform to the fusiform, conical, napiform shape: *Mirabilis jalapa*. In its broader sense, a tap-root that is thick and fleshy. storage); i.e., when tuberation take place in a tap-root.

Pneumatophores (respiratory roots): Part of tap-root system as respiratory roots; found in many mangrove trees. They arise from the thick, mature branches of tap-root systems, and grow upwards. The inner tissue of respiratory roots is full of hollow, airy, tube-like dead cells, giving it a spongy texture. The outer surface of pneumatophores contains tiny pores or openings, which are called pneumathodes: e.g., *Heritiera fomes*, *Rhizophora mucronata*. Pneumatophores can be unbranched or sparingly branched.

Vivipary – This is a feature of many mangrove trees, where the seed germinates when the seed (and fruit) remain joined to the mother plant until the radicle and hypocotyl grow, reach the ground, and establish the root



Prop-roots – In some dome-shaped (deliquescent) trees, from the mature horizontal boughs (stem-branches) some quite thick (millimeters to centimeters) roots come down. After growing and reaching the ground, they establish more elaborate root branches as well as show massive secondary thickening. Thus, they start to resemble the main trunk. Besides carrying the weight of horizontal boughs, when the main trunk is destroyed due to ageing or accident, the established prop-roots support the remaining plant-body, thus helping in vegetative reproduction e.g., *Ficus benghalensis*. The Great Banyan Tree at IBG Kolkata is an example how prop-roots help in vegetative reproduction.



Stilt roots – From upright (erect) trunks, some hard, thick, almost straight roots come-out obliquely and penetrate the ground. Thus, they act like a camera-tripod. They increase balance and support as well as, when these roots penetrate the ground, they increase soil grip.

Root-Buttress or Plank Buttress or Buttress-Root –

Haptera– root-like projections found in macroalgae or lichens that anchor the organism to a rocky substrate.

Reproductive roots – These roots contain root-buds and actively take part in shoot-regeneration, and thus in vegetative reproduction. This is an unusual feature because roots normally do not contain buds.

Modification of stem

Rhizome: It is fleshy, non-green underground stem

Corm: It is a condensed form of rhizome growing in the vertical direction

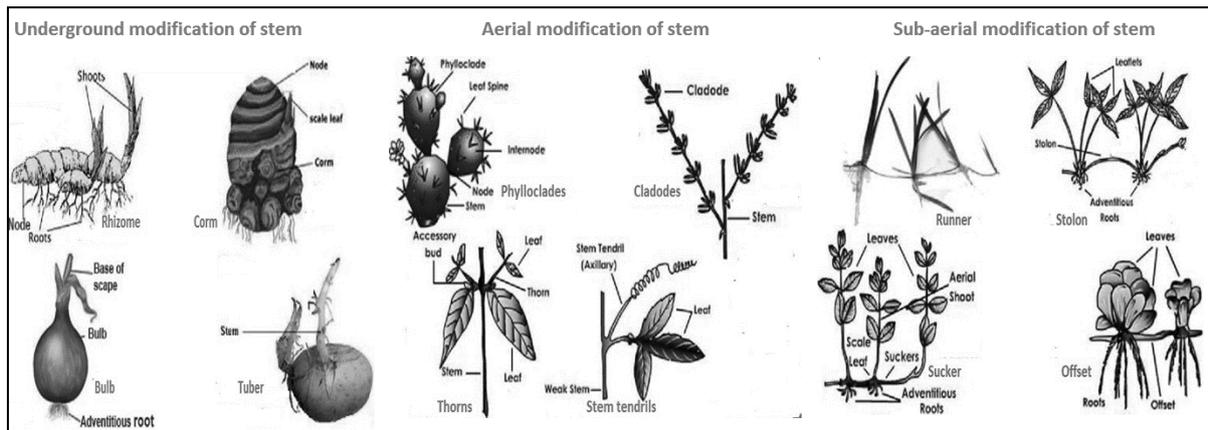
Tuber: Stem tuber is a swollen tip of an underground lateral stem

Runner: It grows parallel to the ground and has creeping stem with long internode

Sucker: It arises from the basal, underground part of main stem. It grows horizontally for a distance under the soil and then emerges obliquely

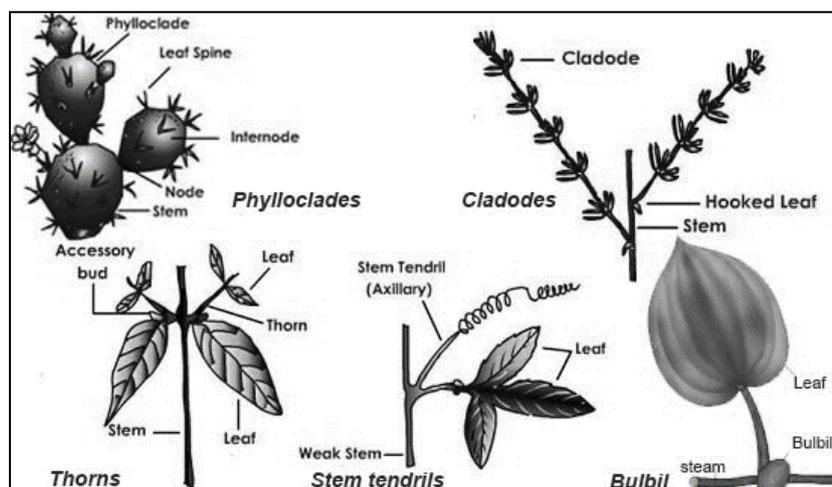
Stolon: It is weak lateral branch that arises from base of main stem

Offset: It is short runner with one internode long



Phyllotaxy: The arrangement of leaves on a stem is known as phyllotaxy. The number and placement of a plant's leaves will vary depending on the species, with each species exhibiting a characteristic leaf arrangement. Leaves are classified as either alternate, spiral, opposite, or whorled. Plants that have only one leaf per node have leaves that are said to be either alternate or spiral.

Venation: The arrangement of veins in a leaf is called the venation pattern. Monocots and dicots differ in their patterns of venation. Monocots have parallel venation in which the veins run in straight lines across the length of the leaf without venation.



Leaf Blade Apex:

Acuminate – narrowing to a point (a term used for other structures, too).

Acute – with a sharp, rather abrupt ending-point.

Acutifolius – with acute leaves.

Attenuate – tapering gradually to a narrow end.

Leaf Blade Margins:

Entire – having smooth edge with neither teeth nor lobes

Toothed – having saw like margin with small tooth having margin

Lobed- having some type of indentation toward the midrib that can vary in profundity and shape (rounded or pointed) and incisions more than halfway to midrib

Dentate- sharp marginal teeth point outward

Crenate – with low rounded or blunt teeth

Crenulate – with shallow, small rounded teeth.

Serrate: marginal teeth pointing towards the leaf apex

Ciliate – hair like edge

Serrulate- small, marginal teeth pointing towards blade apex

Sinuate – deeply wavy margin towards the middle of leaf

Undulate – wavy, curling from the front back of the leaf

Epidermis and periderm texture of leaf

Acantha – a prickle or spine.

Acanthocarpus – fruits are spiny.

Acanthocladous – branches are spiny.

Aculeate – having a covering of prickles or needle-like growth.

Aculeolate – having spine-like processes.

Aden – a gland.

Adenoid – gland-like.

Adenophore – a stalk that supports a gland.

Adenophyllous – leaves with glands.

Arachnoid – having entangled hairs that resemble cobwebs.

Bloom – waxy coating that covers some plants.

Canescent – with gray pubescence.

Ciliate – with a fringe of marginal hairs.

Coriaceous – with a tough or leathery texture.

Fimbriate – finely cut into fringes, the edge of a frilly petal or leaf.

Glabrous – smooth without any pubescences at all.

Glandular-punctate – covered across the surface with glands.

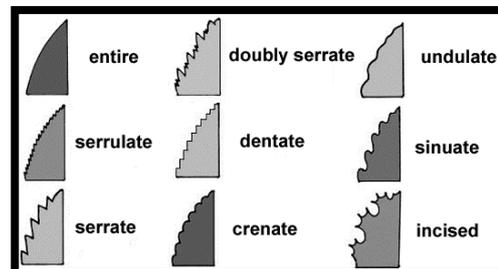
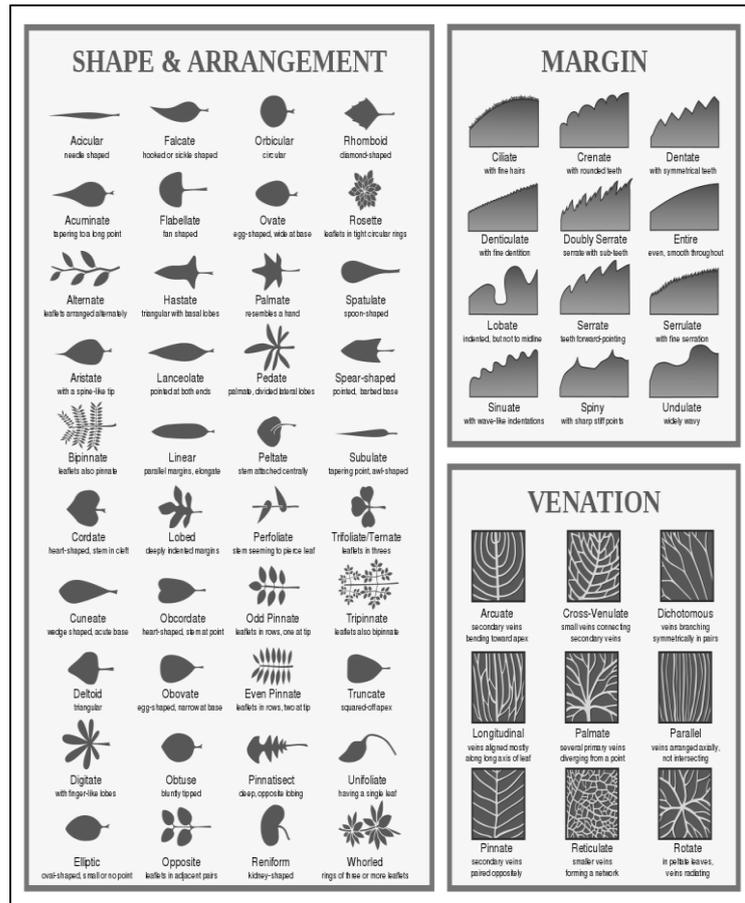
Hirsute – with long shaggy hairs, often stiff or bristly to the touch.

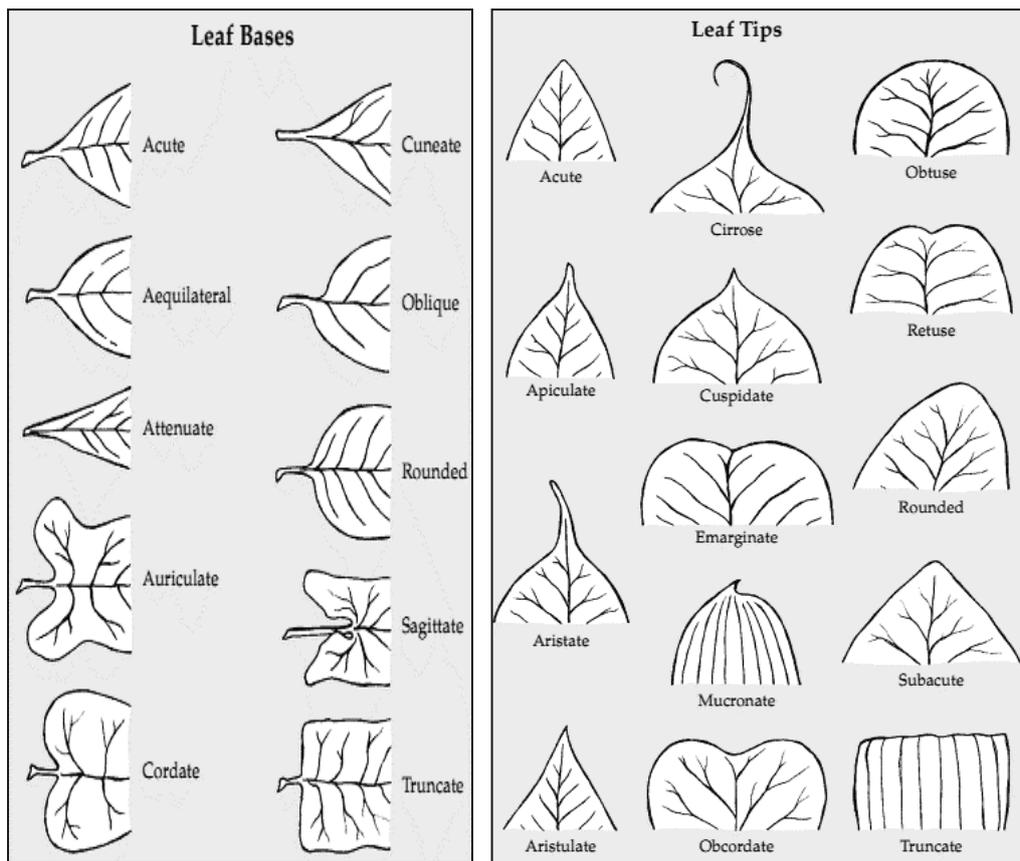
Lanate – with thick wool-like hairs.

Verrucose – with a warty surface having low rounded bumps.

Villose – covered with fine, long hairs that are not matted.

Villosity – villous indument.





Leaf Base: It is lower part of lamina attached to petiole of leaf

Floral morphology

Accrescent – growing larger after anthesis, normally referring to the calyx.

Anthesis – the period when the flower is fully open and functional, ending when the stigma or stamens wither.

TYPICAL STRUCTURE OF BISEXUAL FLOWER

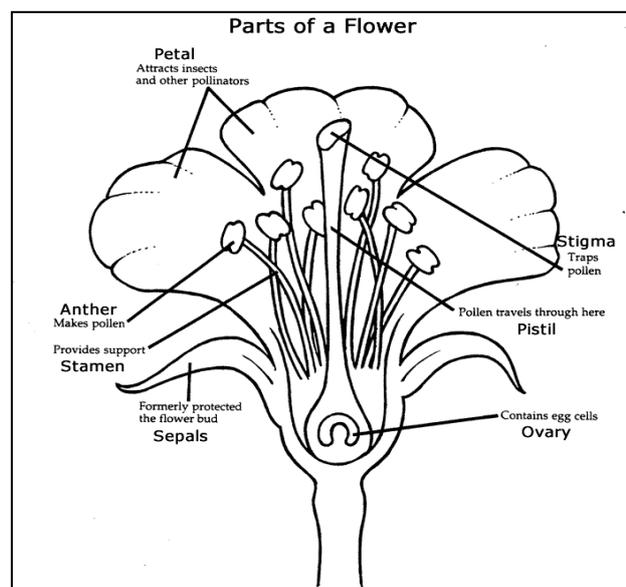
Sexuality in plants: In most plants, the flowers are bisexual. They contain both male and female reproductive parts. In some plants, the male and female flowers are separate. These plants are of two types— monoecious and dioecious.

Monoecious plant: If the male and female flowers grow on the same plant, then the plant is said to be a monoecious plant. Examples: Pumpkin, Maize, Cucumber

Dioecious plant: If the male and female flowers grow on separate plants, then the plant is said to be a dioecious plant. Examples: Palm, Papaya.

Complete flower: When all the four whorls of the flower are present, it is called a complete flower. All bisexual flowers are generally complete flowers.

Incomplete Flower: Some flowers have only the male parts (Staminate) or only the female parts (Pistillate). These are called unisexual or incomplete flowers. Unisexual flowers may occur on the same plant at different places. These are called monoecious plants. If male and female flowers occur on different plants, they are called dioecious plants e.g., palms, Poplars, Salix.



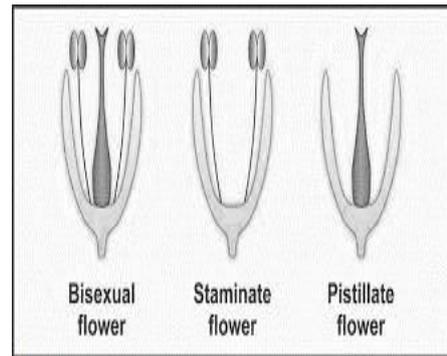
Bisexual Flower – A flower that contains both male and female reproductive structures is called a bisexual flower. Bisexual flowers are also called hermaphrodites. They are perfect flowers.

Unisexual flower – A flower that has only one reproductive structure, either male or female, is called a unisexual flower.

Staminate flower: A unisexual flower, which contains the only androecium is called a male or Staminate flower.

Pistillate flower: A unisexual flower, which contains the only gynoecium, is called a female or pistillate flower.

Neuter flower: A flower in which both male and female reproductive organs are absent is called a neuter flower.



A flower can be divided as below based on the reproductive structure it has:

Essential/ Reproductive Whorls:

The essential whorls of a flower are the whorls that are directly associated with the process of reproduction. A flower cannot function as a reproductive organ in the absence of essential whorls.

Examples: Stamen and carpel

Non- Essential/ Non-Reproductive Whorls:

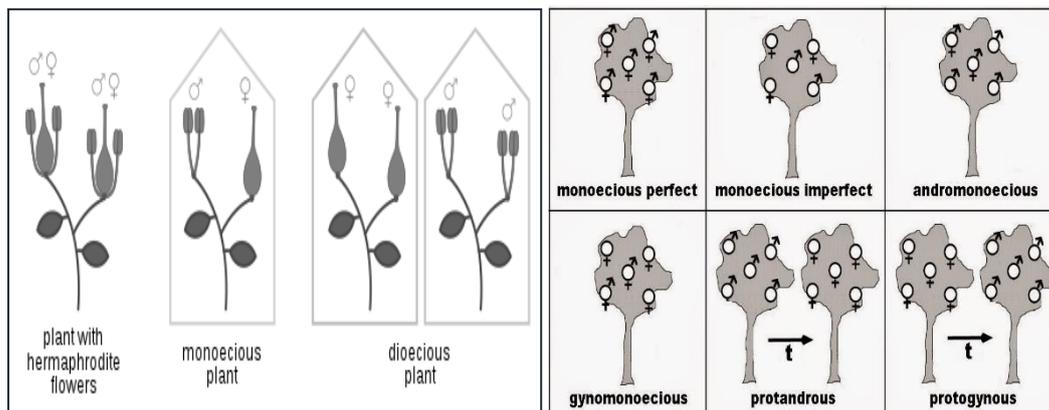
The non-essential whorls of a flower are the whorls that are not directly associated with the process of reproduction. They are the helping parts, which either protect the reproductive parts of the flower or make them attractive for pollination. A plant is able to reproduce in the absence of non-essential whorls. Examples: Calyx and corolla

Perianth: In plants, such as wheat and grasses, the petals and sepals are undifferentiated and together compose the perianth.

Petaloid perianth: In some plants, the sepals are not green but appear brightly coloured as the petals. These sepals are called petaloid sepals, and the perianth is called a petaloid perianth.

Sepaloid perianth: In some plants, the petals appear green in colour and are called sepaloid petals. The perianth is called a sepaloid perianth.

Nectaries: Nectar is a sugary liquid produced by plants. The nectar in flowers is secreted by a group of cells, present either at the base of the pistil or on the petals. These groups of cells are called nectaries. They attract insects such as bees and ants for cross pollination.



INFLORESCENCE

Inflorescence: An inflorescence is a group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches. Morphologically, it is the modified part of the shoot of seed plants where flowers are formed.

Raceme: When peduncle bears many pedicellate flowers in an acropetal manner, e.g., *Delphiniumajacis*, *Veronica*, etc

Spike: A raceme with sessile flowers, e.g., *Adhatoda vasica*, *Callistemon*, etc.

Spikelet: Small spikes arranged in a spike, raceme or panicle manner. Each flower consists of an awned bract, three stamens and an ovary with two feathery stigmas, e.g., *Triticum*.

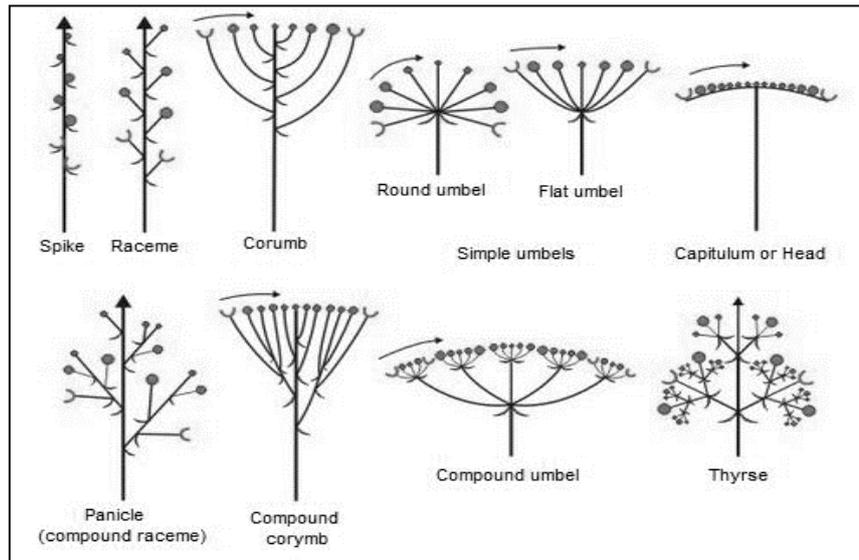
Panicle: Branched raceme, e.g., *Delonix regia*.

Catkin: Pendant spike with unisexual flowers, e.g., *Morus alba*, *Salix*, etc.

Spadix: Spike with a fleshy axis, enclosed by one or more large bracts called spathes, e.g., *Musa*, *Pistia*, etc.

Corymb: Raceme, in which all the flowers reach the same level due to more elongation of the pedicel of older flowers, e.g., *Iberis amara*.

Capitulum or Head: When numerous, small, sessile flowers are aggregated to form a dense inflorescence as in members of Compositae or Asteraceae.



TYPES OF TISSUES

Plant cells are formed at meristems, and then develop into cell types which are grouped into tissues. Plants have only three tissue types: 1) Dermal; 2) Ground; and 3) Vascular. Dermal tissue covers the outer surface of herbaceous plants. Dermal tissue is composed of epidermal cells, closely packed cells that secrete a waxy cuticle that aids in the prevention of water loss. The ground tissue comprises the bulk of the primary plant body. Parenchyma, collenchyma, and sclerenchyma cells are common in the ground tissue. Vascular tissue transports food, water, hormones and minerals within the plant. Vascular tissue includes xylem, phloem, parenchyma, and cambium cells.

1. Dermal system: Plant organ system that provides the covering for the plant

2. Ground system : Plant tissue system, composed mainly of parenchyma cells with some collenchyma and sclerenchyma cells, that occupies the space between the epidermis and the vascular system; is involved in photosynthesis, water and food storage, and support; one of the four main tissue systems in plants.

Vascular plants: Group of plants having lignified conducting tissue (xylem vessels or tracheids).

3. Vascular system: Specialized tissues for transporting minerals and nutrients in plants; also plays a role in supporting the plant; one of the four main tissue systems in plants.

Parenchyma: A generalized plant cell type, parenchyma cells are alive at maturity. They function in storage, photosynthesis, and as the bulk of ground and vascular tissues. Palisade parenchyma cells are elongated cells located in many leaves just below the epidermal tissue. Spongy mesophyll cells occur below the one or two layers of palisade cells. Ray parenchyma cells occur in wood rays, the structures that transport materials laterally within a woody stem. Parenchyma cells also occur within the xylem and phloem of vascular bundles.

Collenchyma : Collenchyma cells support the plant. These cells are characterized by thickenings of the wall, they are alive at maturity. They tend to occur as part of vascular bundles or on the corners of angular stems. In many prepared slides they stain red.

Sclerenchyma : Sclerenchyma cells support the plant. They often occur as bundle cap fibers. Sclerenchyma cells are characterized by thickenings in their secondary walls. They are dead at maturity. They, like collenchyma, stain red in many commonly used prepared slides. A common type of sclerenchyma cell is the fiber.

Xylem : Xylem is a term applied to woody (lignin-impregnated) walls of certain cells of plants. Xylem cells tend to conduct water and minerals from roots to leaves. While parenchyma cells do occur within what is commonly termed the "xylem" the more identifiable cells, tracheids and vessel elements, tend to stain red with Safranin-O. Tracheids are the more primitive of the two cell types, occurring in the earliest vascular plants. Tracheids are long and tapered, with angled end-plates that connect cell to cell. Vessel elements are shorter, much wider, and lack end plates. They occur only in angiosperms, the most recently evolved large group of plants. Tracheids are more primitive.

Phloem : Phloem cells conduct food from leaves to rest of the plant. They are alive at maturity and tend to stain green (with the stain fast green). Phloem cells are usually located outside the xylem. The two most common cells in the phloem are the companion cells and sieve cells. Companion cells retain their nucleus and control the adjacent sieve cells. Dissolved food, as sucrose, flows through the sieve cells.

Epidermis: The epidermal tissue functions in prevention of water loss and acts as a barrier to fungi and other invaders. Thus, epidermal cells are closely packed, with little intercellular space. To further cut down on water loss, many plants have a waxy cuticle layer deposited on top of the epidermal cells.

Guard Cells: To facilitate gas exchange between the inner parts of leaves, stems, and fruits, plants have a series of openings known as stomata (singular stoma). Guard cells are bean-shaped cells covering the stomata opening. They regulate exchange of water vapor, oxygen and carbon dioxide through the stoma.

Placentation: Placentation is the arrangement of ovules in the ovary of a plant. The given diagram shows the types of placentation such as basal, apical, parietal, marginal, axial and free central

Marginal: One elongated is located on one side of ovary.

Axil: Carpels are folded inward with ovules placed along the central axis of ovary

Parietal: Ovules on the inner wall of the ovary

Free- central: Ovule develop on the central axis while the septa is absent

Basal: The ovules are arranged at the base of the ovary

Superficial: Ovules are attached entirely to the inner surface of the ovary

Aestivation: **Aestivation** or estivation is the positional arrangement of the parts of a flower within a flower bud before it has opened.

Types of Aestivation:

1. **Valvate Aestivation**: Petals or Sepals in a whorl merely meet by their edges without overlapping. Example: Sepals of Hibiscus.

2. **Twisted Aestivation**: In this mode of aestivation one margin of each and every sepal or petal overlaps the subsequent one, and the other margin is overlapped by a previous one. Here the overlapping is customary in one direction-clockwise or anticlockwise. Example: Petals of Hibiscus

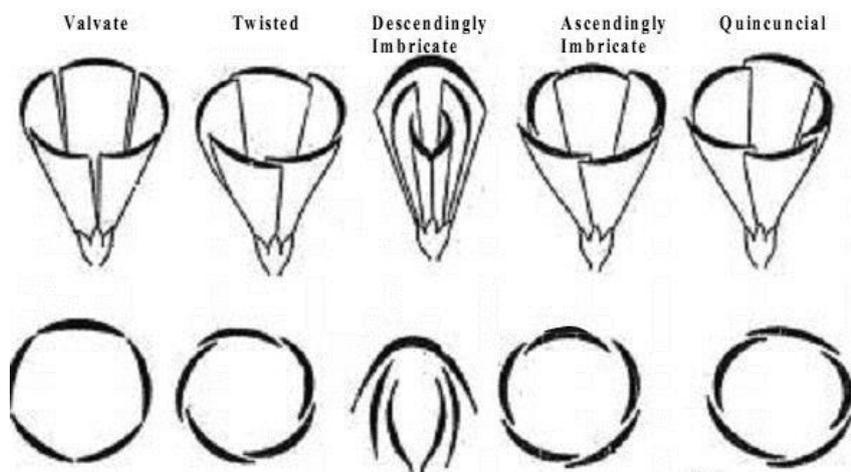
3. **Imbricate**: In this kind, one petal or sepal is internal or being overlapped on both the margins and one petal or sepal is external with both of its margins overlapping. Out of the remaining sepals or petals, one margin is overlapping and another margin is overlapped.

There are two forms of imbricate aestivation namely, descendingly imbricate and ascendingly imbricate.

a. **Descendingly Imbricate or Vexillary Aestivation**: In this form of aestivation the posterior petal overlaps one margin of the two lateral petals. Another margin of such two lateral petals overlaps the two anterior petals that are united. Therefore, the overlapping is in descending order and therefore the name.

b. **Ascendingly imbricate aestivation**: In this form the posterior odd petal is the innermost being overlapped by one margin of the two lateral petals. Another margin of the two lateral petals is overlapped by the two anterior petals. In this, the overlapping of petals starts from the anterior side proceeding towards the posterior side. This is just reverse of descendingly imbricate aestivation. Example: Petals of Caesalpiniaceae

4. **Quincuncial**: This is a modification of imbricate aestivation in which the two petals are internal, two are external and the fifth one has one margin external and the other margin is internal. Example: Guava.



GLOSSARY

Acaulescent: the leaves and inflorescence rise from the ground, and appear to have no stem. They are also known as rosette forms, some of the many conditions that result from very short internodes (i.e. close distances between nodes on the plant stem. See also radical, where leaves arise apparently without stems.

Accessory structures – parts of fruits that do not form from the ovary.

Accrescent – said of the calyx when it is persistent and enlarges as the fruit grows and ripens; sometimes applied to other structures.

Achene – dry indehiscent fruit that have one seed and are formed from a single carpel; the seed is distinct from the fruit wall.

Achlamydeous – a flower without a perianth.

Achlamydeous – without a perianth.

Acid plant : A plants with acid saps, normally due to the production of ammonium salts (malic and oxalic acid)

Acme : the time when the plant or population has its maximum vigor.

Acrandrous – used for moss species that have antheridia at the top of the stem.

Acrocarpous – in mosses, bearing the sporophyte at the axis of the main shoot.

Acrogynous – in liverworts, the female sex organs terminate the main shoot.

Actinomorphic – having a radial symmetry, as in regular flowers.

Actinomorphic : Parts of plants that is radially symmetrical in arrangement.

Actinomorphy – when the flower parts are arranged with radial symmetry.

Acutangular: a stem that has several longitudinally running ridges with sharp edges.

Adelphous – androecium with the stamen filaments partly or completely fused together.

Adrogynous – monoicous, and producing both types of sex organs together.

Adventitious buds: a bud that arises at points on the plant other than at the stem apex or leaf axil.

Alate: having wing-like structures, usually on the seeds or stems, as in *Euonymus alata*.

Alternate: buds are staggered on opposite sides of the branch.

Amphithecium – the external cell layers of the developing sporangium of a bryophyte. (Note: this term is also used in the mycology of lichens.)

Anacrogynous – in liverworts, female sex organs are produced by a lateral cell, and thus the growth of the main shoot is indeterminate.

Androecium – the stamens collectively.

Androecium – collective term for all the male parts of an organism.

Androgynous – used for the inflorescence of *Carex* when a spike has both staminate and pistillate flowers; the pistillate flowers are normally at the base of the spike.

Anisosporous – anisospore production is a rare condition in dioecious bryophytes; meiosis produces two small spores that develop into male gametophytes and two larger spores that develop into female gametophytes; contrast Isosporous.

Annual : plants that live, reproduce, and die in one growing season.

Anther – the distal end of the stamen where pollen is produced, normally composed of two parts called anther-sacs and pollen-sacs (thecae).

Antheridiophore – a specialised branch that bears the antheridia in the Marchantiales.

Antipetalous – when the stamens number the same as, and are arranged opposite, the corolla segments; e.g. *Primula*.

Antisepalous – when the stamens number the same as, and are arranged opposite, the calyx segments.

Apetalous – a flower without petals.

Arborescent : Growing into a tree-like habit, normally with a single woody stem.

Ascending: Growing uprightly, in an upward direction.

Assurgent : Growth ascending.

Autoicous – produces male and female sex organs on the same plant but on separate inflorescences.

Bark: the outer layers of woody plants: cork, phloem, and vascular cambium.

Basifixed – attached by the base.

Beak – normally the slender elongated end of a fruit, typically a persistent style-base.

Biennial: plants that need two growing seasons to complete their life cycle, normally completing vegetative growth the first year and flowering the second year.

Bract – leaf is present below the flower.

Branching : Dividing into multiple smaller segments.

Bud: an immature stem tip, typically an embryonic shoot, either producing a stem, leaves, or flowers.

Bulb: an underground stem normally with a short basal surface and with thick fleshy leaves.

Bundle scar: a small mark on a leaf scar indicating a point where a vein from the leaf was once connected to the stem.

Caducous : Falling away early.

Capitulum – the flowers are arranged into a head composed of many separate unstalked flowers, the single flowers being packed close together and called florets, which is the typical arrangement in *Asteraceae*.

Caryopsis – the pericarp and seed are fused together, the fruit of many grasses.

Caudex: the hard base produced by herbaceous perennials, which serves in overwintering the plant.

Caulescent : With a well-developed stem above ground.

Cauliflora: with the flowers and fruit on the stem, or trunk, as in *Saraca cauliflora*.

Cespitose: Forming dense tufts, normally applied to small plants typically growing into mats, tufts, or clumps.

Chambered pith: a form of pith in which the parenchyma collapses or is torn during development, leaving the sclerenchyma plates to alternate with hollow zones

Circumscissile – a type of fruit that dehisces, where the top of the fruit falls away like a lid or covering.

Cladautoicous – male and female inflorescences are on separate branches of the same plant.

Cladode: a flattened stem that performs the function of a leaf; an example is the pad of the opuntia cactus.

Cladophyll: a flattened stem that is leaf-like and green – used for photosynthesis. Normally such plants have no, or greatly reduced, leaves.

Climbing: typically long stems that cling to other objects.

Complete – of a flower, having all the possible parts represented: sepals, petals, stamens, and pistils.

Compound Umbel – an umbel where each stalk of the main umbel produces another smaller umbel of flowers.

Connective – the part of the stamen joining the anther cells.

Connective – the part of the stamen joining the anther cells.

Corn: a compact, upright-orientated stem that is bulb-like, with hard or fleshy texture, and normally covered by papery, thin, dry leaves. Most often produced under the soil surface.

Corymb – a grouping of flowers where all the flowers are at the same level, the flower stalks of different lengths forming a flat-topped flower cluster.

Creeping: Growing along the ground and producing roots at intervals along the surface.

Cuticle: a waterproof waxy membrane covering leaves and primary shoots

Cyme – is a cluster of flowers where the end of each growing point produces a flower. New growth comes from side shoots, and the oldest and first flowers to bloom are at the top.

Deciduous: Falling away after its function is completed.

Decumbent: Growth starts off prostrate and the ends turn upright.

Decumbent: stems that lie on the ground but whose ends turn upward.

Deflexed: Bending downward.

Dehiscent – a fruit that opens and releases its contents, normally in a regular and distinctive fashion.

Determinate growth: Growing for a limited time, floral formation and leaves (see also Indeterminate).

Diadelphous – united by filaments to form two groups.

Diaphragmed pith: pith in which plates or nests of sclerenchyma may be interspersed with the parenchyma.

Didynamous – having four stamens in two pairs of unequal length.

Dimorphic: Two different forms.

Dioecious – having two forms of gametophyte, one form bearing antheridia and one form bearing archegonia.

Dormant: a state of no, or reduced, growth

Drupe – outer fleshy part that surrounds a shell with a seed inside.

Duration: Duration of individual plant lives are described using these terms:

Early wood: the portion of the annual growth ring that is formed early in the season.

Ecad: A plant assumed to be adapted to a specific habitat.

Ectogenesis : Variation in plants due to conditions outside of the plants.

Endocarp – includes the wall of the seed chamber, the inner part of the pericarp.

Epidermis: a layer of cells that cover all primary tissue, separating it from the outside environment.

Epigynous – flowers are present above the ovary.

Epipetalous – borne on the corolla, often used in reference to stamens attached to the corolla.

Epiphytic: having the nature of an epiphyte.

Equinoctial: plants that has flowers that open and close at definite times during the day.

Erect: growing upright.

Erect: having an essentially upright vertical habit or position.

Escape: a plant originally under cultivation that has become wild, a garden plant growing in natural areas.

Eupotamous: living in rivers and streams.

Euryhaline: normally living in salt water but tolerant of variable salinity.

Eurythermous: tolerant of a wide range of temperatures.

Evergreen: remaining green in the winter or during the normal dormancy period for other plants.

Exclusive species: confined to specific location.

Exocarp – the pericarp's outer part.

Exotic : not native to the area or region.

Exserted – sticking out past the corolla, the stamens protrude past the margin of the corolla lip.

Exsiccates: a dried plant, most often used for specimens in a herbarium.

Extrose – opening towards the outside of the flower.

Filament – the stalk of a stamen.

Flower bud: a bud from which only flowers develop

Fruticose: woody stemmed with a shrub-like habit. Branching near the soil with woody based stems.

Gonioautoicous – male is bud-like in the axil of a female branch.

Guard cell: one of the paired epidermal cells that control the opening and closing of a stoma in plant tissue.

Gynandrium – combined male and female structure.

Gynodioecy – describes a plant species or population that has some plants that are female and some plants that are hermaphrodites.

Gynoecium – the whorl of carpels; may comprise one (syncarpous), or more (apocarpous), pistils, each pistil consisting of an ovary, style, and stigma.

Gynostegium – adnation of stamens and the style and stigma (*Orchidaceae*).

Heartwood: the older, nonliving central wood of a tree or woody plant, usually darker and harder than the younger sapwood.

Herbaceous perennial: non-woody plants that live for more than two years, with the shoot system dying back to soil level each year.

Herbaceous: plants with shoot systems that die back to the ground each year – both annual and non-woody perennial plants.

Homogamous – when the flower's anthers and stigma are ripe at the same time.

Hypogynous – flowers are present below the ovary

Imperfect – of a flower or inflorescence, being unisexual and having organs of only a single sex.

Incubous – describing the arrangement of leaves of a liverwort; contrast with succubous.

Indehiscent – fruits that do not have specialized structures for opening and releasing the seeds; they remain closed after the seeds ripen and are opened by animals, weathering, fire, or other external means.

Indeterminate growth: Inflorescence and leaves growing for an indeterminate time, until stopped by other factors such as frost.

Inflorescence – cluster of flowers

Internode: space between two nodes.

Introrse – opening on the inside of the corolla, the stamens are contained within the margins of the petals.

Involute – a tube of thallus tissue that protects the archegonia.

Late wood: the portion of the annual ring that is formed after the formation of early wood has ceased.

Latent buds: axillary buds whose development is inhibited, sometimes for many years, due to the influence of apical and other buds.

Lateral buds: a bud located on the side of the stem, usually in a leaf axil.

Lax: non upright, growth not strictly upright or hangs down from the point of origin.

Leaf axils: the space created between a leaf and its branch. This is especially pronounced on monocots like the bromeliads.

Leaf scar: the mark left on a branch from the previous location of a bud or leaf.

Leaf: the photosynthetic organ of a plant that is attached to a stem, generally at specific intervals.

Leaf buds: buds that produces leafy shoots.

Lenticel: One of the small, corky pores or narrow lines, on the surface of the stems of woody plants, that allow for the interchange of gases between the interior tissue and the surrounding air.

Mesocarp – the middle layer of the pericarp.

Monocarpic: plants that live for a number of years then, after flowering and seed setting, die.

Monodelphous – stamen filaments united as a tube.

Monoecious – having a single form of gametophyte bearing both antheridia and archegonia, either together or on separate branches.

Naked – uncovered, stripped of leaves, or lacking other covering such as sepals or petals.

Node: where leaves and buds are attached to the stem.

Nut – a fruit formed from a pistil with multiple carpels and having a woody covering; e.g. hickory, pecan, and oak.

Nutlet – a small nut.

Opposite: buds that are arranged in pairs on opposite sides of the branch

Orthotropic growth: growth in the vertical direction.

Panicle – a raceme with branches, each branch having a smaller raceme of flowers. The terminal bud of each branch continues to grow, producing more side shoots and flowers.

Paraphyses – sterile hairs surrounding the archegonia and antheridia.

Parasitic – using another plant as a source of nourishment.

Pedicel – stem holding a one flower in an inflorescence.

Peduncle – the part of a stem that bears the entire inflorescence, normally having no leaves, or the leaves having been reduced to bracts. When the flower is solitary, it is the stem or stalk holding the flower.

Peduncular – referring to or having a peduncle.

Pedunculate – having a peduncle.

Perfect – possessing both stamens and ovary (male and female parts).

Perianth – a protective tube that surrounds the archegonia, characterizing the Jungermannian liverworts.

Pericarp – the body of the fruit from its outside surface to the chamber where the seeds are, including the outside skin of the fruit and the inside lining of the seed chamber.

Perichaetium – the cluster of leaves with the enclosed female sex organs.

Perigonium – the cluster of leaves with the enclosed male sex organs.

Pith : the spongy tissue at the center of a stem.

Plagiotropic growth: growth inclined away from the vertical, inclined towards the horizontal.

Pod (seedpod) – a dry dehiscent fruit containing many seeds e.g., include follicles, dehiscent capsules, and many but not all legumes.

Pome – accessory fruit from one or more carpels; specific to the apple and some related genera in the family Rosaceae.

Poricidal – anthers opening through terminal pores.

Precocious: flowering before the leaves emerge.

Prickle : an extension of the cortex and epidermis that ends with a sharp point.

Procumbent: growing prostrate or trailing, but not rooting at the nodes.

Prostrat: growing flat on the soil surface.

Prostrate : lying flat on the ground, stems or even flowers in some species.

Pseudautoicous – dwarf male plants growing on living leaves of female plants.

Pseudoperianth – an involucre that resembles a perianth, but is made of thallus tissue, and usually forms after the sporophyte develops.

Raceme – a flower spike with flowers that have stalks of equal length. The stem tip continues to grow and produces more flowers, with the bottom flowers opening first and blooming progressing up the stem.

Radial – symmetric when bisected through any angle (circular)

Receptacle – the end of the pedicel that joins to the flower where the different parts of the flower are joined together; also called the torus.

Rhizautoicous – male inflorescence attached to the female stem by rhizoids.

Rhizome : a horizontally orientated, prostrate stem with reduced scale-like leaves, normally growing underground but also on the soil surface.

Rootstock: the underground part of a plant normally referring to a caudex or rhizome.

Rosette : cluster of leaves with very short internodes that are crowded together, normally on the surface of the soil but sometimes higher on the stem.

Rostellate: like a rosette (cf. rostellum).

Rosulate: arranged into a rosette.

Runner: an above-ground stem, usually rooting and producing new plants at the nodes.

Runner: an elongated, slender branch that roots at the nodes or tip.

Samara – winged achene, e.g., maples.

Scandent : a stem that climbs.

Semi-erect: Not growing perfectly straight.

Single – one flower per stem, or flowers greatly spread apart so as to appear to not arise from the same branch.

Solitary – same as single, with one flower per stem.

Sorus / Sori – a group or cluster of sporangia borne abaxially on a fern frond.

Spike – flowers arising from the main stem are without individual flower stalks. The flowers attach directly to the stem.

Spine: an adapted leaf that is usually hard and sharp and is used for protection, and occasionally shading, of the plant

Staminode – a sterile stamen.

Staminodial – (1) concerning a sterile stamen; (2) flowers with sterile stamens.

Stem: vascular tissue that provides support for the plant

Stolon: A branch that forms near the base of the plant, grows horizontally, and roots and produces new plants at the nodes or apex.

Stolon: a horizontally growing stem similar to a rhizome, produced near the base of the plant. They spread out above or along the soil surface. Roots and new plants develop at the nodes or ends.

Stoloniferous: a plant that produces stolons.

Stoloniferous: plants producing stolons.

Stoma: a small pore on the surface of the leaves used for gas exchange with the environment while preventing water loss.

Suberose: having a corky texture.

Succubous – describing the arrangement of leaves of a liverwort; contrast with incubous.

Suffrutescent: somewhat shrubby, or shrubby at the base.

Suture – the seam along which the fruit opens; normally in most fruits it is where the carpel or carpels are fused together.

Synandrous – anthers are connected (*Araceae*).

Syngenesious – anthers are united as a tube; the filaments are free (*Asteraceae*).

Synoiicous – male and female sex organs are on the same gametophyte, but are not clustered.

Tendrils: a thigmotropic organ which attaches a climbing plant to a support, a portion of a stem or leaf modified to serve as a holdfast for other objects.

Terminal: at the end of a stalk or stem.

Tetradynamous – having six stamens, four of which are longer than the others.

Tiller: a shoot of a grass plant.

Translator – a structure uniting the pollinia in *Asclepiadaceae* and *Orchidaceae*.

Trinucleate – pollen containing three nuclei when shed.

Tuber : an enlarged stem or root that stores nutrients.

Umbel – where the flower head has all flower stalks rising from the same point and of equal length, the flower head seeming hemispherical like an open umbrella.

Utricle – a small inflated fruit with one seed that has thin walls. Fruits are usually one-seeded, as are some species of amaranth.

Valve – one of the segments of the capsule.

Valvular – anthers opening through valves or small flaps; e.g., *Berberis*.

Vascular bundles : a strand of woody fibers and associated tissues.

Versatile – anthers pivoting freely on the filament.

Verticil – flowers arranged in whorls at the nodes.

Verticillaster – a whorled collection of flowers around a stem, the flowers produced in rings at intervals up the stem. As the stem tip continues to grow, more whorls of flowers are produced.

Verticillate/Verticil/Verticillatus: leaves or flowers arranged in whorls; said of a collection of three or more leaves or flowers that arise from the same point.

Virgate: wand-like, slender erect growing stem with many leaves or very short branches.

Wing: any flat surfaced structure emerging from the side or summit of an organ; seeds, stems.

Woody perennial : true shrubs and trees, and some vines, with shoot systems that remain alive above the soil level from one year to the next.

Woody: forming secondary growth laterally around the plant so as to form wood.

Zygomorphic – one axis of symmetry running down the middle of the flower so the right and left halves reflect each other.

Zygomorphy – the type of symmetry that most irregular flowers have, where the upper half of the flower is unlike the lower half, but the left and right halves tend to be mirror images of each other.