MORPHOLOGY OF ANGIOSPERMS

Synopsis

Root system and root modifications

- Dicots show tap root system and monocots show fibrous root system
- Adventitious roots develop both in dicots and monocots. Fibrous roots of monocots are adventitious.
- Branches on roots are endogenous in origin.
- Primary roots geotropic. Secondary rots are plagiotropic. Secondary rots at the surface of the soil are diageotropic.
- On roots nodes, leaves, normal buds are absent.
- Root apex is protected by calyptras or root cap. Root cap regenerates periodically.Root caps are absent in aquatic plants, velamin roots, haustorial roots and Mycorrhizal roots
- Rots store different substances and are called storage roots. Eg. Daucus carota, Raphanus sativus, Beta vulgaris. Ipomea batatus, Ruellia tuberose, Asparagus, Mirabilis jalapa
- Beta stores sugars. Dahlia stores inulin, a polyfructose sugar.
- Many storage roots are bienniels.
- Nodulated roots or Tuberculate roots are present in some leguminosae plants like Lucerne (alfalfa), Cajanus, Dolichos, Arachis.
- Plants growing in saline swamps (mangroves) show pneumatophores, mycorhizai roots and vivipary. Eg: Sonneratia, Bruguera, Heritiera(sundari tree), Rhizophora, Avicennia.
- In Momordica moniliform(beaded) roots are present.
- The apex of the roots are swollen (nodulose roots) in Curcuma amada..
- In Vanda, an epiphyte shows velamin roots which absorb moisture frm the atmosphere. A dead velamin tissue is present covering the roots. Velamin is modified epidermis. These roots will not help in anchorage.
- Root are green and photosynthetic in Taeniophyllum(an epiphyte), Tinospora, Trapa(aquatic plant)(Singhara)(water chest nut).
- Parasitic roots or haustorial roots obtain nutrients from the host. They are root or stem parasites. Complete or incomplete. Complete parasites are without photosynthetic pigments.Cuscuta(complete stem parasite). Viscum, Cassytha are partial stem parasites obtaining only water and nutrients from the host. Striga is partial root parasite. Santalum entirely depends on roots of host at seedling stage. Balanophora (on tobacco plants) Orabanche on many vegetable crops are complete root parasite.
- Prop are mechanical roots developing from large horizontal branches and enter into soil(Ficus sps).
- Stilts roots develop from lower nodes in Graminaceae members for additional support as stem is thin and hallow (culm).
- Climbing roots develop from nodes (Piper betel), or internodes (Pothas, Tecoma, Ivy).
- Root buds (adventitious) develop in Murraya, Millingtonia and Moringa.

Shoot system and its modifications

- Shoot system shows underground, aerial and sub aerial modifications.
- Rhizome, corm, stem tubers and bulbs are underground stem modifications.Under stems generally stores food material except in bulbs. Soboles are underground stems without storage substance.

- Rhizomes grow parallel to the surface. Corms grow vertical in the soil.
- Ginger, Curcuma (haldi), Musa and Canna are rhizomes. These are perennating bodies.
- In bulbs stem is discoid. Leaf bases are swollen. Leaf may arrange in concentric circles (Alliumcepa) or imbricately (Allium sativum). Dry scaly leaf(tunic) protects in scaly bulbs (Allium cepa and Allium sativum). Scaly leaf absent in naked bulbs in Lillium.
- In corms contractile roots may be present which maintain the depth of the corm in the soil-Gladiolus, Amorphophallus (zamikand), Colocasia(kachalu).
- Potatoes are stem tubers. Brown periderm protects potatoes. Eye like structure represent nodes. Potatoes are terminal swollen portions of underground branches. Roots are not present on this modified portion.
- Aerial stem modifications are thorn- Carissa carandus, Duranta, Bougainvillea, Citrus. Thorn may be hook like in Hugonia, Artabotrys
- Tendrils are present in Passiflora, Cucurbita, Vitis (grape vine). Branched tendrils are present in Cucurbita.In Antogonon and Cardiospermum inflorescence axis is tendrillar.
- Sometimes aerial stems are swollen like in knoll-kohl, Sugar cane storing food material.
- Axillary buds stores food material, detach and help in propagation. Eg Century plant (Agave). These are called as bulbils.
- Sub-aerial stem modifications help in vegetative modifications. These are runners, stolons, suckers and offsets.
- In Cynodon dactylon runners are present. Rosa , Jasminum, Centella (Brahmi) are other examples.
- Strawberry, chrysanthemum, mentha are examples for stolon.
- In Pistia(water lettuce), Eichornia(water hyacinth) offsets are present.
- In Muhlenbeckia ,Euphorbia tirucallii stems are photosynthetic(phylloclade).

Leaf and leaf modifications

- Leaves present on the aerial stems are called cauline leaves.
- Leaves present on branches are ramal leaves
- Leaves present on underground stems are radical leaves.eg; Allium (all bulbs). Rhizomes, corms also show scaly radical leaves.
- Leaves are protected by stipules at young stages. Leaves without stipules are exstipulate. Cauducous (short lived) stipules are present in Michelia.
- Stipules may modify into spines (Acacia), tendrils (Smilax), foliaceous (Lathyrus, Pisum).
- Leaf base is swollen (pulvinous) in leguminosae. This is responsible for sleeping movements in Leguminosae.
- Leaves may show petioles (petiolate) or no petiole (sessile).
- All leaves show axillary buds in their axils.
- Simple leaves are dissected and mid ribs are branched to become compound leaves.
- They may be pinnately dissected or palmately dissected. Each dissected lamina is called as leaflet . stalk of the leaflet is called petiolule.
- In pinnately compound leaves leaflets are arranged in pairs on either side of the rachis.Rachis may be single (unipinnate) or branched (bipinnate, tripinnate, decompounds). In palmately compound leaves leaflets arise from a single point. Leaflets may be one to many (unifoliate, bifoliate, trifoliate etc).
- In dicot leaves reticulate venation and monocots show parallel venation. Some exceptions are seen.

- In Eryngium, Caulophyllum (dicots) parallel venation and in Smilax,Dioscorea, Colocasia (monocots) reticulate venation is seen.
- If many prominent mid ribs are present they are multicostate venated. If leaves are lobed with many prominent ribs all of them diverge from the base into the lobes (Cucurbita- dictot, Borassus-monocot). If they are not lobed they converge at the apex.Oryza(monocot), Hibiscus(dicot)
- Arrangement of the leaves on the stem is called phyllotaxy .In alternate or spiral phyllotaxy one leaf is present at each node and arranged spirally on the stem. The number of rows on the stem is a genetic character. Each row is called Orthostichy (distichy, tristichy etc).
- In opposite phyllotaxy two leaves are arranged opposite at each node. At each node the pair may superposed or at right angles to the lower pair(decussate)Quisqualis opposite superposed, Calotropis opposite decussate.
- In whorl phyllotaxy many leaves appear at each node. Eg: Alstonia, Nerium, Plumeria.
- They appear as mosaic to longer petioles of lower leaves in Acalypha, Ricinus, Carica.
- Photosynthetic petioles are called as phyllodes. Leaflets fall off early but petiole is persistant.Eg; Acacia melanoxylon (Australian acacia), Parkinsonia .
- Scaly leaves are xerophytic adoptions. (Allium)
- Entire leaf is tendillar in Lathyrus and terminal leaflets in Pisum. Leaf apex in Gloriosa.
- Reproductive leaves with adventious buds developing on the lamina are seen in Bryophyllum (marginal) Scilla(terminal) Begonia (at injured portions).
- In insectivorous plants trap leaves are present eg: Nepenthes(pitcher plant), Dionaea(venous fly trap) Utricularia(bladder wort) Drosera (sundew plant), Pinguicula.

UNIT-2-MORPHOLOGY-II

Inflorescence

Synopsis

- Inflorescence is a modified branch developing from terminal or axillary buds.In Datura and Gossypium terminal and in Hibiscus axillary inflorescences are present.
- Inflorescence axis is called as peduncle. In compound inflorescences peduncle is branched.
- Inflorescences develop from the axils of modified leaves called involucre . Branches develop from involucels.
- Sometimes inflorescences appear on large stems (cauliflory).Eg: Ficus(fig), Theobroma (coco), Polyalthia, Artocarpous(jack fruit).
- In Callistemoni(bottle brush) intercalary inflorescence is seen.
- Inflorescences may be recemose or cymose. Peduncle growth is indefinite and flower number is also indefinite. Flower anthesis is acropetal. (centripetal).Delphinium, Brassica.
- In cymose inflorescence apical bud modifies into flower. Flower anthesis is basipetal .Number of flower are definite.
- Some inflorescences cannot be classified in any category classified as special types. Verticillaster, Cyathium, Hypanthodium.
- Racemose inflorescemces are grouped into two types based on presence or absence of pedicel.
- Simple racemes are seen in Fabaceae members(Crotalaria, Tamarindus, Dolichos). Compound racemes or panicles are found in (Mangifera, Yucca).

- In corybose inlorescences all the flower heads are brought to same height due to longer stalks of the older flowers. Simple corymbs are found in members of Caesalpinaceae(Cassia, Delonix, Caesalpinia), Gynandropsis, Iberis. Compound corymb in Pyrus and cauliflower.
- In Umbels peduncle is condensed to a disc. All the flowers have more or less same length of the pedicels. Simple umbels in Allium and Smilax . Compound umbels in Coriandrum, Daucus, Carum (jeera). In all umbels involucres bracts are prominent.
- Spikes are like simple raceme but flowers are without pedicels. Found in Amaranthaceae members.Compound spikes are present in Poaceae members. It is the most advanced inflorescence in plant kingdom. Some bracts do bear flowers they are glumes.bracts and bracteoles are termed as lemma and palea respectively. Perianth reduced to small structures called lodicules. In maize unisexual flowers are present. Each branch of a compound spike is a spikelet and stalk is rachilla.
- Catkins or amentums have drooping inflorescence axis.Morus alba, Casuarina, Acalypha, Quercus suber.
- Simple spadix is seen in members of Aroideae. Pedincle is fleshy bearing unisexual flowers. Colocasia, Amarphophallus titanium (largest spadix), Pistia, Lemna (smallest spadix), Anthurium. A leathery spathe (modified bract) protects the inflorescence which is also attractive.
- Compound spadix examples are Cocos nucifera, Musa,
- Head inflorescence or anthodium is a typical inflorescence of Asteraceae members. Peduncle is condensed covered by prominent involucres. Two different flowers are present in heterogamous heads (ray florets and disc florets).Single type of florets in homogamous heads. Ray florets in heterogamous heads are female flowers. Homogamous head examples are Chrysanthemum, Tagetus (all ray florets) . Vernonia, Ageratum (all disc florets). Heterogamous heads are seen in Tridax, Helianthus, Cosmos, Zinnia etc. Compound heads are seen in Sphaeranthus, Echinops.
- Single flower cymes are solitary cymes, a characteristic feature of Malvaceae.
- Three flowered simple cymes are seen in Bougainvillea, Jasminum,
- In Monochasial or uniparous cymes a single branch develops after terminal bud modification. Two types- halicoid(Hamelia, Begonia, Drosera) and scorpioid cymes(Heliotropium, Solanum). In all monochasial cymes due to sympodial axis flower appear opposite bracts.
- Dichasial cymes in Clerodendron, Ixora, Dianthus and Polychasial cymes in Nerium, Plumeria are present.
- Cymose heads or globose heads are present in Anthocephalus, Acacia. Parkia, Mimosa etc
- Inflorescence in Ocimum (thyrsus) is classified as a mixed type.
- In special types Verticillaster is seen Lamiaceae members(Leucas, Leonitis, Salvia). At each node two inflorescences appear like a false whorl. It cannot be classified into dichasial or monochasial cyme.
- In Cyathium (typical of Euphorbiaceae) involucre is cup shaped , a single female flower(solitary cyme) many male flowers (monochasial scorpioid) are present. It looks like a small flower. A large nectar gland is present on involucres cup.
- Hypanthodium is seen in Moraceae family. It looks like a fruit. Peduncle is fleshy cup shaped. Male flowers are present at the apex and female at the bottom. Flowers open irregularly. Gall wasp (Blastophaga) pollinates this flower. Insects lays eggs in ovaries of some female flowers making them sterile(gall flowers)After pollination peduncle becomes fleshy and edible(developing into compound fruit Syconus).

Flower

Synopsis.

- Flower is considered as a modified shoot with limited number of nodes by taxonomists like Linnaeus, de Condolle, Goethe, Gaspard Bauhin,
- Monocarpic plants flower only once in their life time and polycarpic many times.
- Flower is a reproductive branch.
- Flowers may be bracteate with a bract or ebracteate without a bract.Pedicil may be present or may not be present.
- At each node leaves are modified into floral leaves.
- Complete flower is with calyx, corolla, stamens and carpels.
- Monochlamydeous flowers with a single whorl of perianth(Euphorbia, Amaranthus, Croton), Achlamydeous(Poinsettia) or naked flowers without any perianth are incomplete.
- Unisexual flowers are also incomplete. Plants are monoecious if unisexual flowers are present on the same plant(Acalypha, castor, maize). If unisexual flowers are present two different plants they are dioecious (Vallisnaria, Borassus, Casuarina Cycas).
- Polygamous plants show more than two types of flowers-male, female, bisexual or neuter flowers.Mangifera, Polygonum, Anacardium.
- Actinomorphic flowers are radially symmetrical(Hibiscus, datura). Zygomorphic flowers are biradially symmetrical. Zygomorphy is due to unequal perianth or staminodes.(Ocimum, Dolichos,Cassia)
- Canna shows Asymmetrical flower.
- Isomerous flowers show each whorl with similar number or multiples of that number of floral parts. Flowers can be trimerous (monocots), tetramerous(Brassica), pentamerous(Hibiscus, Datura)
- Hypogynous flowers have superior ovary with floral parts arising below the Gynoecium. It is primitive.halamus is conical or discoid.
- In perigynous and epigynous flowers thalamus is cup shaped. In prigynous flowers thalamus is not fused with ovary wall. Thalamus position may be superior, inferior or half inferior(Dilochos,Crotolaria, Rosa). In epigynous ovary is fused with thalamus, thalamus is inferior(Tridax, Cucurbita, Ixora).
- Arrangement of perianth in bud condition is called as aestivation. Aestivations may be valvate, Twisted(petals of Hibiscus), Ascendingly imbricate(Fabaceae members), Descendingly imbricate(in petals of Caesalpinaceae). Quincuncial (sepals of Ipomoea, Catheranthus).
- Stamens are modified leaves bearing microsporangia. They may be bithecous with two theca or monothecous with single theca(Malvaceae). Sterile stamens are staminodes (Cassia)
- Length of stamens may be different. In tetradynamous four longer and two shorter (Brassicaceae). In didynamous two short and two long(Ocimum). In Ipomoea all stemens are of different height.
- Attachment of the filament with theca is fixation . Adnate (Nelumbo, Magnolia), Basifixed (Datura), Dorsifixed (Hibiscus), Versatile (Poaceae).
- Dehiscence may be longitudinal, Transverse(Hibiscus), Porus (Solanum, Cassia), Valvular (Cassytha)
- Cohesion of stamen result in monoadelphous (Malvaceae), diadelphous (Fabaceae) or Polyadelphous (Citrus, Ceiba).Syngenesious (union of theca) in Tridax, Helianthus.Synandrous (total union) in Cucurbita.

- Adhesion results in epipetalous (all gamopetalous flowers), episepalous (Grevillea) or epiphyllous in Allium. Stamens unite with gynoecium(gynostegium) in Calotropis.
- Carpels are modified leaves with megasporangium. They may be united(syncarpous) or free(apocarpous). Apocarpous in Annona, Polyalthia, Nelumbo.
- Placentation may be marginal (Fabaceae) parietal (Brassica, Cucurbita), basal (Tridax) freecentral (Dianthus) superficial (Nymphea).
- Locule number and carpel number is not equal always. Due to false septum (replum) locule number increases (Brassica, Datura)
- Style is gynobasic in Lamiaceae(Ocimum).

<u>Fruit</u>

Synopsis

- After fertilization ovary forms into fruit and ovules into seeds. Without fertilization results parthenocarpic fruits.
- If any part other than ovary becomes fleshy those are false fruits.Pyrus malus(edible thalamus), Anacardium occidentale(fleshy peduncle).
- Simple fruits develop from syncarpous ovaries. Aggregate fruits develop from apocarpous ovaries. Annona, Polyalthia(etaerio of berries), Magnolia(etaerio of follicles), Rubus(drups), Naravelia, Nelumbo(achenes).Composite or multiple fruits develop from entire inflorescence (Sorosis-Artocarpous, Morus, Casuarina) Syconus (from hypanthodium-Ficus)
- Simple fruits may be fleshy or dry. Fleshy fruits are berry (banana, tomato, brinjal, date), Pome(Pyrus) Pepo (cucurbits) Hesperidium (Citrus) or Drupe(coconut,mango). Drupes are stony fruit with pericarp stony.
- Dry fruits are dehiscent or indehiscent. Dehiscent fruits are Legume (fabaceae), Siliqua (Brassica) or capsules. Capsules may loculicidal (Malvaceae- Gossypium) septicidal(Aristalochia, Gloriosa, Viola(pansy)) septifragal in Datura and Nicotiana.
- Dry indehiscent fruits are always single seeded. They are achenes(Nelumbo, Naravelia), Caryopsis (cereals) Cypsela (Asteraceae) Nut (Anacardium).In Caryopsis fruit wall and seed coat is fused (endosperm is edible). Cypsela develops from inferior ovary.
- Winged fruits are called as samara. (Hiptage, Gyrocarpous, Ptelea)
- Sometimes both dehiscent and indehiscent characters are seen Schzocarpic fruits or splitting fruits. They break down into single seeded mericarps. They are Cremocarp-2(Coriandrum), Lomentum-many (Mimosa), Regma-3(Ricinus) Carcerulus-4 (Ocimum).
- Seeds without endosperm are non endospermic. Seeds with left over nucellus are perispermic (Piper nigram, Nymphea, Coffee).
- Aril may be present in some seeds. Pithacalobium, Myristica, Litchi.
- Caruncle is present in seeds of Euphorbiaceae(Ricinus).
- Embryonal axis is called tigellum.
- Single cotyledon in monocot seeds is Scutellum.