

RPS DEGREE COLLEGE

BALANA (MAHENDERGARH)-123029



Lab Manual

Botany (B.Sc.3rd & 4th Semester)

Department of Botany

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GYMNOSPERMS

ANATOMY OF CYCAS

Classification

Division- Gymnosperms

Class- Cycadopsida

Order -Cycadales

Family-Cycadaceae

Genus -Cycas

Anatomy of young root

T.S. of young primary root stained in safranin-fast green combination shows the following structures

1. **Outline circular.** It shows an outermost layer the epiblema or epidermis multilayered cortex and centrally placed stele or vascular cylinder.
2. **Epidermis:** The epidermis is made up of single layer of thin walled cells. Unicellular root hair arise from some of these cells.
3. **Cortex:** It is made up of many layers of cells. These cells are parenchymatous and filled with starch grains. A few cells also contain tanin and mucilage too.
4. **Endodermis:** The innermost layer of cortex is endodermis.
5. **Pericycle:** It is next to endodermis and is composed of a few layers of cells.
6. **Stele or vascular cylinder:** It is made up of radially arranged vascular bundles. The xylem is exarch. The roots may be diarch to tetrach. Trachcids are with spiral

thickenings and metaxylem with scalariform thickenings the phloem consists of sieve tubes and phloem parenchyma. Pith is highly reduced or absent.

Anatomy of Leaflet (Pinna) of Cycas

A thin T.S. or V.S. of leaflet stained in safranin-fast green combination shows the following

1. The outline structure shows a thick, distinct midrib with lateral wing like structure.

2. **Upper epidermis:** It is made up of single layer of cells and is covered by thick cuticle.

3. **Hypodermis:** It is present below the epidermis is made up of thick walled sclerenchymatous cells.

4. **Mesophyll tissue:** It is present next to hypodermis. It is well developed and differentiates into upper palisade layer and lower spongy parenchyma. Many intercellular spaces are present in the spongy parenchyma.

5. **Single cell thick lower epidermis:** It is present next to spongy parenchyma. It has sunken stomata and is covered by thick cuticle outside.

ANATOMY OF PINUS

Classification

Division-Gymnosperms

Class-Coniferopsida

Order -Coniferales

Family -Pinaceae

Genus –Pinus

Anatomy of long shoot (young) of Pinus

Cut a thin T.S. of young long shoot, stain in combination of safranine-fast green.

It shows the following structure:

1. T.S. of young long shoot is wavy in outline due to the presence of scale leaves on its surface. The young stem is differentiated into epidermis, cortex and vascular cylinder.
2. **Epidermis:** It is the single outer most layer of cells. It is covered by a thick cuticle.
3. **Cortex:** Next to epidermis is multilayered cortex of few outer layers of cells are made up of thick walled sclerenchymatous cells forming the hypodermis. Inner layers of cells are thin walled parenchymatous. A number of resin canals and leaf traces are irregularly distributed in the cortex. The pericycle and endodermis are not distinct.

4. **The vascular cylinder or stele:** It is ectophloic siphon stele having 5-6 vascular bundles arranged in a ring. The bundles are conjoint, collateral open with endarch xylem. A narrow strip of cambium is present between xylem and phloem of each vascular bundle. Protoxylem is made up of tracheids with spiral thickenings and metaxylem tracheids possess reticulate thickenings. Vessels are absent. Resin canals are present in the xylem also.

T.S. Young Root of Pinus

A thin, double stained T.S. of primary root of Pinus shows the following structure:

1. **Epidermis or Epiblema:** It is the outermost single layer of thin parenchymatous cells. Some epidermal cells extend to form unicellular root hairs.

2. **Cortex:** Next to epidermis, is a multilayered cortex. It is also made up of thin walled parenchymatous cells. Resin is present in some cells of the cortex.

3. **Endodermis:** It is the inner most layer of cortex. The endodermal cells have deposition of suberin or tanin and are brown-orange in colour. Presence of casparian thickenings in the radial walls of endodermal cells.

4. **Pericycle:** Inside the endodermis there is a multilayered pericycle made up of thin walled parenchymatous cells. Starch and tanin are present in some of these cells.

5. **Vascular cylinder or stele :** Pinus roots are diarch to hexarch. Vascular bundles are arranged radially, protoxylem is exarch and is forked therefore, the xylem appears Y shaped. A resin canal is present in the two arms of Y' xylem. Xylem consists of tracheids. Vessels are absent. Phloem bundles alternate with xylem bundles. Phloem consists of sieve cells and phloem parenchyma.

ANATOMY OF EPHEDRA

T.S. of Primary Root of Ephedra

Primary root shows the following structure:

1. **Epidermis:** it is made up of single layer of thin walled perenchymatous cells. Some epidermal cells are extended into root hairs.
2. **Cortex:** Inside the epidermis there is a broad perenchymatous cortex. It is differentiated into an outer zone.
3. **Endoermis:** It is the innermost layer of cortex.
4. **Pericycle:** Endodermis is followed by a single layer of thin walled cells of pericycle. Xylem and phloem bundles are present.

T.S. of Primary (young) stem of Ephedra

It is irregular in outline due to the presence of ridges and furrows.

1. **Epidermis:** It is made up of single layer of thick walled cells. On outside, it is covered with a thick cuticle. Stomata are present these are deeply. Sunken and embedded in circular pits.
2. **Hypodermis:** It is present inside the epidermis in the ridges. It is made up of thick walled sclernchymatous cells that provide strength to the stem.
3. **Cortex:** It is of 2-3 layers of palisade like cells. The inner cortex has 2-3 layers of cells. It is into outer cortex and inner cortex. The outer cortex is made up of

Palisade and spongy cells of cortex contain chloroplasts and thus perform photosynthesis.

4. **Endodermis:** the inner most layer of cortex is poorly developed into endodermis.

5. **Pericycle:** it is followed by endodermis and not well marked.

ANATOMY OF ANGIOSPERMS

T. S. OF YOUNG DICOT STEM OF SUNFLOWER

A T.S. of young sunflower stem shows:

1. **Epidermis:** It is the outermost surface layer composed of compactly arranged parenchymatous cells. The outer walls of epidermal cells are thickened due to the presence of cuticle.

2. **Cortex:** There is a multi layered thick cortex within the epidermis. It is differentiated into outer hypodermis which is composed of collenchymatous cells having thickening along their tangential walls. Hypodermal cells also contain chloroplasts and serve the function of photosynthesis. The remaining cortex is made up of thin walled cells polygonal in shape. Small oil cavities are also present in this part of the cortex. Cavity has secretory cells that secrete oil.

3. **Endodermis:** It is the innermost layer of the cortex. The endodermal cells are biconvex with thickened radial walls. These thickenings are known as casparian strips. Endodermis is also known as bundle sheath or starch sheath.

4. **Pericycle:** It is the region between endodermis and vascular cylinder. It is composed of alternate patches of thick walled sclerenchymatous cells with thickened radial walls. These thickenings are full of starch grain.

5. **Vascular Cylinder:** It is composed of a ring of vascular bundles. Each vascular bundle is conjoint, collateral, open and endarch. The xylem is made up of tracheids vessels xylem parenchyma and xylem fibres. The protoxylem lies towards the inner side of stem. The phloem consists of sieve tubes, phloem parenchyma and companion cells. There is a ring of cambium between the xylem and phloem bundle.

6. **Medullary Rays:** The parenchymatous cells present between the vascular bundles.

7. **Pith:** It is the central part of the stem and is made up of thin parenchymatous rounded cells with intercellular spaces.

Points of identification:

1. Presence of conjoint collateral vascular bundles
 2. Presence of Endarch protoxylem.
 8. Well developed endodermis and pericycle.
 4. Vascular bundles are arranged in a ring.
 5. Combium is present and pith is well developed.
- These characters show that it is the section of Dicot stem.

T.S. OF MONOCOT STEM OF MAIZE

1. Epidermis: It is the outermost boundary of the stem and is made up of single layer of cells. Outer walls of epidermal cells are covered with a thick cuticle. Stomata are present in the epidermis.

2. Hypodermis: A few layers of sclerenchymatous cells present the epidermis constitute the hypodermis. Cell walls are thick and lignified. The cells appear polygonal in shape.

3. Ground tissues: There is no differentiation into cortex, endodermis, pericycle and pith. The whole mass of parenchymatous cells present next to hypodermis constitute the ground tissue. The cells are thin walled smaller in size and polygonal in shape. Towards the center, the cells become loosely arranged.

4. Vascular bundles: Numerous vascular bundles are scattered throughout the ground tissue. Vascular bundles are conjoint, collateral, endarch and closed. Bundles are numerous and closely arranged. There is no cambium present in the bundles. Each vascular bundle is oval in outline. The xylem consists of both proto and metaxylem. They are located in the shape of English letter T. Their walls have pitted. The proto xylem occupied the lower arm T. It consists of two smaller vessels with and xylem parenchyma. The monocot stem is composed of sieve tubes and companion cells. Phloem parenchyma and phloem fibres are absent. The meta phloem is the functional in mature vascular bundles. It has distinct sieve tubes and companion cells.

Points of identification

1. Presence of endarch protoxylem.
2. Absence of well differentiated cortex, endodermis and pericycle.
3. Vascular bundles are closed and scattered in the ground tissue.

Therefore, it is a section of monocot stem.

T.S. OF DICOT ROOT OF GRAM

A T.S. through the root of gram shows the following structures

1. **Epidermis or epiblema:** It is the outermost layer of thin walled cells which are closely packed. Some epidermal cells are extended to form root hairs.
2. **Cortex:** Present inside the epidermis is a several layered tissue called cortex. It is composed of thin walled parenchymatous cells with intercellular spaces.
3. **Endodermis:** It is the innermost layer of cortex that separates it from vascular tissue. It is composed of barrel shaped closely packed cells with casparian thickenings at the radial and tangential walls. The endodermal cells in close contact with protoxylem. These are called as passage cells.
4. **Pericycle:** Next to endodermis, the pericycle is composed of thin walled compactly arranged parenchyma cells.
5. **Vascular cylinder:** It consists of four vascular bundles that are radial and exarch. The xylem and phloem bundles are equal in number and alternate with each other. Xylem consists of tracheids vessels and xylem parenchyma. Protoxylem elements are smaller with annular or spiral thickenings. Metaxylem elements are larger in size and possess reticulate and pitted. Phloem consists of sieve tubes, companion cells and phloem parenchyma.
6. **Pith:** It is a small and central in position. It is made up of thin walled parenchymatous.

Points of identification

1. Presence of radial vascular bundles with exarch protoxylem.
2. Presence of unicellular root hairs
3. Presence of four xylem bundles i.e., tetrach. Condition.
4. Pith is reduced and small.

Therefore, it is a section of Dicot root.

T.S. OF MONOCOT ROOT OF MAIZE

T.S through root of maize reveals the following tissue systems

1. **Epidermis or epiblema:** It is made up of a single layer of thin walled cells that are compactly arranged. Some epidermal cells are extended to form unicellular root hairs

2. **Cortex:** Below the epidermis, there are 1-4 layers of thick walled suberised cells. These make the exodermis. Inside the exodermis, cortex is composed of many layers of thin walled cells that are rounded or oval in shape. Intercellular spaces are present in these cells

3. **Endodermis:** It is the innermost layer of cortex and is composed of barrel shaped cells. These cells possess casperian thickenings on their radial and inner walls. Some cells present opposite to the protoxylem elements are thin walled and are known as passage cells. They permit lateral conduction of water and nutrients.

4. **Pericycle:** Next to endodermis is the pericycle made up of 1-2 layers of thin walled cells. These cells retain the power of division and give rise to lateral root primordia.

5. **Vascular cylinder :** The vascular cylinder is made up of large no. of xylem and phloem bundles alternating with each other. Thus, the root is polyarch. The xylem bundles consist of protoxylem facing the pericycle and metaxylem towards the pith. Such a condition of xylem called as exarch. Protoxylem is made up of a few tracheids and vessels. Metaxylem is represented by single or two large and oval

vessels. Xylem parenchyma cells are also present. The protoxylem vessels have spiral or annular thickenings whereas, metaxylem vessels have Phloem bundles alternate with xylem bundles. Each phloem bundle has sieve tubes with polygonal outline. The protophloem is present towards the pericycle. It has sieve tubes associated with phloem parenchyma.

6. **Pith:** It is wide and made up of parenchymatous cells. The cells are rounded to oval in shape.

Points of Identification

1. Presence of alternating (radial) vascular bundles.
2. Unicellular root hairs in epidermal cells.
3. Presence of many (six or more) xylem bundles i.e., polyarch condition.
4. Pith is large and well developed.

Therefore, it is a section of monocot root.

FAMILY: BRASSICACEAE (CRUCIFERAE)

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub Class: Polypetalae
Series: Thalamiflorae
Order: Parietales
Family: Brassicaceae

Distribution

This family is commonly called as 'mustard family'. It includes about 300 genera and about 3700 species. There are around 150 species recorded in India.

Characteristic Features

Habit: Usually annual or perennial herbs

Root: Tap root system

Stem: Herbaceous, erect and branched

Leaves: Simple, alternate, radical or cauline, usually entire, sometimes lobed, petiolate, exstipulate reticulate venation

Inflorescence: Raceme or corymbose raceme

Flower: Ebracteate, pedicellate, mostly actinomorphic, bisexual, heterochlamydeous, dimerous or tetramerous hypogynous

Calyx: Sepals 4, polysepalous, in two whorls of two each imbricate aestivation

Corolla: Petals 4, arranged in single whorl alternating with sepals, polypetalous, often with long claws and spread out to form a cross. Hence, the name cruciform corolla. Valvate aestivation

Androecium: Stamens 6, polyandrous, arranged in two whorls of 4 and 2 (tetradynamous), outer two are short and the inner four are long, anthers bilobed, basifixed, introse.

Gynoecium: Bicarpellary, syncarpous, initially unilocular and later bilocular, (formation of pseudoseptum), style short, stigma bifid, sometimes bilobed, ovary superior

Fruit: Siliqua or silicula

Seeds: Endospermic

Floral Formula: $\text{Ebr}, \text{Ebrl}, \text{K}_{2+2}, \text{C}_4, \text{A}_{2+4}, \text{G}_{(2)}$

Common Examples

(Mustard, Sarson), *Raphanus sativus* (Radish, Muli), *Brassica rapa* (Turnip, Shaljam).

FAMILY: LILIACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Monocotyledonae
Series: Coronarieae
Order: Liliflorae
Family: Liliaceae

Distribution

It is commonly called Lily family. It includes about 250 genera and 3700 species that have a cosmopolitan distribution. Around 200 species are available in India.

Characteristic Features

Habit: Mostly perennial herbs, stem often modified into bulbs or corms, rarely shrubs and trees (Dracenea, Yucca). Some are climbers (Gloriosa, Smilax). Many are xerophytes (Aloe, Agave and Asparagus)

Root: Adventitious, fibrous, sometimes tuberose.

Stem: Erect or climbing, branched or unbranched herbaceous, may be modified as phylloclade (Ruscus) or cladode (Asparagus) or bulb (Alium) is parallel and reticulate in Smilax

Leaves: Radical or cauline, simple or rarely compound well developed or reduced to sheaths or scales

Inflorescence: Variable, mostly racemose, simple raceme or spike or umbel or panicle. Sometimes solitary cyme

Flower: Bracteate, actinomorphic, bisexual, pedicellate, homochlamydeous, trimerous, incomplete, and hypogynous

Perianth: Tepals 6, in two whorls, polyphyllous or gamophyllous, imbricate or valvat

Androecium: Stamens 6, in two whorls of three each usually free or attached to tepals usually versatile, introse or extrose

Gynoecium: Carpels 3 (tricarpeous), syncarpous, trilocular, two ovules in each locule attached on axile placentation style simple, stigma trifid, and ovary superior

Fruit: Berry or capsule

Seed: Small, endospermic

Floral Formula: $\text{Br, Ebr, } P_{3+3}, A_{3+3}, G_{(3)}$

Common Examples

Allium cepa (Onion), *Allium sativum* (garlic), *Asphodelus tenuifolius* (Piazi), *Asparagus adscendens* (Safed Musli) *Asparagus racemosus* (Satavar), *Aloe vera*, *Ruscus aculeatus*, *Yucca*, *Smilax*, *Lilium*, *Tulipa*, etc.

FAMILY: RUTACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub Class: Polypetalae
Series: Disciflorae
Order: Geraniales
Family: Rutaceae

Distribution

It is commonly called as 'Citrus family'. It includes about 150 genera and 1500 species. Members have a cosmopolitan distribution. There are around 80 species found in India.

Characteristic Features

Habit: Plants are shrubs or trees, rarely herbs often aromatic or strong-smelling.

Root: Tap root, branched

Stem: Erect, woody, branched, often thorny

Leaves: Simple, alternate less frequently opposite, more often pinnately compound, but in the latter case some apparently simple by reduction of leaflets to one, ever-green, and extensively gland-dotted or fragrant

Inflorescence: Usually cymose or solitary, rarely raceme

Flower: Bracteate, bisexual (rarely unisexual), actinomorphic (rarely zygomorphic), pentamerous (rarely tetramerous), hypogynous with a large cushion-like disc below the ovary

Calyx: Sepals 4 or 5, free or united

Corolla: Petals 4 or 5, free (sometimes absent), imbricate or valvate aestivation

Androecium: 10 or 8, less or sometimes indefinite, attached to the disc, free, opposite the petals (obdiplostemonous), may be united into groups (polyadelphous), anther two-celled, introse, inferior syncarpous (sometimes free towards base), ovary deeply lobed in *Peganum*, ovary, axile placentation, parietal in *Feronia*, style erect, stigma terminal, entire, lobed

Gynoecium: Bi to pentacarp superior placed on a disc

Fruit: Berry (hesperidium)

Seed: Endospermic or non-endospermic, polyembryony, embryo curved or straight

Floral Formula: $\text{Br, } K_{4-5}, C_{5 \text{ or } 4} A_{10} \propto G_{(2)}$

Common Examples

marmelos (Bael), *Murraya paniculata* (Marua or Kamini), *Murraya koenigii* (Mitha neem), *Zanthoxylum armatum* (Tejpat),

FAMILY: CUCURBITACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub-class: Polypetalae
Series: Calyciflorae
Order: Pasiflorales
Family: Cucurbitaceae

Commonly known as 'Gourd family'. It includes about 100 genera and 850 species.

Characteristic Features

Habit: Plants are mostly annual or perennial weak stem, tendrils and with plenty of juicy sap in the leaves and stems

Root: Taproot, branched and get thickened due to storage of food and water

Stem: Herbaceous, climbing by means of tendrils or trailing, rooting at nodes, angular

Leaves: Alternate, usually simple but often deeply lobed or divided and palmately veined, reticulate, petiole long and hollow. Tendrils may be simple or branched arising in the axil or opposite to the leaf at the node

Inflorescence: Variable flowers often solitary. Large and showy or sometimes in racemes or cymes or in panicles, uni-sexual, male and female borne on the same plant (monoecious e.g.: Lufa, cucumis) or on different plants (dioecious e.g. Trichosanthes).

Flower: Regular, unisexual, rarely bisexual, smaller or large showy, white or yellow, epigynous

Male flower: They are usually produced in much larger number, campanulate

Calyx: Sepals five, fused, pointed, petaloid, campanulate, aestivation is imbricate fused (in momordica only at the base, in cucurbila throughout and campanulate), or free (Lufa) valvate, imbricate, inserted on calyx tube when free. Form of corolla may be campanulate or rotate. usually 5 stamens, sometimes 3, free or combined to form a central column inserted on the calyx tube, imbricate, often deeply five lobed, Form of anthers may be I-lobed or 2-lobed, paired stamens have either 2-lobed or 4-lobed anthers

FAMILY: ASTERACEAE (COMPOSITAE)

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Subclass: Gamopetalae
Series: Inferae
Order: Asterales
Family: Asteraceae (compositae)

Distribution

It has a cosmopolitan sunflower family. It is the largest family in dicots. It includes about 1100 genera and 200% distribution. There are around 100 species found in India

Characteristic Features

Habit: Mostly annual herbs, rarely shrubs and trees (Vernonia)

Root: Tap root system branched

Stem: Herbaceous or woody, erect, branched

Leaves: Simple, alternate or opposite, exstipulate, petiolate, hairy, reticulate venation

Inflorescence: Head or capitulum, terminal or axillary. Florets surrounded by an involucre of bracts

Flower: Bisexual, pentamerous, heterochlamydeous, epigynous

Ray florets: Towards periphery, sessile, bracteate, pistillate or neutral, zygomorphic, ligulate

Calyx: Absent or hairy pappus, or scaly persistent

Corolla: Petals 5, polypetalous, ligulate

Androecium: Absent

Gynoecium: Bicarpellary, syncarpous, unilocular, one ovule, the locule, basal placentation, style narrow, stigma branched ovary inferior

Disc Florets: Towards the centre, bracteate, bisexual, actinomorphic, tubular, epigynous

Calyx: Absent or modified into pappus

Corolla: Sepals 5, Gamosepalous, tubular

Androecium: Stamens 2, epipetalous, syngenesious ditheous

Gynoecium: Bicarpellary, Syncarpous, unilocular, one ovule, on basal placenta
Neutral florets: Both androecium and gynoecium are absent.

Fruit: Cypsela

Seed: Non-endospermic

Floral Formula:

Ray floret : Br, K_{pappus} $C_{(5)}$ $A_{(5)}$ G_0

Disc floret : Br, \boxplus , K_{pappus} , $C_{(5)}$, A_5 , $G_{(2)}$

Common Examples:

Helianthus annus (Sunflower), Tagetes erecta (Big-marigold), Aster amellus, Lactuca sativa (Salad) etc.

FAMILY: ASCLEPIADACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub Class: Gamopetalae
Series: Bicarpellatae
Order: Gentianales
Family: Asclepiadaceae

Distribution

Asclepiadaceae is commonly called as 'Milk weed family'. It includes about 250 genera and 2000 species. The members of this family are found throughout the world, but they are more commonly met with in the tropical regions. There are around 250 species found in India.

Characteristic Features

Habit: Plants are perennial herbs, shrubs, vines or rarely small trees, usually with milky latex, latex is poisonous

Root: Tap root, branched, adventitious in epiphyte Dischidia, sometimes roots are fleshy and tuberous for food storage

Stem: Woody below, herbaceous above, covered with wax in many cases

Leaves: Simple, entire, exstipulate, opposite decussate or whorled, rarely alternate, in Dischidia, the leaves modified into pitchers in which water collects, rarely reduced to thorns or scales

Inflorescence: Usually cymose, rarely racemose or umbellate

Flower: Pedicellate, bracteates, bracteolate, complete, actinomorphic rarely zygomorphic, pentamerous, hypogynous

Calyx: Sepals 5, which are either free (polysepalous) or somewhat connate at the base, imbricate or valvate aestivation

Corolla: Petals 5, gamopetalous, corolla tube short, valvate or twisted (contorted) in bud, corolla tube rotate, campanulate

Androecium: Stamens 5, epipetalous, inserted at or near the base of corolla tube, stamens free in *Cryptostegia*

Gynoecium: Bicarpellary, apocarpous but fused with style and stigma, unilocular, many ovules, ovary superior

Fruit: A pair of follicles.

Floral Formula: $\text{Br, K}_5, \text{C}_{(5)} \text{A}_{(5)} \text{G}_{(2)}$

FAMILY: POACEAE (GRAMINAE)

Systematic Position

Division: Spermatophyta

Sub-Division: Angiospermae

Class: Monocotyledonae

Family: Poaceae (Graminae) (The grass family)

Distribution

It is one of the largest families in monocots consisting of 620 genera and over 10,000 species. Members are cosmopolitan in distribution. Around 900 species are present in India

Characteristic Features

Habit: Mainly herbs (annuals or perennials) or shrubs. Some are trees like (Bambusa)

Root: Adventitious, fibrous, branched or stilt (as in maize)

Stem: Underground rhizome in all perennial grasses, cylindrical, distinct nodes and internodes, herbaceous or woody

Leaves: Alternate, simple, exstipulate, sessile, leaf base forming tubular sheath, sheath open, surrounding the internodes completely, hairy or rough, linear, parallel venation.

Inflorescence: Compound spike, sessile or stalked. Each unit is called spikelet, may be a spike of spikelets (Triticum)

Flower: Bracteate, bracteolate, sessile, incomplete, bisexual or unisexual (Zea mays), zygomorphic, hypogynous

Perianth: Represented by membranous scales called lodicules, many (Ochlandra) or three or two or absent

Androecium: Stamens usually three, sometimes six

Gynoecium: Monocarpellary (presumed to be three of which two are aborted), unilocular, single ovule on basal placentation, dithecous, stigma bifid, ovary superior

Fruit: A caryopsis with pericarp completely united with the seed coat, rarely a nut (Dendrocalamus) or a berry (Bambusa).

FAMILY: SOLANACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub Class: Gamopetalae
Series: Bicarpellatae
Order: Polymoniales
Family: Solanaceae

Distribution

Solanaceae is commonly called as 'Brinjal family'. It includes about 90 genera and 2800 species. Members cosmopolitan distribution. In India the family is represented by 60 species

Characteristic Features

Habit: Mostly annual herbs (*Solanum nigrum*), under shrubs (*Solanum melongena*). Some are shrubs rarely trees (*Solanum grandiflorum*) and climbers

Root: Tap root, branched

Stem: Herbaceous or woody, branched, often with prickles

Leaves: Simple, alternate, sometimes pinnately divided into unequal lobes, exstipulate

Inflorescence: Cymose, often solitary cyme

Flower: Ebracteate, actinomorphic, bisexual, pedicellate, heterochlamydeous, hypogynous

Calyx: Sepals 5, gamosepalous, persistent (in the fruit condition also) velvet aestivation

Corolla: Petals 5, gamopetalous, rotate or companulate or bilabiate (Schizanthus) or infundibuliform (Datura). Twisted or valvate aestivation

Androecium: Stamens 5, epipetalous

Gynoecium: Bicarpellary, syncarpous, bilocular or tetralocular due to pseudoseptum. Many ovules, Ovary superior, Obliquely placed

Fruit: Berry or capsule

Common Examples

Solanum tuberosum (Potato), Solanum melongena (Brinjal), Lycopersicum esculentum (Tomato)

FAMILY EUPHORBIACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub Class: Monochlamydeae
Series: Unisexuales
Order: Euphorbiales
Family: Euphorbiaceae

Distribution

Euphorbiaceae is also called spurge family is a large and extremely variable one containing about 283 genera and 7300 species. The family is cosmopolitan in distribution except in the arctic regions but they are mostly abundant in tropical region. In India the family is represented by 336 species.

Characteristic Features

Habit: Herbs, shrubs and trees usually with milky latex

Root: Tap root

Stem: Erect or prostrate, herbaceous to woody, branched, cylindrical and solid

Leaves: Mostly simple rarely compound, alternate rarely opposite or whorled, stipulate, stipules are sometimes in the form of hairs, glands or thorns (rarely absent)

Inflorescence: Mostly cyanthium, sometimes a raceme or panicle

Flower: Bracteate, bracteolate, unisexual (monoecious or dioecious), actinomorphic, hypogynous rarely perigynous. with 3-5 sepals and 3-5 petals, perianth usually free or partly fused, valvate or imbricate aestivation

Perianth: Five, sepaloid, much reduced, sometimes absent, sometimes perianth is differentiated into calyx and corolla

Androecium (in male flower): Stamens one to many, either free or united by filaments (monadelphous or polyadelphous), anthers bicelled, intrastaminal disc usually present, dehiscence by longitudinal

Gynoecium (in female flower): Tricarpellary, syncarpous, ovary superior, trilocular, axile placentation with one or two lobes per locule, styles 3, often bipartite, free or more or less united

Fruit: A schizocarpic capsule, sometimes a regma, berry or drupe

Seed: Endospermic, embryo curved or straight

Common Examples

Euphorbia royleana (Dandathor), Euphorbia splendens (Crown of thorns), Manihot esculenta, Phyllanthus niruri, Hevea brasiliensis (Indian para-rubber), etc.

FAMILY FABACEAE (LEGUMINOSAE)

Systematic Position

Division: Spermatophyta

Sub-Division: Angiospermae

Class: Dicotyledonae

Sub Class: Polypetalae

Series: Calyciflorae

Order: Rosales

Family: Leguminosae (According to Bentham and Hooker)

Fabaceae (According to Takhtajan)

Distribution

Leguminosae is one of the largest families in dicots, including about 690 genera and nearly 18,000 species. In all the major systems of classification, the family Leguminosae has been traditionally considered to include three sub families

(1) Papilionatae (Papillionaceae), (Fabaceae according to Cronquist)

(2) Caesalpinioideae (Caesalpinaceae)

(3) Mimosoideae (Mimosoaceae)

On the basis of vegetative characters, it is very difficult to characterize the sub families. However, the following characteristic features, with some exception, can be considered as common to all the three subfamilies of Leguminosae.

Characteristic Features

Habit: Many herbs (*Cicer arietinum*, *Arachis hypogea*), under shrubs (*Indigofera trita*), shrubs (*Cajanus cajan*)

Roots: Contain root nodules that harbour symbiotic, nitrogen fixing bacteria

Stem: Herbaceous or woody, branched, often with prickles

Leaves: Compound, alternate, stipulate and pulvinate

Inflorescence: Variable form of racemose types

Flowers: Generally zygomorphic, hypogynous, heterochlamydeous, pentam

Stamens: Usually ten in number, monadelphous or diadelphous or free

Gynoecium: Monocarpellary, unilocular with marginal placentation

Fruit: Legume or lomentum.

FAMILY LABIATAE (LAMIACEAE)

Systematic Position

Division: Spermatophyta

Sub-Division: Angiospermae

Class: Dicotyledonae

Sub Class: Gamopetalae

Series: Bicarpellatae

Order: Lamiales

Family: Labiatae (According to Bentham and Hooker)

Lamiaceae (According to Cronquist and Takhtajan)

Distribution

Labiatae is also called mint family. It includes about 200 genera and 3200 species of world-wide distribution, growing under great variety of climate and soil conditions. In India many wild species are met with in hills. There are around 39 species found in India.

Characteristic Features

Habit: Usually aromatic annual or perennial herbs or shrubs, sometimes short trees

Root: Tap root, branched

Stem: When herbaceous usually erect, squarish and hairy, sometimes underground sucker, a few trees are found in tropics

Leaves: Simple, opposite and decussate, exstipulate, whorled in a few species, due to the presence of gland-secreting volatile oils

Inflorescence: Verticillaster, arranged in raceme, spike or panicle

Flower: Bisexual, rarely unisexual as in *Nepta* and *Thymus* with pistillate flowers only, irregular, zygomorphic

Calyx: Five, gamosepalous, usually united into funnel-shaped or companulate tube, often bilabiate (1/4 or 3/2)

Corolla: Five, gamopetalous, bilipped (4/1 or 3/2), bilabiate ringent, valvate, imbricate or twisted (contorted)

Androecium: Stamens 2-4, epipetalous, usually didynamous (monadelphous), filaments free (rarely fused), anthers bithecous, dehiscence longitudinal

Gynoecium: Bicarpellary, syncarpous, ovary superior, bilocular which ultimately becomes tetralocular one ovule in each locule, axile placentation, a honey disc is present below the ovary, style one gynobasic

Fruit: Schizocarpic carcerulus, sometimes a drupe

Seed: Non-endospermic

Common Examples

Ocimum sanctum (Tulsi), *Ocimum basilicum* (Niazbo), *Mentha piperata* splendens, *Leucas aspera*, *Lavendula* (Lavender) etc

FAMILY UMBELLIFERAE (APIACEAE)

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Sub Class: Polypetalae
Series: Calyciflorae
Order: Myrtales
Family: Umbelliferae

Distribution

Umbelliferae is commonly called as Carrot family. It includes about 200 genera and 2900 species. Members are distributed throughout the world but most abundant in north temperate zone. There are around 180 species found in India.

Characteristic Features

Habit: Mostly annual or perennial, herbs, rarely shrubs, commonly aromatic due to presence of oil ducts called vittae, in root, stem and fruits

Root: Tap root, branched, sometimes swollen to store food

Stem: Erect or prostrate, herbaceous, swollen nodes and usually fistular internodes

Leaves: Exstipulate, alternate, simple (Hydrocotyle and Bupleurum), decompounds

Inflorescence: Usually cymose or solitary, rarely raceme

Flower: bisexual (rarely unisexual), actinomorphic (rarely zygomorphic) pentamerous

Calyx: Five, polysepalous, teeth may be present, adnate to ovary, superior

Corolla: Five, polypetalous, reflexed, inflexed in Foeniculum, sometimes unequal, imbricate or valvate aestivation

Androecium: Five, polyandrous, anthers dorsifixed, alternipetalous, inflexed in bud, superior

Gynoecium: Bicarpellary, superior, bilocular, axile placentation, inferior, ovary placed antero-posteriorly

Fruit: Schizocarpic cremocarp with two mericarps joined by carpophores

Seed: Copious endosperm, minute embryo

Common Examples

Coriandrum sativum (Coriander), Foeniculum vulgare (Fennel), Ferula asafetida (Hing), etc.

FAMILY: RANUNCULACEAE

Systematic Position

Division: Spermatophyta
Sub-Division: Angiospermae
Class: Dicotyledonae
Subclass: Polypetalae
Series: Thalamiflorae
Order: Ranales
Family: Ranunculaceae

Distribution

This family is commonly known as buttercup or crowfoot family. It includes about 35 genera and 1500 species. Plants are cosmopolitan in distribution but flourish well in temperate climate. There are around 163 species found in India.

Characteristic Features

Habit: Plants are predominantly herbs, annual, rarely shrubs or vines (Clematis), hydrophyte (*Ranunculus aquatilis*), tree (*Paeonia*)

Root: Tap or adventitious, sometimes tuberous (*Paeonia*, *Aconitum*)

Stem: Mostly herbaceous aerial and annual, in some perennials it is an underground sympodial rhizome (*Anemone*), climbing (*Clematis*)

Leaves: Usually alternate, simple to divided to palmately- compound, usually exstipulate, petiolate, hairy, reticulate venation

Inflorescence: Solitary terminal or axillary, sometimes cymose or raceme

Flower: Pedicellate, ebracteate, rarely bracteates (Clematis), bisexual (unisexual in *Thalictrum*)

Calyx: 3 to several, polypetalous, imbricate, inferior

Corolla: Usually 5 or more, polypetalous, imbricate, nectaries in *Ranunculus*. In *Delphinium*, the sepals and petals are extended into conspicuous spurs

Androecium: Stamens numerous, free, spirally arranged on the thalamus, anthers adnate, dehiscing by longitudinal

Gynoecium: Carpels usually many, free, rarely united, superior, ovules one or more on pendulous or erect, marginal or basal placentation, stigma one, style one

Fruit: Achene, follicle, or berry (rarely capsule)

Seed: Small containing copious oily endospermic

Common Examples

Ranunculus (Buttercup), *Delphinium* (Larkspur), *Anemone* (Wind-flower), *Clematis* (Virgins bower), *Aconitum*