

# PHARMACOGNOSY

## Principles of Classification of Plants

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### Keywords

Classification, Pharmacognosy, Rhodophyceae, Eumycetes, Pinaceae, Gnetaceae, Angiosperms, Distribution, Morphological Characters, Chemical Constituents, Medicinal Significance.

## **Introduction**

Man and Animals depend on the plants for their very existence. Our environment is characterized by richly diversified plant life. Plant diversity is composed of more than 500,000 botanical species. The green scum and the duckweed on surface of some ponds, the lichens, fungi, liverworts, mosses, ferns, conifers and the flowering plants are the representatives of the plant diversity.

Worldwide, drugs derived from various organisms continue to be significant for the treatment and prevention of diseases.

**Pharmacognosy** is the study of medicinal products obtained from our living environment. This includes: plants, animals, insects and microbes of both terrestrial and marine origin. Some medicinal products are also derived from mineral sources.

Pharmacognosy may also be defined as science of nature-derived pharmaceuticals and poisons.

Pharmacognosy is an established basic pharmaceutical science. This subject has changed considerably, from being largely descriptive botanical and mycological field to having more of chemical and biological focus. It has also evolved to include phytotherapy and nutraceuticals.

## **Need to Classify Drugs**

Classification is a prerequisite to study the various aspects of the plant diversity. The main aim of classification is to study the origin of plants and their evolution from a simpler to advanced form over a period of time, in other words to investigate the phylogenetic relationships of plants.

An attempt to classify the plants has led to the development of various fields like Taxonomy and Systematics. The terms such as classification, taxonomy and systematics are inter-related. G Simpson (1961) relates classification as arranging of organisms into groups, and taxonomy as the study of principles and procedures of classification. He explains systematics as the study of comparative and evolutionary relationships of plants, based on their comparative anatomy, physiology, and biochemistry.

**Systematics** is an important tool in Pharmacognostical practice and research. This is due to the fact that related families often contain similar type of compounds. The systematic position of a particular plant helps to have an idea about the probable presence of secondary metabolites in it. For example, many members of Family Umbellifereae contain volatile oils.

## **Units of Classification**

Taxonomy is the science of naming the organisms. This is based on the study of morphological variation of organisms, and to investigate the cause of this variation. That is to integrate a particular organism into the current system of nomenclature by manipulating the data so obtained.

A taxon (pl. taxa), stands for any named taxonomic unit such as a phylum, a family or a species. It is used to indicate the rank of a group as well as the organisms contained within that group.

A series of hierarchical categories are structured to understand the diversity of plants.

The categories which represent the natural relationship between all the taxa are: Species, Genus, Family, Order, Class, Phylum, Subphylum, Division and Kingdom.

**Species:** A species is a group of individuals, characterized by: morphologically and functionally similar members; able to inbreed freely and true to type; have 2n chromosomes in somatic cells and n chromosomes in reproductive cells.

**Varieties:** Sometimes, individuals of a species show variation in form, size, shape and color under the influence of environmental factors. These individuals are said to form varieties.

**Genus:** A genus is a collection of species bearing a close resemblance to each other in terms of morphological and reproductive characters.

**Family:** A family is a group of genera have general structural resemblance in their floral organs.

### Nomenclature

The system of designating a plant with a name consisting of two parts is known as binomial nomenclature. Carl von Linnaeus (Linne), Swedish Botanist (1707-1778) developed the binomial nomenclature. It was accepted by the International Botanical Congress held in Amsterdam in 1935.

**Significance of Taxonomy :** The naming of plants and understanding of the species' relationship to other species is essential for biologists, and people working in the field of agriculture, forestry, pharmacognosy, phytochemistry and industry. This forms the basis of correct identification and authentication of the crude drug. Correctly identified drug will lead to phytopharmacological studies and development of novel drugs.

### Example of Botanical Classification: *Cuminum cyminum* Linn. (L.)

The above name indicates the genus (*Cuminum*) and species (*cyminum*) followed by the authority- Linn. represents the botanist who provided the first scientific description of the species and assigned the botanical name. In this case it is Carl von Linnaeus (Linne).

**Species:** *cyminum*

**Genus:** *Cuminum*

**Family:** Umbelliferae

**Class:** Magnoliopsida

**Subphylum:** Magnoliophytina (seed bearing plants with covered seeds)

**Division (Phylum):** Spermatophyta (seed bearing plants)

**Kingdom:** Plantae (plants)

**Special Case:** *Aloe vera* (L.) Burm. f.

The name in parentheses indicates the botanist Linnaeus. He first described the species but assigned it to a different genus. The second name, Burm. f., stands for botanist Nicolaas Laurens Burman; f. stands for filius (son), he is the son of another well known botanist.

### Classification of the Plant Kingdom

The basic classification of the plant kingdom includes the following main groups:

1. Thallophytes include: Bacteria, Algae, Fungi and Lichens.
2. Bryophytes
3. Pteridophytes
4. Gymnosperms
5. Angiosperms

The present chapter will focus on the following families of pharmaceutical interest.

**Thallophyta:** the body is undifferentiated into root, stem or leaf. This group is nearest to beginning of the plant kingdom.

### **Algae**

Algae are green thallophytes that contain chlorophyll. In many Algae, other pigments like, brown, red, blue-green are also present besides chlorophyll. The body of algae is composed of true parenchymatous tissue and the cell wall is composed of true cellulose. Reserve carbohydrate in algae is present in the form of starch. Reproduction takes place vegetatively by cell division.

The commercially important algae are limited to the diatoms and marine forms of brown and red algae. The Kelps and Rockweeds (brown algae) are the most important source of iodine and are also harvested for their potash content as a fertilizer.

Agar and Alginic acid (red algae) because of their abundant mucilage content are used as demulcents and nutritives.

### **Rhodophyceae**

The group is represented largely by marine algae and few fresh water forms. Marine red algae are beautiful plants and are found at great depths. The plant body is unicellular, filamentous and membranous. Their plastids contain *chlorophyll a* along with phycoerythrin, a red pigment, present in large amounts and phycocyanin, and the blue pigment of Cyanophyceae. The storage product Floridean starch, an amylopectin stains red with iodine.

Gelatinous material is abundant in red algae, present within the thallus or forms a sheath in the filamentous form. Few forms are incrustated with lime. Rhodophyceae is the most highly specialized group of Algae.

Agar and Alginic acid, two important members of the family are discussed below:

#### **(i) Agar**

**Synonyms:** Agar-agar, Vegetable Gelatin, Japanese or Chinese Gelatin, Japanese Isinglass.

**Biological Source:** It is the dried colloidal concentrate prepared from the decoction of various species of the genus *Gelidium*, family Gelidaceae. The genus *Gelidium* provides about 35% of the total raw material. Japanese agar is obtained from *Gelidium amansii*.

It is also obtained from genus *Gracilaria*, family Gracilariaceae. Other Geographical Sources include Korea, South Africa, Atlantic and Pacific Coasts of the USA, Chile, Spain and Portugal. More than 6500 tonnes of agar is produced annually.

**Collection and Preparation:** In the coastal area of Japan, the algae are cultivated in special areas. The poles are planted in the sea to form supports for the development of algae. The poles are withdrawn from time to time and the algae are stripped off in the months from May to October. The algae are dried, beaten and shaken to remove any earthy material adhering to it. It is then bleached by watering and drying in the sun. The algae are then boiled with acidulated water for several hours. A mucilaginous decoction is formed, which is filtered

while hot through a linen cloth. On cooling, a jelly is produced which is cut into bars and subsequently strips are produced.

The manufacturing of agar takes place only in winter season. The moisture is removed by freezing, thawing and drying at about 35 ° C.

**Morphological Characters:**

**Form:** occurs in two forms: 1) Coarse powder or flakes 2) bundles of translucent, and crumpled, strips, 2-5mm wide.

**Color:** colorless to pale yellow.

**Fracture:** Tough when damp and brittle when dry.

**Odor:** not distinct

**Taste:** mucilaginous

**Chemical Constituents:** It is a heterogeneous polysaccharide composed of two principal constituents: agarose and agarpectin. Agarose represents the gel strength and agarpectin is responsible for the viscosity of the agar solutions.

**Uses:**

- The gels of pure agarose are used for the electrophoresis of proteins.
- Agar is used for the preparation of culture media
- It is used as an emulsifying agent
- In the treatment of constipation
- Used in affinity chromatography

**Physical Characteristics:**

Solubility:

Cold water: does not dissolve but swells to a gelatinous mass

Boiling water: dissolves and 1% solution gives a stiff jelly on cooling

**Chemical Tests:**

1. Warm a small quantity of drug with caustic potash solution, a canary-yellow color is produced.
2. To 5ml of 0.5% solution of drug in water, add 0.5ml of HCl and heat on a water bath for about 30 min. neutralize the solution and divide it into two portions. To one portion, add Fehling's solution and heat on a water bath, a red precipitate is formed. To other portion, add solution of BaCl<sub>2</sub>. A slight, white precipitate is formed (tragacanth gives no precipitate) (on hydrolyzing, galactose and sulphate ions are produced, former reducing Fehling's solution and the latter precipitating with BaCl<sub>2</sub>)
3. Moisten the drug with N/50 iodine solution, a deep crimson color is produced (distinction from Acacia and Tragacanth)
4. Moisten the drug with a solution of Ruthenium red, a pink color is produced.
5. Heat a little drug in a test tube with soda-lime. Test the vapours with litmus paper, no alkaline reaction (since no ammonia is produced)
6. Warm a little drug with acetic acid, solution occurs on prolonged heating.
7. Dissolve 0.2 g of the drug in 40ml of hot water. Divide the solution in three parts and treat it as follows:
  - a. Add a few drops of 10% solution of tannic acid. A white precipitate in the cold and on boiling, an opalescence is produced.
  - b. Add a few drops of Millon's reagent. No white precipitate is produced.

- c. Add excess of saturated solution of trinitrophenol. No yellow precipitate is formed.

**Note:** Tests 4-6 differentiate it from gelatin

**Adulterants:**

- The powdered drug is adulterated with starch.
- Mount the drug in chloral-iodine solution and observe the starch grains.

**Note:** Agar BP is required to comply for the absence of *Escherichia coli* and *Salmonella*.

The general microbial contamination should not exceed a level of  $10^3$  microorganisms/ gram by a plate count.

**(ii)Alginic Acid**

**Biological Source:** It is prepared from large quantities of brown seaweeds (Phaeophyceae). Species of *Laminaria* and *Fucus* are commonly used for the preparation of alginic acid. The main producers of alginic acid are: USA, Chile, China, Canada, Irish Republic, Australia, Iceland, UK and South Africa.

**Method of Preparation:** Large quantities of seaweed are collected from colder waters of the world. They are dried and washed with faintly acidulated water to remove the salt content. They are then chopped and bruised in a hammer mill. The dried milled seaweed is macerated with dilute sodium carbonate solution and diluted with sufficient soft water to separate the insoluble material. Soft water is added to avoid the precipitation of insoluble alginates. The resulting clear liquid is poured into dilute sulphuric acid as a result the insoluble alginic acid is precipitated as a bulky, heavily hydrated gel. The liquid is removed from the gel by expeller presses.

**Chemical Constituents:** It is composed of residues of D-mannuronic and L-galuronic acids.

**Physical Characteristics:**

Solubility: cold water: insoluble but swells and absorbs many times its own water.

Hot water: slightly soluble

Organic Solvents: insoluble

**Uses:**

Used as a tablet disintegrating agent

In the textile industry

**Fungi**

Fungi are thallophytes, lacking in chlorophyll. They have infinite variety of shapes and sizes. The carbohydrate food is stored in the form of glycogen and not starch. They closely resemble the algae (not blue-green algae) and other green plants in their nuclear organization. The plant bodies of fungi are the simplest in the plant kingdom, being either unicellular or filamentous. In the latter case, the plant body is called mycelium and the individual filaments are called hyphae. The cell walls of most fungi contain chitin, others contain cellulose and polysaccharides.

Some fungi develop absorptive branches, called rhizoids in saprophytic species and haustoria in parasitic species.

In some species like mushrooms (toadstools), puffballs and shelf fungi, the vegetative mycelium is the 'fruiting body', which arises in some of the sac and club fungi. The fruiting

body of a fungus has been preceded by an extensive vegetative mycelium that has grown for months or years.

Fungi are classified in five major classes:

- Myxomycetes or slime fungi
- Phycomycetes or alga-like fungi
- Ascomycetes or sac fungi
- Basidiomycetes or club fungi
- Deuteromycetes or imperfect fungi

The following drugs are of pharmaceutical interest:

### **Ergot**

It is an important member of the class Ascomycetes.

**Synonyms:** Ergota, Ergot of Rye

**Biological Source:** It is the dried sclerotium of a fungus, *Claviceps purpurea* Tulasne, Family Hypocreaceae (Clavicipitaceae), arising in the ovary of the rye plant, *Secale cereale* Linn., Family Gramineae.

The main source of the crude drug is the controlled field cultivation of rye plant. The chief producers are: Czechoslovakia, Hungary, Switzerland and Yugoslavia. Commercially, ergot of wheat is becoming more important (90% in UK).

**Life history of the Fungus:** In the spring or early summer (flowering stage), the ovary of rye plants get infected by the ascospores of the fungus. During damp weather, the spores germinate at the base of the ovary, forming filamentous hyphae which enter the wall of the ovary by an enzymatic action and form a soft, white mass over its surface. This stage is called 'sphacelia', it produces a yellowish, reducing saccharine secretion, 'honey dew'. Insects are attracted by the secretion and carry away the spores to other rye plants which become infected with the disease. As the development of the hyphae proceeds, they penetrate deeper and deeper, feeding on the ovarian tissue and finally replacing it by a compact tissue called as pseudoparenchyma. This forms the sclerotium or the resting stage of the fungus. In the summer, as the rye ripens, a dense core of compact hyphae develops in the diseased ovary and projects from the ear of the rye, bearing at its apex the pale coloured remains of the sphacelia. This compact, hard structure is dark purplish-brown in colour and is known as the sclerotium. The sclerotia falls along with the ripened rye grains falls on the ground and remain in the ground through out winter. In the following spring, the sclerotium germinates and forms several cylindrical stalks or stromata (10-20mm long). The apex of each stroma swells into a spherical head (2mm in diameter), in which are embedded numerous flask shaped cavities, perithecia. Each perithecium contains numerous elongated asci (sporangia), each contains eight filiform ascospores. The ascospores escape from the pore in the apex of the ascus, fall on the ground and develop into small branching threads, which in turn abstricts small spores. These small pores are carried by the wind to the ovaries of new crop of rye, at their flowering stage.

**Cultivation and collection:** The number and size of the sclerotia varies on each spike of rye. The number of sclerotia produced on rye is usually more than that produced on wheat. Ergots are cultivated successfully by spraying the culture of spores on the rye crops during their flowering season. ]

The ergots are picked by hand or separating from the rye after threshing the crop. This separation is effected by use of special machines. Sometimes the grain is thrown into a 20-30% solution of common salt, whereby the ergots float and the rye sinks.

**Macroscopical characters:**

**Form:** thick, fusiform or sub-cylindrical with tapering ends, three sided with a shallow groove along each face.

**Color:** externally dark-purple to nearly black

**Fracture:** short and the exposed surface is white or pinkish, showing few darker lines radiating from the centre, the outer margin is purplish-violet.

**Taste:** unpleasant

**Odor:** disagreeable and faint.

**Microscopical Characters:** The pseudoparenchyma consists of oval or rounded cells containing fixed oil and protein. It is marked by an outer zone of obliterated purplish-brown rectangular cells. Cellulose and lignin are absent.

**Chemical Constituents:** The ergotalkaloids (ergolines) the percentage (.01-0.25%) varies according to the geographical source. These are of two types: the clavine-type and the lysergic acid derivatives. The lysergic acid derivatives are pharmacologically active alkaloids. Each active alkaloid is associated with an inactive isomer involving isolysergic acid.

Six pairs of alkaloids predominate in the sclerotium and are classified as water soluble (ergometrine or ergonovine) and water insoluble (ergotamine or ergotoxine).

**Uses:** Ergot has been replaced by the isolated alkaloids. Ergometrine produces oxytocic effect; Ergotamine and the semisynthetic dihydroergotamine salts are used as analgesics for the treatment of migraine; Lysergic acid diethylamide (LSD-25), prepared from lysergic acid is used as a psychotomimetic.

**Storage:** Ergot should be dried after collection, kept entire and stored in a cool, dry place, as it is liable to be attacked by insects, moulds and bacteria. If required in a powdered form, it should be immediately defatted; else it will lose its activity.

**Yeast**

**Biological Source:** It consists of unicellular fungi, genus *Saccharomyces*, family Saccharomycetaceae. The species used in industry are: *S. cerevisiae*, *S. carlsbergensis* and *S. monacensis*.

**Cultivation and Preparation:** It is grown in brewers' medium at 20-25 degree centigrade. It multiplies rapidly by germination or budding. The yeast is skimmed off from the surface, washed in water and the liquor is passed through sieves, after several washings the yeast is allowed to settle and removed by filter presses.

**Morphological Characters:** consists of rounded or ovoid cells, occurring singly or in short straight or branched chains; the cells are colourless (4-7-9 microns in diameter).



**Chemical Constituents:** contains about 73% of moisture, 13% proteins (partly free and partly combined with nucleic acid) and 0.27% of oil. It contains enzymes like invertase, maltase, diastase and zymase. It also contains vitamins of the Vitamin B complex.

**Uses:** It is a chief source of Vitamin B complex.

## **Mushrooms**

Mushrooms, the edible and poisonous species are saprophytes, generally called as 'toadstools', as they depend on wood and soils rich in organic matter. The mushroom is a basidiocarp (fruiting body) of the organism. It is built up by complicated interwoven hyphae of the filamentous mycelium. The mushroom cap bears gills on its lower surface. The gills produce the basidia and basidiospores and are also composed of interwoven hyphae. Mushrooms have two additional features of special interest:

Bioluminescence and hallucinogenic properties of some species. The mycelium of some species is luminescent, mediated by the enzyme luciferase in the presence of luciferin as substrate.

### **Types of mushrooms:**

**Edible Mushrooms:** There are about 200 species of edible mushrooms available. *Agaricus bisporus* is the common edible mushroom. It is grown commercially from spawn, a mass of soil, manure and rotting leaves that contains the mycelium of the fungus. Other common edible species are: *Agaricus campestris*, *Morchella esculenta*, and *Volvaria terastria*.

**Poisonous Mushrooms:** It is very difficult to distinguish between edible and poisonous mushrooms. On the basis of experience, there are some observations, which may help to identify the poisonous mushrooms: bright color, pink spores, a hot burning taste or acidic flavor, growing on wooden pieces in hidden places, difficult to break and bear a cup like structure (volva) at the base.

Some of the poisonous mushrooms when taken orally produce hallucinations. These include toadstools of the genera *Amanita*, *Psilocybe* and *Conocybe*.

Since it is difficult to distinguish poisonous mushrooms on the basis of morphological characters, they are classified on a physiologic basis that is according to the symptoms produced by them following ingestion:

### **Protoplasmic poisons:**

**Amanita Toxins:** It is a mixture of peptide toxins and was first detected in *Amanita* species. Genus *Amanita* is characterized by: white spores, presence of both annulus and volva and free gills.

Some species of genus *Galerina* also contain peptide toxins. These are characterized by small non – descript carpophores with yellowish brown spores. They often occur in lawns and grassy areas.

Poisoning of amanita toxins is characterized by a long latent period between ingestion and onset of symptoms; asymptomatic latent period lasting up to 24 hours precedes violent diarrhea and vomiting which may cause death. If the patient survives this initial period, the

progressive injury to the liver, kidneys, heart and skeletal muscles continues and death results in 50% of the cases within 2-5 days.

The treatment includes: removal of the toxic material from the GIT, followed by symptomatic and supportive therapy. No antidote is sufficiently established till date.

**Gyromitrin:** The toxic principle is N-methyl-N-formylhydrazine of acetaldehyde. *Helvella esculenta* (*Gyromitra esculenta* Fries), *Helvella gigas* Krombholz and *Helvella underwoodii* Seaver are some of the species representing this class. This genus is characterized by pileus surface (nearly smooth to strongly convoluted).

Poisoning of gyromitrin is characterized by its toxic effect on liver. The hematopoietic and the central nervous system is also effected. A minimum latent period of 6-10 hours is observed between onset of symptoms and ingestion of the drug. The treatment is similar to that given in poisoning caused by *Amanita* toxins. The mortality rate ranges between 2-4%.

**Orellanine:** Orellanine is the toxic principle and species of *Cortinarius* (*C. orellanus* Fries) represents this class. This genus is characterized by brownish to reddish brown spores. Orellanine poisoning is characterized by an extremely long latent period (3-14 days). An intense burning thirst is followed by GIT disturbances, headache, pain in the limbs, spasms and loss of consciousness. Severe poisoning may lead to kidney damage and death after several weeks. About 15% of the cases have proved fatal. Symptomatic and supportive treatment with specific maintenance of kidney function is recommended.

#### **Compounds exerting Neurologic effects:**

**Muscarine:** Muscarine is the toxic principle and species of genus *Amanita muscaria* (Fries) Hooker and *A. pantherina* (Fries) represents this class. Muscarine is also found in species of *Boletus*, *Clitocybe*, *Lepiota*, *Hebeloma*, *Inocybe* and *Russula*. *Clitocybe* and *Inocybe* contain high concentration of muscarine (3% of dry weight). *Clitocybe* is recognized by white spores, fleshy central stripes, broadly adnate to decurrent gills. *Inocybe* is recognized by its subconic to campanulate pileus and brownish spores. Muscarine poisoning is characterised by increased salivation, perspiration and lacrimation within 15-30 minutes. These symptoms are followed by abdominal pain, severe nausea and diarrhea. Though the patient's mental condition is stable, his pulse is slowed down, heavy breathing and the pupil is constricted. The cardiac and respiratory failure leads to death, which is rare. Treatment involves gastric lavage and administration of a specific antidote atropine.

**Ibotenic acid-Muscimol:** Muscimol and ibotenic acid are the toxic principles. Muscimol is five times as active as ibotenic acid. *Amanita muscaria* (fly agaric) and *A. pantherina* represents this class. The poisoning is characterized by an initial state of excitement, followed by muscular twitching, depression and loss of consciousness within 1-2 hours. Death is rare and treatment involves mild depressants followed by stimulants and the recovery is rapid.

**Psilocybin:** The toxic principle is 2 tryptamine derivatives, psilocybin and psilocin. Species of *Psilocybe* and *Conocybe* represents this class. The genus is characterized by the presence of bluish stains near the base of stipe, when the tissue is damaged or becomes aged. Psilocybin poisoning develops rapidly and leads to anxiety and difficulty in concentration and comprehension. It lasts for several hours and true hallucinations may be experienced. Recovery is spontaneous and complete after 5-10 hours.

**Gastrointestinal irritants:** Toxic principles are resin like substances. *Boletus satanas* Lenz. *Lactarius torminosus* (Fries) Gray, *Russula emetica* (Fries) SF Gray are some of the species representing this class. Symptoms of the poisoning are quick and include nausea, vomiting and diarrhoea. It is fatal among children. Treatment includes symptomatic care, bed rest and light diet. Generally, recovery is spontaneous and complete.

**Disulfiramlike Constituents:** Toxic principles are the constituents resembling disulfiram like or cyanamide. *Coprinus atramentarius* (Fries) and the subsequent ingestion of alcohol represent this class. This species is recognized by black spores, smooth or minutely scaly grayish pileus and free gills that deliquesce into a dark colored fluid as the spores are discharged. Poisoning symptoms include: flushing, palpitations, dysopnea, hyperventilation and tachycardia. Treatment includes gastric lavage and symptomatic care. Recovery is spontaneous and complete.

## **Gymnosperms**

The phanerogams, seed producing plants are of two types: angiosperms, or flowering plants and Gymnosperms. The family consists of 750 species, out of which more than 50 species occur in India. In gymnosperms, the seeds develop on the surface or at the tip of an appendage- ovuliferous scale or peduncle. The seed bearing structures of gymnosperms may occur in cones or strobili. These structures hide the seeds from the view by the grouping and overlapping of these structures. They do not enclose the seeds.

Gymnosperms may be woody trees, shrubs, or vines, for example, pine, hemlock, fir, *Ginkgo biloba*. In woody plants, the vascular cambium adds annual increments of secondary xylem or wood. Stems of herbaceous plants are green and soft because very little secondary xylem is added by the vascular cambium.

Gymnosperms include divisions: Cycadophyta, Ginkgophyta, Coniferophyta and Gnetophyta.

**Coniferophyta:** Extensive forests are formed by Pines and associated conifers. They are the rich source of wood pulp for the manufacture of paper and coniferous gums and resins. There are numerous canals within the leaves and throughout the plant, filled with resin. Pine leaves are known as needles and have little surface area. The stems and roots of pine contain active, vascular cambial layers that add secondary xylem, increasing the woodiness and diameter of the axis. The wood largely consists of conducting cells, tracheids and associated living parenchyma cells. Internally, the leaves are covered by a heavily cutinized epidermis with sunken stomata and a hypodermis. Resin canals occur in the mesophyll. A prominent endodermis surrounds the vascular tissue, may be in one or two groups, depending on the species.

**Genetophyta:** This division includes three genera: *Ephedra*, *Gnetum* and *Welwitschia*. These are restricted in distribution and not widely cultivated.

## **1. Pinaceae**

**Distribution:** The family consists of 9 genera and 230 species. It is widely distributed in north temperate regions of the world. They are frost and drought resistant plants which form large tree or shrub dominated zones of vegetation. It is also called pine family or coniferae.

**Identifying Morphological Characters of the family:** Leaves are needle shaped and linear (pine needles), usually evergreen. Flowers are separate and monoecious. The cones are small and herbaceous. They produce large amount of pollen, carried away by wind. The female cones are woody with spirally arranged scales, two winged wind-distributed seeds per scale are present.

**Chemical Constituents of the family:** Essential oils and balsams are the main constituents of pharmaceutical interest. Monoterpenoids (alpha pinene and borneol) are the main constituents of essential oils and balsams. Flavonoids, condensed tannins and lignans are widely present in the members of this family.

**Important Medicinal Plants of the family:**

**Turpentine:** manufacture of fragrances, flavours and insecticides

**Colophony:** residue left after the distillation of the oil of turpentine from the crude oleo resin of various species of *Pinus*; stimulant and diuretic.

## 2. Genetaceae

Genetaceae is an important family of the order *Gnetales*. The *Gnetales* have reached the highest degree of evolution among the Gymnosperms. They bear a close resemblance to Angiosperms. Gnetaceae is represented by a single genus *Gnetum*.

## Angiosperms

Angiosperms (Magnoliophyta): The angiosperms include more than 250,000 species. These are the fruit bearing plants (seed is covered by closed carpels) and include herbs, shrubs and trees. The phylum is divided into monocotyledons and dicotyledons.

This section of the chapter will highlight the pharmaceutically important families. In other words, the families producing medicinally important crude drugs.

## 1. Apocynaceae

**Distribution:** A family of about 250 genera and 2000 species, out of which 67 species are available in India. Most of the members are woody climbers and are natives of tropical and sub-tropical region.

**Identifying Morphological Characters of the family:** These are mostly twining or erect shrubs, a few herbs and trees with latex; leaves are simple, opposite or whorled, rarely alternate; flowers are regular, bisexual and hypogynous, in cymes, funnel shaped, often with corolla; sepals are 5, rarely 4, gamosepalous and often united only at the base; 5 petals, rarely 4, gamopetalous and twisted; 5 stamens, rarely 4, epipetalous, alternating with the petals, included within the corolla tube; carpels are 2 or (2), apocarpous or syncarpous, superior; Fruits are a pair of follicles, berries or drupes; seeds are flattened and often have a crown of long silky hairs.

It is closely related to Asclepiadaceae

**Floral Formula:** ♂<sup>K</sup> (5) <sup>C</sup> (5) <sup>A</sup> (5) <sup>G</sup> 2 or (2)

**Main Chemical Constituents of the family:** The family is a rich source of indoline alkaloids; steroidal alkaloids and cardioactive glycosides. The other constituents are cyanogenetic glycosides, saponins, tannins, coumarins, phenolic acids and triterpenoids.

**Important Medicinal Plants of the family:**

*Alstonia scholarasis*: cardioactive

*Catharanthus roseus*: anticancer

*Holarrhena antidysenterica*: bitter and antidysenteric

*Nerium* (Olender): cardioactive

*Rauwolfia serpentina*: management of essential hypertension

*Strophanthus kombe*: diuretic

*Thevetia nererifolia* (yellow oleander): cardioactive



Fig.1. Floral diagram of *Apocynaceae*



Fig.4. Floral diagram of *Cruciferae*

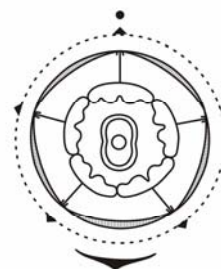


Fig.2. Floral diagram of *Compositae* (disc floret)

## 2. Cruciferae

**Distribution:** A family of about 375 genera and about 3200 species out of which 174 species are available in India. Distributed in temperate regions

**Identifying Morphological Characters of the family:** Commonly known as Mustard family; annual herbs; leaves are alternate, simple, rarely compound, exstipulate, entire, or toothed, often more or less hairy; inflorescence at first is a corymbs or shortened raceme, later elongating into a loose raceme; flowers are regular-rarely irregular (candytuft), and tetramerous; sepals 4, green, equal or the 2 laterals may be pouched as nectar receptacles; petals 4, yellow to white, pink or purple and arranged in the form of a cross; stamens tetradynamous, hypogymous; pistil, syncarpous, bicarpellate; superior; carpels lateral; fruit is a capsule (silique) that bursts lengthwise by two valves; seeds remain attached to a wiry frame work, called the replum which surrounds the fruit.

**Floral formula:**  $\sigma^K 2+2^C 4^A 2+4^G (2)$

**Chemical Constituents of the family:** Many members contain mustard-oil glycosides. Cardiac glycosides are present in some genera. Seeds usually contain mucilage and fixed oil.

**Important Medicinal Plants of the family:** The members of this family are rich source of fixed oils and condiments; rubefacient and counter-irritant. e.g. *Brassica campestris* (mustard), *B alba* (white mustard), *B nigra* (black mustard), *B napus* (Indian rape)

## 3. Compositae

**Distribution:** The family contains about 900 genera and more than 21000 species, out of which 674 species are available in India. It is also known as Asteraceae or Daisy family. It is distributed in all parts of the world, except Antarctica. It is widely distributed in Central America and Mexico.

**Identifying Morphological Characters of the family:** All the members of the family have a complex inflorescence (the capitula) gave rise to the older name of the family compositae (inflorescence composed of many flowers). Herbs, rarely shrubs or trees of annual or perennial habit, and with watery or milky juice; Leaves alternate, rarely opposite, simple to compound, estipulate; Inflorescence a capitulum or a raceme of capitula, each capitulum surrounded by an involucre or protective whorl of bracts, and composed of numerous florets that may be: (a) wholly regular tubular and hermaphrodite (thistle) or (b) central florets as in (a) but marginals strap-shaped or ligulate and usually pistillate (Daisy, Dahlia); or (c) florets all ligulate and hermaphrodite (chicory); or (d) florets in part or in whole bilabiate (Mutisia). Flowers small (florets), closely crowded, pentamerous shaped as above, with ovary inferior and other floral parts superior. Sepals rudimentary, tooth like (sunflower), or reduced to a papose or hairy rudiment above ovary that is functionless during flowering, but that expands in fruit as a hairy fruit disseminator (thistle); or sepals wholly absorbed (Daisy). Petals synpetalous, tubular, ligulate or rarely bilabiate, greenish-yellow to white, or through pink-crimson and purple to blue (chicory). Stamens five, epipetalous; Carpels two, syncarpous; Fruit an indehiscent achene, often (thistle) crowned by the papose, calyx rudiment (pappus) seed single. The ray florets are zygomorphic, ligulate, unisexual (female), or sometimes neuter, as in sunflower, and epigynous, each usually in the axil of a bracteole calyx is usually modified into pappus; corolla has (5) petals, gamopetalous and lingulate (strap-shaped); gynoecium and fruit are similar to disc floret.

**Floral Formula:** ♂<sup>K</sup> pappus or O<sup>C</sup> (5)<sup>G</sup> (2)

**Chemical Constituents of the family:** A characteristic feature of the family is the storage of carbohydrate in the form of inulin; sesquiterpene lactones; polyacetylenic compounds and essential oils; alkaloids of pyridine, quinoline, diterpenoid and pyrrolizidine group in small amounts; diterpene glycoside.

**Important Medicinal Plants of the family:** It includes plants having antitumour or antibacterial activity. Some members are also commercial sources of rubber latex.

*Chrysanthemum cinerarifolium*: insecticide

*Artemisia cina*: anthelmintic

*Artemisia annua*: antimalarial

*Artemisia absinthium*: bitter tonic and choleric

*Calendula officinalis*: topical use for skin infections

*Arnica montana*: externally in hair preparations and for bruises

*Echinacea angustifolia*: immunostimulant

*Stevia rebaudiana*: stevioside; sweetener for soft drinks.

*Chicory intybus*: hepatoprotective

#### 4. Convolvulaceae

**Distribution:** A family of about 55 genera and 1650 species, out of which 157 species occur in India. Also called as Morning Glory family.

**Identifying Morphological Characters of the family:** Herbaceous more rarely sub woody to woody, perennial climbing plants with underground parts sometimes swollen into tuberous roots (Jalap, sweet potato); stems rarely short, upright or tufted, usually elongate and circumnating in action; leaves alternate, simple, estipulate, varying from cordate to cordate-

sagittal, to broad reniform to reniform, palmately – lobed to palmatifid to palmately – compound (*Ipomoea*); stems and leaves frequently contain a dull, viscous, watery to milky-white juice; inflorescence is cymose; flowers are regular, bisexual, hypogynous, often large and showy; flowers pentamerous; sepals five, green, gamosepalous; corolla varying in shape from rotate to funnel-like with expanded mouth, in color from greenish-yellow to white or through yellowish-pink to scarlet, crimson, purple or blue, stamens five; Fruit usually a capsule, rarely a berry.

It is related to Solanaceae by virtue of its persistent calyx, regular gamopetalous corolla, 5 epipetalous stamens, often false septum in the ovary, bicollateral vascular bundles. But it is distinguished from Solanaceae by the fact that it has a definite number (1 or 2) of ovules in each chamber of the ovary, the micropyle points downwards, median carpels.

**Floral Formula:**  $\text{♂}^{\text{K}}(5)^{\text{C}}(5)^{\text{A}}(5)^{\text{G}}(2)$

**Chemical Constituents of the family:** It includes indole, isoquinoline, pyrrolidine and tropane and pyrrolizidine alkaloids. Purgative resins, phenolic acids and triterpenoid saponins are also reported in some species.

#### Important Medicinal Plants of the family:

*Ipomoea hederacea*: purgative

*Cuscuta reflexa*: as hypotensive and have bradycardiac effects

*Ipomoea purga*: strong purgative

*Argyreia speciosa*: roots in rheumatic affections and leaves in skin diseases and wounds



Fig.3. Floral diagram of *Convolvulaceae*

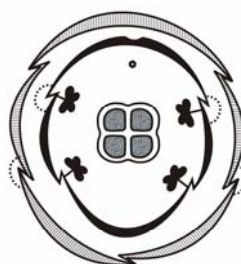


Fig.5. Floral diagram of *Labiatae*

## 5. Labiatae

**Distribution:** A family of about 200 genera and 3300 species, out of which 391 species are available in India. It is also known as Lamiaceae or Mint family. It is widely distributed in Mediterranean region to Central Asia.

**Identifying Morphological Characters of the family:** Herbs producing creeping runners that spread out and root at the nodes. Square Stems, rarely cylindrical in outline leaves opposite, decussate, mainly petiolate; leaf margin nearly always serrate, dentate or crenate. Stems and leaves further characterized by the presence of glandular hairs containing aromatic volatile oil. These hairs consist of a short one-celled stalk and a head (gland) of six or eight cells. Inflorescence a raceme or spike of verticillaster. Flowers typically pentamerous; five fused sepals, five zygomorphic petals, four or two stamens and two characteristic fused gynaecia. Fruit consisting of four nutlets, each with one seed.

**Floral Formula:**  $\text{♂}^{\text{K}}(5)^{\text{C}}(5)^{\text{A}}4^{\text{G}}(2)$

**Chemical Constituents of the family:** Volatile oils; menthol and thymol; other constituents include: diterpenoids and triterpenoids, saponins, polyphenols, tannins, iridoids and their glycosides and coumarins. Pyridine and pyrrolidine alkaloids are also present.

**Important Medicinal plants of the family:**

*Ocimum sanctum*: antipyretic, respiratory problems

*Mentha arvensis*: for respiratory problems

*Mentha piperita*: source of menthol; Flavouring, carminative

*Thymus vulgaris*: antispasmodic

*Rosemarinus officinalis*: carminative and spasmolytic

*Salvia officinalis*: topical antiseptic and orally as a carminative and spasmolytic

*Lavendula angustifolia*: carminative and spasmolytic

## 6. Leguminosae

**Distribution:**

The family contains 600 genera and 12000 species, out of which 951 are available in India. It is divided into three sub families: papilionaceae, mimosoideae, caesalpinoideae. Also called as pea or bean family

**Identifying Morphological characters of the family:** Herbs, shrub, trees, twiners or climbers; the roots of papilionaceae have tubercles; many contain nitrogen fixing bacteria in root nodules, which enables the availability of physiologically usable nitrogen. Leaves alternate, and pinnately compound, two, usually free, stipules. Flowers are bisexual and complete; Sepals 5 united, green, petals 5, with the odd one anterior. Stamens, 10 or more, free or united; one carpel; Fruit a legume or a pod.

**(i) Papilionaceae (Fabaceae):**

A subfamily with 11000 species of which 754 species are available in India. Distributed in tropical and temperate regions; herbs, shrubs or rarely trees. Leaves are pinnate and sometimes the terminal leaf is modified to form a tendril; Flowers papilionaceous (butterfly like shape); Inflorescence is racemose; five sepals united at the base; five petals with two lower petals fused and forming a keel-shaped structure, the two lateral ones protruding on both sides of flower and the largest petal extending above the flower; stamens ten, (9+1), forming a tubular structure. Fruit is a legume.

**Floral Formula:**  $\sigma^{\text{K}}(5) \text{ }^{\text{C}}(5) \text{ }^{\text{A}}(9) + 1 \text{ }^{\text{G}}1$

**Chemical Constituents of the family:** Flavonoids and tannins are common. Quinolizidine and pyrrolizidine alkaloids are specific to certain genera; Isoflavonoids, coumarins and saponins are other important phytoconstituents reported in many species. Lectins, high molecular weight sugar-binding proteins are present in the seeds of many species. Phasin from *Phaseolus* species is toxic to mammals.

**Important Medicinal Plants of the family:**

*Psoralea corylifolia*: various skin infections

*Glycine hispida*: source of proteins

*Mucuna pruriens*: Parkinsonism

*Arachis hypogea*: Fixed oil

*Astragalus gummifer*: demulscent, suspending and emulsifying agent

*Trigonella foenagræum*: source of steroids



*Tolu balsam*: cough mixtures and antiseptic

*Peru balsam*: antiseptic and expectorant

*Tragacanth*:

*Indigofera tinctoria*:

*Glycyrrhiza glabra*: expectorant

## (ii)Caesalpiniaceae

**Distribution:** Formerly part of Leguminosae (Fabaceae), about 110 species are available in India. Distributed in tropical region.

**Identifying Morphological Characters of the family:** Shrubs and trees, rarely climbers or herbs; leaves pinnate or bipinnate; inflorescence, raceme; flowers zygomorphic, resembles a shallow cup when seen from above; sepals 5, polysepalous, imbricate; petals 5, free. The odd one always innermost, aestivation imbricate; ten stamens, free, many taxa showing reduction in stamens (5) or development of staminodes instead of stamens.

**Floral Formula:**  $\sigma^{\text{K}} 5^{\text{C}} 5^{\text{A}} 10^{\text{G}} 1$

**Chemical constituents of the family:** Major ones are anthraquinones; diterpene alkaloids are also reported in some taxa.

### Important medicinal plants of the family:

*Cassia acutifolia*: Laxative

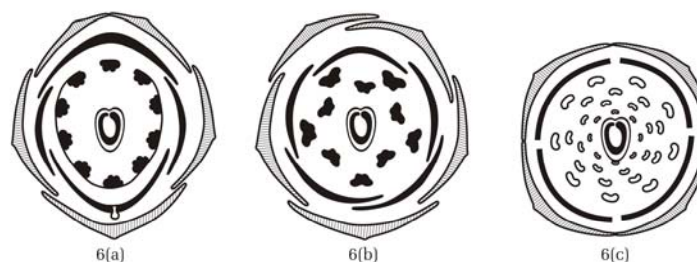
*Cassia angustifolia*: Laxative

*Caesalpinia sappan*: red dye

*Cassia tora*: Laxative

*Cassia occidentalis*: Laxative

*Cassia fistula*: Laxative



Floral diagram (three types) Fig.6(a). *Papilionaceae*; Fig.6(b). *Caesalpinieae*; Fig.6(c). *Mimoseae*

## (iii)Mimoseae

**Distribution:** The larger genera are: *Acacia* (800 species) and *Mimosa* (500 species). Distributed in the tropical region.

**Identifying Morphological characters of the family:** Most members are trees or shrubs; leaves usually bipinnate; Inflorescence head or a spike; Flowers regular, often small and aggregated in spherical heads; 5 or 4 sepals, generally gamosepalous, valvate, 5 or 4 petals, mostly gamopetalous, valvate; Stamens equal in number to the petals or twice as numerous; fruit legume.

**Floral Formula:**  $\sigma^{\text{K}} (5-4)^{\text{C}} (5-4)^{\text{A}} \square \text{ or } 10^{\text{G}} 1$

**Chemical constituents of the family:** Tannins and polysaccharides are common constituents of the family

**Important Medicinal Plants of the family:**

*Acacia senegal*: gums

*Acacia catechu*: astringent, tanning and dyeing industry

*Acacia farnesiana*: perfumery

*Albizzia lebbek*: timber tree

## 7. Rubiaceae

**Distribution:** A family of about 500 genera and 6000 species, out of which 489 species are available in India. It is called as Madder family; widely distributed in tropical and warmer regions.

**Identifying Morphological Characters of the family:** Herbs, shrubs, or trees with fibrous roots, sometimes annually enlarged (Ipecac). Leaves simple, opposite (decussate), entire and stipulate. Inflorescence cymose.; flowers bisexual and epigynous; sepals four to five gamosepalous. The calyx-tube adnates to the ovary; petals five to four, varying from shallow-rotate to elongate-tubular or funnel-shaped with stellate limbs; stamens five to four, epipetalous; two gynaecia; Fruit capsule, berry or drupe.

Rubiaceae is distantly related to compositae by virtue of the head or capitulum.

**Floral Formula:**  $\sigma^K (4-5)^C (4-5)^A (4-5)^G (2)$

**Chemical constituents of the family:** A large diversity in constituents; alkaloids indole, oxindole, quinoline and purine type are common; catechins; anthraquinones, di and triterpenoids; irridoid glycosides.

**Important Medicinal Plants of the family:**

*Cinchona ledgeriana*, *C calisaya*, *C officinalis*, *C succirubra*: antimalarial, bitter tonic and febrifuge

*Cephaelis ipecacuanha*: expectorant and emetic

*Uncaria gambier*: astringent, tanning and dyeing industry

*Coffea arabica*: stimulant

*Morinda citrifolia*: traditional drug, anthraquinones

## 8. Rutaceae

**Distribution:** The family consists of 150 genera and 1700 species, out of which 66 species are available in India. It is widely distributed all over the world, particularly tropical regions are rich sources of these plants.

**Identifying Morphological characters of the family:** It is also called as Rue and Citrus family; shrubs and trees. Stems upright, often wiry xerophytic, leaves are simple or compound, alternate or rarely opposite and gland-dotted. Flowers are regular, bisexual and hypogynous, varying in colour from yellow, white, pink to pink crimson. The disc below the ovary is prominent and ring or cap-like; 4 or 5 sepals free or connate below and imbricate. Petals 4 or 5, free, imbricate; stamens are twice as many as the petals or numerous, free or united in irregular bundles and inserted on the disc.

Carples 4 or 5, syncarpous or free at the base and united above, and either sessile or seated on the disc; Fruit capsule, hesperidium or berry. Many of the plants contain volatile oils in their secretory cavities. Membrane crystals and hesperidin are common.

Polyembryony is common in citrus fruits.

**Floral Formula:**  $\cdot \overset{\text{K}}{\underset{\text{C}}{\text{♂}}} 4-5 \overset{\text{A}}{\text{C}} 4-5 \overset{\text{G}}{\text{8}}, 10 \overset{\text{G}}{\text{(4,5)}}$

**Chemical Constituents of the family:** Essential oil is the common constituent of this family found in lysigenous secretory cavities in the parenchyma and pericarp. Furano and pyranocoumarins are the typical constituents of this family. Imidazole, acridone and benzyltetrahydroisoquinoline type of alkaloids have been reported. Many of the fruits are rich source of Vitamin C and citric acid.

#### Important Medicinal plants of the family:

*Citrus aurantium*: as food, flavouring agent

*Citrus limonia*: vitamin C

*Aegle marmelos*: immunomodulatory activity

*Ruta graveolens* : formerly used as emmenagogue and spasmolytic

*Pilocarpus jaborandi* : Pilocarpine, used in ophthalmology

*Murraya paniculata*: contraceptive



Fig.7. Floral diagrams of *Rubiaceae*



Fig.8. Floral diagram of *Rutaceae*

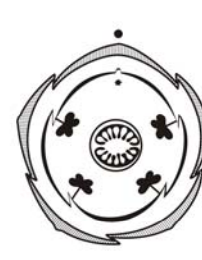


Fig.9. Floral diagram of *Scrophulariaceae*

## 9 Scrophulariaceae

**Distribution:** a family of 220 genera and 3000 species, out of which 258 species are available in India. It is also called as Figwort family.

**Identifying Morphological Characters of the family:** : Herbs or undershrubs, stems, branches and leaves usually green and independently vegetating, Stems cylindrical to frequently quadrangular, especially when leaves are opposite. Leaves alternate to opposite and decussate, simple, exstipulate, often hairy, reduced to scales (because of draught). Inflorescence a raceme of cymes or a simple raceme or spike or if leaves are opposite, often a whorl of axillary flowers or solitary axillary flowers.

Flowers mostly irregular, five sepals condensed through absorption of one sepal by fusion of two sepals; five to four petals, synpetalous, varying from rotate, to irregular tubular to elongate, irregular bilabiate to funnel-shaped; greenish to greenish yellow or white to pure white or from red to purple to blue. Stamens, 4, didynamous sometime 2, arching over in pairs. The posterior stamen is absent or a staminode. The anthers are divaricate. The carpels are 2 and syncarpous. Fruit capsule.

**Floral Formula:**  $\overset{\text{K}}{\underset{\text{C}}{\text{♂}}} (5) \overset{\text{A}}{\text{C}} (5) \overset{\text{G}}{\text{4 or 2}} \overset{\text{G}}{\text{(2)}}$

**Chemical Constituents of the family:** Cardiac glycosides, bitter irridoid glycosides, other constituents include: steroidal and triteroenoid saponins, cyanogenetic glycosides and anthraquinones.

**Important Medicinal Plants of the family:**

*Digitalis purpurea*: cardioactive

*Digitalis lanata*: cardioactive

*Picrorhiza kurroa*: liver ailments

*Verbascum thapsus*: bronchial ailments

*Baccopa monniera*: brain and nerve tonic

## 10 Solanaceae

**Distribution:** A family of about 90 genera and more than 2000 species, out of which 58 species are available in India; also called as Nightshade family. Distributed in tropical and temperate regions of the world.

**Identifying Morphological characters of the family:** Herbs, shrubs, or small trees; flowers are regular, bisexual and hypogynous; Leaves are simple, alternate, sepals 5, united and persistent; petals vary in color( greenish-yellow, greenish-white , white, pink, crimson, purple), The petals are (5) and united. It is usually funnel or cup-shaped 5 lobed. The lobes are valvate or twisted in the bud; stamens five, epipetalous, hypogynous, along with style usually forming nectar glands; The carples are (2) and syncarpous. Fruit, a capsule or a berry.

**Floral Formula:**  $\text{♂}^K(5)^C(5)^A(5)^{\underline{G}}(2)$

**Chemical Constituents of the family :** The family is known for the presence of tropane, nicotine and steroidal type of alkaloids.

**Important Medicinal plants of the family:**

*Atropa belladonna* : pain relief, inflammatory conditions, anti-emetic

*Datura stramonium* : spasmodic affections of the respiratory organs

*D metel* and *D innoxia*: hallucinogen, source of hyoscyne, preoperative medication

*Hyoscyamus niger*: spasmolytic and anticholinergic properties; atropine is used in ophthalmology.

*Withania somniferum*:antioxidant, immunomodulatory

*Duboisia species*: source of tropane alkaloids

*Solanum nigrm*: source of steroids, hepatoprotective

*Capsicum annum*: counter irritant

*Nicotiana tabacum*: source of nicotine; insecticide



Fig.10. Floral diagram of *Solanaceae*

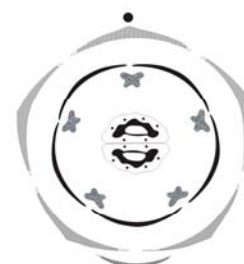


Fig.11. Floral diagram of *Umbelliferae*

## 11 Umbelliferae

**Distribution:** The family consists of 275 genera and 3000 species, out of which 176 species are available in India. Members of the family are distributed to temperate regions of the northern hemisphere. Presently called as Apiaceae. Also known as Parsley family.

### Identifying morphological characters of the family:

Generally as herbs. The stem is usually fistular (hollow at internodes and solid at nodes); The leaves are alternate, simple, often much divided, petiole usually sheathing at the base; Inflorescence: an umbel, usually compound, surrounded by an involucre of bracts or bracteoles; The flowers are regular, small, epigynous, bisexual or polygamous; 5 sepals, free, adnate to the ovary, often considerably reduced in size; the petals are 5, free, adnate to the ovary. The margin is often curved inwards, valvate or imbricate; 5 stamens, free, alternating with the petals, epigynous; carpels are (2), syncarpous; fruit is a cremocarp, consisting of two indehiscent carpels, laterally or dorsally compressed, breaking up into two parts, called mericarps, which are attached to a slender, often forked axis (carpophore). Each mericarp usually shows five longitudinal ridges and oil canals (vittae).

**Floral Formula:**  $\% \text{ } \overset{\text{K}}{\text{5}} \overset{\text{C}}{\text{5}} \overset{\text{A}}{\text{5}} \overset{\text{G}}{\text{(2)}}$

**Chemical Constituents of the family:** Rich source of essential oils; some species accumulate alkaloids and furanocoumarins, coumarins, terpenes and sesquiterpenes and triterpenoid saponins.

### Important Medicinal Plants of the family:

*Carum carvi*: carminative and spice

*Coriandrum sativum*: carminative and spice

*Cuminum cyminum*: carminative and spice

*Anethum graveolens*: carminative and spice

*Foeniculum vulgare*: mild carminative and an excellent eye wash

*Pimpinella anisum*: expectorant, spasmolytic and carminative

*Trachyspermum ammi*: carminative, source of thymol

### Suggested Readings

1. AC Dutta; Botany for Degree Students; 6<sup>th</sup> edition, 2005, published by Oxford University Press.
2. TE Wallis; Textbook of Pharmacognosy; 5<sup>th</sup> edition, 2002, published by CBS Publishers and Distributors.
3. Michael Heinrich, Joanne Barnes, Simon Gibbons and Elizabeth M. Williamson; Fundamentals of Pharmacognosy and Phytotherapy; 2004, Elsevier Science Limited.
4. Trease and Evans; Pharmacognosy; 15<sup>th</sup> edition, 2002, Elsevier Science Limited.