BSc Part-I Hons

Paper -2 (Topic 5 to 12)

Topic- Pteeridophytes+Gymnosperm+Angiosperm

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Topic-5

Male and Female gametophyte of Pinus

Male gametophyte of Pinus

Microsporophyll is the microspore containing structure. The microsporangium is sessile and surrounded by a single layer of cells.

↓

Each microsporangium produces several microspores. Each microspore is covered by inner intine and outer exine. Microspore is winged.

↓

Microspore is the first cell of male gametophyte.

↓

Microspore begins to germinate within the microsporangium.

↓

The microspore nucleus divides to form a very small first Prothallial and a large cell.

↓

The large cuts off a second Prothallial cell and the antheridial cell

↓

At this stage Microspore is shed and falls in close vicinity to the female gametophyte. Further development of male gametophyte is inside the female gamertophyte..

↓

The two Prothallial cell degenerate and the antheridial cell divide to form a small generative cell and a large tube cell(tube nucleus)..

↓

The tube nucleus regulates the growth of the pollen tube in close proximity to the nucellus of Female gametophyte.

↓

A mature ovule (megasporangium) secretes a mucilaginous substance from the micropyle. A large number of Pollen grains gets attached to the mucilaginous substance.

↓

A few of them are drawn inside when the mucilage dries up and reaches close to the apex of the nucellus.

↓

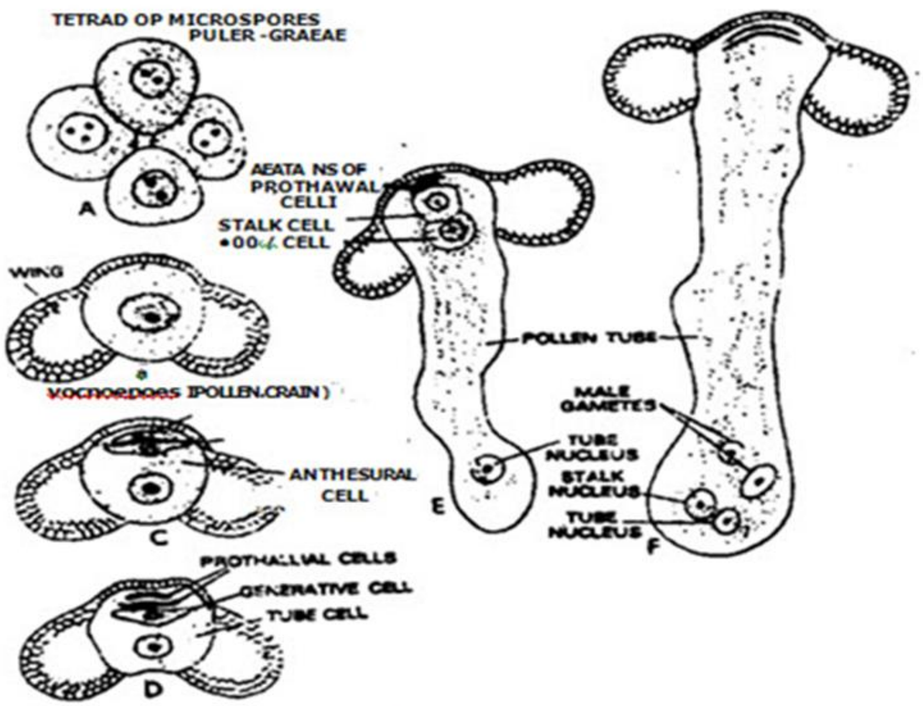
The tube cell grows and protrudes to form Pollen tube. The pollen tube is the proliferation of the intine of the microspore. The pollen tube penetrates the nucellus.

↓

The generative cell then divides to form a sterile stalk cell and a fertile body cell.

↓

The body cell then divides to form two non-motile unequal sized male gametes(Sperms).This marks the end of the development of male gametophyte of Pinus.



Germination of pollen grain

Female gametophyte of Pinus

The megasporophyll of the female cone is composed of large ovuliferous scale and smaller bract scale both are free from each other

↓

Each ovuliferous scale bears two anatropous ovules or megasporangia.The ovuliferous scale bears two inverted megasporangium on its upper surface towards the base.

↓

Each megasporangium consists of a massive tissue called as Nucellus and a covering called as integument.At the basal portion the integument is fused with the nucellus and open at the top forming a micropyle.

↓

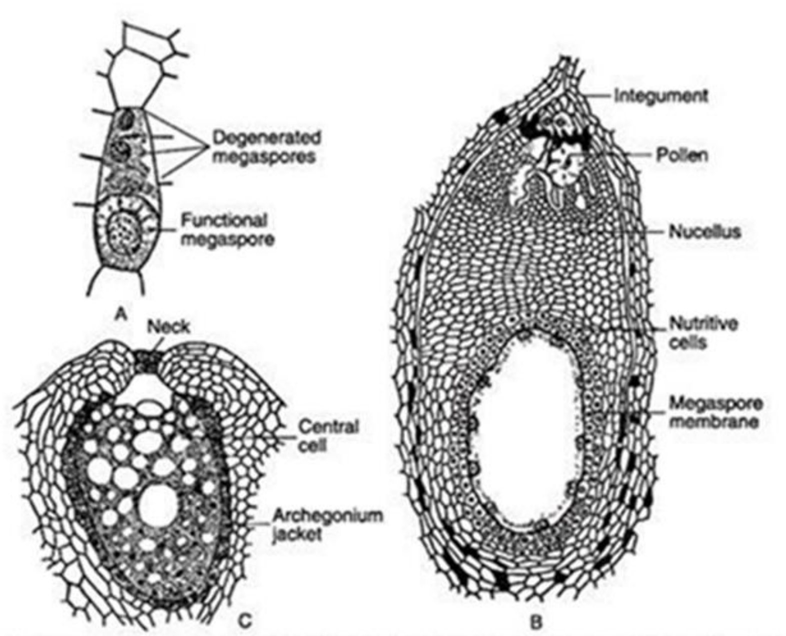
A single megaspore mother cell is differentiated within the nucellus. This divides meiotically to form a row of four megaspore.

↓

Out of the four megaspores only the lowermost remains functional while others degenerate.

↓

The only functional megaspore increase in size and gets involved in the development of female gametophyte(Archegonia).

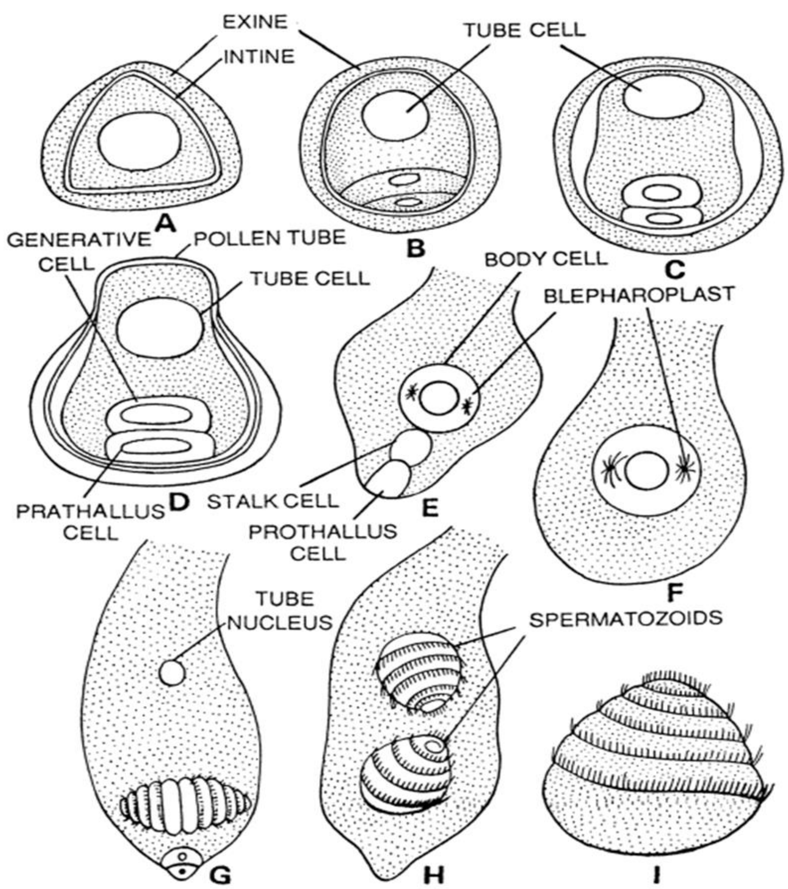


Development of Archegonia from Megaspore

Topic-6

Male and Female gametophyte of Cycas

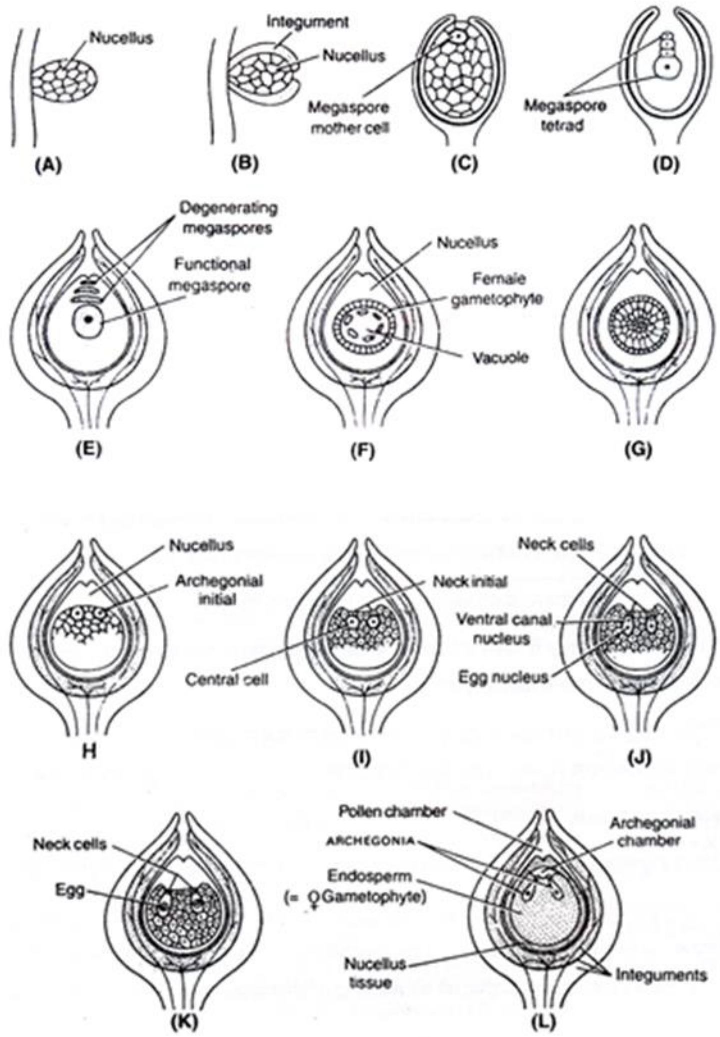
Male gametophyte of Cycas- Do it your self as described above



Cycas sp. A-G, successive stages in the development of male gametophyte; H, two spematozoids. I, one mature spermatozoid.

Method of devevelopment of male gametophyte of Cycas is almost similar to Pinus two antherozoids (multiflagellate) develop to mark the completion of development.

Female gametophyte of Cycas



Different stages of development of female gametophyte

One single functional megaspore from the tetrad develops into Archegonia as described in Pinus.

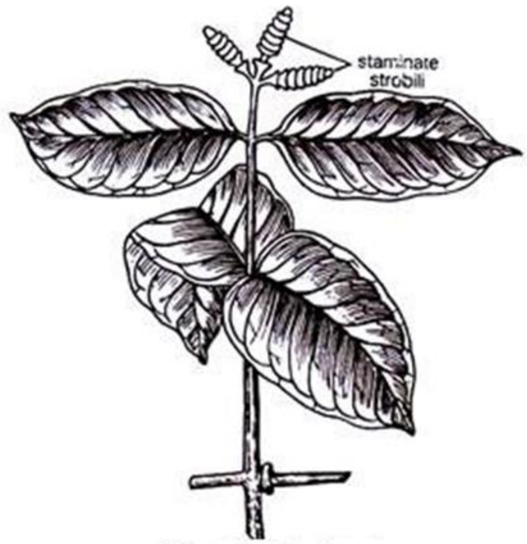
Topic-7

Life cycle of Gnetum and its angiospermic feature

Gnetum (35 species) inhabits a variety of humid, tropical lowland, riparian, and swamp rainforests of South East Asia, Papua New Guinea, Fiji, the Americas, and Africa . Gnetum bears remarkably angiosperm-like leaves, consisting of a broad, entire-margined lamina with pinnate-reticulate venation and multiple vein orders The majority of Gnetum species are large woody climbers, producing xylem from multiple cambia. Some Gnetum vines ascend high into the canopies of dense riparian vegetation and lowland forest trees; other species occur as low scramblers in open, fire-burnt pastures and disturbed forest edges. Two Gnetum taxa (i.e., G. gnemon, widespread in the Indo-Pacific; G. costatum, from eastern Papua New Guinea and the Solomon Islands), that form sun-exposed medium-sized subcanopy trees in lowland rainforest and riverine gallery forests (typically 7 to 15 m, as high as 20 m) possess some peculiar liana-like features. In addition to the occasional production of scandent branches, older trees of G. gnemon develop additional anomalous cambia in the bark that are akin to multiple cambia of lianoid Gnetum species . Interestingly, molecular phylogenetic analyses indicate that tree-forming Gnetum species are well nested among Gnetum climbers, suggesting that arborescence is secondarily derived.

1.Habit of Gnetum:

Majority of the Gnetum species are climbers except a few shrubs and trees.The branch is of limited growth ,unbranched and bears decussate foliage leaves.The leaves are oval in shape having entire margin showing reticulate venation.



A branch of *Gnetum*.

Anatomy of Gnetum:

(i) Root:

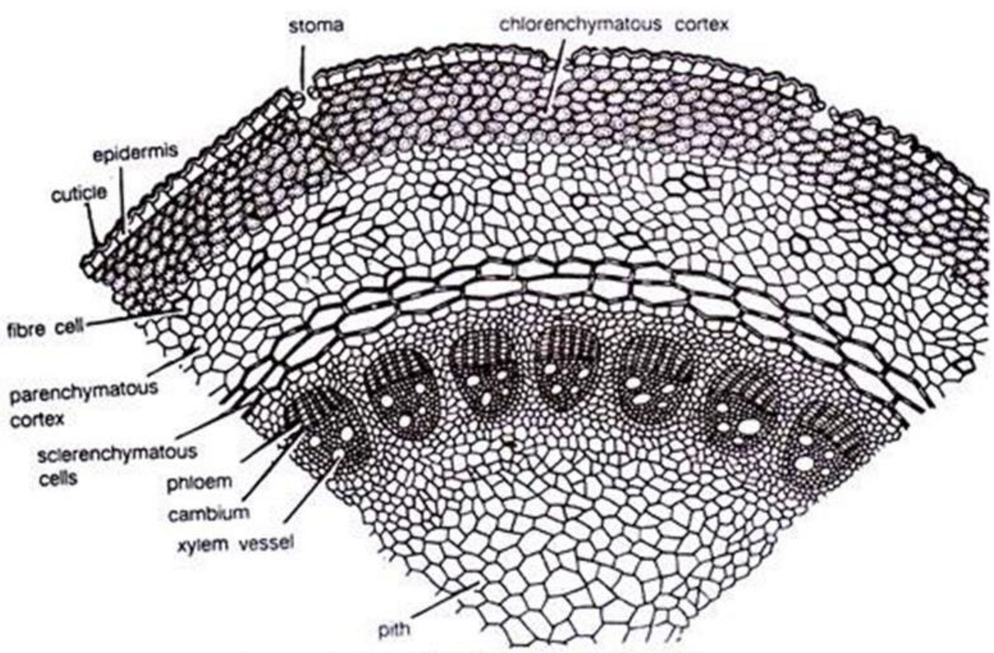
Young root has several layers of starch-filled parenchymatous cortex, the cells of which are large and polygonal in outline. An endodermal layer is distinguishable. Casparian strips are seen in the cells of the endodermis. The endodermis follows 4-6 layered pericycle. Roots are diarch and exarch. Small amount of primary xylem, visible in young roots, becomes indistinguishable after secondary growth.The secondary growth is of normal type. . It consists of tracheids, vessels and xylem parenchyma. The tracheids have uniseriate bordered pits along with bars of Sanio. Vessels have simple or small multiseriate bordered pits.

(ii) Young Stem:

The young stem in transverse section is roughly circular in outline, and resembles with a typical dicotyledonous stem. It remains surrounded by a single-layered epidermis, which is thickly circularized and consists of rectangular cells.The cortex consists of outer 5-7 cells thick chlorenchymatous region, middle few-cells thick parenchymatous region and inner 2-4 cells thick sclerenchymatous region. Several conjoint, collateral, open and endarch vascular bundles are arranged in a ring in the young stem. Xylem consists of tracheids and vessels. Presence of vessels is an angiospermic character. Protoxylem elements are spiral or annular while the metaxylem shows bordered pits which are circular in outline. The phloem consists of sieve cells and phloem parenchyma.

Old stems in Gnetum show secondary growth. In G. gnemon the secondary growth is normal, as seen also in the dicotyledons. But in majority of the species (e.g., G. ula, G. africanum, etc.) the anamolous secondary growth is present.

The primary cambium is short lived this cambium ceases to function after some time ,the secondary cambium in different parts of cortex develops in the form of successive rings, one after the other . The first cambium cuts off secondary xylem towards inside and secondary phloem towards outside. Another cambium gets differentiated along the outermost secondary phloem region, and the same process is repeated. In the later stages, more secondary xylem is produced on one side and less on the other side, and thus the eccentric rings of xylem and phloem are formed in the wood.Thus an abnormal type of growth is noticed.In old stems the secondary wood consists of tracheids and vessels. Tracheids contain bordered pits on their radial walls while vessels contain simple pits..



Gnetum. T. S. young stem.

Reproduction of Gnetum:

Gnetum is dioecious. The reproductive organs are organised into well-developed cones or strobili. These cones are organised into inflorescences, generally of panicle type. Sometimes the cones are terminal in position.

Male Cone and Male Flower:

The male flowers are arranged in definite rings above each collar on the nodes of the axis of male cone. The number of rings varies between 3-6. The male flowers in the rings are arranged alternately. There is a ring of abortive ovules or imperfect female flowers above the rings of male flowers.

Each male flower contains two coherent bracts which form the perianth. Two unilocular anthers remain attached on a short stalk enclosed within the perianth from which it comes out during maturity to dehisce.

Development of Male Flower :

In very young cones, certain cells below each collar become meristematic. They divide repeatedly and form a small hump-like outgrowth. Certain cells on the upper side of this annular outgrowth start to differentiate into the initials of the ovules. They develop into abortive ovules which form the uppermost ring. The cells of the lower side of this annular outgrowth form the primordium of male flower.

A central cushion of cells develops by the repeated divisions in the male flower primordium. This cushion gets surrounded by a circular sheath called perianth. The sheath-like perianth encloses the central cushion-like mass only partially. With the development of a depression or notch in the central mass two lobes differentiate and later on develop into two anther lobes.

With the help of many divisions the basal portion of this central mass of cells starts to differentiate into a stalk. This stalk elongates and pushes the anther lobes towards the outer side. Each anther lobe remains surrounded by an epidermal layer and a few wall layers which enclose a microsporangium.The innermost wall layer enclosing the sporogenous tissue is known as tapetum.

The sporogenous cells become loose, contract round up and change into the spore mother cells. In the process of microspore formation the tapetum and two wall layers are used for the developing microspores. The spore mother cells undergo meiosis and ultimately the spore tetrads are formed.

Female Cone:

The female cones resemble with the male cones except in some definite aspects. A single ring of 4-10 female flowers or ovules is present just above each collar . Only a few of the ovules develop into mature seeds In the young condition, there is hardly any external difference between female and male cones. All the ovules are of the same size when young but later on a few of them enlarge and develop into mature seeds. All the ovules never mature into seeds.Each ovule consists of a nucellus surrounded of three envelopes. The nucellus consists of central mass of cells. The inner envelope elongates beyond the middle envelope to form the micropylar tube or style. The nucellus contains the female gametophyte. There is no nucellar beak in the ovule of Gnetum.

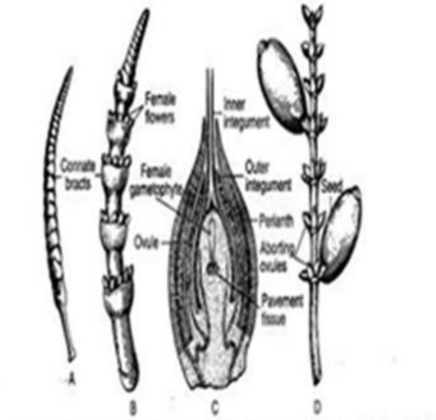
Fertilization in Gnetum

After the entry of pollen tube into the female gametophyte, whose lower end has become partly cellular, one or more nuclei (3-8) at its upper end also become delimited by cell-walls. These groups of cells are usually present in the neighbourhood of the pollen tube. Out of each such group, one or rarely two cells behave as egg cells, which often become surrounded by one or two layers of minute and degenerated cells.

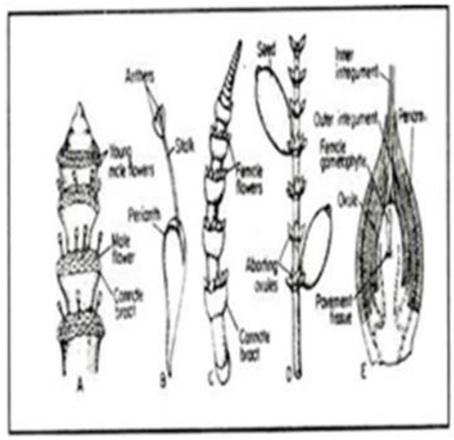
In all probability these inconspicuous cells provide nourishment to the egg and become used up at the time of fertilization. Only a male nucleus enters the egg, while its sheath is left outside. In cases where two eggs are present in the vicinity of the pollen-tube, double fertilization may result.

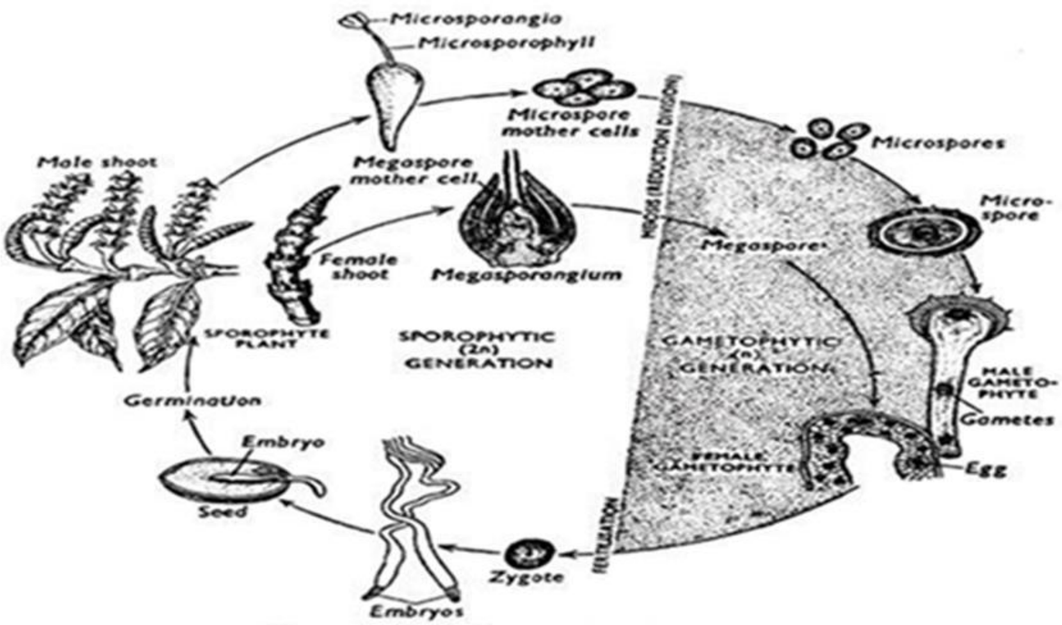
Gnetum is remarkable among gymnosperms in the fact that a typical gymnospermic endosperm, which is formed prior to fertiliza-tion, is lacking here. Madhulata (1960) reports in G. gnemon that while eggs are being differentiated, the female gametophyte re-mains in a free nuclear condition, and only when zygotes are produced in the micropylar region of the ovule, the first walls are laid down in the chalazal region producing in an upward direction.

Very rarely the cell-wall formation may take place simultaneously throughout the gametophyte. Sometimes walls may be laid down even when eggs are not differentiated within the gametophyte.



Gnetum ula : A. An young female inflorescence, B. A mature female inflorescence, C. Median L.S. of a female flower, D. A female inflorescence bearing two mature seeds





Life cycle of *Gnetum*

Angiospermic feature of Gnetum

A key position to Gnetum has been assigned by scientists while discussing the origin of angiosperms. Both Gnetales and angiosperms originated from a common stalk called “Hemi-angiosperm”

In a beautiful monograph on Gnetum, Maheshwari and Vasil (1961) are of the view that Gnetum possesses some strong angiospermic features” and hence they are close to angiosperms.

Some of the resemblances between Gnetum and angiosperms are mentioned below:

1. The general habit of the sporophyte of many species of Gnetum resembles with angiosperms.

2. Reticulate venation in the leaves of Gnetum is an angiospermic character.

3.Presence of Endarch vascular bundle shows closeness to dicot angiosperms

4.Presence of vessels in xylem is again an angiospermic character.

5. Clear tunica and corpus configuration of shoot apices is a character of both Gnetum and angiosperms.

6. Strobili of Gnetum resemble much more with angiosperms than any of the gymnosperms

7. Micropylar tube of Gnetales can be compared with the style of the angiosperms because both perform more or less similar functions.

8. Tetrasporic development of the female gametophyte is again a character which brings Gnetum close to angiosperms.

9. Absence of archegonia again brings Gnetum and angiosperms much closer.

10. Dicotyledonous nature of the embryo of Gnetum brings it quite close to the dicotyledons.

11.The presence of companion cells in the angiosperms is one of the constant anatomical features which …

12. Double fertilization

13 Some members of Gnetopsida produce nectars which is also found in Angiosperms.

Thompson (1916) opined that the ancestors of both Gnetum and angiosperms were close relatives. Hagerup (1934) has shown a close relationship between Gnetales and Piperaceae.

Topic-8

International code of Botanical nomenclature

The International Code of Nomenclature for Cultivated Plants (ICNCP), also known as the Cultivated Plant Code, is a guide to the rules and regulations for naming cultigens, plants whose origin or selection is primarily due to intentional human activity.

The International Code of Botanical Nomenclature (ICBN) is the set of rules and recommendations dealing with the formal botanical names that are given to plants. Its intent is that each taxonomic group ("taxon", plural "taxa") of plants has only one correct name that is accepted worldwide. The value of a scientific name is that it is an identifier; it is not necessarily of descriptive value, or even accurate.

The guiding principle in botanical nomenclature is priority. The ICBN sets the formal starting date of plant nomenclature at 1 May 1753, the publication of Species Plantarum by Linnaeus (or at later dates for specified groups and ranks).A botanical name is fixed to a taxon by a type. This is almost invariably dried plant material and is usually deposited and preserved in a herbarium, though can be an image. Some type collections can be viewed online at the websites of the herbaria in question.It was formerly called the International Code of Botanical Nomenclature (ICBN); the name was changed at the International Botanical Congress in Melbourne in July 2011 as part of the Melbourne Code which replaced the Vienna Code of 2005.

Principles, Rules and Recommendations and Provisions for the gover-nance of the code.

A. Division I.

Principles:This division provides 6 Principles which form the basis of the system of Botanical Nomenclature.

These are:

I. Botanical nomenclature is independent of zoological and bacteriological nomenclature. The Code applies equally to names of taxonomic groups treated as plants whether or not these groups were originally so treated.

II. The application of names of taxonomic group is determined by means of nomenclatural type.

III. The nomenclature of taxonomic group is based on the priority of publication.

IV. Each taxonomic group with a particular circumscription, position and rank can bear only one correct name, the earliest that is in accordance with the Rules, except in specified cases.

V. Scientific names of taxonomic groups are treated as Latin, regardless of their derivation.

VI. The Rules of Nomenclature are retro-active unless expressly limited.

The binomial nomenclature is the system where naming of plants consists of two words — a generic name and a specific name. The first one is the generic name and the second one is the specific name. Both the names together form a binary or binomial name.

In a binomial, only the generic name should start with capital letter and all others in small letters. After selecting the name of a particular plant, it must be added with the name of the author. If the author's name is too long, it should be mentioned in abbreviated form. The names of the plants are written in Latin. The scientific name i.e., the Latin name of Paddy is Oryza sativa. The first name, Oryza is the generic name and the second name sativa is the specific name.

To complete the name, the author's name in abbreviated form should be added at the end. So the complete scientific name of Paddy is Oryza sativa L. The L. indicates the name of Linnaeus, who has given the name. Binomials should be typed in Italic type face or in case of handwriting both generic and spe-cific epithet should be underlined separately.

Topic-9

Natural system and Phylogenetic system of classification

Many systems of classification of angiosperms have been proposed by many taxonomists from time to time. This is divided into three categories:

i. Artificial Systems based on superficial features.: These systems of classification were based on one or few morphological characters. Theophrastus (370 – 285 BC), a Greek philosopher, in his book Historia Plantarum classified about 480 plants into four groups on the basis of their habit-herbs, undershrub's, shrubs and trees. Carolus Linnaeus (also called Carl Linnaeus) (1707-1778), a Swedish naturalist in his book Species Plantarum (1753) classified 7300 species of plants into 24 classes, mainly on the basis of number, union and length of stamens. For example, he described the classes as Monandria (1 Stamen), Diandria (with 2 stamens), Triandria (with 3 stamens) and so on Polyandria (with 20 or more stamens). This system is commonly known as sexual system of classification.

ii. Natural systems based on form relationships. In these systems the organisms are classified on the basis of their natural affinities (i.e. the basic similarities in the morphology) rather than on a single character for determining the affinities.

(i) A.L. de Jussieu (1748-1836) published a natural system of classification of plants in his book Genera Plantarum secundus ordines Naturales Disposita. The plants were divided into three main groups, i.e. Acotyledones (plants without cotyledons). Monocotyledones (plants with one cotyledon) and Dicotyledones (plants with two Cotyledons

(ii) A.P. de Candolie (1778-1841) a French botanist published Theorie elementaire de la Boanique in which he classified about 58,000 species into 161 families. He divided plants into two major groups i.e. cellulares (non-vascular plants) and vasculares (vascular plants).

(iii) Bentham and Hooker's Classification:

The most important and the last of the natural systems of classification of seed plants was proposed by two British taxonomists George Bentham (1800-1884), a self trained botanist, and Joseph Dalton Hooker (1817-1911), the first director of the Royal Botanical Garden, Kew (England). Their monumental work which took about quarter of a century for completion was described in three volumes of Genera Plantarum, published in Latin during July 1862 and April 1883. Bentham and Hooker's system of classification is still used and followed in several herbaria of the world. It is still the best system of classification followed in India.

Salient Features of Bentham and Hooker's system:

1. It is a classification of only the "seed plants" or phanerogams.

2. They described 97,205 species of seed plants belonging to 7,569 genera of202 families starting from Ranunculaceae up to Gramineae.

3. They classified all the seed plants into 3 groups or classes i.e. Dicotyledons (165 families), gymnosperms (3 families) and monocotyledons (34 families).

4. They included disputed orders among Ordines Anomali which they could not place satisfactorily.

5. Monocotyledons were described after the dicotyledones.

6. The dicotyledons were divided into 3 Divisions (Polypetalae, Gamopetalae and Monochlamydeae) and 14 series. Each series again divided into cohorts (modern orders) and cohorts into orders (modern families).

7. Creation of the Disciflorae, a taxon not described by the earlier taxonomists.

8. Among the Monochlamydeae, major taxa, like the series, were divided on the basis of terrestrial and aquatic habits.

9. Polypetalae carries 82 families, 2610 genera & 31,874 species. Gamopetalae carries 45 families 2619 genera & 34,556 species. Monochlamydae includes 36 families, 801 genera & 11,784 species. Similarly Monocotyledons consist 34 families, 1495 genera and 18,576 species.

Merits of Bentham and Hooker's System:

1. Each plant has been described either from the actual specimen or preserved herbarium sheets so that the descriptions are detailed as well as quite accurate.

2. The system is highly practical and is useful to students of systematic botany for easy identification of species.

3. The flora describes geographical distribution of species and genera.

4. The generic descriptions are complete, accurate and based on direct observations.

5. Larger genera have been divided into sub genera, each with specific number of species.

6. Dicots begin with the order Ranales which are now universally considered as to be the most primitive angiosperms.

7. Placing of monocots after the dicot is again a natural one and according to evolutionary trends.

8. The placing of series disciflorae in between thalami florae and calyciflorae is quite natural.

9. The placing of gamopetalae after polypetalae is justified since union of petalsis considered to be an advanced feature over the free condition.

Demerits of Bentham and Hooker's System:

1. Keeping gymnosperms in between dicots and monocots is anomalous.

2. Subclass monochlamydeae is quite artificial.

3. Placing of monochlamydeae after gamopetalae does not seem to be natural.

4. Some of the closely related species are placed distantly while distant species are placed close to each other.

5. Certain families of monochlamydeae are closely related to families in polypetalae, e.g. Chenopodiaceae and Caryophyllaceae.

6. Advanced families, such as Orchiadaceae have been considered primitive in this system by placing them in the beginning. Placing of Orchidaceae in the beginning of monocotyledons is unnatural as it is one of the most advanced families of monocots. Similarly, Compositae (Asteraceae) has been placed near the beginning of gamopetalae which is quite unnatural.

7. Liliaceae and Amaryllidaceae were kept apart merely on the basis of characters of ovary though they are very closely related.

8. There were no phylogenetic considerations

Phylogenetic system of Classification

John Hutchinson (1884-1972):

John Hutchinson was a British botanist asso-ciated with Royal Botanic Gardens, Kew, England. He developed and proposed his system based on Bentham and Hooker and also on Bessey. His phylogenetic system first appeared as "The Families of Flowering Plants" in two volumes.The first volume contains Dicotyledons (published in 1926) and second volume contains Monocotyledons (published in 1934). He made several revisions in different years. The final revi-sion of "The Families of Flowering Plants" was made just before his death on 2nd September 1972 and the 3rd i.e., the final edition, was pub-lished in 1973.

The following principles were adopted by Hutchinson to classify the flowering plants:

1. Evolution takes place in both upward and downward direction.

2. During evolution all organs do not evolve at the same time.

3. Generally, evolution has been consistent.

4. Trees and shrubs are more primitive than herbs in a group like genus or family.

5. Trees and shrubs are primitive than climbers.

6. Perennials are older than annuals and biennials.

7. Terrestrial angiosperms are primitive than aquatic angiosperms.

8. Dicotyledonous plants are primitive than monocotyledonous plants.

9. Spiral arrangement of vegetative and floral members are primitive than cyclic arrange-ments.

10. Normally, simple leaves are more primitive than compound leaves.

11. Bisexual plants are primitive than unisexual plants and monoecious plants are primitive than dioecious plants.

12. Solitary flowers are primitive than flowers on inflorescence.

13. Types of aestivation gradually evolved from contorted to imbricate to valvate.

14. Polymerous flowers precede oligomerous flowers.

15. Polypetalous flowers are more primitive than gamopetalous flowers.

16. Flowers with petals are more primitive than apetalous flowers.

17. Actinomorphic flowers are more primitive than zygomorphic flowers.

18. Hypogyny is considered as more primitive from which perigyny and epigyny gradually evolved.

19. Apocarpous pistil is more primitive than syncarpous pistil.

20. Polycarpy is more primitive than gynoecium with few carpels.

21. Flowers with many stamens are primitive than flowers with few stamens.

22. Flowers with separate anthers are primitive than flowers with fused anthers and/fila-ments.

23. Endospermic seeds with small embryo is primitive than non-endospermic one with a large embryo.

24. Single fruits are primitive than aggregate fruits

Merits and Demerits Merits:

1. Hutchinson proposed the monophyletic origin of angiosperms from some hypo-thetical Proangiosperms having Bennettitalean characteristics.

2. He made a valuable contribution in phylogenetic classification by his care-ful and critical studies.

3. Monocots have been derived from Dicots.

4. According to him, the definitions of orders and families are mostly precise, particularly in case of subphylum Monocotyledones.

Demerits:

1. There is undue fragmentation of fami-lies.

2. Too much emphasis is laid on habit and habitat. Thus, creation of Lignosae and Herbaceae is thought to be a defect reflecting the Aristotelean view.

3. The origin of angiosperms from Bennettitalean-like ancestor is criticised by many, because the anatomical struc-tures of the early dicotyledons are not tenable with such ancestry.

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Topic-10

Cycadeoidea

Cycadeoidea, also called Bennettites by several European palaeobotanists is represented by about 30 species. The name Cycadeoidea was put forward in 1827 for petrified trunks from Isle of Portland. Though Bennettites is still employed for plant fossils from the Isle of Wight, Cycadeoidea is now the valid name of the genus.It has been reported from Upper Jurassic to Upper Cretaceous rocks of America, India, Russia and several European countries. It occurs in the form of a large number of petrifactions in different parts of the world.

Salient feature

Cycadeoidea, a genus of extinct seed plants that was common worldwide during the Early Cretaceous Epoch (145 million to 100 million years ago). It was one member in a larger group, the order Bennettitales (known as the order Cycadeoidales in some classifications), which has been evolutionarily linked to angiosperms (flowering plants).

Superficially, Cycadeoidea resembled modern cycads. They possessed a squat bulbous or branched trunk covered in sturdy leaf bases and scales that protected the woody stem within. No mature leaves have ever been found attached to Cycadeoidea trunks. However, immature leaves were once pinnate (i.e., leaflets are attached directly to the leaf's central axis) and resemble those of modern cycads, which were also common in the Cretaceous. Cycadeoid leaves were tough, like those of cycads, and this characteristic may have been an evolutionary response to herbivory (plant consumption by animals).

The reproductive structures of the Bennettitales, however, distinguish them from cycads. The cones of Cycadeoidea were embedded in the trunk with only the tips exposed between the leaf bases and contained both pollen and ovules. This arrangement differs from most gymnosperms but is similar to many flowering plants. Pollen was borne in sacks on a whorl of modified leaves that encircled the ovule-bearing structure. Ovules were clustered on a central structure and were separated from one another by sterile scales. The entire cone was encased in a whorl of petal-like modified leaves. This arrangement of bracts, pollen organs, and ovules led many paleobotanists to align the Bennettitales, including Cycadeoidea, with flowering plants. This link has been supported by the identification in Cycadeoidea of chemical markers typical of angiosperms.

The pollination of Cycadeoidea remains unclear. Some argued that the reproductive structures opened at maturity, allowing insects to pollinate, as is the case with cycads and many flowering plants. Others argued that Cycadeoidea cones remained closed at maturity, making them self-pollinated. Since the only open cones ever observed have been those bearing mature seeds, the latter opinion prevails. Some have further suggested that inbreeding, the result of exclusive self-pollination, contributed to the decline and extinction of Cycadeoidea in the Late Cretaceous.

Detailed account of Bennettitales

Nomenclature, History and Distribution of Bennettitales

The name “Bennettitales” has been given to honour J.J. Bennett,an English botanist. The fossilized trunk of genus Bucklandia was the first specimen of Bennettitales, collected from Great Britain in1825. A silicified trunk of Cycadeoidea etrusca was discovered in 1867 in an Etruscan tomb.

Williamson (1870) coined the name Williamsonia for a combination of foliage and reproductive organs of Williamsonia gigas. Professor Birbal Sahni (1932) discovered Williamsonia sewardiana from the Upper Gondwana beds of India.

A rich fossil flora of Bennettitales has been reported from Rajmahal Hills of Bihar (India). Some of the reported members include Bucklandia sahnii, B. indica, Dictyzamites, Otozamites benghalensis, Cycadinocarpusrajmahalensis, Sahnioxylon rajmahalensis, Williamsonia indica, W. sahnii and W. sewardiana. Classified Arnold (1948) classified Bennettitales into two families viz. Williamsoniaceae and Cycadeoideaceae while Sporne (1965) divided it into following three families

1. Williamsoniaceae, e.g. Williamsonia,Pterophyllum.

2. Wielandiellaceae, e.g. Wielandiella,Williamsoniella.

3. Cycadeoideaceae, e.g. Cycadeoidea(=Bennettites)

Distinguishing Features of Bennettitales

1. These extinct Mesozoic plants were present on the earth from Triassic to Cretaceous.

2. Bennettitales were so abundant during Mesozoic era that this period is known as ‘Age of Cycads’.

3. The members of this group are found either as compressions or petrifactions.

4. The stems were stout or slender and had a wide pith.

5. The stem grew very slowly and had manoxylic (It is the non-compact wood with large amount of parenchyma, large pith and cortex mixed with less amount of xylem tracheids or wood. -Parenchyma cells are filled with starch grains) wood. This wood is not durable.

6. Resembling living Cycads, the Bennettitalean leaves were mostly pinnately compound, and only occasionally simple.

7. Venation was open, and only rarely closed.

8. Syndetocheilic(In some gymnosperms, applied to a type of stoma in which the 2 guard cells and the subsidiary cells are all derived from a single mother cell) type of stomata were present.

9. The wall of the epidermal cells was sinuous (many curves and turns).

10. The reproductive organs were organised in the form of hermaphrodite (e.g. Cycadeoidea) or unisexual (e.g. Wielandiella) "flowers", which in turn were protected by many bracts.

11. The 'flowers' developed in the axil of leaves.

12. Male reproductive organs were borne in a whorl. They were free or fused, entire or pinnately compound.

13. Microsporangia were present abaxially in the form of synangia.

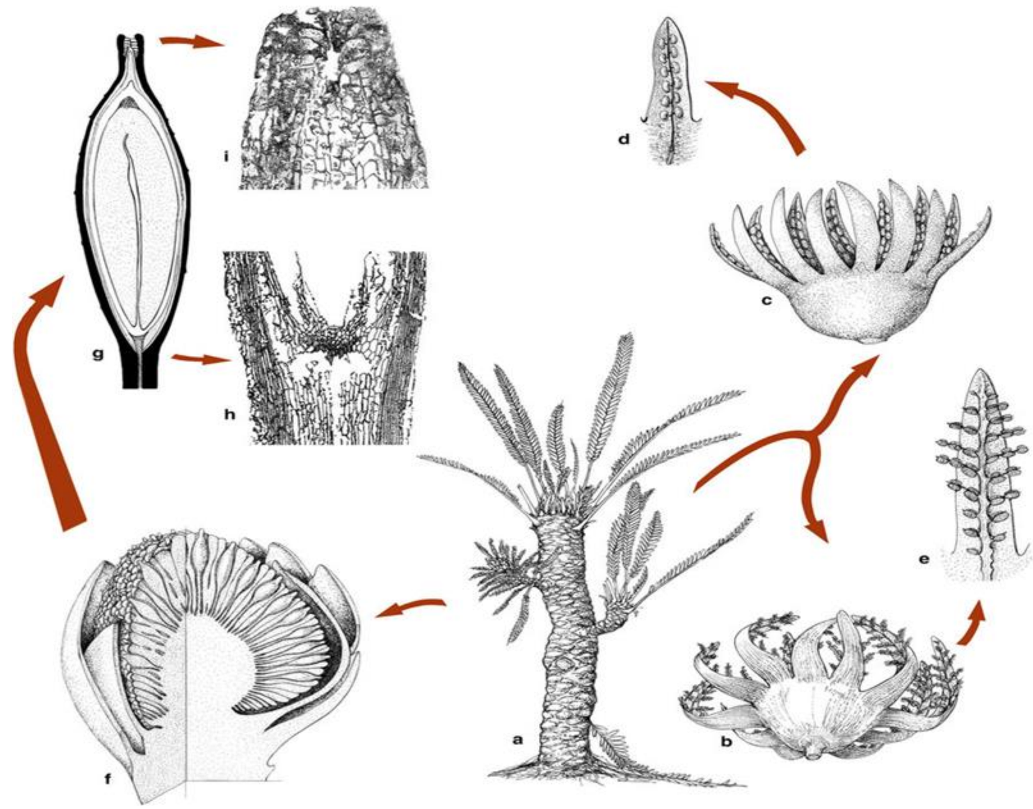
14. Microsporophyll's sometimes surrounded megasporophylls forming hermaphrodite "flowers".

15. Ovules were numerous and stalked and borne on a conical, cylindrical or dome-shaped receptacle.

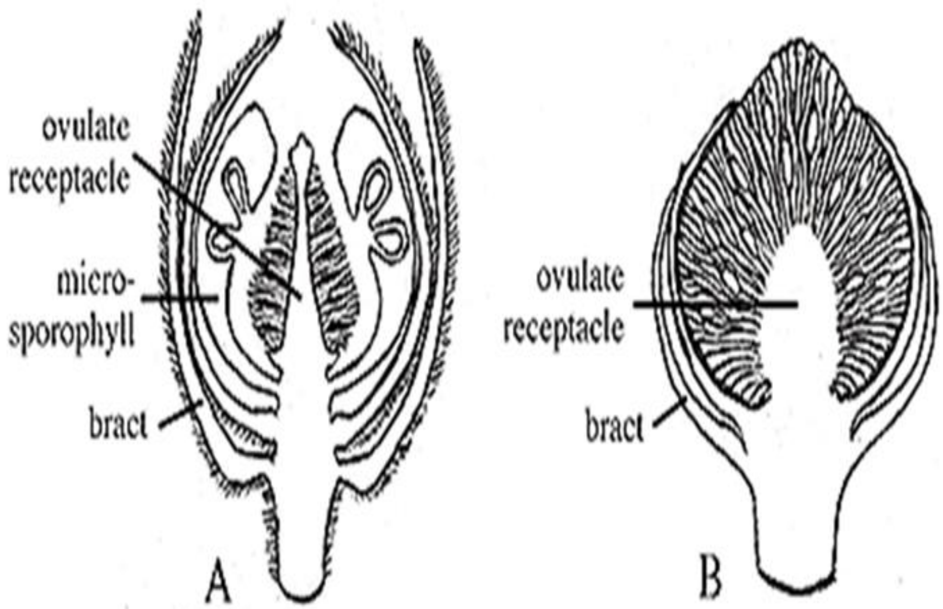
16. Many inter-seminal bracts were present on the ovule containing receptacle.

17. The scales or bracts were united at end to form shield through which micropyle protrudes.

18. Seeds were dicotyledonous.



Diagrammatic life cycle of Bennettitales



Female flower of Bennettitales

Topic-11

Ranunculaceae family

Diagnostic characters

I. Habits: Annual or perennial herbs

Roots: Tuberous root

Stem: Herbaceous stem, develops rhizome

Leaves: Petiolate. Alternate rarely opposite. simple or compound, exstipulate, reticulate venation.

Inflorescence: Cymose. sometimes raceme. Inflorescence:

Solitary terminal (Anemone), axillary (Clematis), raceme (Aconitum, Delphinium) and cymose (Ranunculus spp.).

Pedicellate, ebracteate rarely bracteate, hermaphrodite, (unisexual in Thalictrum). Mostly actinomorphic (Ranunculus) rarely zygomorphic (Delphinium and Aconitum) hypogynous, complete, pentamerous.

Calyx:

There is no distinction of calyx and corolla in most of the flowers. Sepals 5, caducous, polysepalous, petaloid, imbricate or valvate aestivation.

Corolla:

Petals 5, polypetalous, variously coloured, caducous or wanting; nectaries present at the base of petals. Petals are united to form spur (Delphinium).

Androecium:

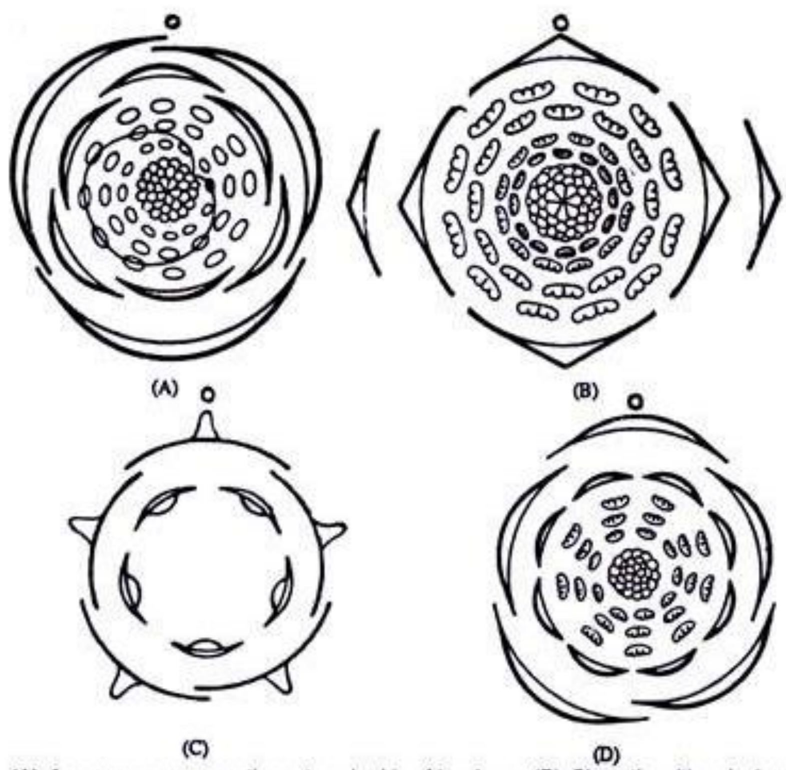
Stamens indefinite, polyandrous, spirally arranged on the thalamus, inferior; anthers dithecous, extrorse and adnate.

Gynoecium:

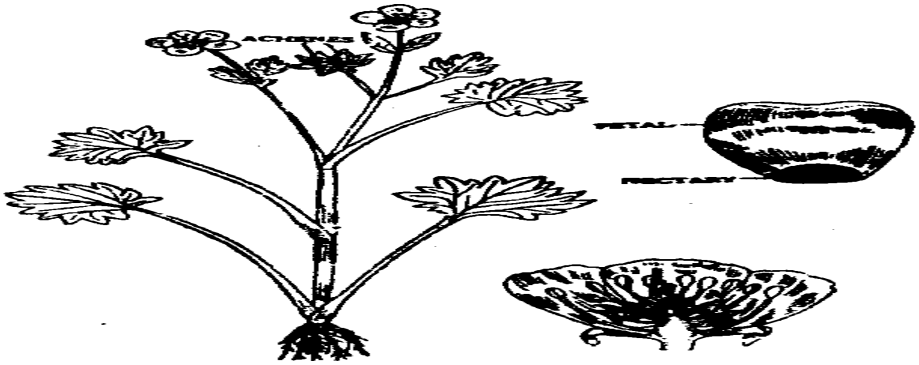
Polycarpellary (one carpel in Delphinium and 3 to 5 in Aconitum), apocarpous rarely syncarpous (Nigella), ovary superior, marginal placentation (axile in Nigella).

Floral formula:

$\oplus$ ⚥ K4–5 C5 A_{α} $G_{\underline{\alpha}}$



(A) *Anemone numerosa*; the outer whorl is of involucre. (B) *Clematis*; with only 4 petaloid sepals. (C) *Myosurus*; only sepals and petals shown; sepals have a spur each (D) *Adonis* (after Eichler)



Important Species

I. *Ranunculus muricatus*. Butter cup

2 *Delphinium ajacis,* Larkspur

3 *Ranunculus muricatus* (a weed)

4 *Aconitum uncinatum* (a wild herb)

Topic- 12

Floral characters of Family Lamiaceae or Labiatae

B. Floral characters

Inflorescence:

Very commonly verticillaster consisting of a pair of condensed dichasial cymes at each node; often the verticillasters are grouped together in a thyrsus form; rarely solitary (Scutellaria).

Flower:

Pedicellate or sessile, bracteate, complete, zygomorphic rarely actinomorphic (Mentha, Elsholtzia), hermaphrodite, rarely unisexual (Nepeta, Thymus), pentamerous hypogynous.

Calyx:

Sepals 5, gamosepalous, bilabiate (Salvia, Thymus) campanulate (Teucrium), persistent, valvate or imbricate aestivation. When a bilabiate calyx is present the arrangement of the sepals may be (1/4) as in Ocimum or (2/3) as in Calamintha.

Corolla:

The corolla possesses a tubular base which widens towards the mouth. Petals generally 5, gamopetalous and the five teeth are sub-equal and mostly bilabiate. In Mentha a four lobed corolla arises due to the fusion of two upper teeth. When a distinct bilabiate condition is found the arrangement of the petals may be gamopetalous 2/3 i.e. two petals in the posterior upper lip and three in the anterior lower lip (*Salvia, Nepeta, Leucas* etc.).

In *Ocimum, Coleus, Plectranthus* etc. the petals arrangement is gamopetalous 4/1 i.e. four petals in the posterior upper lip and only one petal in the anterior lower lip. In extreme cases the arrangement may be gamopetalous 0/5 i.e. all the five petals forming the lower lip so that the corolla becomes one lipped. Aestivation in the petals is valvate or imbricate.

Androecium:

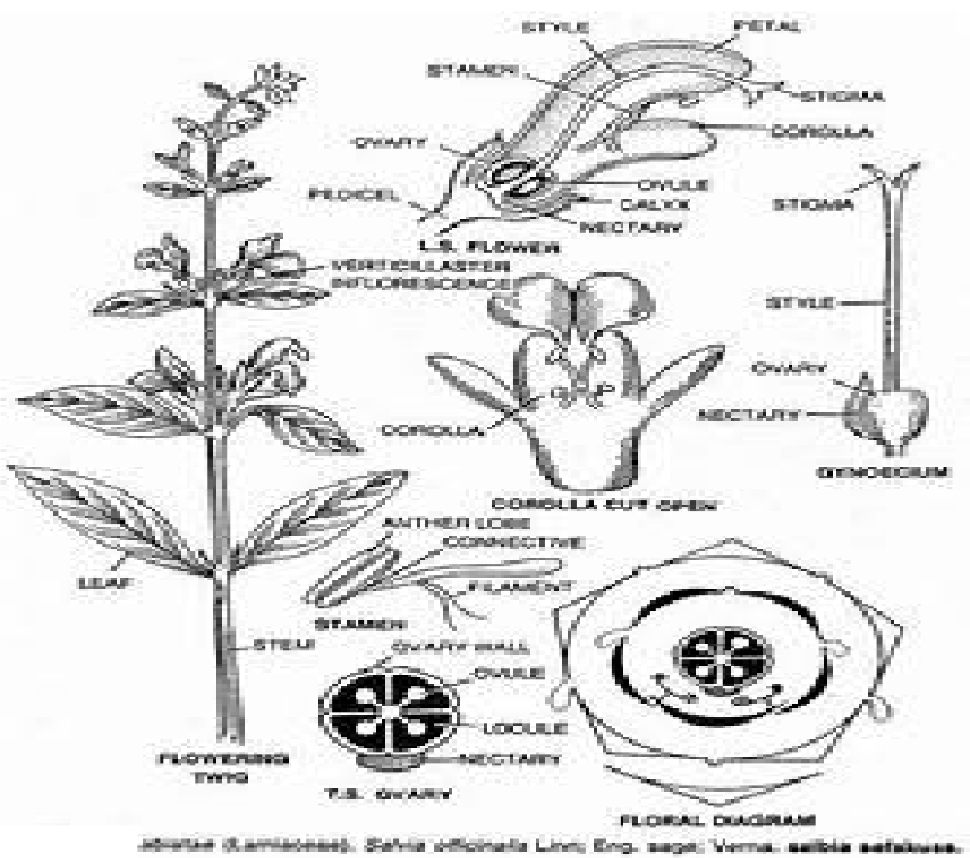
Typically only 4 stamens, didynamous (2+2) and posterior stamen is reduced or represented by a staminode; in Calamintha only two perfect stamens are found, two are imperfect and the fifth reduced. In Salvia only two stamens on the anterior side are found; they are characterised by peculiarly long connectives which help in insect pollination stamens generally introrse and dithecous.

Gynoecium:

Bicarpellary, syncarpous, superior, situated on hypogynous honey secreting disc; bilocular becomes tetralocular by the formation of false septum; axile placentation, one ovule in each loculus; style gynobasic (arising from the base of the ovary), stigma bilobed. The gynoecium character is thus uniform without any variation.

Floral- formula:

$$\mathbf{Br}\ \mathbf{op}\ ☿\ K_{(3/2)\ or\ 5}\ \overbrace{C_{(2/3)\ or\ (4/1)\ or\ (0/5)}\ A}_{}{}_{2+2\ (std)}\ G_{\underline{(2)}}.$$



Plants of this family

1.lavender (Lavandula species)2. lemon balm (Melissa officinalis)3. marjoram (Origanum majorana)4 mint (Mentha species),peppermint (*M.* ×*piperita*),Ocimum speciesbasil (O. basilicum) 5.oregano (Origanum vulgare),sage (Salvia officinalis)

Also prepare notes on – From Study material provided

1. **Inflorescense**
2. **Family cucurbitaceae**
3. **Placentation**
4. **Pinus needle**
5. **Cycas coralloid root—Transfusion tissue**