PLANT SYSTEMATIC AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

PRACTICAL-I

M.Sc. BOTANY

SEMESTER-I, PAPER-V

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M.Sc. BOTANY: PLANT SYSTEMATIC AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

PRACTICAL-I

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FOREWORD

Since its establishment in 1976, Acharya Nagarjuna University has been forging ahead in the path of progress and dynamism, offering a variety of courses and research contributions. I am extremely happy that by gaining 'A+' grade from the NAAC in the year 2024, Acharya Nagarjuna University is offering educational opportunities at the UG, PG levels apart from research degrees to students from over 221 affiliated colleges spread over the two districts of Guntur and Prakasam.

The University has also started the Centre for Distance Education in 2003-04 with the aim of taking higher education to the door step of all the sectors of the society. The centre will be a great help to those who cannot join in colleges, those who cannot afford the exorbitant fees as regular students, and even to housewives desirous of pursuing higher studies. Acharya Nagarjuna University has started offering B.Sc., B.A., B.B.A., and B.Com courses at the Degree level and M.A., M.Com., M.Sc., M.B.A., and L.L.M., courses at the PG level from the academic year 2003-2004 onwards.

To facilitate easier understanding by students studying through the distance mode, these self-instruction materials have been prepared by eminent and experienced teachers. The lessons have been drafted with great care and expertise in the stipulated time by these teachers. Constructive ideas and scholarly suggestions are welcome from students and teachers involved respectively. Such ideas will be incorporated for the greater efficacy of this distance mode of education. For clarification of doubts and feedback, weekly classes and contact classes will be arranged at the UG and PG levels respectively.

It is my aim that students getting higher education through the Centre for Distance Education should improve their qualification, have better employment opportunities and in turn be part of country's progress. It is my fond desire that in the years to come, the Centre for Distance Education will go from strength to strength in the form of new courses and by catering to larger number of people. My congratulations to all the Directors, Academic Coordinators, Editors and Lesson-writers of the Centre who have helped in these endeavors.

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M.Sc. BOTANY

SEMESTER-I, PAPER-V

105BO24 - PLANT SYSTEMATIC AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

PRATICAL-I

SYLLABUS

Plant Systematics Laboratory Exercises:

1) Description of specimens from locally available representative families.
2) Description of a genus based on 3-4 different species.
3) Identification of plant specimens using floras and identification keys.
4) Preparation of identification keys for at least 10 specimens based on morphological features.
5) Study of herbarium specimens of different families covered in theory course.

Reproductive Biology of Angiosperms Laboratory Exercises:

1) To study the permanent slides of different types ovules.
2) To study the T.S of Tetralobed duthecous anther and Bilobed monothecous anther.
3) To study the permanent slides of different types of embryosacs.
4) To study the permanent slides of Dicot embryo and monocot embryo.
5) To perform Pollen viability test.

CONTENTS

PLANT SYSTEMATICS

1. Experiment: Taxonomical Identification of different genera of Capparaceae (Caper Family)

50 genera 800 species

Widespread in tropical and subtropical regions.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Polypetalae	Subclass	Dillenidae	Subclass	Dilleniidae
Series	Thalamiflorae			Superorder	Violanae
Order	Parietales	Order	Capparales	Order	Capparales

B & H as Capparidaceae. Cronquist and Takhtajan as Capparaceae

Field Identification: Herbs or shrubs, sepals and petals 4 each, free, stamens many, ovary unilocular with parietal placentation, superior, sometimes with gynophore, fruit a capsule or berry.

Description: Herbs or shrubs, rarely trees or climbers. Leaves alternate, rarely opposite, simple or palmately compound, stipules present, sometimes reduced to glands or spines. Inflorescence typically racemose, corymbose, or umbel. Flowers bisexual, actinomorphic or zygomorphic, hypogynous. Sepals 4, rarely 2-8, free or connate, in two whorls, sometimes in one whorl. Petals usually 4 and cruciform (arranged in a cross), rarely 8 or even lacking, clawed. Androecium of 4 or more stamens, free, dehiscence longitudinal, nectaries often present near base of stamens. Gynoecium of 2-12 united carpels (syncarpous), unilocular with one-many ovules, placentation parietal, ovary superior, often on a gynophore, style 1, stigma capitate or bilobed. Fruit a berry, capsule, drupe, or nut, often stalked. Seeds 1-many, embryo curved, endosperm usually absent.

Importance: The family contributes a few ornamentals such as *Cleome* and *Crataeva.* The

fruit of *Capparis decidua* is pickled and also given to heart patients. The dried floral buds of C. *spinosa* are called capers and are used in seasoning. The decoction of *Cleome chelidonii* is used to cure scabies.

***Capparis decidua* 'Dela':**

Xerophytic shrub or small tree. **Leaves:** Alternate, simple, linear, unicostate reticulate, present only on very young shoots, stipules persistent, modified into spines. **Inflorescence:** Many flowered corymbs on short lateral branches. **Flower:** Ebracteate, ebraeteolate, pedicellate, complete, zygomorphic, bisexual, hypogynous, tetramerous, cyclic. **Calyx: 4**, polysepalous, in two whorls, antero-posterior pair outer, lateral pair inner smaller and saccate at base, green, inferior. **Corolla: 4**, polypetalous, cruciform, twisted, scarlet or reddish-brown, inferior. **Androecium:** Many, polyandrous, inserted on a disc at the base of gynophore, filaments long, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous superior ovary, unilocular, ovules many, placentation parietal, style minute, stigma bifid. Fruit: Many seeded berry.

Floral Formula: % ♂♀ $K_{2+2}C_4A_{OC}G_{(2)}$

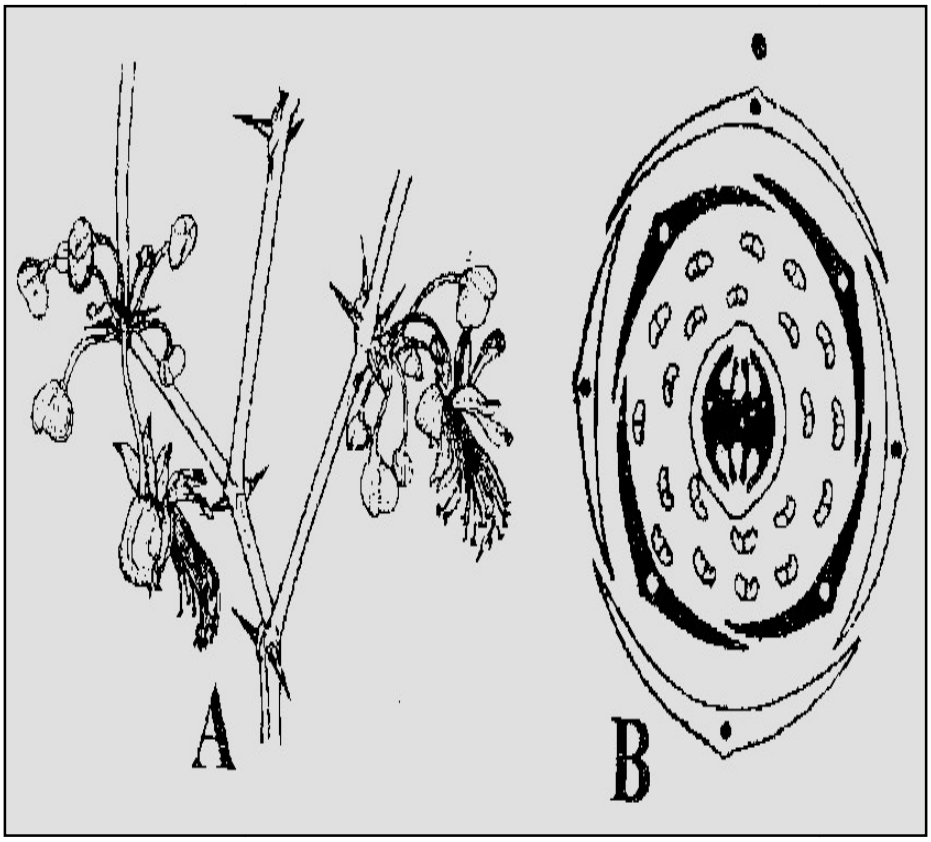

Fig. *Capparis decidua*: A, habit; B, floral diagram

***Cleome gynandra* 'Hurhur':**

Wild annual herb. **Leaves:** Alternate, palmately compound, 3-5 foliate, unicostate reticulate. **Inflorescence:** Corymbose raceme. **Flower:** Bracteate (bract leafy), ebracteolate, pedicellate, complete, actinomorphic, bisexual, hypogynous, thalamus elongated into a long androgynophore, tetramerous, cyclic. **Calyx:** 4, polysepalous, in two whorls, antero-posterior pair outer, lateral pair inner, green, inferior. **Corolla:** 4, polypetalous, cruciform, white or purple, clawed, inferior. **Androecium:** 6, polyandrous, seated on gynophore forming distinct androphore, anthers bithecous, basifixed, dehiscence longitudinal, extrorse. **Gynoecium:** Bicarpellary syncarpous superior ovary, unilocular, ovules many, placentation parietal, style short, stigma bifid. Fruit: Elongated capsule

Floral Formula: ⊕ ♂♀ $K_{2+2}C_4A_{OC}G_{(2)}$

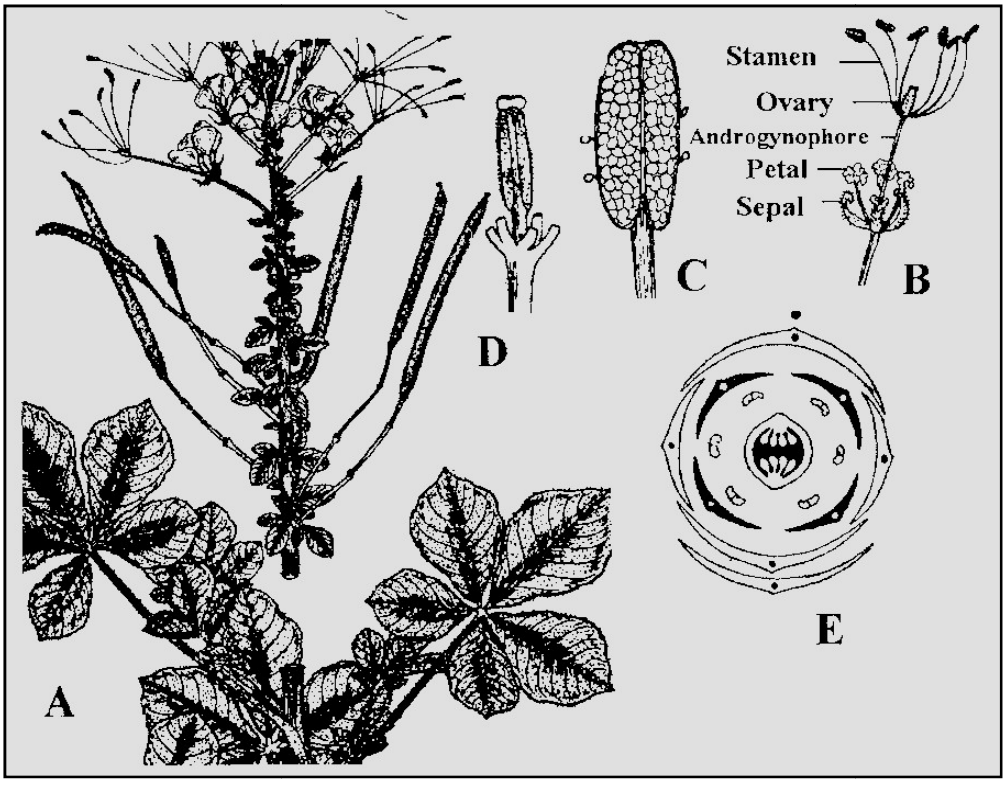

Fig. *Cleome gynandra*; A, habit; B, V.S.flower; C, stamen; D, gynoecium; E, floral diagram

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***2. Experiment: Taxonomical Identification of different genera of. Malvaceae* (Mallow Family)**

75 genera 1000 species

Distributed in tropical and temperate climates, mainly in the South American tropics.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Polypetalae	Subclass	Dillenidae	Subclass	Dilleniidae
Series	Thalamiflorae			Superorder	Malvanae
Order	Malvales	Order	Malvales	Order	Malvales

Field identification: Herbs and shrubs with stellate pubescence, often mucilaginous, leaves palmately veined, stipules prominent, flowers usually with epicalyx, stamens numerous with united filaments, anthers monothecous, carpels five or more, ovary superior, placentation axile.

Description: Herbs or shrubs, rarely small trees. Plants often mucilaginous. Leaves alternate, simple, palmately veined, pubescence stellate, stipules present. Inflorescence cymose or flowers solitary axillary. Flowers bisexual, actinomorphic, hypogynous. Sepals 5, more or less united, often subtended by epicalyx (bracteoles). Petals 5, free, often adnate at base to staminal tube. Androecium of many stamens, filaments united into a tube (monadelphous), anthers monothecous, dehiscence longitudinal. Gynoecium of 2-many (usually 5) united carpels (syncarpous), multilocular (locules as many as carpels) with many ovules, placentation axile, ovary superior, styles branched above. Fruit a loculicidal capsule or schizocarp, rarely a berry. Seeds I-many, embryo curved, endosperm absent.

Importance: The family is represented by several ornamentals such as China rose *(Hibiscus rosasinensis),* hollyhock *(Althaea rosea)* and rose of Sharon *(Hibiscus syriacus).* Young fruits of okra *(Hibiscus esculentus)* are used as vegetable. Cotton is obtained from different species of *Gossypium.*

***Hibiscus rosasinensis* China rose, Shoe flower:**

Ornamental shrub. **Leaves:** Alternate, simple, serrate, stipulate, unicostate reticulate. **Inflorescence:** Solitary axillary, peduncle jointed. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, mucilaginous, pentamerous, cyclic. **Epicalyx:** 5-7, free, green, linear. **Calyx:** 5, gamosepalous, campanulate, valvate, green, inferior. **Corolla:** 5, polypetalous, twisted, red, mucilaginous, inferior. **Androecium:** Many, monadelphous, epipetalous, staminal tube with 5 antipetalous teeth at apex, anthers monothecous, transversely attached, dehiscence longitudinal, extrorse. **Gynoecium:** Pentacarpellary syncarpous superior ovary, pentalocular, ovules many, placentation axile, style divided above into 5 branches, stigmas 5, capitate. **Fruit:** Loculicidal capsule.

Floral Formula: ⊕ ♂♀ Epi $K_{5-7}K_{(5)}C_5A_{(a)}G_{(\underline{5})}$

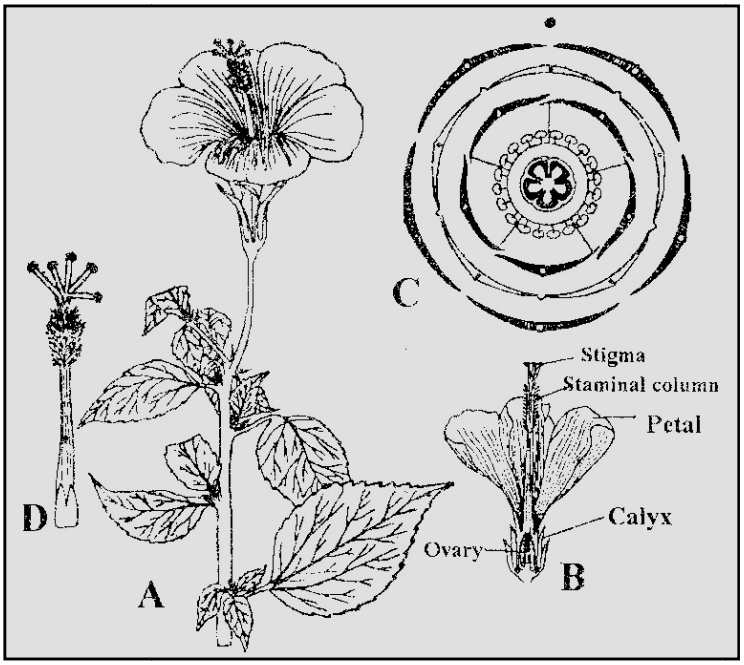

Fig. *Hibisucs rosasinensis:* A, habit; B, V.S. flower; C, floral diagram; D, staminal tube with enclosing style and stigmas.

***Althaea rosea* Hollyhock:**

Cultivated annual herb. **Leaves:** Alternate, simple, palmately lobed, stipulate, multicostate reticulate. **Inflorescence:** Solitary axillary or axillary cymose clusters. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, mucilaginous, pentamerous, cyclic. **Epicalyx:** 6-9, united, green, linear. **Calyx:** 5, gamosepalous, campanulate, valvate, green, inferior. **Corolla:** 5, polypetalous, twisted, variously coloured,

mucilaginous, inferior. **Androecium:** Many, monadelphous, epipetalous, staminal tube enclosing ovary, anthers monothecous, transversely attached, dehiscence longitudinal, extrorse. **Gynoecium:** Polycarpellary syncarpous superior ovary, multilocular, ovule one in each loculus, placentation axile, style divided above into as many branches as carpels, stigmas linear. **Fruit:** Carcerulus splitting into one seeded mericarps.

Floral Formula: ⊕ ♂♀ Epi $K_{(6-9)}K_{(5)}C_5A_{(oc)}G_{(\alpha)}$

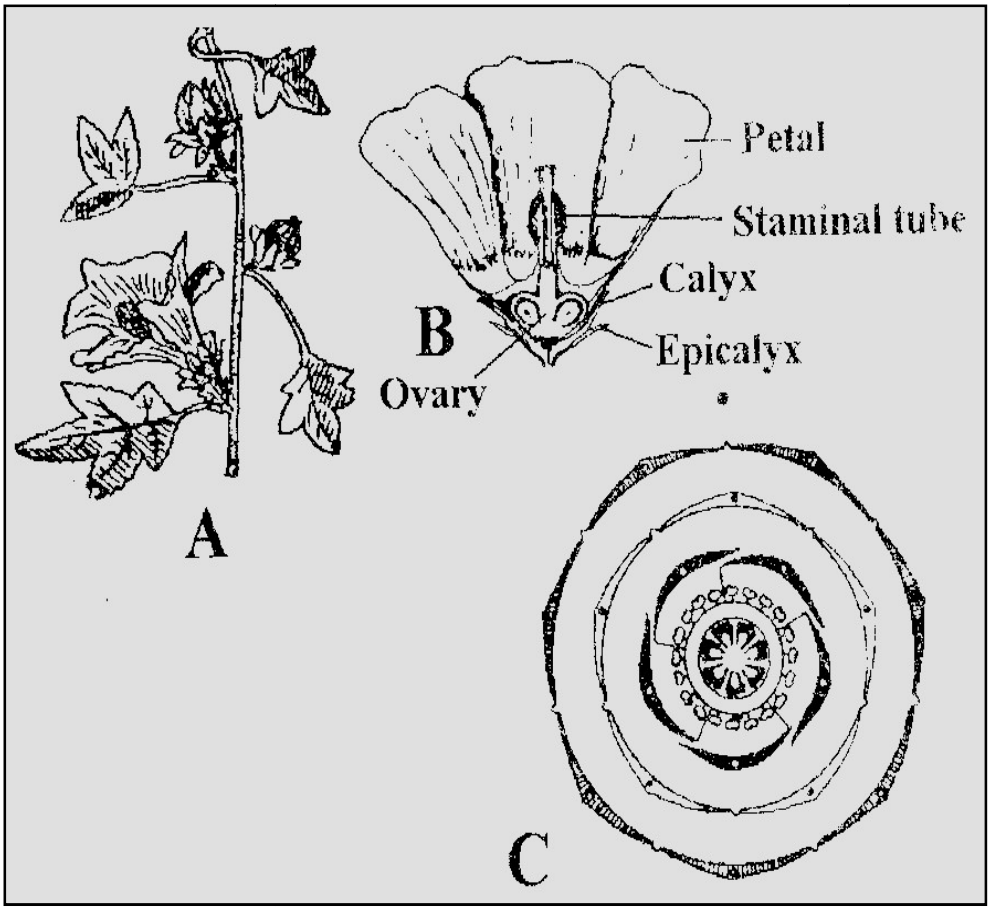

Fig. *Althaea rosea*: A, habit; B, V.S. flower; C, floral diagram

***Malva parviflora* Common mallow 'Sonchal':**

Wild annual herb. Leaves: Alternate, simple, palmately 5-7-lobed, stipulate, multicostate reticulate. **Inflorescence:** Axillary cymose clusters, sometimes solitary axillary. **Flower:** Bracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, mucilaginous, pentamerous, cyclic. **Epicalyx:** 3, free, green, linear. **Calyx:** 5, gamosepalous, odd sepal anterior, campanulate, valvate, green, persistent, inferior. **Corolla:** 5, polypetalous, twisted, white or pink, mucilaginous, inferior. **Androecium:** Many, monadelphous, staminal tube enclosing ovary, anthers monothecous, transversely attached, dehiscence longitudinal,

extrorse. **Gynoecium:** Polycarpellary syncarpous superior ovary, multilocular, ovule one in each loculus, placentation axile, style divided above into as many branches as carpels, stigmas linear. **Fruit:** Carcerulus splitting into one seeded mericarps.

Floral Formula: ⊕ ♂♀ Epi $K_3K_{(5)}C_5A_{(\alpha)}G_{\underline{(\alpha)}}$

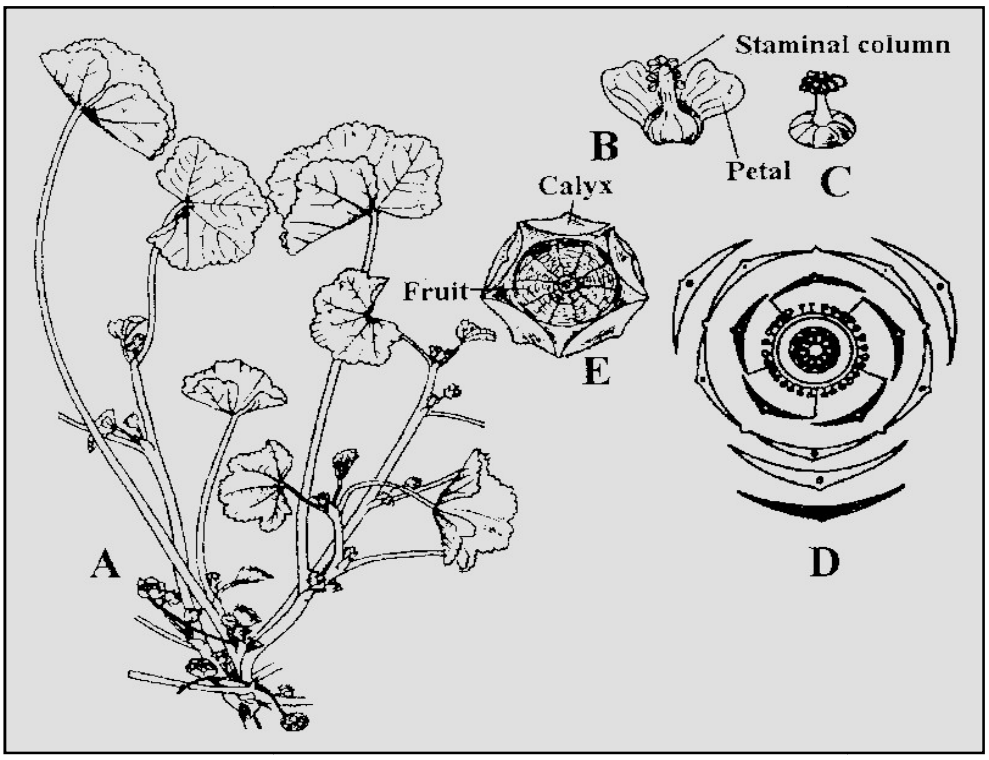

Fig. *Malva parviflora*: A, habit; B, flower; C, gynoecium; D, floral diagram; E, fruit enclosed in calyx.

***Gossypium herbaceum* Cotton 'Bari':**

Cultivated shrub. **Leaves:** Alternate, simple, palmately 3-5 lobed, stipulate, multicostate reticulate. **Inflorescence:** Solitary axillary, peduncle jointed. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, mucilaginous, pentamerous, cyclic. **Epicalyx:** 3, united, leafy. **Calyx:** 5, gamosepalous, odd sepal anterior, cupulate, valvate, green, persistent, inferior. **Corolla:** 5, polypetalous, twisted, pale yellow, mucilaginous, inferior. **Androecium:** Many, monadelphous, staminal tube enclosing ovary, anthers monothecous, transversely attached, dehiscence longitudinal, extrorse. **Gynoecium:** Tri- to pentacarpellary syncarpous superior ovary, 3-5 locular, many ovules in each loculus, placentation axile, style unbranched, stigmas 3-5. **Fruit:** Capsule opening by 3-5 valves.

Floral Formula: ⊕ ♂♀ Epi $K_{(3)}K_{(5)}C_5A_{(\alpha)}G_{\underline{(3-5)}}$

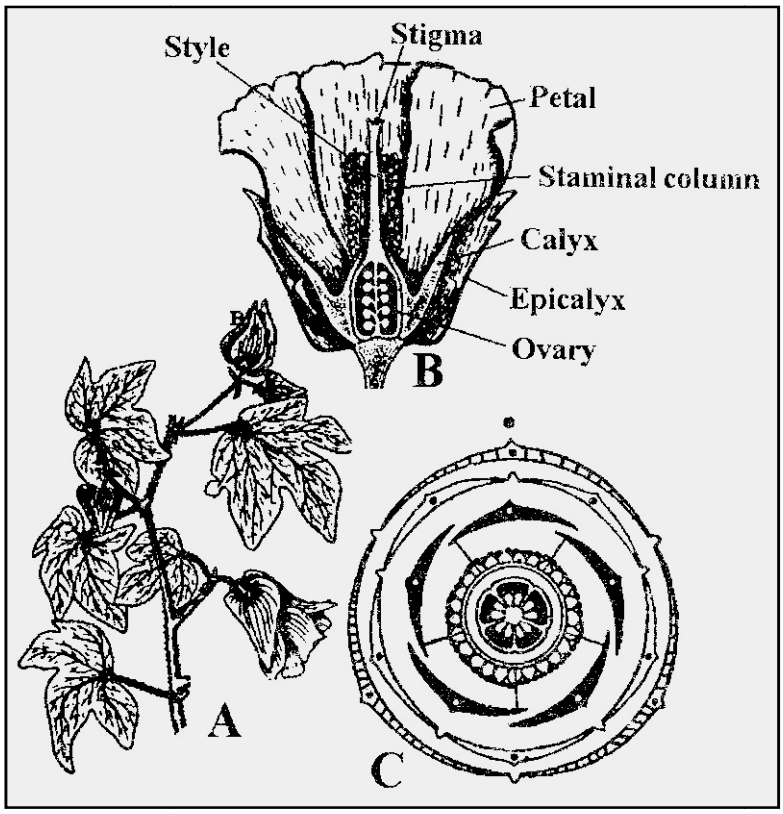

Fig. *Gossypium herbaceum*: A: habit; B: V.S. flower; C: floral diagram

***Abutilon indicum* 'Kanghi':**

Wild shrub or undershrub. **Leaves:** Alternate, simple, stipulate, multicostate reticulate. **Inflorescence:** Solitary axillary, peduncle jointed. **Flower:** Ebracteate, pedicellate, pedicel very long, complete, actinomorphic, bisexual, hypogynous, mucilaginous, pentamerous, cyclic. **Epicalyx:** Absent. **Calyx:** 5, gamosepalous, campanulate, valvate, green, persistent, inferior. **Corolla:** 5, polypetalous, twisted, yellow, inferior. **Androecium:** Many, monadelphous, anthers monothecous, transversely attached, dehiscence longitudinal, extrorse. **Gynoecium:** Multicarpellary syncarpous superior ovary, multilocular, 2 ovules in each loculus, placentation axile, style unbranched, stigmas many. **Fruit:** Schizocarpic capsule.

Floral Formula: ⊕ ♂♀ Epi $K_0K_{(5)}C_5A_{(\alpha)}G_{(\underline{\alpha})}$

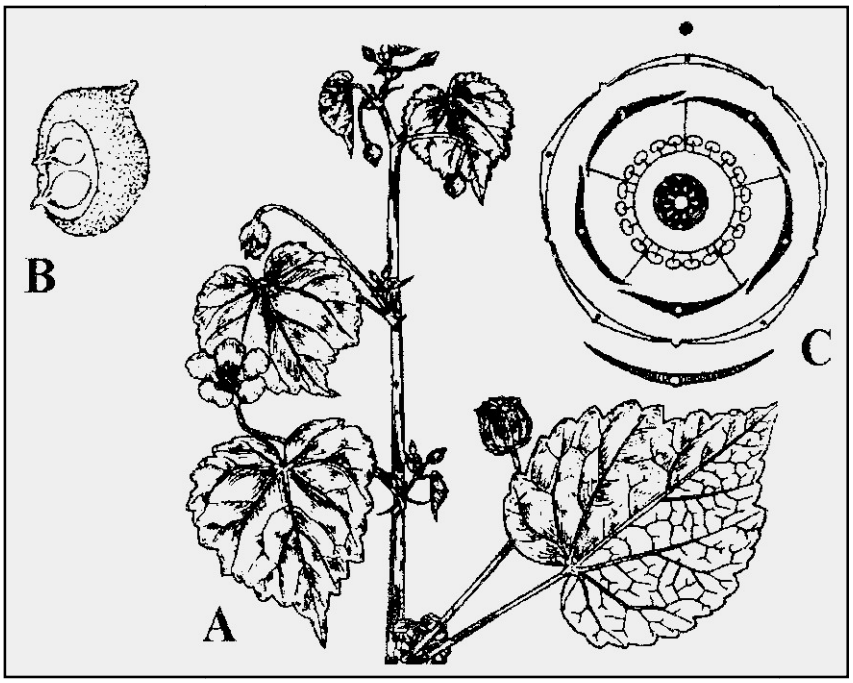

Fig. *Abutilon indicum*: A, habit; B, portion of fruit cut lengthwise; C, floral diagram

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3. Experiment: Taxonomical Identification of different genera of Rutaceae

150 genera 1500 species

Distributed in warm temperate and tropical regions with greatest diversity in Australia and South Africa.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Polypetalae	Subclass	Rosidae	Subclass	Rosidae
Series	Disciflorae			Superorder	Rutanae
Order	Geraniales	Order	Sapindales	Order	Rutales

Field identification: Trees or shrubs, leaves usually compound and gland dotted, stamens free or polyadelphous, sometimes obdiplostemonous, ovary superior, seated on a nectary disc, fruit a berry.

Description: Shrubs or trees, rarely herbs, often aromatic. Leaves alternate, rarely opposite, usually pinnate compound, sometimes unifoliate due to reduction of lower two leaflets *(Citrus),* less frequently simple, gland dotted, stipules absent. Inflorescence cymose or flowers solitary. Flowers bisexual (rarely unisexual), actinomorphic (rarely zygomorphic), hypogynous. Sepals 4-5, free or more or less united. Petals 4-5, free, sometimes absent. Androecium of 8-10 (rarely many) stamens, free or polyadelphous, sometimes obdiplostemonous, anthers bithecous, dehiscence longitudinal. Gynoecium of 2-5 united carpels (syncarpous), multilocular (locules as many as carpels) with I-many ovules, placentation axile, ovary superior and lobed, style 1, stigma small. Fruit a berry, drupe, hesperidium or schizocarp. Seeds 1-many, embryo curved or straight, endosperm absent or present.

Importance: The family is important for its citrus fruits such as lemon *(Citrus limon),* lime (*C. aurantifolia),* sweet orange or 'mousmi' (*C. sinensis),* tangerine or 'sangtra' (*C. reticulata)* and grapefruit (*C. paradisi). Aegle marmelos* is grown for its fruits. *Murraya paniculata* is cultivated as ornamental shrub, whereas *M. koenigii* is cultivated for its curry leaves. Leaves of *Skimmia laureola* are burnt to purify air.

***Murraya paniculata* 'Kamini':**

Cultivated evergreen shrub. **Leaves:** Alternate, imparipinnate, leaflets 57, gland-dotted, coriaceous, exstipulate, unicostate reticulate. **Inflorescence:** Axillary or terminal many flowered cymes. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, valvate, green, inferior. **Corolla:** 5, polypetalous, imbricate, gland-dotted, fragrant, white, inferior. **Androecium:** 10, in two whorls, outer whorl alternating with petals, inner opposite (diplostemonous), anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bi- to tricarpellary syncarpous superior ovary, bi- to trilocular, 1-2 ovules in each loculus, placentation axile, style long, stigma 2-3-fid, ovary surrounded at base by a large nectariferous disc. **Fruit:** Red ovoid berry.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_5A_{5+5}G_{(2-3)}$

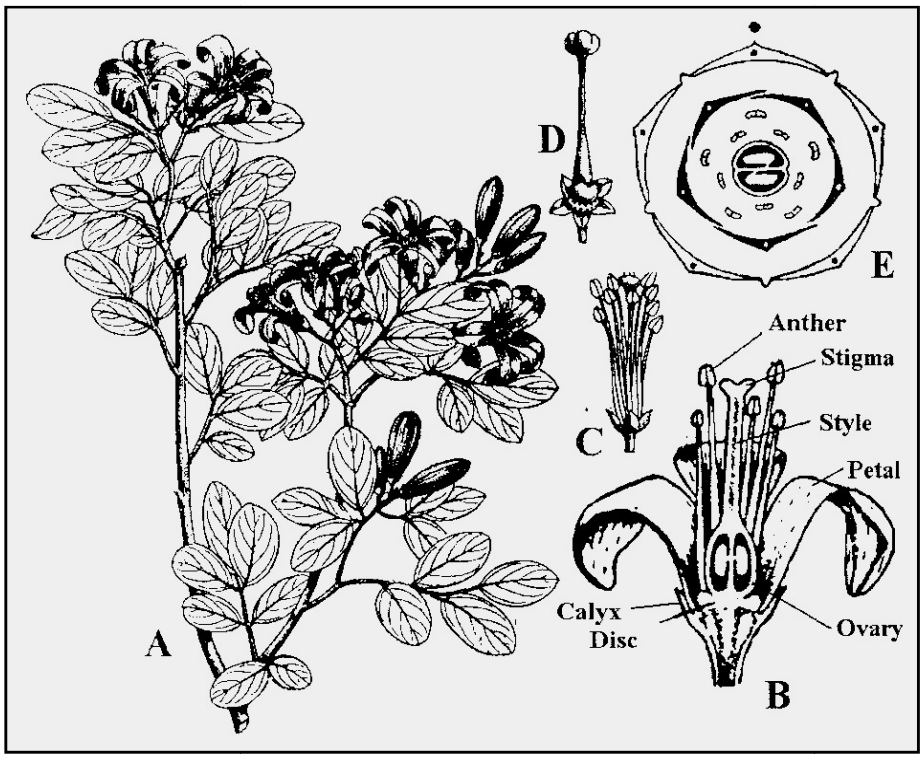

Fig. *Murraya paniculata*: A, habit; B, V.S. flower; C, flower with petals removed; D, gynoecium; E, floral diagram.

***Citrus auratnium* Sour orange 'Khatta':**

Cultivated evergreen tree. **Leaves:** Alternate, compound, unifoliate (trifoliate compound leaf with reduced lower two leaflets forming wings of petiole below the developed terminal leaflet), gland-dotted, coriaceous, exstipulate, unicostate reticulate. **Inflorescence:** Few

flowered axillary cymes. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, 5-fid, valvate, green, inferior. **Corolla:** 5, polypetalous, imbricate, gland-dotted, fragrant, white, inferior. **Androecium:** Many, polyadelphous, filaments fused at base into five or more groups, anthers bithecous, dorsifixed, dehiscence longitudinal, introrse. **Gynoecium:** Polycarpellary syncarpous superior ovary, multiocular, many ovules in each loculus, placentation axile, style long, stigma capitate, ovary surrounded at base by a large nectariferous disc. **Fruit:** Berry called hesperidium.

Floral Formula: ⊕ ♂♀ $KC_5A_{(oc)}G_{(\underline{oc})}$

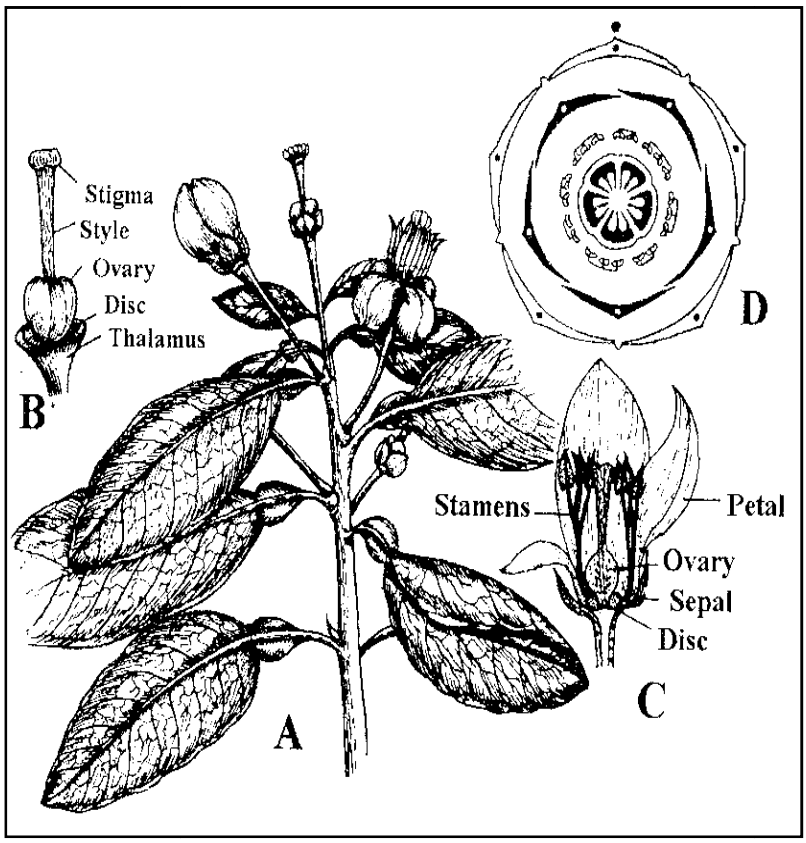

Fig. *Citrus aurantium:* A, habit; B, gynoecium; C, V.S. flower; D, floral diagram.

* * * * *

4. Experiment: Taxonomical Identification of different genera of. Fabaceae (Leguminosae) Bean or Pea family

640 genera 17200 species

Probably the third largest family, cosmopolitan in distribution, primarily in warm temperate regions.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Polypetalae	Subclass	Rosidae	Subclass	Rosidae
Series	Calyciflorae			Superorder	Fabanae
Order	Rosales	Order	Fabales	Order	Fabales

B & H as Leguminosae, Takhtajan as Fabaceae.

Cronquist recognises three independent families Fabaceae, Caesalpiniaceae and Mimosaceae, thus restricting the name Fabaceae to include only papilionaceous (members of Papilionoideae) members, for which the alternate name is Papilionaceae and not Leguminosae.

This large family has traditionally been divided into three subfamilies Papilionoideae (Faboideae), Caesalpinioideae and Mimosoideae. These have been recognised as independent families Fabaceae (Papilionaceae), Caesalpiniaceae and Mimosaceae in several recent systems of classification. It must be noted that name Fabaceae is valid for family sensu lato as well as for Papilionoideae upgraded as family. Leguminosae is the alternate name only for former whereas Papilionaceae is the alternate name for latter. Common features of the family include leaves usually compound with pulvinate base, odd sepal anterior, flowers perigynous, carpel 1 with marginal placentation and fruit commonly a pod or lomentum.

Subfami1y ***Paboideae (Papilionoideae)***

B & H as Papilionoideae, Takhtajan as Faboideae

Cronquist as family **Fabaceae (Papilionaceae)**

440 genera 12000 species

Field identification: Trees, shrubs or herbs, leaves usually pinnate compound with pulvinate base, flowers zygomorphic with papilionaceous corolla, sepals united, odd sepal anterior, stamens 10, usually diadelphous (1+9), carpel 1, ovary superior, fruit a pod.

Description: Trees, shrubs or herbs commonly with root nodules. Leaves alternate, pinnately or palmately compound, sometimes simple, leaf base (sometimes also the base of leaflets) pulvinate, stipules present. Inflorescence racemose, in racemes, heads or spikes. Flowers bisexual, zygomorphic, perigynous. Sepals 5, more or less united, odd sepal anterior. Petals 5, free, papilionaceous consisting of a posterior standard or vexillum, two lateral wings or alae and two anterior petals fused along margin to form keel or carina which encloses stamens and pistil, posterior petal outermost. Androecium of 10 stamens, diadelphous (1 posterior free and filaments of nine fused into a tube which is open posteriorly), rarely monadelphous, anthers bithecous, dehiscence longitudinal. Gynoecium with a single carpel, unilocular with many ovules, placentation marginal, ovary superior, style single, curved. Fruit a legume or pod, rarely a lomentum. Seeds 1many, seed coat hard, endosperm minute or absent, food reserves in cotyledons.

Importance: The subfamily is of major economic importance ranking second to Poaceae. It is the source of several pulse crops such as kidney bean *(Phaseolus vulgaris),* green gram *(P. aureus),* black gram *(P. mungo),* lentil *(Lens esculenta),* chick pea *(Cicer aurantium)* pea *(Pisum sativum)* and pigeon pea *(Cajanus cajan).* Soybean *(Glycine max)* and peanut *(Arachis hypogaea)* yield oil and high-protein food. Indigo dye is obtained from *Indigofera tinctoria.* The seeds of *Abrus precatorius* are used in necklaces and rosaries, but are extremely poisonous and can be fatal if ingested. The important fodder plants include alfalfa *(Medicago sativa)* and clover *(Trifoliym).* Common ornamentals include lupin *(Lupin us),* sweet pea *(Lathyrus odoratus), Wisteria, Laburnum* and *Erythrina.*

Lathyrus odoratus **Sweet pea**

Cultivated annual herb climbing by tendrils. **Leaves:** Alternate, pinnate compound, upper 3-5 leaflets modified into tendrils, leaf base pulvinate, stipulate, unicostate reticulate. **Inflorescence:** Few flowered raceme. **Flower:** Bracteate (bract caducous), pedicellate, complete, zygomorphic, bisexual, perigynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, campanulate, odd sepal anterior, valvate, green, inferior. **Corolla:** 5, polypetalous, papilionaceous consisting of large posterior standard or vexillurn, two lateral wings, and two anterior connate to form keel, vexillary or descending imbricate aestivation, pink or purple,

inferior. **Androecium:** 10, diadelphous, 1 + (9), 9 fused into a tube surrounding the ovary and tenth posterior free, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Monocarpellary superior ovary, unilocular, ovules many, placentation marginal, style long, curved, stigma simple. **Fruit:** Legwne.

Floral Formula: % ♂♀ $K_{(5)}C_{1+2+(2)}A_{1+(9)}\underline{G_1}$

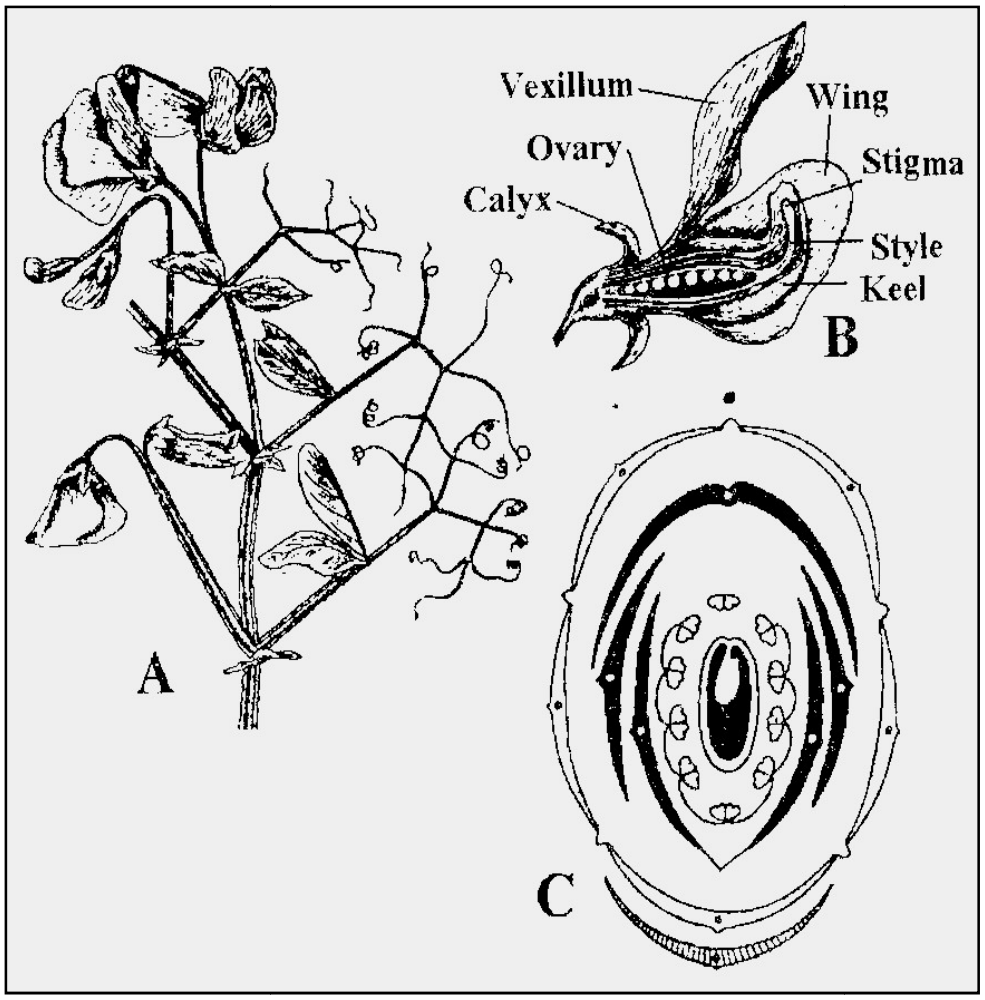

Fig. *Lathyrus odoratus*: A, habit; B, V.S. flower; C, floral diagram. *Cajanus cajan* Pigeon pea 'Arhar'

Small tree. **Leaves:** Alternate, trifoliate compound, leaf base pulvinate, stipulate, unicostate reticulate. **Inflorescence:** Axillary and terminal racemes. **Flower:** Bracteate (bract caducous), pedicellate, complete, zygomorphic, bisexual, perigynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, campanulate, odd sepal anterior, valvate, green, inferior. **Corolla:** 5, polypetalous, papilionaceous consisting of large posterior standard or vexillum, two lateral wings, and two anterior connate to form keel, vexillary or descending imbricate aestivation, yellow or purple, inferior. **Androecium:** 10, diadelphous, 1 + (9), 9 fused into a tube

surrounding the ovary and tenth posterior free, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Monocarpellary superior ovary, unilocular, ovules many, placentation marginal, style long, curved, stigma simple. **Fruit:** Legume, constricted between seeds.

Floral Formula: % ♂♀ $K_{(5)}C_{1+2+(2)}A_{1+(9)}\underline{G_1}$

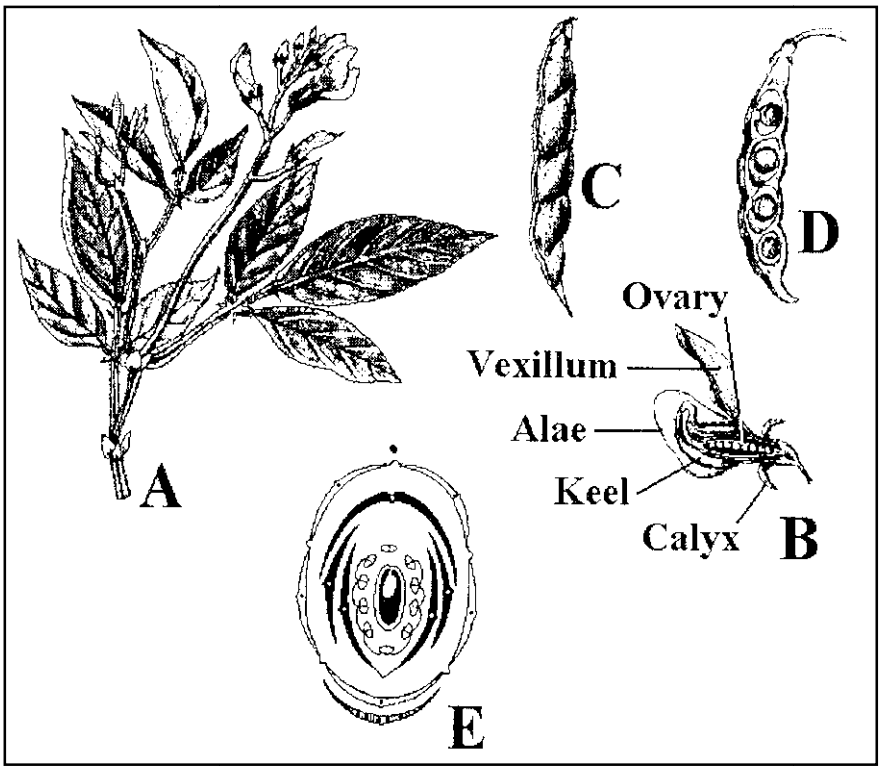

Fig. *Cajanus cajan*: A, habit; B, V.S. flower; C, fruit, D, fruit split open; E, floral diagram.

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5. Experiment: Taxonomical Identification of different genera of *Rubiaceae*

450 genera 6500 species

Worldwide in distribution, but mainly distributed in tropics and subtropics especially the woody members.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Gamopetalae	Subclass	Asteridae	Subclass	Lamiidae
Series	Inferae			Superorder	Gentiananae
Order	Rubiales	Order	RubialesOrder	Rubiales	

Field identification: Mainly shrubs and trees, leaves opposite or whorled, stipules interpetiolar, inflorescence cymose, flowers pentamerous, stamens 5, ovary inferior.

Description: Trees or shrubs, rarely herbs. Leaves opposite, with interpetiolar stipules which often become as large a leaves and thus forming whorled arrangement of leaves, simple, entire. Inflorescence cymose, sometimes capitate, or solitary. Flowers bisexual, actinomorphic (rarely zygomorphic) epigynous. Sepals 4-5, adnate to ovary, 5-lobed, lobes often very small. Petals 4-5 (rarely 8-10), united forming a tube, valvate. Androecium of 4-5 stamens, free, epipetalous, anthers bithecous, dehiscence longitudinal. Gynoecium of 2 (rarely 1-many) united carpels (syncarpous), bilocular (rarely 1-many locules) with 1-many ovules in each chamber, placentation axile (rarely apical or basal), ovary inferior, style slender, stigma capitate or lobed. Fruit a berry, capsule, drupe or schizocarp. Seeds 1-many, with small embryo, curved or straight, endosperm present or absent.

Importance: The family is economically important for being the source of coffee, quinine and a large number of ornamentals. Coffee is obtained from roasted seeds of *Coffea arabica* and *C. canephora.* Quinine, a remedy for malaria is derived from several species of *Cinchona.* Madder *(Rubia tinctoria)* was formerly cultivated for its red dye alizarin. Important ornamentals include *Gardenia, Ixora, Hamelia, Anthocephalus* and *Mussaenda.*

Hamelia patens

Ornamental shrub or small tree. **Leaves:** Opposite, simple, stipules interpetiolar, sometimes becoming leafy to form whorled arrangement of leaves, unicostate reticulate. **Inflorescence:** Terminal polychasial cymes or paniculate, successive branches dichasial cymes, ultimate branches helicoid cymes. **Flower:** Ebracteate, sessile (or subsessile), complete, actinomorphic, bisexual, epigynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, lobes very small, valvate, tinged with orange, superior. **Corolla:** 5, gamopetalous, tubular, lobes small, valvate, orange, superior. Androecium: 5, polyandrous, epipetalous, anthers bithecous, dorsifixed, dehiscence longitudinal. **Gynoecium:** Pentacarpellary (rarely tetracarpellary), syncarpous inferior ovary, pentalocular (rarely tetralocular) with many ovules in each loculus, placentation axile, style simple, stigma simple. **Fruit:** Berry.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_5A_5G_{(5)}$

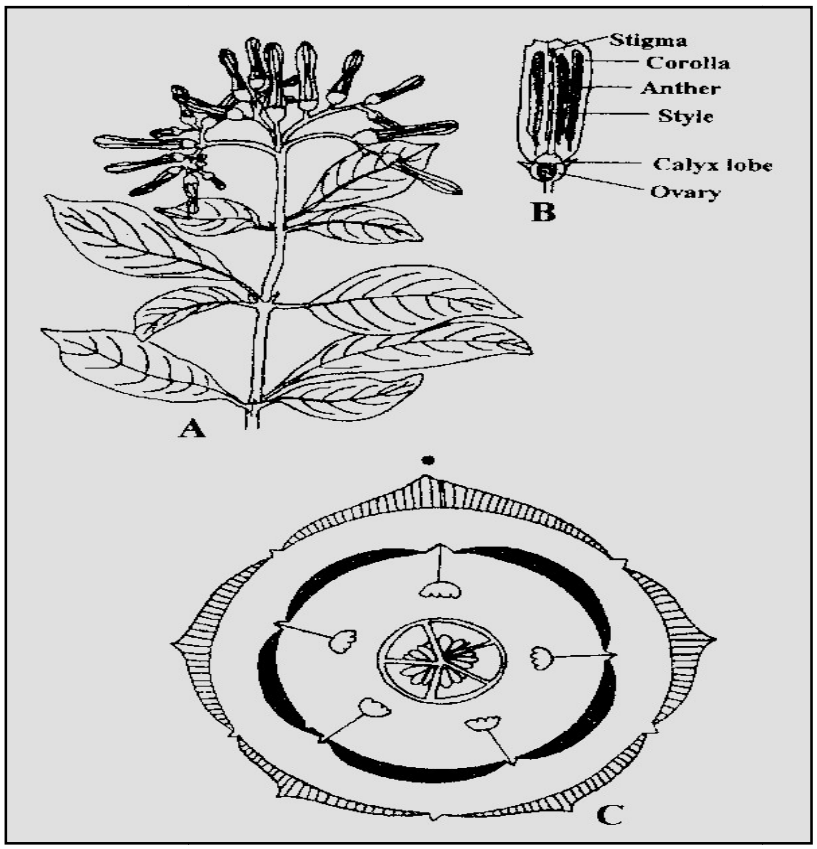

Fig. *Hamelia patens*: A, habit; B, V.S. flower; C, floral diagram

Mussaenda luteola:

Ornamental shrub or small tree. **Leaves:** Opposite, simple, stipules interpetiolar, unicostate reticulate. **Inflorescence:** Terminal compound cymes, rarely solitary. **Flower:**

Ebracteate, pedicellate, complete, actinomorphic (some flowers zygomorphic), bisexual, epigynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, lobes small, one calyx lobe in some flowers enlarged leaf-like and light yellow, valvate, yellow, superior. **Corolla:** 5, gamopetalous, tubular, valvate, yellow, throat hairy, superior. **Androecium:** 5, polyandrous, epipetalous, anthers bithecous, dorsifixed, dehiscence longitudinal. **Gynoecium:** Bicarpellary syncarpous inferior ovary, bilocular with many ovules in each loculus, placentation axile, style simple, stigmas 2. **Fruit:** Berry.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_5A_5G_{(2)}$

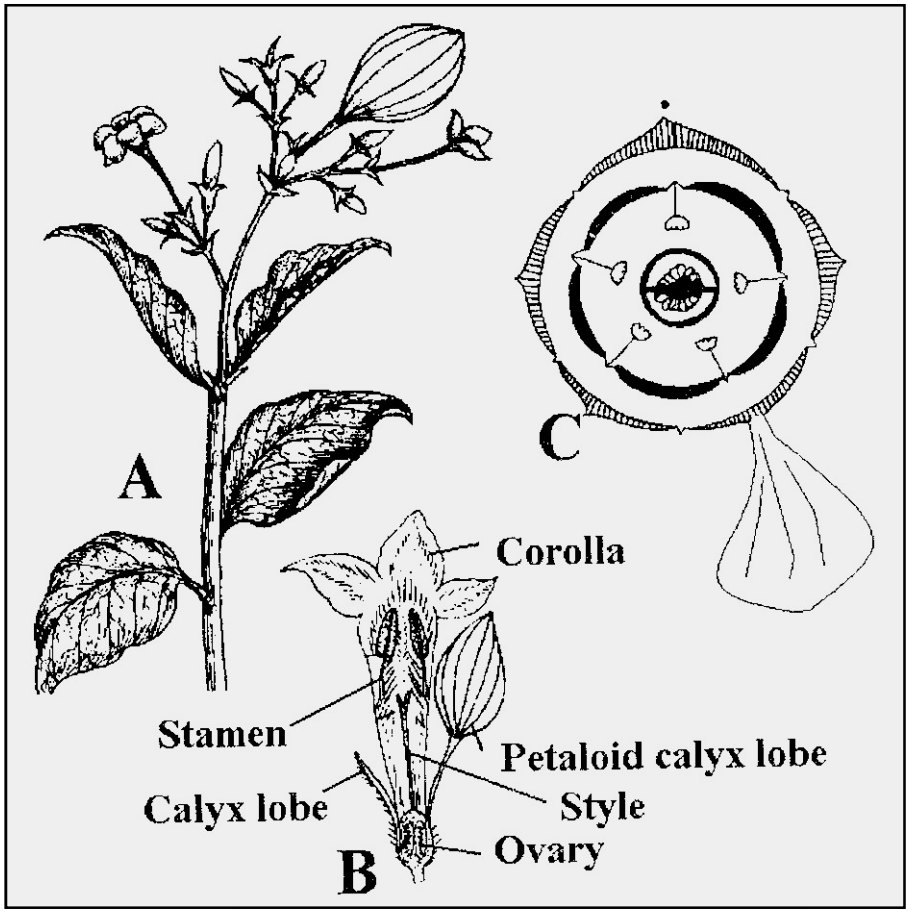

Fig. *Mussaenda luteola*; A, habit; B, V.S. flower; C, floral diagram

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6 Experiment: Taxonomical Identification of different genera of *Asteraceae* (Compositae) Sunflower or Aster family

1100genera 20000 species

Largest family of flowering plants, worldwide in distribution mainly in temperate and subtropical climate.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Gamopetalae	Subclass	Asteridae	Subclass	Asteridae
Series	Inferae			Superorder	Asteranae
Order	Asterales	Order	Asterales	Order	Asterales

B & H as Compositae Cronquist and Takhtajan as Asteraceae

Field identification: Usually herbs, inflorescence a capitulum with ray florets and disc florets (one type or both in a head), surrounded by involucre bracts (phyllarles), calyx represented by pappus, anthers united forming a cylinder around style, style with two branches, fruit a cypsela, ovary inferior.

Description: Usually herbs or shrubs, rarely trees *(Vernonia)* or lianas, often covered with pubescence or glands, sometimes with milky latex. Leaves usually alternate and simple, sometimes compound *(Dahlia, Bidens),* rarely opposite *(Dahlia)* or whorled, stipules absent. Inflorescence a capitulum with broad receptacle containing disc florets (discoid head), ray florets (ligulate head) or both type of florets with latter towards the periphery (radiate head), all types of head having florets surrounded by involucre bracts (phyllaries); capitula solitary or arranged in cymes, heads, racemes or panicles. Flowers bisexual (usually disc florets in radiate and discoid heads and ray florets of ligulate head) or unisexual (commonly ray florets in ligwate head, which may even be sterile), actinomorphic (usually disc florets) or

zygomorphic (usually ray florets), epigynous. Sepals absent or represented by pappus in the form of scales, bristles, or hairs. Petals 5, united, tubular and 5-lobed (disc floret) or ligulate with 3-5 teeth (ray floret: sometimes also bilabiate). Androecium of 5 stamens with free filaments and united anthers (syngenesious) forming a tube around the style, epipetalous, anthers bithecous, dehiscence longitudinal. Gynoecium of 2 united carpels (syncarpous), unilocular with a single ovule, placentation basal, ovary inferior, style with two branches. Fruit a cypsela (often called achene which typically, however, is formed from single carpel with superior ovary) usually with pappus at tip. Seeds 1, embryo straight, endosperm usually absent.

Importance: Compared to the number of species included, the family is of lesser economic importance. Common valuable ornamentals include species of *Aster, Dahlia, Chrysanthemum, Gerbera, Helichrysum, Tagetus* and *Zinnia.* A few food plants include *Lactuca* (lettuce), *Cynara* (artichoke), *Helianthus* (sunflower oil), and *Cichorium* (chicory, added to coffee). Safflower a red dye is obtained from *Carthamus tinctorius. Chrysanthemum cinerariefolium* is the source of natural insecticide pyrethrum. *Artemisia cina* yields santonin which is used to treat iritestinal parasites.

Helianthus annuus **Sunflower 'Suraj mukhi'**

Cultivated annual herb. **Leaves:** Alternate, simple, hairy, stipules absent, unicostate reticulate. **Inflorescence:** Capitulum, radiate head with broad receptacle bearing disc florets towards centre and ray florets towards periphery surrounded by green involucre bracts (phyllaries). **Ray Floret:** Bracteate, sessile, incomplete, zygomorphic, female or sterile, epigynous, pentamerous, cyclic. **Calyx:** Represented by pappus with 2-3 free scales. **Corolla:** 5, gamopetalous, ligulate, 3-toothed, valvate, yellow, superior. **Androecium:** Absent. **Gynoecium:** Absent if present bicarpellary syncarpous inferior ovary, unilocular with single ovule, placentation basal, style bifid above, stigmas 2. **Fruit:** Cypsela. **Disc Floret:** Bracteate, sessile, complete, actinomorphic, bisexual, epigynous, pentamerous, cyclic. **Calyx:** Represented by pappus with 2-3 free scales. **Corolla:** 5, gamopetalous, tubular, 5-toothed, valvate, yellow, superior. **Androecium:** 5, epipetalous, syngenesious anthers forming a tube aroud style, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous inferior ovary, unilocular with single ovule, placentation basal, style bifid above, stigmas 2. **Fruit:** Cypsela.

Floral Formula: Ray floret %♀ $K_{pappus}C_{(5)}A_0G_{(2)}$

Disc floret ⊕ ♂♀ $K_{pappus}C_5A_5G_{(2)}$

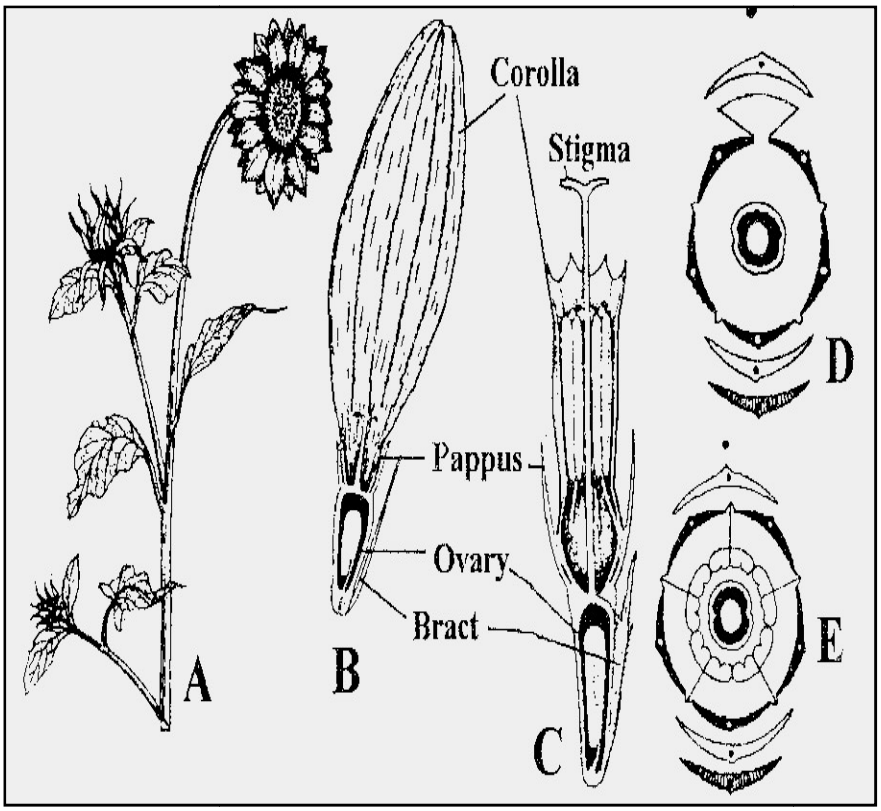

Fig. *Helianthus annuus*: A, habit; B, V.S. ray floret; C, V.S. disc floret; D, floral diagram of ray floret;

E, floral diagram of disc floret.

Calendula officinalis Pot marigold

Cultivated annual herb. **Leaves:** Alternate, simple, hairy, stipules absent, unicostate reticulate. **Inflorescence:** Capitulum, radiate head with broad receptacle bearing disc florets towards centre and ray florets towards periphery surrounded by green involucre bracts (phyllaries), sometimes only peripheral florets are fertile. **Ray Floret:** Bracteate (outer) or ebractate (inner), sessile, incomplete, zygomorphic, female, epigynous, pentamerous, cyclic. **Calyx:** Represented by pappus with 2-3 free scales orllbsent. **Corolla:** 5, gamopetalous, ligulate, 3-5-toothed, valvate, yellow, superior. **Androecium:** Absent. **Gynoecium:** Bicarpellary syncarpous inferior ovary, unilocular with single ovule, placentation basal, style bifid above, stigmas 2. **Fruit:** Cypsela. **Disc Floret:** Ebracteate, sessile, actinomorphic, bisexual or sterile, epigynous, pentamerous, cyclic. **Calyx:** Represented by pappus with 2 free scales or absent. **Corolla:** 5, gamopetalous, tubular, 5-toothed, valvate, yellow, superior.

Androecium: Absent or 5, epipetalous, syngenesious anthers forming a tube aroud style, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous inferior ovary, unilocular with single ovule, placentation basal, style bifid above, stigmas 2, often with rudimentary stigmas and sterile. **Fruit:** Cypsela

Floral Formula: Ray floret %♀ $K_{pappus}C_{(5)}A_0G_{(2)}$

Disc floret ⊕ ♂♀ $K_{pappus}C_5A_5G_{(2)}$

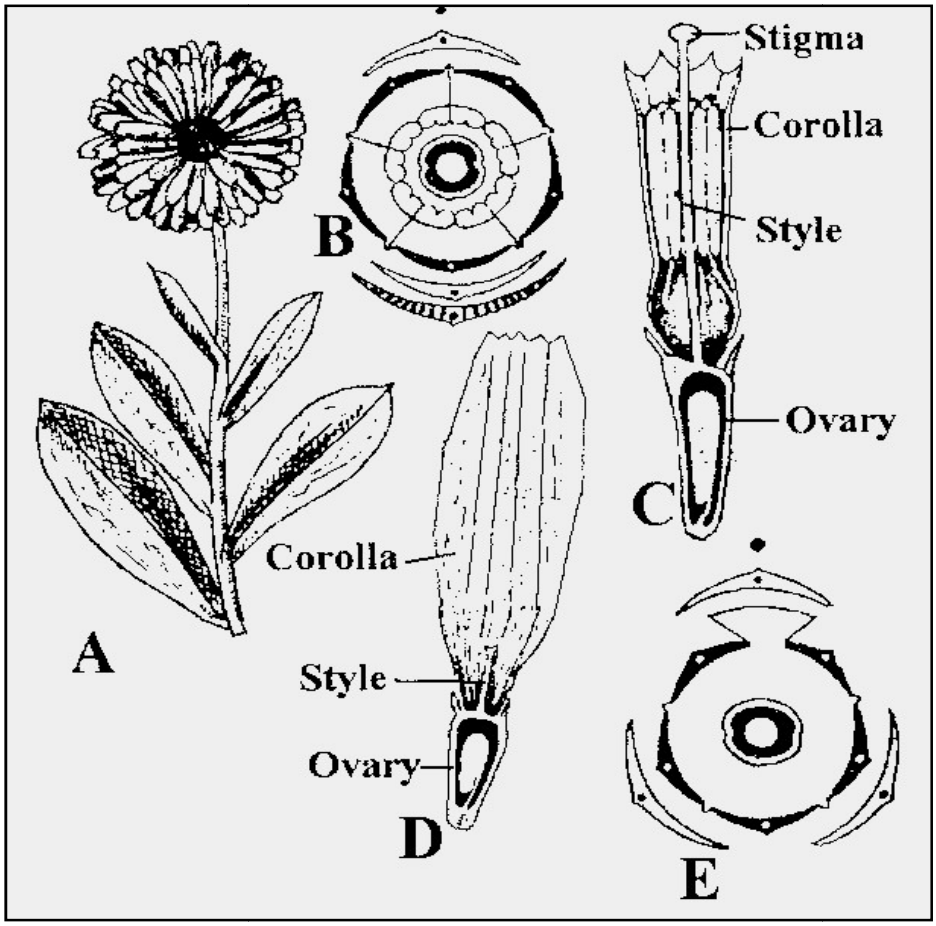

Fig. *Calendula officinals*: A, habit; B, floral diagram of disc floret; C, V.S. of disc floret; D, V.S. ray floret, E, floral diagram of ray floret.

Ageratum houstonianum

Cultivated annual herb. **Leaves:** Alternate, simple, hairy, stipules absent, unicostate reticulate. **Inflorescence:** Capitulum, discoid head with broad receptacle bearing disc florets surrounded by green involucre bracts (phyllaries). **Disc Floret:** Ebracteate, sessile, actinomorphic, bisexual, epigynous, pentamerous, cyclic. **Calyx:** Represented by pappus with 5 connate scales. **Corolla:** 5, gamopetalous, tubular, 5-toothed, valvate, violet, superior. **Androecium:** 5, epipetalous, syngenesious anthers forming a tube aroud style, anthers

bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous inferior ovary, unilocular with single ovule, placentation basal, style very long, bifid above, stigmas 2. **Fruit:** Cypsela with 5 pappus scales.

Floral Formula: Disc floret ⊕ ♂♀ $K_{pappus}C_5A_5G_{(2)}$

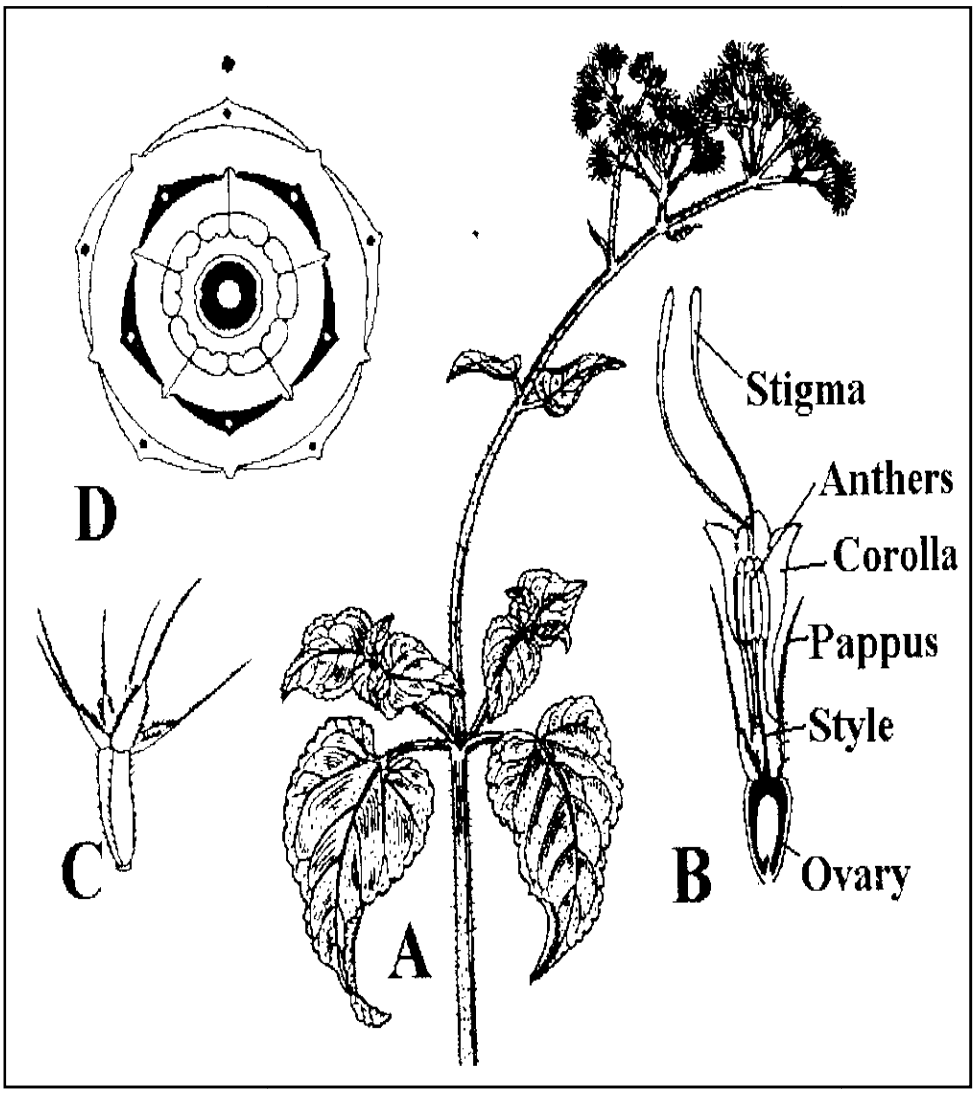

Fig. *Ageratum houstonianum*: A, habit; B, V.S. of disc floret; C, fruit; D, floral diagram of disc floret.

Sonchus oleraceous Milk thistle 'Pili dudhi'

Wild annual herb with milky latex. **Leaves:** Alternate, simple, pinnatifid, with auricles at base, stipules absent, unicostate reticulate. **Inflorescence:** Capitulum, ligulate head with broad receptacle bearing ray florets surrounded by involucre bracts (phyllaries), latter covered by stalked glands. **Ray Floret:** Ebracteate, sessile, zygomorphic, bisexual, epigynous, pentamerous, cyclic. **Calyx:** Represented by pappus with numerousw hairs. **Co-**

rolla: 5, gamopetalous; ligulate, 5-toothed, valvate, yellow, superior. **Androecium:** 5, epipetalous, syngenesious anthers forming a tube aroud style, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous inferior ovary, unilocular with single ovule, placentation basal, style bifid above, stigmas 2. **Fruit:** Cypsela with hairy pappus at tip.

Floral Formula: Ray floret %♂♀ $K_{pappus}C_{(5)}A_{(5)}G_{(2)}$

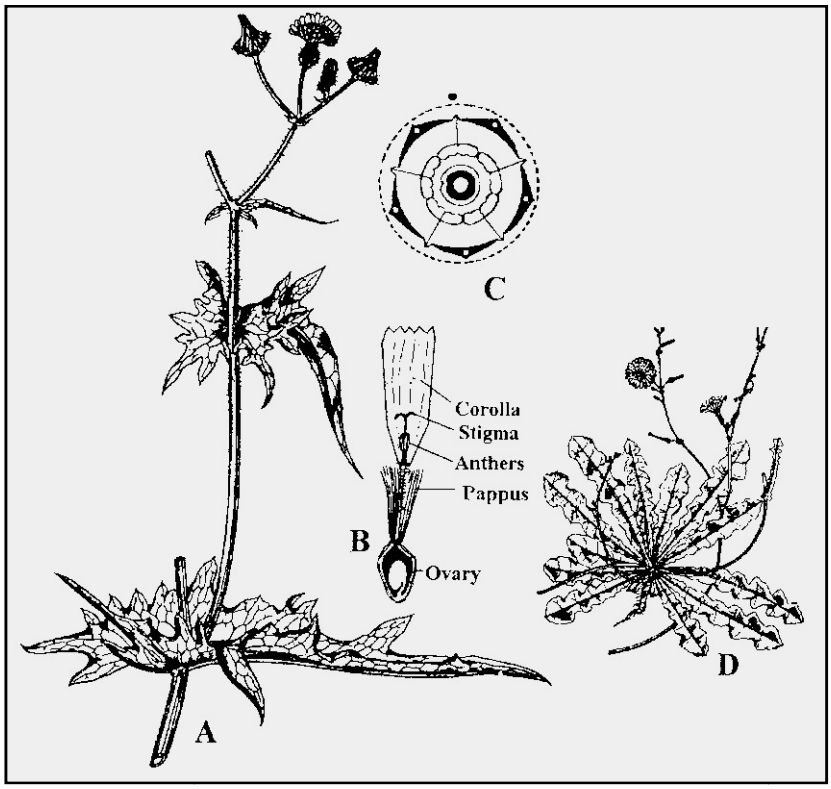

Fig. *Sonchus oleraceous*; A, habit; B, V.S. of ray floret; C, floral diagram of ray floret; D, *Launaea nudicaulis* habit.

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7. Experiment: Taxonomical Identification of different genera of *Apocynaceae* Myrtle or dogbane family

200genera 2000 species

Mostly tropical and subtropical with a few species in temperate regions.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Gamopetalae	Subclass	Asteridae	Subclass	Lamiidae
Series	Bicarpellatae			Superorder	Gentiananae
Order	Gentianales	Order	Gentianales	Order	Apocynales

Field identification: Milky sap, leaves opposite or whorled, throat of corolla tube with scales, pollinia absent, ovary superior; fruit a follicle, seed with a tuft of hairs. .

Description: Trees, shrubs, perennial herbs, Hanas with milky sap. Leaves opposite or whorled, simple, entire, stipules absent. Inflorescence racemose, cymose or solitary. Flowers bisexual, actinomorphic, hypogynous. Sepals 4(5), united, glandular inside. Petals 5, united into a tube often with scales in throat of tube, twisted in bud. Androecium of 4(5) stamens inserted in the tube, filaments free (rarely united), anthers introrse, dehiscence longitudinal. Gynoecium bicarpellary, apocarpous apically united, unilocular or bilocular, marginal placentation, ovary superior, style 1. Fruit a follicle sometimes capsule, drupe or berry. Seed flat with a crown of hairs.

Importance: *Nerium, Catharanthus,* and *Tabernaemontana* are grown as ornamentals. *Nerium* and *Thevetia* are poisonous (can be fatal). *Rauvolfia* roots yield reserpine used as tranquiliser for patients suffering from schizophrenia and hypertension. Latex from *Plumeria* is used for toothache.

***Catharanthus roseus* (syn: *Vinca rosea)* Periwinkle 'Sada Bahar'**

Ornamental erect herb with tap root and cylindrical branched stem. **Leaves:** Opposite, simple, unicostate-reticulate. **Inflorescence:** Axillary cluster of 2 flowers each. **Flower:** Ebracteate, sub-sessile, complete, actinomorphic, bisexual, hypogynous, pentamerous. **Calyx:** 5, slightly gamosepalous, valvate, green, inferior. **Corolla:** 5 gamopetalous, tubular (swollen below), salver shaped, twisted, pink, inferior. **Androecium:** 5, polyandrous, epipetalous, anthers bithecous, basifixed, sagittate with longitudinal dehiscence. **Gynoecium:** Bicarpellary apocarpous ovary superior, unilocular, ovules many, placentation marginal, style simple, stigma annulate or calyptrate, 2 scaly nectaries on either side of carpels. Fruit: Etaerio of follicles.

Floral Formula: ⊕ ♂♀ $K_{(5)}A_5G_{\underline{2}}$

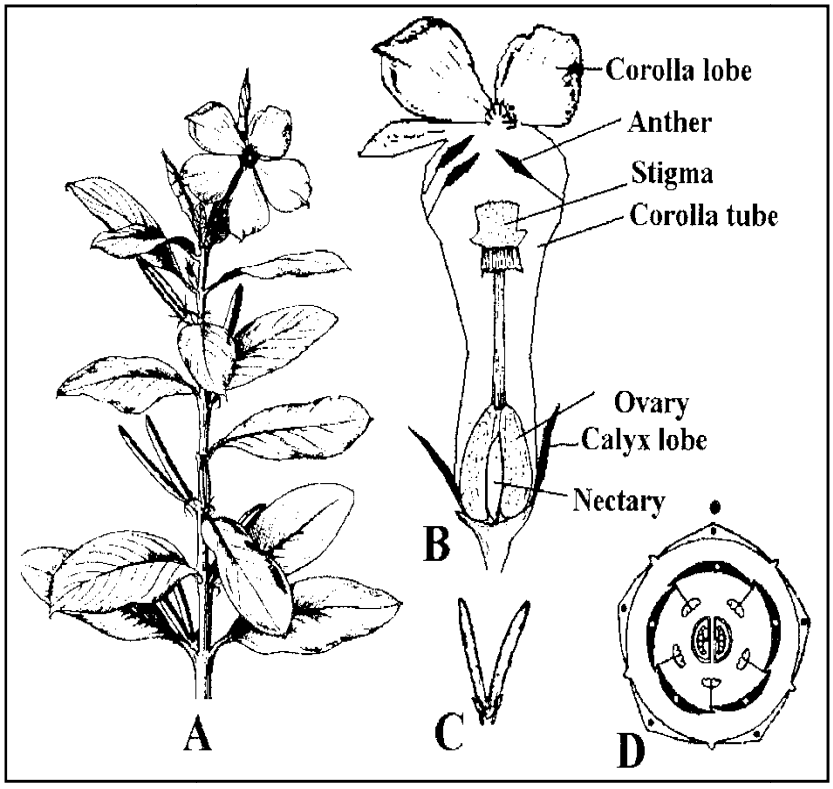

Fig. *Catharanthus roseus*: A, habit; B, V.S. flower; C, fruit; D, floral diagram

***Nerium indicum* Oleander 'Kaner':**

Evergreen shrub cultivated for beautiful flowers. **Leaves:** Usually in whorls of 3, simple, linear-lanceolate with reticulate venation. **Inflorescence:** terminal raceme of cymes. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, rose coloured, pentamerous. **Calyx:** 5, gamosepalous, campanulate, quincuntial imbricate, green,

inferior. **Corolla:** 5, gamopetalous, funnel shaped, twisted lobes with petalloid corona. **Corona:** Laciniate into numerous irregular segments. **Androecium:** 5, polyandrous, epipetalous, anthers sagittate, connivent around stigma and produced into long twisted hairy appendage at the top, anthers bithecous, basifixed, dehiscence longitudinal. **Gynoecium:** Bicarpellary, apocarpous, ovary superior, ovules many, placentation marginal, style simple, stigma simple, nectaries absent. **Fruit:** Etaerio of follicles.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_{(5)}A_5\underline{G_2}$

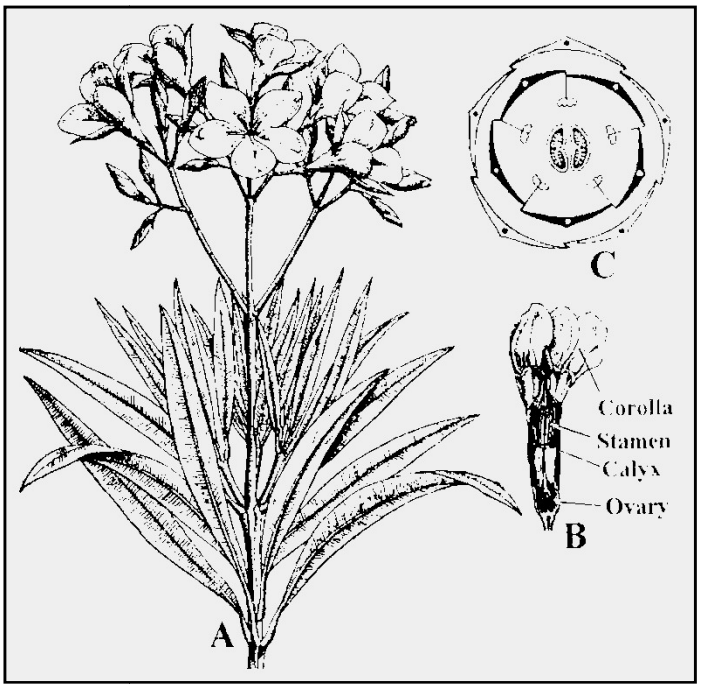

Fig. *Nerium indicum*: A, habit; B, V.S. flower, C, floral diagram.

Thevetia nerifolia **Yellow oleander 'Peeli kaner':**

Evergreen ornamental shrub. **Leaves:** Alternate or sub-opposite, simple with reticulate venation. **Inflorescence:** Flowers solitary or in cyrnose clusters. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, pentamerous, large, yellow. **Calyx:** 5, gamosepalous, campanulate, quincuntial imbricate, green with many glands inside at base, inferior. **Corolla:** 5, gamopetalous, funnel shaped, slightly hairy at the throat, imbricate, yellow, large, inferior. **Androecium:** 5, polyandrous, epipetalous, anthers bithecous, basifixed, appendaged at top, longitudinal dehiscence, introrse. **Gynoecium:** bicarpellary syncarpous ovary superior, bilocular with 2 ovules in each loculus, placentation axile, style filiform, stigma bilobed, nectary at the base of ovary. **Fruit:** drupe outer fleshy and inner hard portion.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_5A_5G_{(2)}$

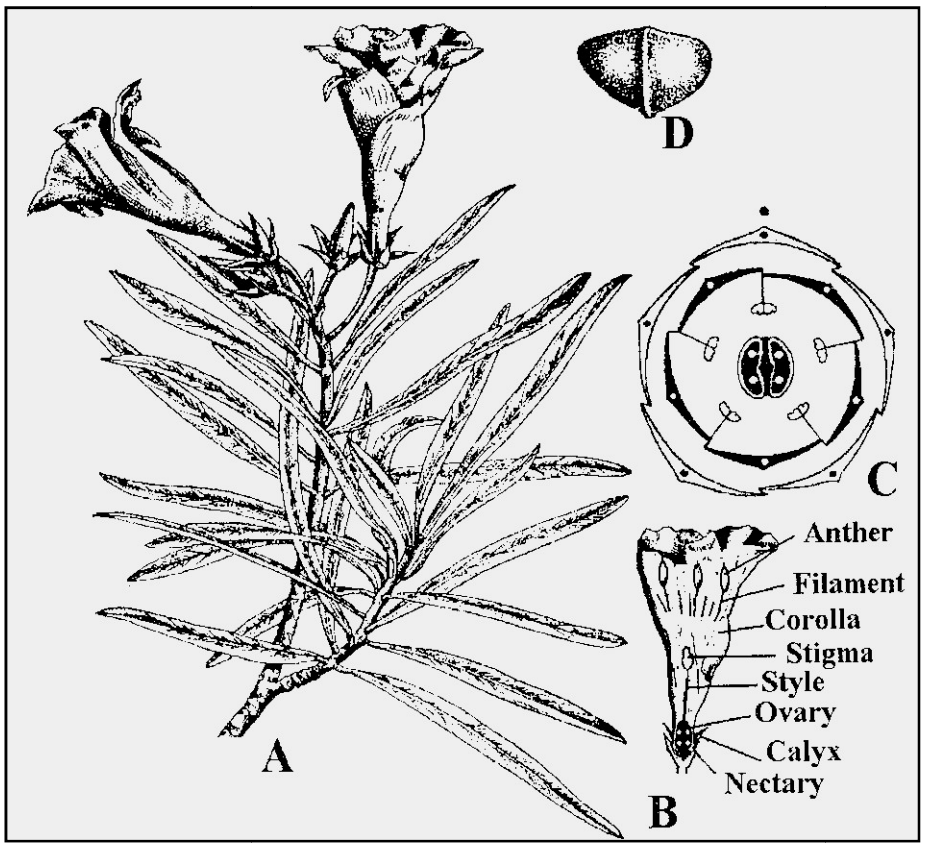

Fig. *Thevetia nerifolia*: A, habit; B, V.S. flower; C, floral diagram; D, fruit

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8 Experiment: Taxonomical Identification of different genera of *Solanacea* Nightshade or Potato family

90genera 3000 species

Cosmopolitan in distribution found both in temperate and tropical climates with largest concentration in Central and South America.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Gamopetalae	Subclass	Asteridae	Subclass	Lamiidae
Series	Bicarpellatae			Superorder	Solananae
Order	Polemoniales	Order	Solanales	Order	Solanales

Field identification: Leaves alternate, stipules absent, flowers actinomorphic, stamens 5, carpels 2, ovary superior, 2-chambered, placenta swollen, septum oblique, ovules numerous, fruit a berry or capsule.

Description: Herbs, shrubs or small trees, rarely lianas, often poisonous. Leaves alternate, simple, rarely pinnately compound (potato), stipules absent. Inflorescence cymose or of solitary flowers. Flowers bisexual, actinomorphic, hypogynous. Sepals 5, united, persistent. Petals 5, united, rotate or tubular, rarely funnel shaped *(Datura).* Androecium of 5 stamens, epipetalous, inserted in corolla tube, filaments free, anthers introrse, dehiscence longitudinal or by apical pores. Gynoecium of 2 carpels (bicarpellary), united (syncarpous), ovary superior, bilocular, axile placentation, placenta swollen, septum oblique, ovary often further divided by false septa, style I, stigma bilobed. Fruit berry or capsule. Seeds many, embryo straight, endosperm present.

Importance: The family includes a number of food plants such as tomato *(Lycopersicon esculentum),* potato *(Solanum tuberosum),* egg plant or brinjal *(S. melongena),* ground cherry *(Physalis peruviana).* Peppers *(Capsicum annuum)* are used both as food source (young) and spices (ripe). Many poisonous species are important drug plants such as *Atropa belladona* (atropine), *Hyoscyamus niger* (henbane-hypnotic drug), *Datura stramonium* (stramonium)

and *Mandragora officinarum.* Tobacco *(Nicotiana tabacum* and *N. rustica)* contains toxic alkaloid nicotine and is grown for chewing, smoking and snuff.

Solanum nigrum **Black nightshade 'Mako':**

Wild annual herb. **Leaves:** Alternate, simple with reticulate venation. **Inflorescence:** Extra-axillary scorpioid cyme known as rhipidiurn. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, campanulate, valvate, green persistent, inferior. **Corolla:** 5, gamopetalous, rotate, valvate, white, inferior. Androecium: 5, polyandrous, epipetalous, anthers bithecous, basifixed, slightly connivent, dehiscence by apical pores. **Gynoecium:** bicarpellary syncarpous ovary superior, bilocular with many ovules in each loculus, placentation axile, placentae swollen, septum oblique, style simple, stigma bilobed. **Fruit:** Succulent berry.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_5A_5G_{(2)}$

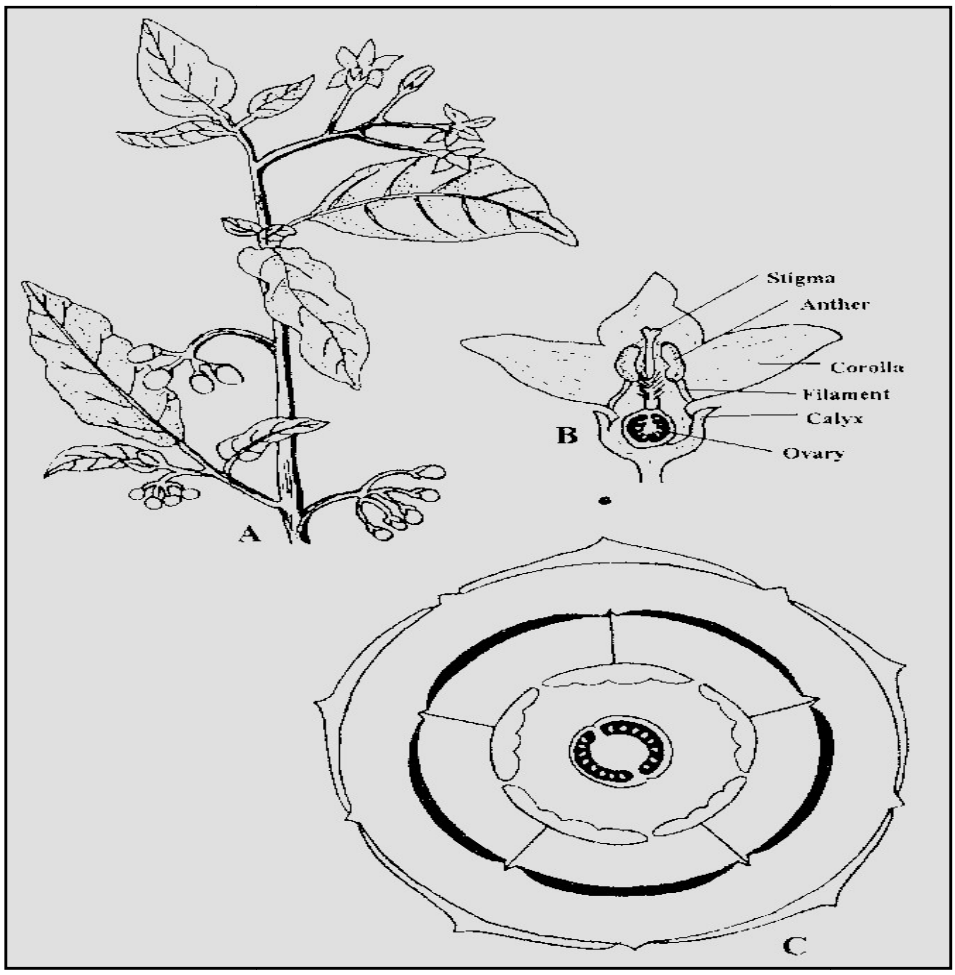

Fig. *Solanum nigrum*: A, habit; B, V.S. flower; C, floral diagram

***Withania somnifera* 'Asgandh':**

Wild perennial herb or subshrub. **Leaves:** Alternate, simple with reticulate venation. **Inflorescence:** Axillary 3-5 flowered cymes. **Flower:** Ebracteate, subsessile, complete, actinomorphic, bisexual, hypogynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, campanulate, valvate, green, persistent, enlarged in fruit and becoming urceolate, inferior. **Corolla:** 5, gamopetalous, campanulate, valvate, greenish yellow, lobes reflexed at tip, inferior. **Androecium:** 5, polyandrous, epipetalous, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** bicarpellary syncarpous ovary superior, bilocular with many ovules in each loculus, placentation axile, placentae swollen, septum oblique, ovary seated on orange coloured disc, style simple, stigma bilobed. **Fruit:** Succulent berry surrounded by urceolate persistent calyx.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_5A_5G_{(2)}$

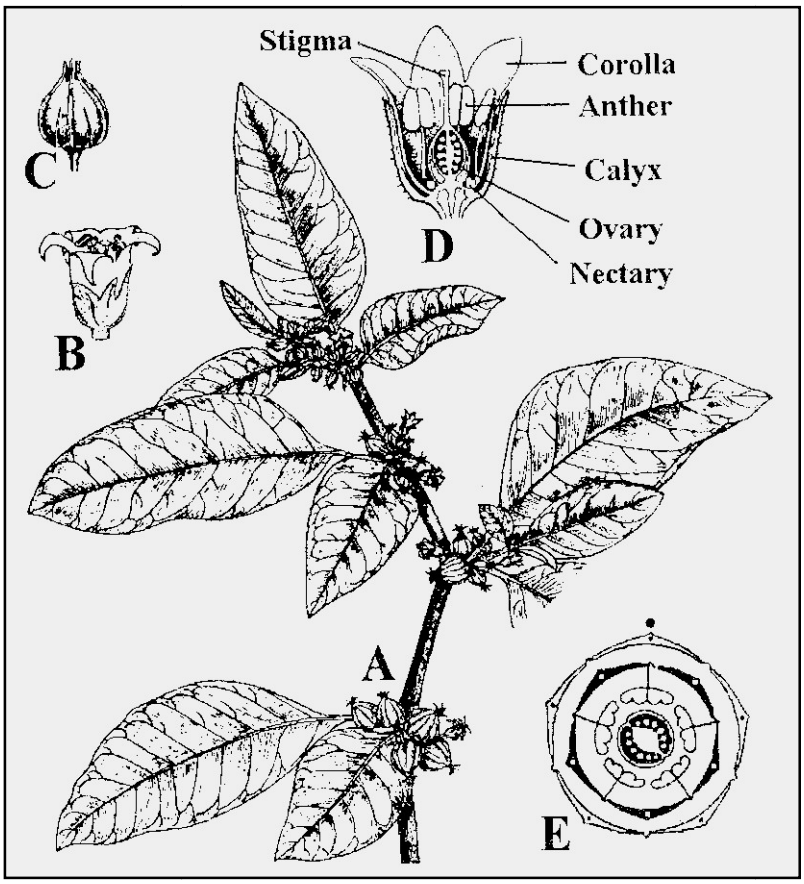

Fig. *Withania somnifera*: A, habit; B, flower; C, fruiting calyx; D, V.S. flower; E, floral diagram.

Datura inoxia **Datura, Angel trumpet:**

Shrubby annual herb. **Leaves:** Alternate or subopposite, simple with reticulate venation. **Inflorescence:** Solitary axillary. **Flower:** Ebracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, tubular, valvate, green, persistent, inferior. **Corolla:** 5, gamopetalous, trumpet shaped with spreading plicate limb, twisted, white, inferior. **Androecium:** 5, polyandrous, epipetalous, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** bicarpellary syncarpous ovary superior, bilocular becoming tetralocular due formation of a false septa, with many ovules in each loculus, placentation axile, placentae swollen, septum oblique, style simple, stigma bi-lobed. **Fruit:** Capsule covered with prickles.

Floral Formula: ⊕ ♂♀ $K_{(5)}C_{(5)}A_5G_{(2)}$

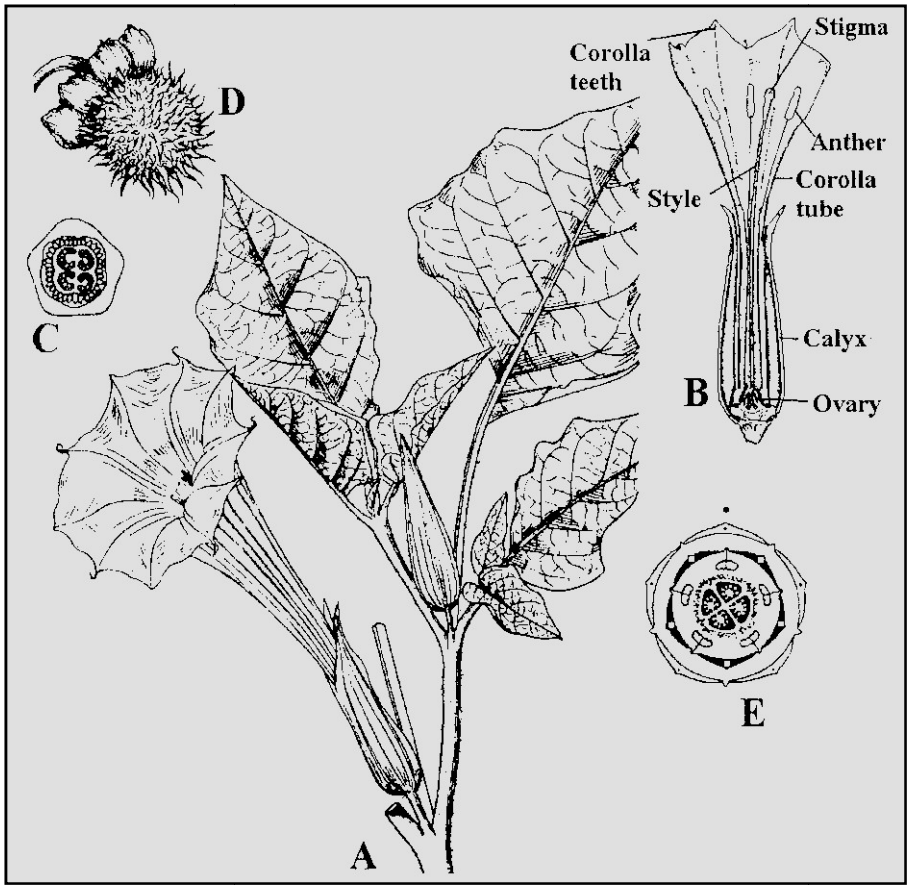

Fig. *Datura inoxia*: A, habit; B, V.S. flower; C, T.S. young ovary; D, fruit; E, floral diagram

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9 Experiment: Taxonomical Identification of different genera of *Lamiaceae (Labiatae)* Mint family

200genera 3000 species

Worldwide in distribution, largely concentrated in the Mediterranean Region.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Gamopetalae	Subclass	Asteridae	Subclass	Lamiidae
Series	Bicarpellatae			Superorder	Lamianae
Order	Lamiales	Order	Lamiales	Order	Lamiales

B & H as Labiatae, Cronquist and Takhtajan as Lamiaceae

Field identification: Plants aromatic, stem 4-angled, leaves opposite, stipules absent, inflorescence verticillaster, flowers zygomorphic, stamens 2-4, carpels 2, ovary superior, 2-chambered, finally 4 chambered due to false septum, ovules 4, ovary deeply 4-lobed, style gynobasie, fruit schizocarpic breaking into 4 nutlets.

Description: Aromatic herbs or shrubs, sometimes small trees. Stem 4-angled. Leaves opposite (rarely alternate), simple or pinnate compound, stipules absent. Inflorescence verticillaster, arranged in raceme, spike or panicle. Flowers bisexual, zygomorphic, hypogynous, often bilabiate. Sepals 5, united, often bilabiate 1/4 or 3/2. Petals 5, united, usuallybilabiate 4/1 or 2/3. Androecium of 2-4 stamens epipetalous, usually didynamous, inserted in corolla tube, filaments free, dehiscence longitudinal. Gynoecium of 2 carpels (bicarpellary), united (syncarpous), ovary superior, bilocular, ovules 2 in each chamber, finally 4-locular due to false septum with 1 ovule in each chamber, axile placentation, ovary 4-lob~d, style I, gynobasic, stigma bilobed. Fruit a schizocarp splitting into 4 nutlets. Seed with straight embryo , endosperm minute or absent.

Importance: The family includes several plants used in cooking and flavouring such as spearmint *(Mentha spicata),* peppermint *(M. piperita)* thyme *(Thymus vulgaris),* sweet basil 'niazbo' *(Ocimum basilicum),* pot marjoram *(Origanum vulgare)* and sage *(Salvia officinalis).* The family is also source of popular perfumes such as lavender *(Lavandula angustifolia)* and

rosemary *(Rosmarinus officinalis).* Basil *(Ocimum sanctum)* is sacred in India. Common ornamentals include sage *(Salvia),* horsemint *(Monarda), Molucella* and *Coleus.*

Ocimum basilicum **Basil 'Niazbo'**

Cultivated perennial aromatic herb. **Leaves:** Opposite and decussate, simple, ovate, serrate with reticulate venation. **Inflorescence:** Terminal raceme of verticillasters. **Flower:** Ebracteate, pedicellate, complete, zygomorphic, bisexual, hypogynous, pentamerous, cyclic. **Calyx:** 5, gamosepalous, bilabiate, 1/4, upper lip with large rounded lobe and lower lip with 4 small teeth, **Androecium:** 4, 5th posterior stamen absent, polyandrous, didynamous, epipetalous, postero-lateral stamens with hairy processes on filaments, anthersbithecous, dorsifixed, dehiscence longitudinal, introrse. **Gynoecium:** bicarpellary syncarpous ovary superior, bilocular with 2 ovules in each loculus, subsequently becoming tetralocular due to formation of a false septum with 1 ovule in each loculus, placentation axile, ovary 4-lobed, seated on a nectary, style gynobasic, stigma bifid. **Fruit:** Schizocarpic fruit known as carcerulus, breaking into four 1-seeded nutlets green, persistent, inferior. **Corolla:** 5, gamopetalous, bilabiate, 4/1, violet or white, inferior.

Floral Formula: % ♂♀ $K_{(1/4)}C_{(4/1)}A_{2+2}G_{(2)}$

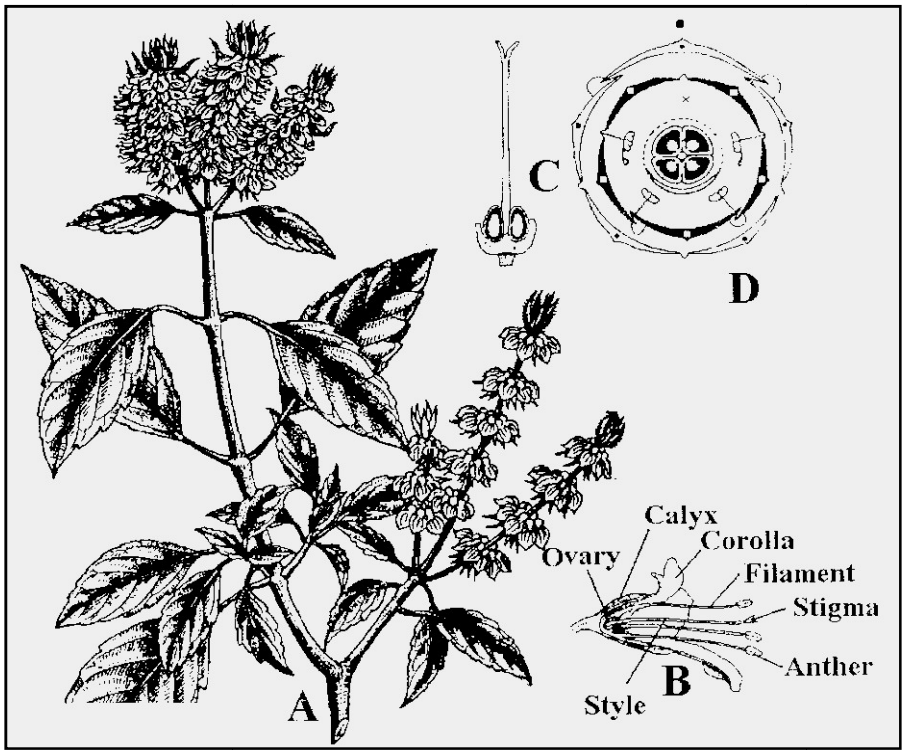

Fig. *Ocimum basilicum*: A, habit; B, V.S. flower; C, gynobasic style; D, floral diagram

Salvia splendens

Cultivated annual aromatic herb. **Leaves:** Opposite and decussate, simple, ovate-elliptical, crenate with reticulate venation. **Inflorescence:** Terminal raceme of verticillasters. **Flower:** Ebracteate, pedicellate, complete, zygomorphic, bisexual, hypogynous, pentamerous, showy, cyclic. **Calyx:** 5,gamosepalous, bilabiate, 3/2, upper lip often entire lower bifid, scarlet like petals, persistent, inferior. **Corolla:** 5, gamopetalous, bilabiate, 2/3, scarlet, inferior. **Androecium:** 2, on lower lip, polyandrous, epipetalous, with turn pipe mechanism having very long connective with sterile lower anther lobe and fertile upper lobe, versatile, dehiscence longitudinal, introrse. **Gynoeclum:** bicarpellary syncarpous ovary superior, bilocular with 2 ovules in each loculus, subsequently becoming tetralocular due to formation of a false septum with 1 ovule in each loculus, placentation axile, ovary 4-lobed, seated on a nectary, style gynobasic, long, purple, stigma bifid. **Fruit:** Schizocarpic fruit known as carcerulus, breaking into four I-seeded nutlets.

Floral Formula: % ♂♀ $K_{(3/2)}C_{(2/3)}A_2G_{(\underline{2})}$

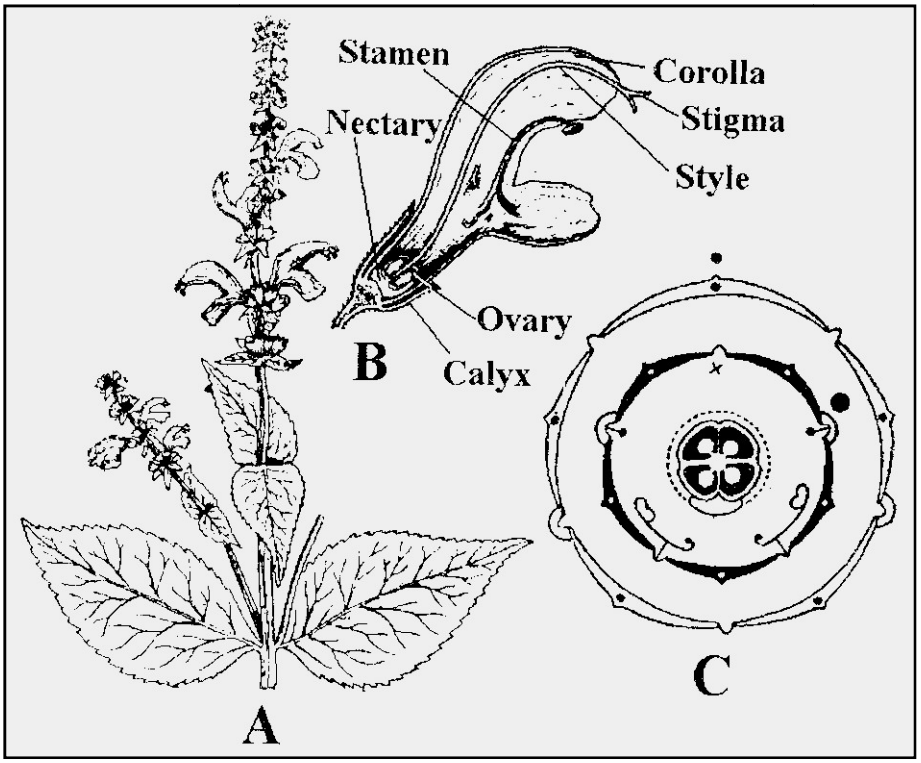

Fig. *Salvia splendens*: A, habit; B, V.S. flower; C, floral diagram

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10 Experiment: Taxonomical Identification of different genera of *Euphorbiaceae* Spurge family

300 genera 7500 species

Distributed widely in tropicaland subtropical regions, with few species in temperate regions.

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Dicotyledons	Class	Magnoliopsida	Class	Magnoliopsida
Subclass	Monochlamydeae	Subclass	Rosidae	Subclass	Dilleniidae
Series	Unisexuales			Superorder	Euphorbianae
Order		Order	Euphorbiales	Order	Euphorbiales

Field identification: Plants usually with milky latex, leaves alternate, flowers unisexual, carpels 3, ovary superior, 3-cl1am.bered, ovule with a caruncle.

Description: Herbs shrubs or trees with often milky or coloured latex. Leaves alternate (rarely opposite), simple or compound, stipules present, sometimes glandular, rarely absent- Inflorescence of various types, commonly a cup shaped cyathium, sometimes a raceme or panicle. Flowers unisexual (manoecious or dioecious), actinomorphic, hypogynous. Perianth usually 5 (representing sepals, petals absent rarely 5) or absent. Androecium of l-many stamens, filaments free or connate, dehiscence longitudinal. Gynoecium of 3 carpels (tricarpellary), united (syncarpous), carpels rarely 4-many, ovary superior, trilocular with 1:2 ovules in each chamber, placentation axile, styles usually 3. Fruit a schizoccUpic capsule, a regma *(Ricinus),* rarely a berry or drupe. Seed often with conspicuous fleshy outgrowth called caruncle, embryo curved or straight, endosperm abundant or absent.

Importance: The family includes a number of valuable plants such as the sources of Brazilian rubber *(Hevea brasiliensis),* Cassava or tapioca *(Manihot esculentus),* castor oil *(Ricinus communis)* and tung oil *(Aleurites fordit}* The common ornamentals are *Euphorbia'pulcherrima, E. milii, Acalypha hispida, Jatropha panduraefolia* and *Codiaeum variegatum.* The fruit of *phyllanthus emblica* ('Amla') is very rich source of vitamin C.

Euphorbia milii **Crown of thorns:**

Ornamental thorny undershrub. **Leaves:** Alternate, simple, spathulate, venation reticulate. **Inflorescence:** Cyathia arranged in dichotomous umbellate cymes, each cyathium is surrounded by two scarlet bracts and is cup shaped with 5 nectaries along the rim and enclosing numerous male flowers (each represented by a single stamen; it is a flower because of presence of bract, joint in the middle of stalk and scorpioid arrangment) arranged in scorpioid cymes and a single female flower in the centre. **Male Flower:** Bracteate, pedicellate Goint separating pedicel from filament), incomplete, unisexual. **Perianth:** Absent. **Androecium:** 1, anther bithecous, innate, dehiscence longitudinal, introrse. **Gynoecium:** Absent. **Female flower:** Bracteate, subsessile, a joint below ovary, incomplete, unisexual, hypogynous. **Perianth:** Absent. **Androecium:** Absent. **Gynoecium:** Tricarpellary syncarpous ovary superior, trilocular with single ovule in each loculus, placentation axile, styles 3, stigmas 3. **Fruit:** Schizocarpic splitting into 3 one seeded cocci.

Floral Formula: Male ♂ $P_0\, A_1\, G_0$

Female ♀ $P_0\, A_0\, G_3$

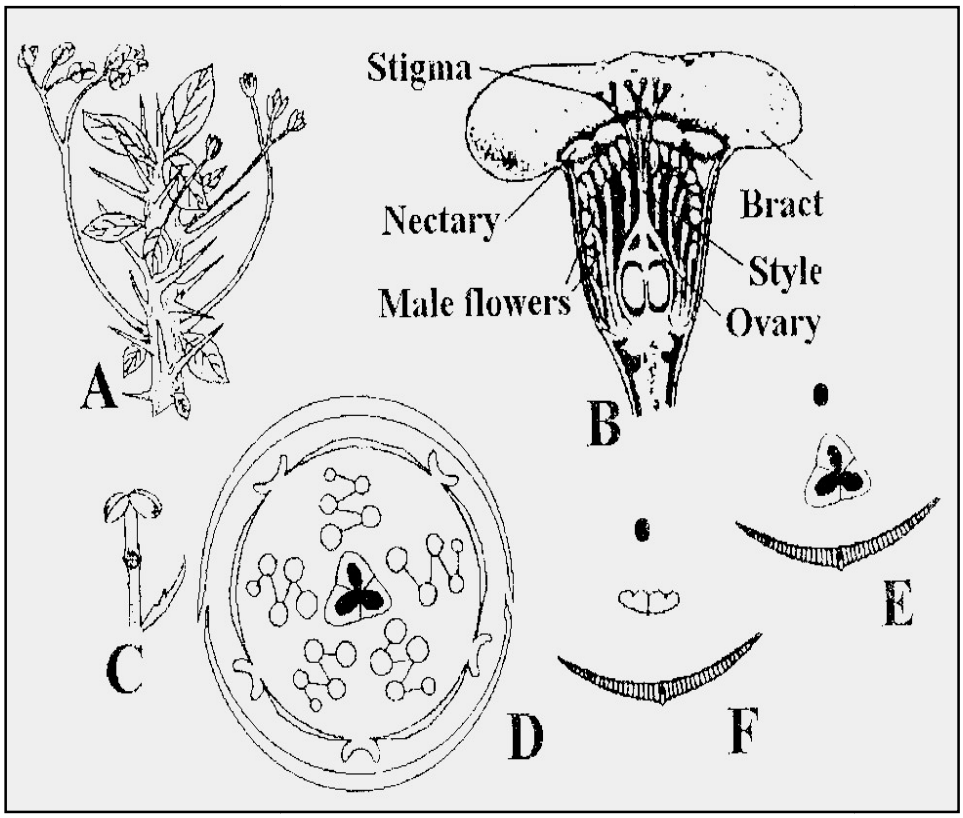

Fig. *Euphorbia milii*. A, habit; B, V.S. cyanthium; C, male flower; D, floral diagram of cyathium; E, floral diagram of female flower; F, floral diagram of male flower.

Euphorbia hirta:

Wild annual herb. **Leaves:** Opposite and superposed, simple, ovate-lanceolate, stipulate, unicostate reticulate. **Inflorescence:** Cyathia arranged in globose cymes, each cyathium cup shaped with 4 nectaries along the rim and enclosing numerous male flowers (each represented by a single stamen; it is a flower because of presence of bract, joint in the middle of stalk and scorpioid arrangment) arranged in scorpioid cymes and a single female flower in the centre. **Male Flower:** Bracteate, pedicellate (joint separating pedicel from filament), incomplete, actinomorphic, unisexual. **Perianth:** Absent. **Androecium:** 1, anther bithecous, innate, dehiscence longitudinal, introrse. **Gynoecium:** Absent. **Female flower:** Bracteate, subsessile, a joint below ovary, incomplete, actinomorphic, unisexual, hypogynous. **Perianth:** Absent. **Androecium:** Absent. **Gynoecium:** Tricarpellary syncarpous ovary superior, trilocular with single ovule in each loculus, placentation axile, styles 3, stigmas 3. **Fruit:** Schizocarpic splitting into 3 one seeded cocci.

Floral Formula: Male ♂$P_0\,A_1\,G_0$

Female ♀ $P_0\,A_0\,G_{(3)}$

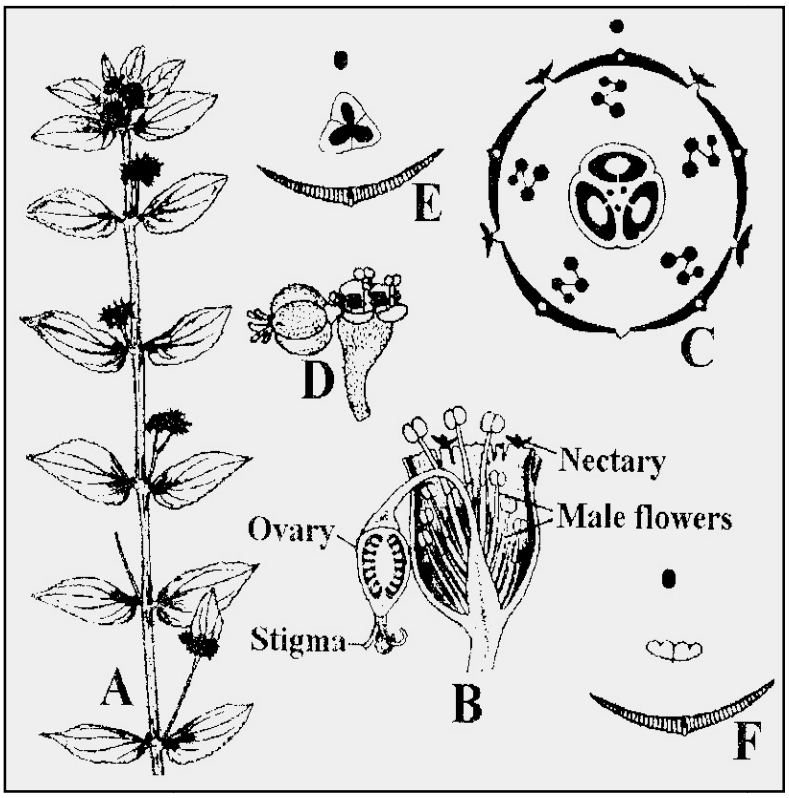

Fig. *Euphorbia hirta*: A, habit; B, V.S. cyanthium; C, floral diagram of cyathium; D, cyathium; E, floral diagram of female flower; F, floral diagram of male flower.

Phyllanthus niruri

Wild annual herb. **Leaves:** Alternate, simple, small, oblong, arranged in two rows so that branches appear like pinnate leaves, unicostate reticulate. **Inflorescence:** Male and female flowers appear separately, male flowers solitary or in cymose clusters of 2-3 in axils of lower leaves, female flowers borne singly in axils of upper leaves. **Male Flower:** Bracteate, subsessile, incomplete, actinomorphic, unisexual, trimerous. **Perianth:** 6, in two whorls, a glandular disc present inside perianth, whitish green with green midrib. **Androecium:** 3, monadelphous, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Absent. **Female flower:** Bracteate, subsessile, incomplete, actinomorphic, unisexual, hypogynous. **Perianth:** 6, in two whorls, a glandular disc present inside perianth, whitish green with green midrib. **Androecium:** Absent. **Gynoecium:** Tricarpellary syncarpous ovary superior, trilocular with 2 ovules in each loculus, placentation axile, styles 3, stigmas 3. **Fruit:** Schizocarpic splitting into 3 one seeded cocci.

Floral Formula: Male ⊕ ♂$P_3\, A_{(3)}\, G_0$

Female ⊕ ♀ $P_3\, A_0\, G_{\underline{(3)}}$

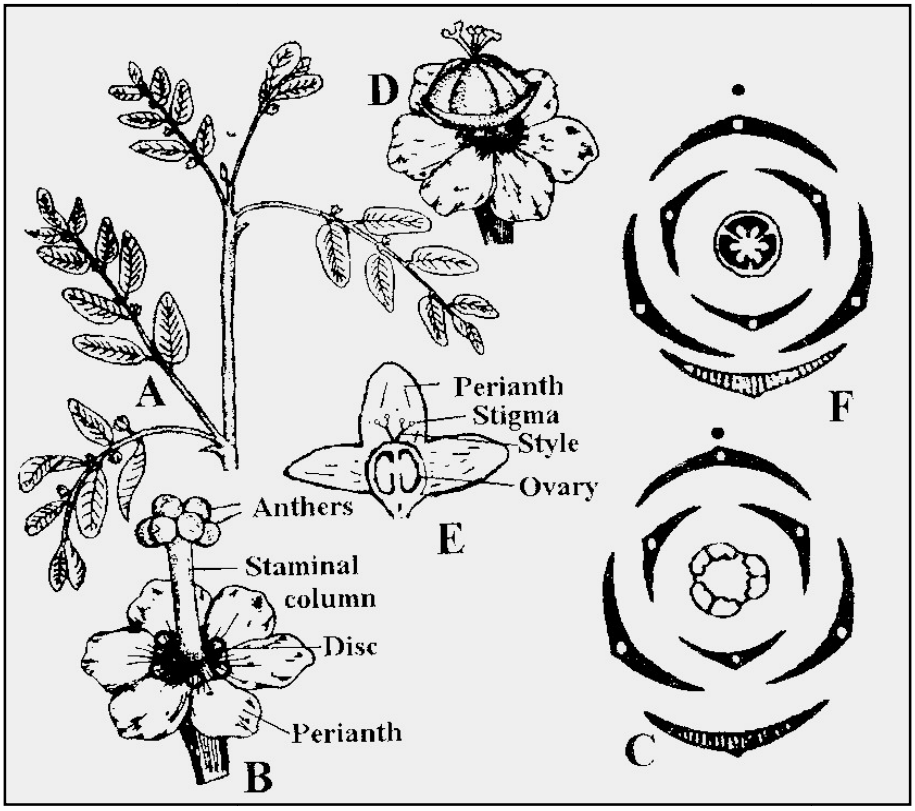

Fig. *Phyllanthus niruri*: A, habit; B, male flower; C, floral diagram of male flower; D. female flower; E, V.S. of female flower; F, floral diagram of female flower.

Croton bonplandianum

Wild perennial herb or undershrub. **Leaves:** Alternate, simple, lanceolate, unicostate reticulate. **Inflorescence:** Racemose, female flowers towards the base and solitary, male flowers towards the top, solitary or in clusters. **Male Flower:** Bracteate, pedicellate, incomplete, actinomorphic, unisexual, pentamerous. **Calyx:** 5, S-partite, gamosepalous, valvate, green. **Corolla:** 5, polypetalous, valvate, white. **Androecium:** Many, polyandrous, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Absent. **Female flower:** Bracteate, pedicellate, incomplete, actinomorphic, unisexual, hypogynous. **Calyx:** 5, S-partite, gamosepalous, valvate, green. **Corolla:** Absent. **Androecium:** Absent. **Gynoecium:** Tricarpellary syncarpous ovary superior, trilocular with 1 ovule in each loculus, placentation axile, styles 3, each bifurcating into two, each branch bearing stigma. **Fruit:** Schizocarpic splitting into 3 one seeded cocci.

Floral Formula: Male $\oplus\ K_{(5)}C_5A_{OC}G_0$

Female $\oplus\ \varphi\ K_{(5)}C_0A_0\underline{G_{(3)}}$

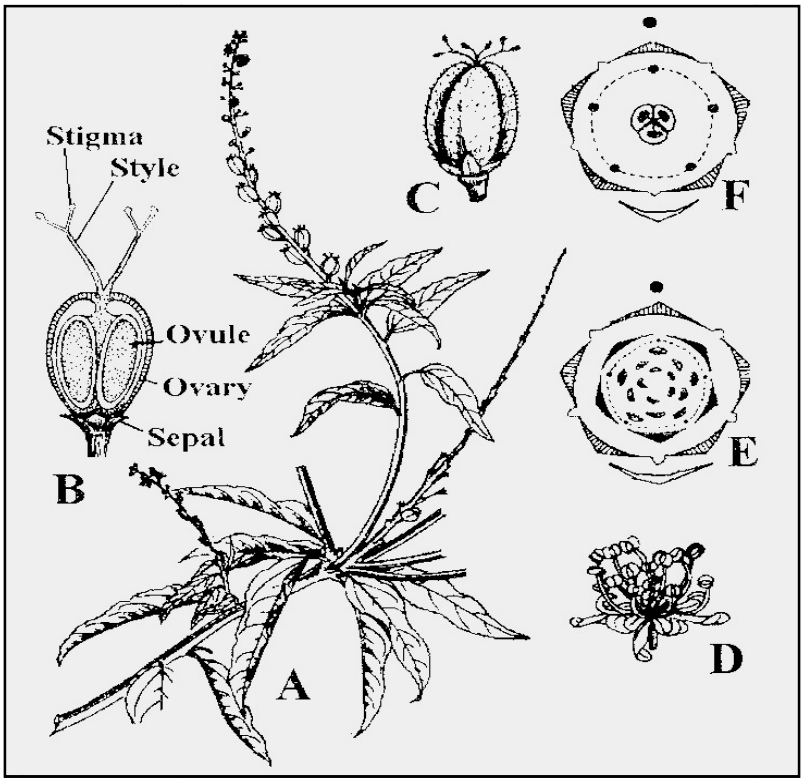

Fig. *Croton bonplandianum*: A, habit; B, V.S. female flower; C, female flower, D, male flower; E, floral diagram of male flower; F, floral diagram of female flower.

***Ricinus communis* Castor:**

Tall perennial herb or suffrutescent tree or shrub. **Leaves:** Alternate, simple, peltate, large, palmately 7-9-lobed, multicostate reticulate. **Inflorescence:** Terminal panicle with male flowers towards the base and female towards the top. **Male Flower:** Bracteate, pedicellate, incomplete, actinomorphic, unisexual, pentamerous. **Perianth:** 5, gamophyllous, valvate, splitting unequally into 3-5 segments, green. **Androecium:** 5 or more each repeatedly branched with anthers on ultimate branches, giving appearance of numerous stamens, anthers globose, dehiscence longitudinal, introrse. **Gynoecium:** Absent. **Female flower:** Bracteate, pedicellate, incomplete, actinomorphic, unisexual, hypogynous. **Perianth:** 5, gamophyllous, valvate, splitting unequally into 3-5 segments, green. **Androecium:** Absent. **Gynoecium:** Tricarpellary syncarpous ovary superior, trilocular with 1 ovule in each loculus, placentation axile, styles 3, each bifurcating into two, each branch bearing stigma. **Fruit:** Schizocarpic regma splitting into 3 one seeded cocci.

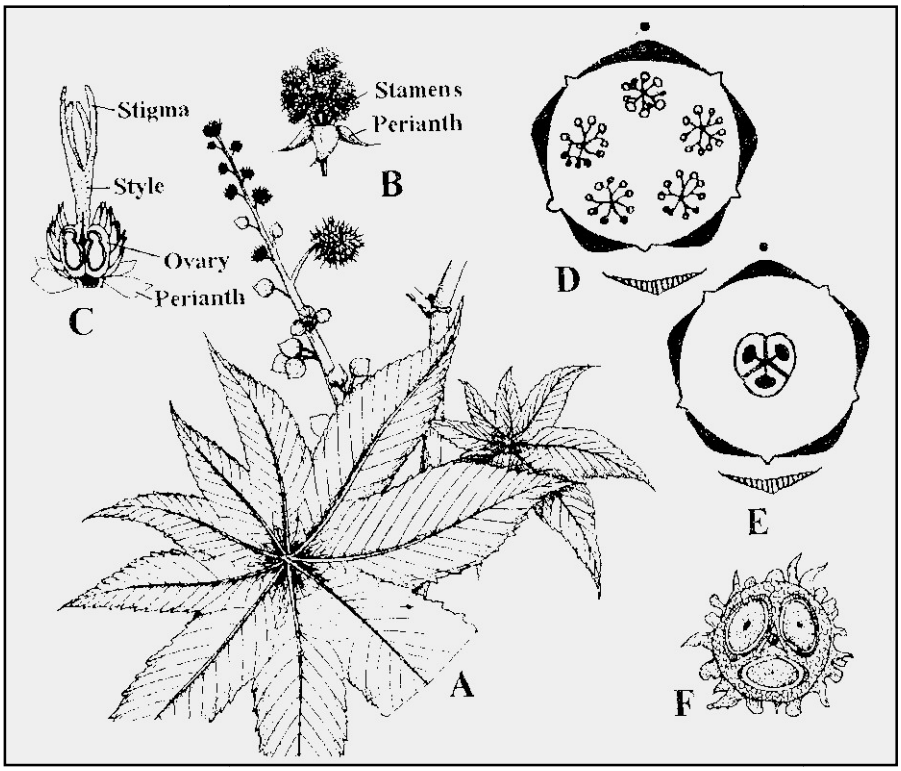

Fig. 11.64 *Ricinus communis*: A, habit; B, male flower; C, V.S. female flower; D, floral diagram of male flower; E, floral diagram of female flower; F, T.S. ovary.

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11 Experiment: Taxonomical Identification of different genera of *Poaceae (Gramineae)* Grass family

650 genera 10000 species

Fourth largest family worldwide in distribution

Placement:

B & H		**Cronquist**		**Takhtajan**	
Class	Monocotyledons	Class	Liliopsida	Class	Liliopsida
Subclass		Subclass	Commelinidae	Subclass	Commelinidae
Series	Glumaceae			Superorder	Poanae
Order		Order	Cyperales	Order	Poales

B & H as Gramineae, Cronquist and Takhtajan as Poaceae

Field identification: Herbs or shrubs with hollow internodes and jointed stems, leaves distichous with distinct sheath enclosing the stem and linear blade with often a ligule at their junction, flowers reduced enclosed in glumes, perianth represented by lodicules, ovary superior, stigma feathery, fruit caryopsis.

Description: Herbs or rarely woody shrubs or trees, stem (culm) with hollow internodes and jointed swollen nodes. Leaves distichous, alternate, simple, with basal sheath surrounding internode and free linear blade, a ligule often present at the junction of blade and sheath, venation parallel, stipules absent. Inflorescence of spikelets arranged in racemes, panicle or spikes. Each spikelet with 2 glumes enclosing 1 or more florets borne on an axis called rachilla. Flowers small, reduced (floret), zygomorphic (due to only 2 lodicules displaced on one side), usually bisexual rarely unisexual *(Zea),* enclosed in lemma and palea. Perianth absent or represented by 2 rarely 3 lodicules. Androecium of usually 3 (rarely 1-6) stamens, filaments free, dehiscence longitudinal. Gynoecium variously interpreted as bicarpellary, tricarpellary (with one reduced style), syncarpous or monocarpellary, unilocular with 1 ovule, placentation basal, styles 2 (rarely 1 or 3), stigmas often feathry. Fruit a caryopsis, rarely nut berry or utricle. Seed fused with pericarp, embryo straight, endosperm starchy.

Importance: The family is of great economic importance being source of important cereals such as rice (*Oryza sativa),* wheat *(Triticum aestivum)* and corn or maize *(Zea mays).* The family also includes other food crops such as barley *(Hordeum vulgare),* pearl millet *(Pennisetum glaucum),* oats *(Avena sativa),* rye *(Secale cereale)* and sorghum *(Sorghum vulgare).* Grasses such as *Cynodon, Axonopus* and *Agrostis* are extensively used in lawns and turfs. *Andropogon, Agropyron,* and *Phleum* are major forage grasses. Sugarcane *(Saccharum officinarum)* is the major source of commercial sugar.

Avena sativa **Oat 'Javi':**

Cultivated annual herb. **Leaves:** Distichous, alternate, simple, with basal sheath surrounding internode and free linear blade, ligule present at the junction of blade and sheath, venation parallel, stipules absent. **Inflorescence:** Panicle of spikelets, each spikelet with two glumes enclosing 2 fertile florets and 1 sterile floret borne on rachilla. **Flower:** Bracteate (represented by green lemma which has dorsal awn), bracteolate (represented by membranous palea with incurved margins), sessile, incomplete, zygomorphic, bisexual, hypogynous, trirnerous. **Perianth:** represented by 2 teeth like lodicules. **Androecium:** 3, free, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous (variously interpreted as tricarpellary syncarpous or monocarpellary) ovary superior, unilocular with 1 ovule, placentation basal, style short, stigmas 2, feathery. **Fruit:** Caryopsis.

Floral Formula: 1st view % ♂♀$P_{2\ lod}\ A_3\ G_{(\underline{2})}$

2nd view % ♂♀$P_{2\ lod}\ A_3\ G_{(\underline{1})}$

3rd view % ♂♀$P_{2\ lod}\ A_3\ G_{(\underline{3})}$

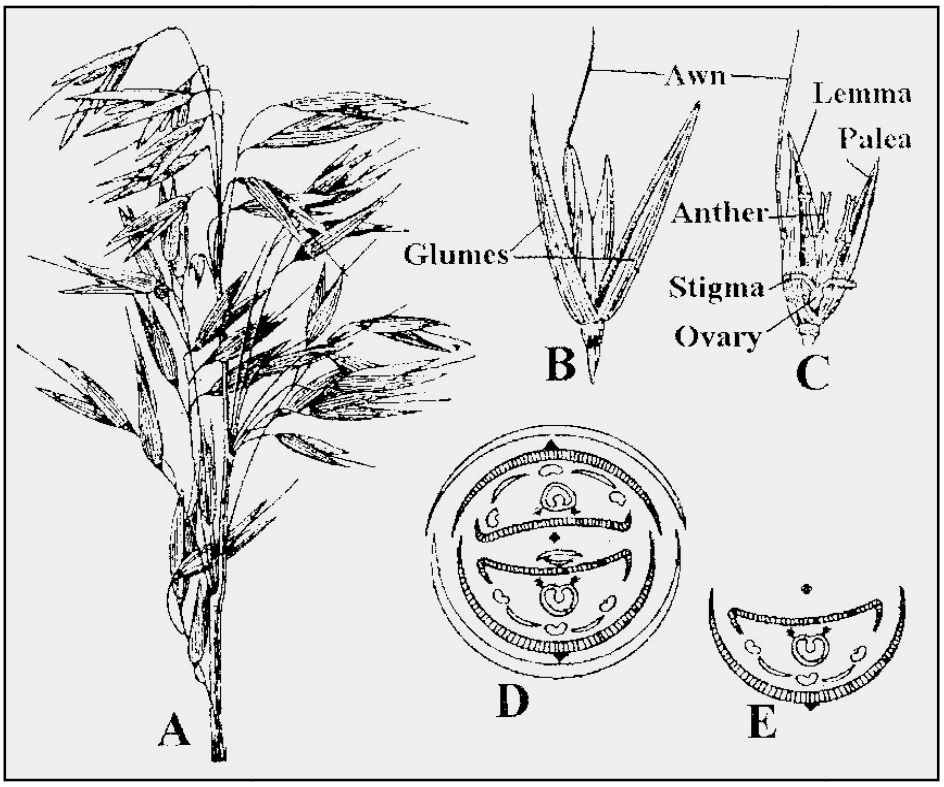

Fig. *Avena sativa*: A, habit; B, spikelet; C, floret; D, floral diagram of spikelet; E, floral diagram of floret

Poa annua:

Wild annual herb. **Leaves:** Distichous, alternate, simple, with basal sheath surrounding internode and free linear blade, ligule present at the junction of blade and sheath, venation parallel, stipules absent. **Inflorescence:** Panicle of spikelets, each spikelet with two short glumes at base not enclosing florets, fertile florets 3-5, sterile floret 1, florets borne on rachilla. **Flower:** Bracteate (represented by green lemma without awn), bracteolate (represented by membranous palea with incurved margins), sessile, incomplete, zygomorphic, bisexual, hypogynous, trimerous. **Perianth:** represented by 2 teeth like lodicules. **Androecium:** 3, free, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous (variously interpreted as tricarpellary syncarpous or monocarpellary) ovary superior, unilocular with 1 ovule, placentation basal, style short, stigmas 2, feathery. **Fruit:** Caryopsis.

Floral Formula: as in *Avena*

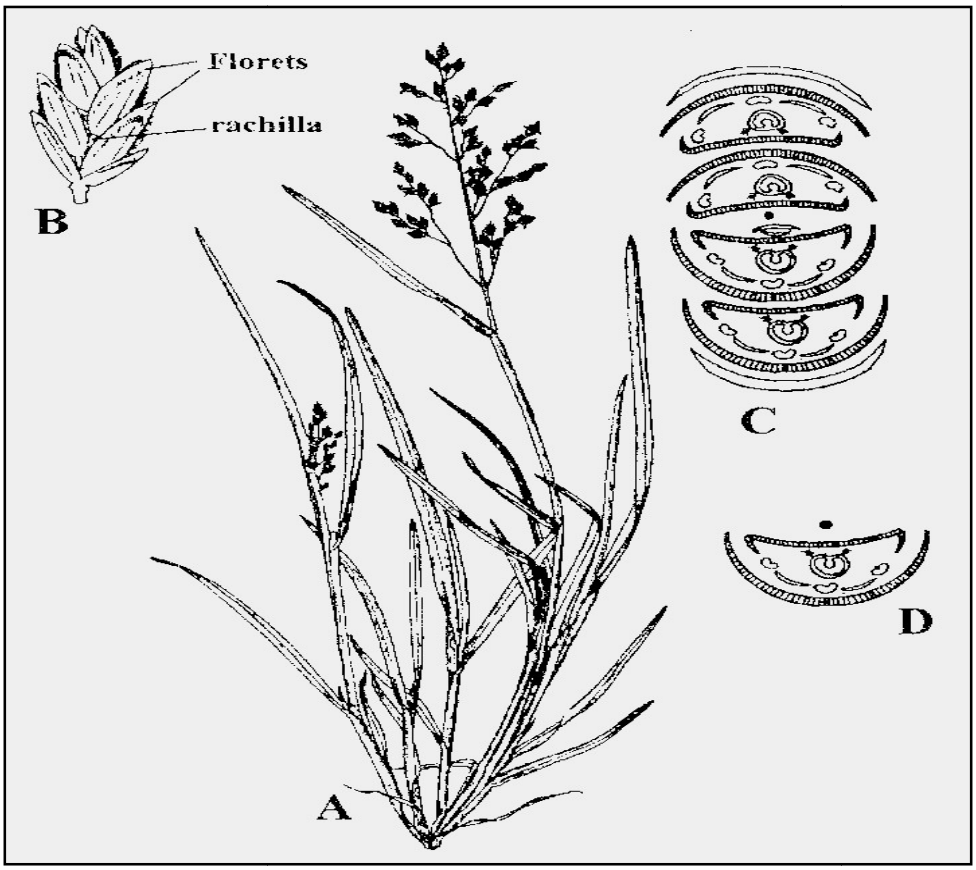

Fig. *Poa annua*: A, habit; B, spikelet; C, floral diagram of spikelet; D, floral diagram of floret.

Triticum aestivum **Wheat 'Gheon'**

Cultivated annual herb. **Leaves:** Distichous, alternate, simple, with basal sheath surrounding internode and free linear blade, ligule present at the junction of blade and sheath, venation parallel, stipules absent. **Inflorescence:** Spike of spikelets, each spikelet with two glumes at base not enclosing florets, fertile florets 3-5, sterile floret 1, florets borne on rachilla. **Flower:** Bracteate (represented by green lemma with subterminal awn), bracteolate (represented by membranous palea within curved margins), sessile, incomplete, zygomorphic, bisexual, hypogynous, trimerous. **Perianth:** represented by 2 teeth like lodicules. **Androecium:** 3, free, anthers bithecous, basifixed, dehiscence longitudinal, introrse. **Gynoecium:** Bicarpellary syncarpous (variously interpreted as tricarpellary syncarpous or monocarpellary) ovary superior, Unilocular with 1 ovule, placentation basal, style short, stigmas 2, feathery. **Fruit:** Caryopsis.

Floral Formula: as in *Avena*

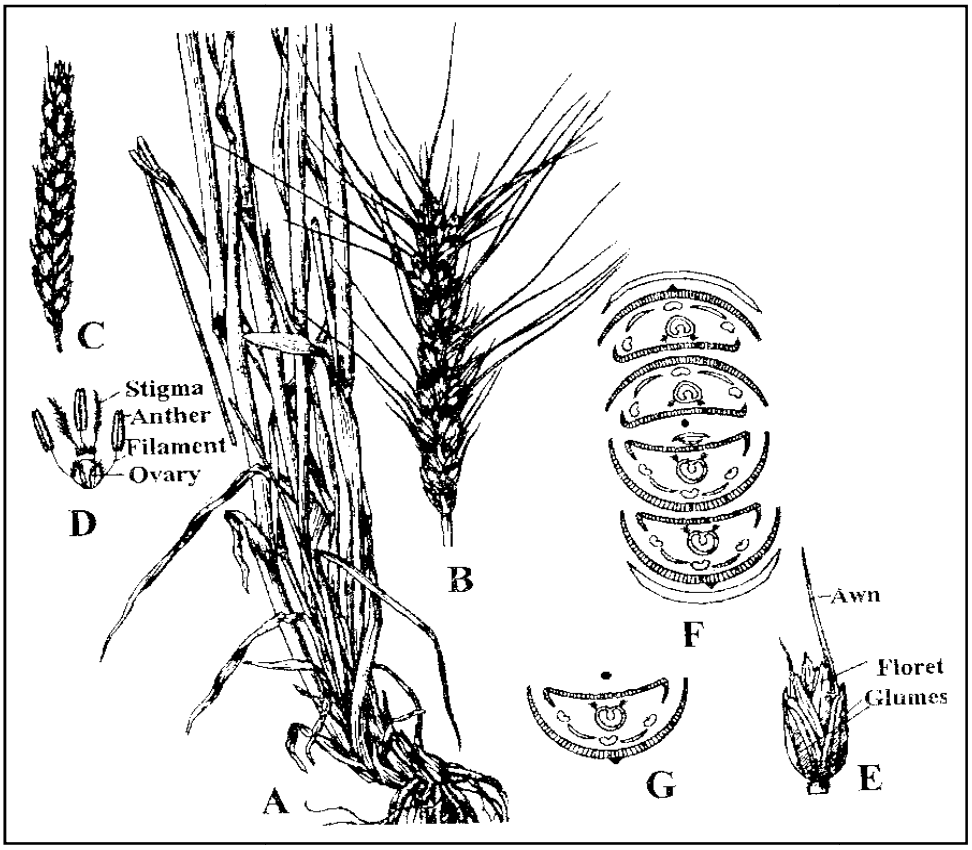

Fig. *Triticum aestivum*: A, habit; B, spike; C, spike in fruit; D, floret with lemma and palea removed; E, spikelet; F, floral diagram of spikelet; G, floral diagram of floret.

Zea mays **Maize 'Maka':**

Cultivated annual herb. **Leaves:** Distichous, alternate, simple, with basal sheath surrounding internode and free linear blade, ligule present at the junction of blade and sheath, venation parallel, stipules absent. **Inflorescence:** Separate male and female inflorescences. **Male inflorescence:** Terminal panicle of spikelets, spikelets in pairs with one sessile and one stalked spikelet, each spikelet with 2 glumes enclosing 2-flowers both fertile. **Male Floret:** Bracteate (represented by green lemma with subterminal awn), bracteolate (represented by green palea), sessile, incomplete, zygomorphic, unisexual staminate, trimerous. **Perianth:** represented by 2 teeth like lodicules. **Androecium:** 3, free, anthers bithecous, linear, dorsifixed, dehiscence longitudinal, extrorse. **Gynoecium:** rudimentary. **Female inflorescence:** Axillary spadix (cob) enclosed in a number of large spathes, spikelets compactly arranged in several rows, each spikelet with 2 glumes enclosing 2-flowers, lower flower sterile upper fertile. **Female Floret:** Bracteate (represented by broad green lemma), bracteolate (represented by green palea), sessile, incomplete, zygomolphic, unisexual

pistillate, hypogynous, trimerous. **Perianth:** represented by 2 teeth like lodicules. **Androecium:** Absent. **Gynoecium:** Bicarpellary syncarpous (variously interpreted as tricarpellary syncarpous or monocarpellary) ovary superior, unilocular with 1 ovule, placentation basal, style very long and silky. **Fruit:** Caryopsis.

Floral Formula: Female 1st view % ♀$P_{2\ lod}\ A_0\ G_{(\underline{2})}$

2nd view % ♀$P_{2\ lod}\ A_0\ G_{\underline{1}}$

3rd view % ♀$P_{2\ lod}\ A_0\ G_{(\underline{3})}$

Male % ♂$P_{2\ lod}\ A_3\ G_{(0)}$

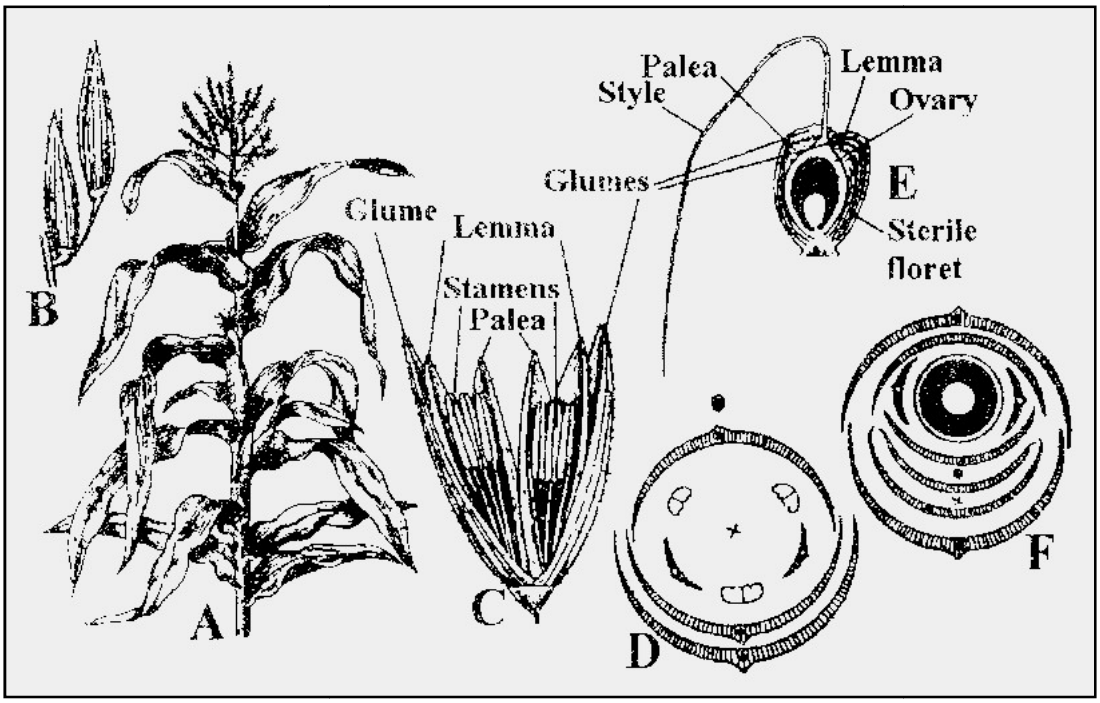

Fig. *Zea mays*: A, habit; B, paired male spikelets; C, male spikelet opened; D, floral diagram of male floret; E, V.S. of female spikelet; F, floral diagram of female spikelet.

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Lesson Writer

Dr. P Sathya Narayana Raju

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

1. Experiment: To Study Anther Wall Layers and Microsporogenesis

Aim:

To observe and study the different layers of the anther wall and the process of microsporogenesis.

Materials Required:

1) Fresh flower buds
2) Microscope
3) Glass slides
4) Coverslips
5) Forceps
6) Blade
7) Safranin stain
8) Glycerine
9) Needle

Procedure:

1) Take a young flower bud and carefully remove the anther using forceps.
2) Using a blade, make a thin longitudinal or transverse section of the anther.
3) Stain the sections with safranin and mount them in glycerine on a glass slide.
4) Observe the prepared slide under a microscope.

Observations:

The anther wall consists of **four layers**:

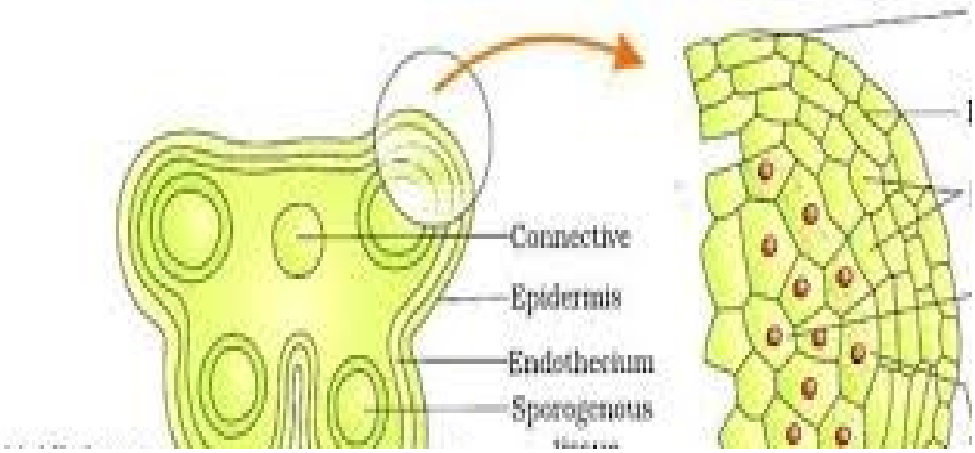
Epidermis – Outer protective layer.

Endothecium – Thick-walled layer that helps in anther dehiscence.

Middle layers – Two to three layers of thin-walled cells that later degenerate.

Tapetum – Innermost layer, provides nutrients to developing pollen grains.

Microsporogenesis can be observed, where **microspore mother cells (MMC)** undergo **meiosis** to form **haploid microspores**, which later develop into **pollen grains**.


Connective
Epidermis
Endothecium
Sporogenous

2. Experiment: To Study a Mature Anther and its Dehiscence

Aim:

To observe the structure of a mature anther and study its dehiscence mechanism.

Materials Required:

1) Mature flower anthers
2) Microscope
3) Glass slides
4) Coverslips
5) Forceps
6) Blade
7) Safranin stain
8) Glycerine

Procedure:

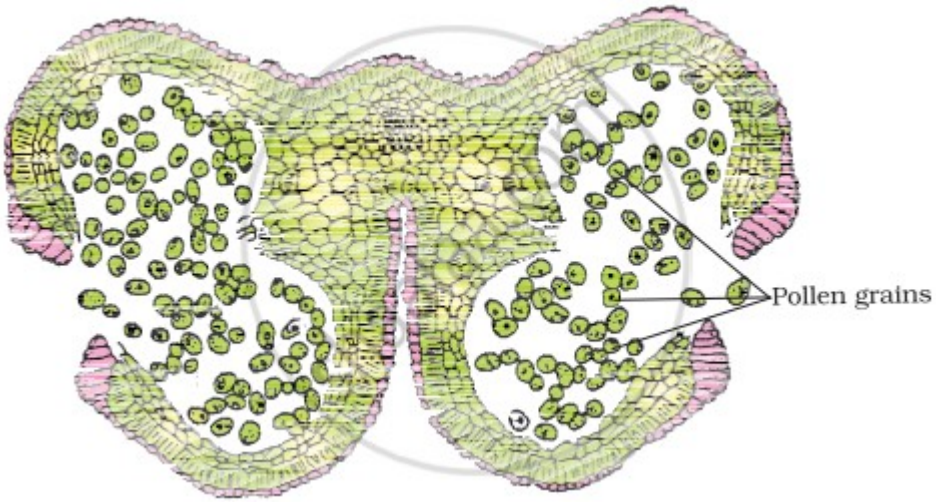
1) Take a mature flower and carefully remove the anther using forceps.
2) Using a blade, make a thin section of the mature anther.
3) Stain the section with safranin and mount it in glycerine on a slide.
4) Observe the slide under a microscope.

Observations:

- A mature anther consists of **two lobes**, each containing two pollen sacs filled with pollen grains.
- The **endothecium layer** develops fibrous thickenings, which help in dehiscence.
- As the anther matures, **dehiscence** occurs due to the contraction of the endothecium layer, causing the anther to split open along the **stomium** to release pollen grains.

Conclusion:

- The anther wall has distinct layers that play a crucial role in pollen development and dispersal.
- Microsporogenesis leads to the formation of pollen grains.
- The endothecium layer is responsible for anther dehiscence, ensuring efficient pollen release for fertilization.


Pollen grains

3. Experiment: To Dissect and Study Free-Nuclear Type of Endosperm from Developing Seeds

Aim:

To observe and study the free-nuclear type of endosperm in developing seeds.

Materials Required:

1) Developing seeds (e.g., maize, coconut)
2) Dissecting microscope
3) Forceps
4) Scalpel or blade
5) Glass slides
6) Coverslips
7) Glycerine
8) Safranin stain

Procedure:

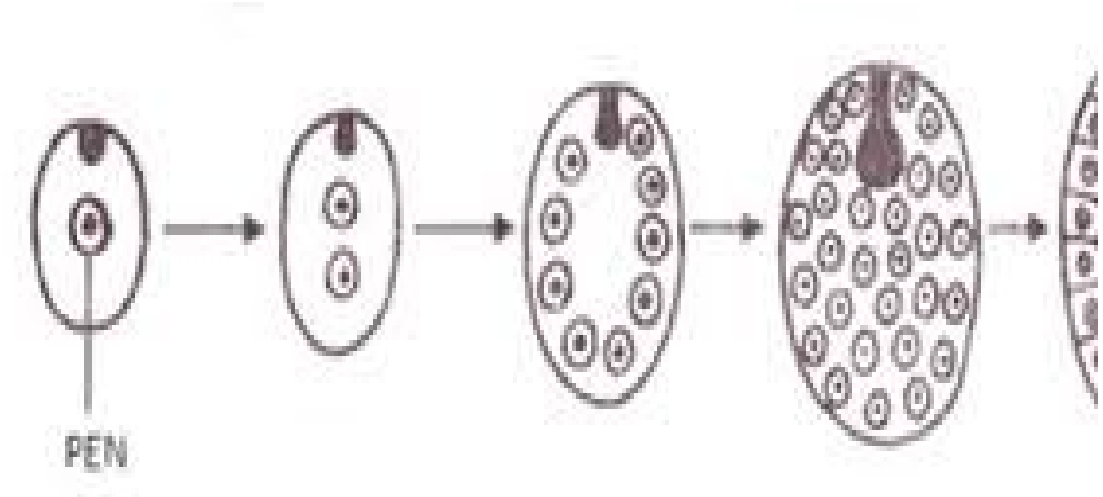
1) Collect developing seeds from a suitable plant, such as **maize or coconut**.
2) Using forceps and a scalpel, carefully dissect the seed to expose the endosperm.
3) Transfer a small portion of the endosperm onto a glass slide.
4) Add a drop of glycerine and stain with safranin (if needed) to enhance visibility.
5) Cover with a coverslip and observe under a microscope.

Observations:

1) The endosperm consists of **free nuclei** without cell wall formation.
2) It appears as a **multinucleate mass** in the early stages.
3) The nuclei are **evenly distributed** within the cytoplasm.
4) In coconut, the **liquid endosperm (coconut water)** represents the free-nuclear stage, while the solid part (coconut kernel) represents the later cellular stage.

Conclusion:

1) The **free-nuclear type of endosperm** is characterized by repeated nuclear divisions without cytokinesis.
2) It plays a significant role in **nourishing the developing embryo** until cellularization occurs.



4. Experiment: To Identify the Cellular Stage of Pollen at the Time of Anther Dehiscence

Aim:

To determine the stage of pollen development at the time of anther dehiscence.

Materials Required:

1) Mature anthers
2) Microscope
3) Glass slides
4) Coverslips
5) Forceps
6) Blade
7) Acetocarmine stain
8) Glycerine

Procedure:

1) Take a **mature flower** and remove an anther using forceps.
2) Crush the anther on a slide with a few drops of **acetocarmine stain** to release the pollen grains.
3) Add a drop of glycerine, place a coverslip, and observe under a microscope.

Observations:

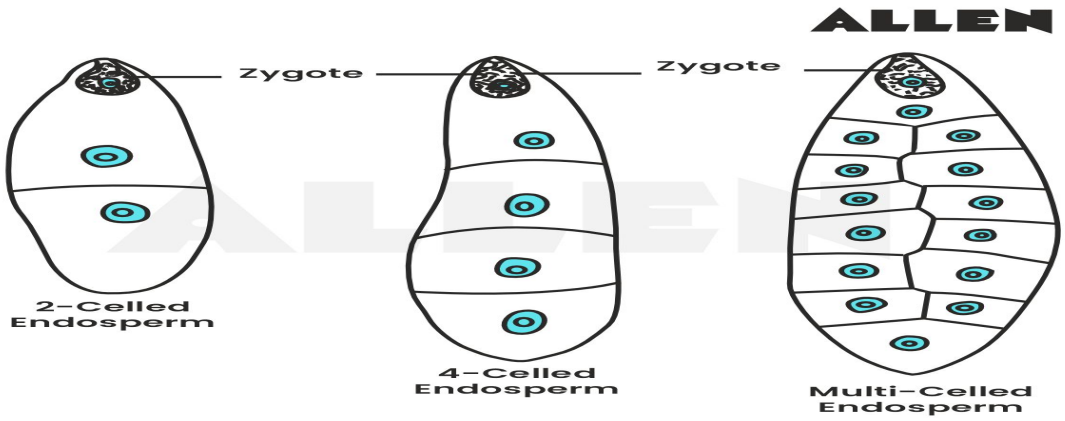
- At the time of **anther dehiscence**, pollen grains are usually in the **binucleate stage** (two nuclei):
    - **Vegetative nucleus** – Larger and irregular in shape.
    - **Generative nucleus** – Smaller and eventually divides to form two sperm cells.
- In some species (e.g., wheat, rice), pollen may be released at the **trinucleate stage**, where the generative cell has already divided into two sperm cells.

Conclusion:

- The **majority of plants release pollen at the binucleate stage**.

- In some species, pollen is released at the **trinucleate stage**, ensuring quicker fertilization.
- The **stage at dehiscence** depends on the species and its reproductive strategy.

5. Experiment: To Study the Ultrastructure of the Male Germ Unit (MGU).



Aim:

To observe and understand the ultrastructure of the Male Germ Unit (MGU) in pollen grains.

Materials Required:

1) Electron microscope images (Transmission Electron Microscope - TEM)
2) Fresh pollen grains (e.g., maize, lily)
3) Acetocarmine stain
4) Microscope
5) Glass slides
6) Coverslips
7) Forceps
8) Blade

Procedure:

1) Collect mature pollen grains from freshly dehisced anthers.
2) Prepare a slide by placing pollen grains in a drop of acetocarmine stain.
3) Cover with a coverslip and observe under a microscope.
4) To study **ultrastructure**, electron microscopy images of the **Male Germ Unit (MGU)** are analyzed.

Observations:

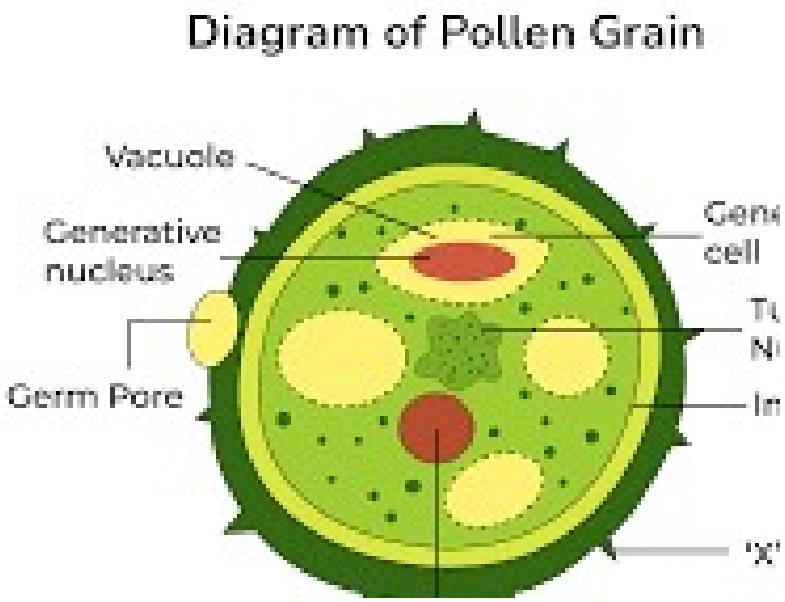
- The **Male Germ Unit (MGU)** consists of:

1) **Vegetative nucleus** – Larger, irregularly shaped, metabolically active.
2) **Generative nucleus (or two sperm cells)** – In binucleate pollen, a single generative nucleus; in trinucleate pollen, two sperm cells.
3) **Cytoskeletal components** – Microtubules help in nuclear movement and sperm cell delivery.

- In some species, sperm cells remain **attached to the vegetative nucleus**, forming a functional unit for fertilization.

Conclusion:

- The MGU plays a crucial role in **double fertilization** by guiding sperm cells towards the egg and central cell.
- The structural organization varies across species but is essential for successful fertilization.



6. Experiment: To Test Pollen Grain Fertility and Viability

Aim:

To assess the fertility and viability of pollen grains using different staining methods.

Materials Required:

1) Fresh pollen grains
2) **Acetocarmine stain** (for fertility test)
3) **TTC (2,3,5-triphenyl tetrazolium chloride) stain** (for viability test)
4) **Fluorescein diacetate (FDA) stain**
5) **Sucrose solution (10–15%)** (for germination test)
6) Microscope
7) Glass slides
8) Coverslips
9) Forceps

Procedure:

1. Acetocarmine Staining (Fertility Test)

1) Collect fresh pollen grains on a glass slide.
2) Add a drop of **1% acetocarmine stain** and cover with a coverslip.
3) Observe under a microscope.
4) **Fertile pollen grains** will appear **darkly stained**, while sterile ones remain unstained or faint.

2. TTC Staining (Viability Test)

1) Mix pollen grains with **0.5% TTC solution** and incubate for 10–15 minutes.
2) Observe under a microscope.
3) **Viable pollen grains** will appear **red** due to enzyme activity, while non-viable ones remain colorless.

3. Fluorescein Diacetate (FDA) Staining (Viability Test)

1) Prepare a **0.01% FDA solution** and mix with pollen grains.

2) Observe under a fluorescence microscope.

3) **Viable pollen grains** will emit **green fluorescence**.

4. In Vitro Germination Test (Pollen Tube Growth Test)

1) Prepare a **10–15% sucrose solution** on a slide.

2) Sprinkle fresh pollen grains onto the drop and incubate for **30–60 minutes**.

3) Observe under a microscope.

4) **Viable pollen grains** will germinate and form **pollen tubes**.

Observations:

1) **Fertile pollen grains** stain dark with acetocarmine.

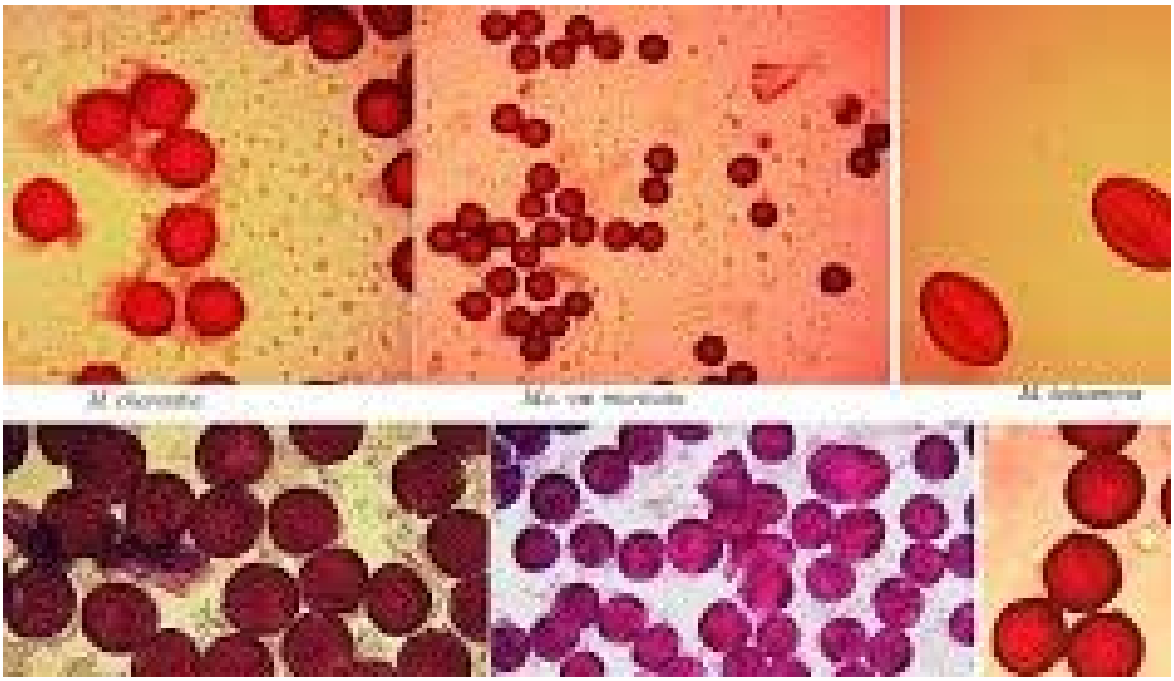
2) **Viable pollen grains** turn **red with TTC** and **fluoresce green with FDA**.

3) **Germination percentage** indicates pollen viability and reproductive potential.

Conclusion:

1) Pollen fertility and viability can be assessed through **staining methods and germination tests**.

2) These tests help in plant breeding, hybridization, and conservation studies.



7. Experiment: To Estimate the Production of Pollen Grains in a Flower

Aim:

To estimate the number of pollen grains produced per flower.

Materials Required:

1) Fresh flowers (e.g., Hibiscus, Datura)
2) Microscope
3) Hemocytometer (for accurate counting)
4) Glass slides
5) Coverslips
6) Forceps
7) Blade
8) Acetocarmine stain

Procedure:

1. **Collect an anther sample:**

   Select a mature flower with dehisced anthers.

   Carefully remove **one anther** using forceps.

2. **Crush the anther to release pollen grains:**

   Place the anther on a glass slide and crush it in a drop of water.

   Stain with acetocarmine for better visibility.

Count pollen grains per anther:

Transfer a known volume of pollen suspension to a **hemocytometer**.

Count the number of pollen grains under a microscope.

Estimate total pollen per flower:

Multiply the **pollen count per anther** by the **total number of anthers per flower**.

Use the formula:

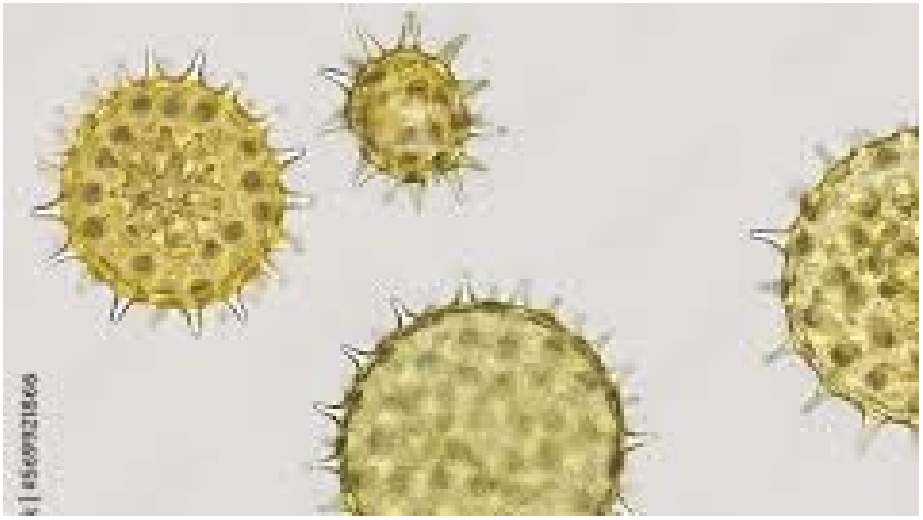
Total pollen per flower=Pollen per anther×Number of anthers per flower\text{Total pollen per flower} = \text{Pollen per anther} \times \text{Number of anthers per flower}

Observations:

1) The total number of pollen grains varies among species.
2) In **Hibiscus**, a single anther may produce thousands of pollen grains.
3) **Pollen production depends on factors like species, environment, and flower size.**

Conclusion:

1) **Estimating pollen count** helps in understanding plant **reproductive success** and **pollination strategies**.
2) **Pollen-to-ovule ratio** indicates the reproductive efficiency of a plant.



Hibiscus Pollengrains

8. Experiment: To Study the Ultrastructure of the Male Germ Unit (MGU)

Aim:

To observe and understand the ultrastructure of the Male Germ Unit (MGU) in pollen grains.

Materials Required:

1) Electron microscope images (Transmission Electron Microscope - TEM)
2) Fresh pollen grains (e.g., maize, lily)
3) Acetocarmine stain
4) Microscope
5) Glass slides
6) Coverslips
7) Forceps
8) Blade

Procedure:

1) Collect mature pollen grains from freshly dehisced anthers.
2) Prepare a slide by placing pollen grains in a drop of acetocarmine stain.
3) Cover with a coverslip and observe under a microscope.
4) To study **ultrastructure**, electron microscopy images of the **Male Germ Unit (MGU)** are analyzed.

Observations:

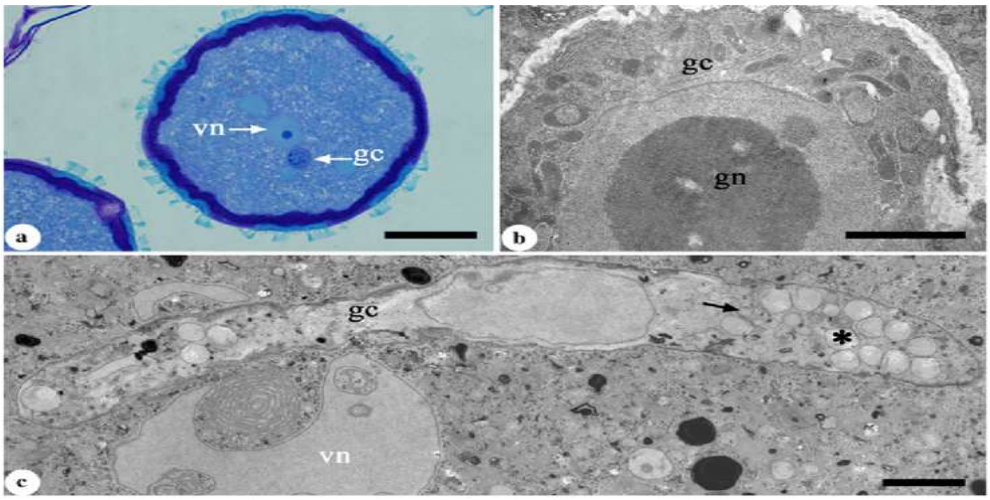
The **Male Germ Unit (MGU)** consists of:

1) **Vegetative nucleus** – Larger, irregularly shaped, metabolically active.
2) **Generative nucleus (or two sperm cells)** – In binucleate pollen, a single generative nucleus; in trinucleate pollen, two sperm cells.
3) **Cytoskeletal components** – Microtubules help in nuclear movement and sperm cell delivery.
4) In some species, sperm cells remain **attached to the vegetative nucleus**, forming a functional unit for fertilization.

Conclusion:

The MGU plays a crucial role in **double fertilization** by guiding sperm cells towards the egg and central cell.

The structural organization varies across species but is essential for successful fertilization.



Structure of Male germ Unit

9. Experiment: To Test Pollen Grain Fertility and Viability

Aim:

To assess the fertility and viability of pollen grains using different staining methods.

Materials Required:

1) Fresh pollen grains
2) **Acetocarmine stain** (for fertility test)
3) **TTC (2,3,5-triphenyl tetrazolium chloride) stain** (for viability test)
4) **Fluorescein diacetate (FDA) stain**
5) **Sucrose solution (10–15%)** (for germination test)
6) Microscope
7) Glass slides
8) Coverslips
9) Forceps

Procedure:

1. Acetocarmine Staining (Fertility Test)

1) Collect fresh pollen grains on a glass slide.
2) Add a drop of **1% acetocarmine stain** and cover with a coverslip.
3) Observe under a microscope.
4) **Fertile pollen grains** will appear **darkly stained**, while sterile ones remain unstained or faint.

2. TTC Staining (Viability Test)

1) Mix pollen grains with **0.5% TTC solution** and incubate for 10–15 minutes.
2) Observe under a microscope.
3) **Viable pollen grains** will appear **red** due to enzyme activity, while non-viable ones remain colorless.

3. Fluorescein Diacetate (FDA) Staining (Viability Test)

1) Prepare a **0.01% FDA solution** and mix with pollen grains.

2) Observe under a fluorescence microscope.

3) **Viable pollen grains** will emit **green fluorescence**.

4. In Vitro Germination Test (Pollen Tube Growth Test)

1) Prepare a **10–15% sucrose solution** on a slide.

2) Sprinkle fresh pollen grains onto the drop and incubate for **30–60 minutes**.

3) Observe under a microscope.

4) **Viable pollen grains** will germinate and form **pollen tubes**.

Observations:

Fertile pollen grains stain dark with acetocarmine.

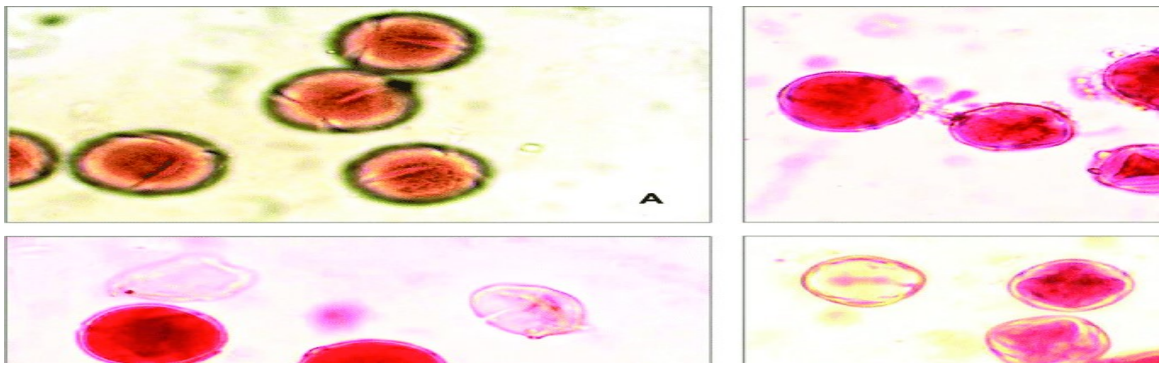
Viable pollen grains turn **red with TTC** and **fluoresce green with FDA**.

Germination percentage indicates pollen viability and reproductive potential.

Conclusion:

Pollen fertility and viability can be assessed through **staining methods and germination tests**.

These tests help in plant breeding, hybridization, and conservation studies.



10. Experiment: To Estimate the Production of Pollen Grains in a Flower

Aim:

To estimate the number of pollen grains produced per flower.

Materials Required:

1) Fresh flowers (e.g., Hibiscus, Datura)
2) Microscope
3) Hemocytometer (for accurate counting)
4) Glass slides
5) Coverslips
6) Forceps
7) Blade
8) Acetocarmine stain

Procedure:

1. **Collect an anther sample:**

Select a mature flower with dehisced anthers.

Carefully remove **one anther** using forceps.

2. **Crush the anther to release pollen grains:**

Place the anther on a glass slide and crush it in a drop of water.

Stain with acetocarmine for better visibility.

3. **Count pollen grains per anther:**

Transfer a known volume of pollen suspension to a **hemocytometer**.

Count the number of pollen grains under a microscope.

4. **Estimate total pollen per flower:**

Multiply the **pollen count per anther** by the **total number of anthers per flower**.

Use the formula:

Total pollen per flower=Pollen per anther×Number of anthers per flower\text{Total pollen per flower} = \text{Pollen per anther} \times \text{Number of anthers per flower}

Observations:

The total number of pollen grains varies among species.

In **Hibiscus**, a single anther may produce thousands of pollen grains.

Pollen production depends on factors like species, environment, and flower size.

Conclusion:

Estimating pollen count helps in understanding plant **reproductive success** and **pollination strategies**.

Pollen-to-ovule ratio indicates the reproductive efficiency of a plant.

11. Experiment: To Study the Morphological Features (Shape, Exine Pattern, and Aperture) of Pollen Grains of Different Species

Aim:

To observe and compare the morphological features of pollen grains, including their **shape, exine pattern, and aperture**, from different plant species.

Materials Required:

1) Fresh or preserved pollen grains from different plant species (e.g., Hibiscus, Datura, Lily, Sunflower, Grass)
2) Acetocarmine or Safranin stain
3) Glycerine
4) Glass slides
5) Coverslips
6) Forceps
7) Needle
8) Light microscope

Procedure:

1. **Collection of Pollen Grains:**

   Collect pollen from freshly dehisced anthers of different flowers.

   Transfer a small amount of pollen onto a clean glass slide.

2. **Staining and Mounting:**

   Add a drop of **glycerine** and **stain (Acetocarmine/Safranin)** to the pollen grains.

   Place a coverslip and gently press to spread the pollen evenly.

3. **Microscopic Observation:**

   Observe the slide under a **light microscope** at different magnifications.

   Record observations of **shape, exine pattern, and aperture type** for each species.

Observations:

Plant Species	Pollen Shape	Exine Pattern	Aperture Type
Hibiscus	Spherical	Spiny (echinate)	Tricolporate
Datura	Oval	Reticulate	Tricolpate
Lily	Elliptical	Smooth	Monocolpate
Sunflower	Round	Reticulate	Tricolporate
Grass (Poaceae)	Oblong	Smooth	Monoporate

Key Features Studied:

1. **Shape of Pollen Grain:**

   Spherical: Common in dicots (e.g., Hibiscus, Sunflower).

   Elliptical/Oval: Found in monocots (e.g., Lily, Grasses).

2. **Exine Pattern (Outer Layer of Pollen Wall):**

   Smooth: Found in monocots like grasses.

   Reticulate (Net-like): Common in species like Sunflower and Datura.

   Spiny (Echinate): Seen in pollens of wind or insect-pollinated plants like Hibiscus.

3. **Aperture Type (Pollen Openings for Germination):**

   Tricolporate (3 furrows &pores): Seen in dicots (Hibiscus, Sunflower).

   Monocolpate (Single furrow): Found in monocots (Lily).

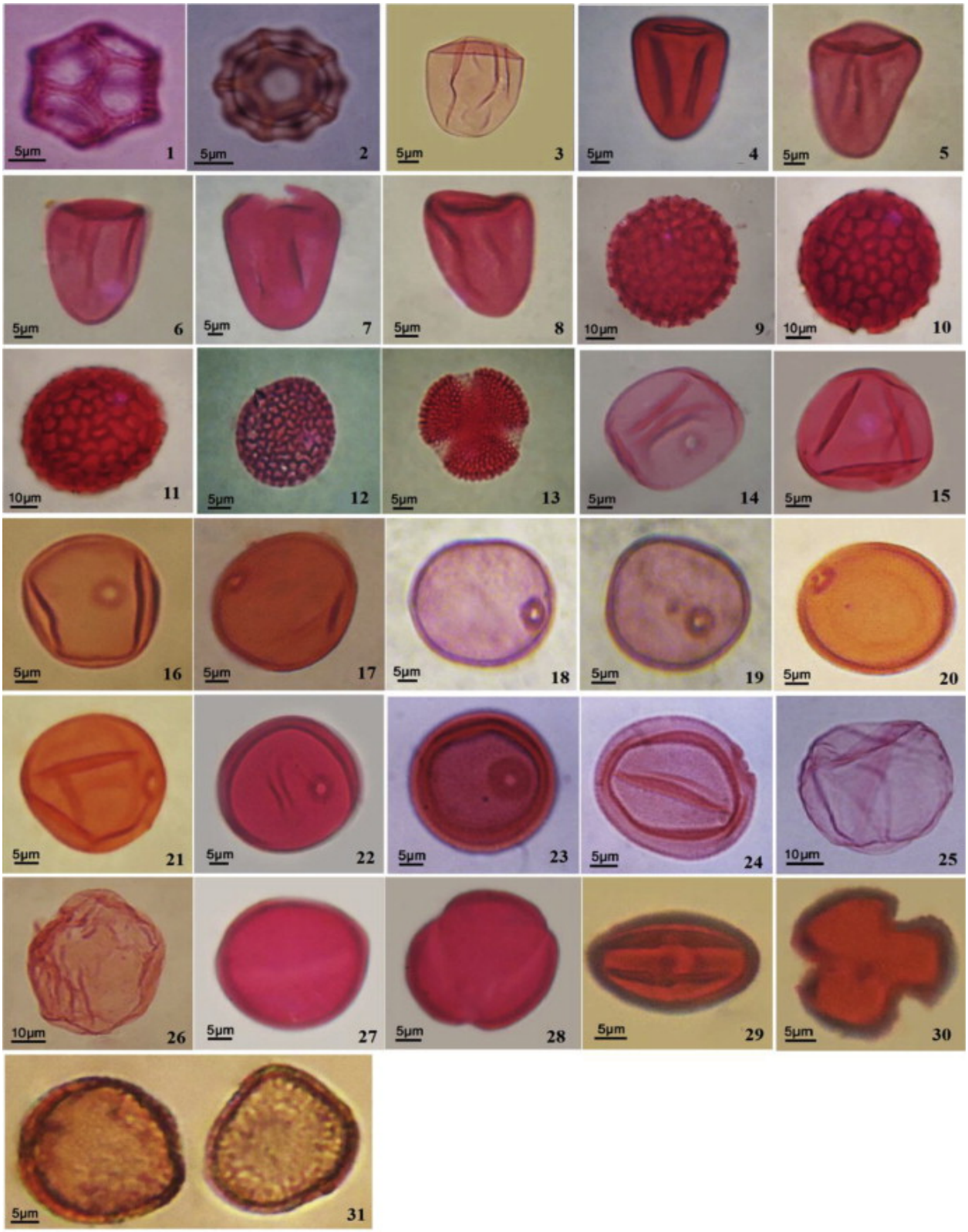
   Monoporate (Single circular pore): Common in grasses.

Conclusion:

Pollen morphology varies significantly among species and is adapted to different pollination mechanisms.

Dicots tend to have **tricolporate pollen** with a textured exine, while **monocots** usually have **monocolpate or smooth pollen**.

These features help in **pollen identification, evolutionary studies, and plant breeding research**.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5µm 27
5µm 28
5µm 29
5µm 30
5µm 31

12. Experiment: To Study Different Types of Ovules

Aim:

To observe and classify different types of ovules based on their orientation and structure.

Materials Required:

1) Flower buds from different plant species (e.g., Pea, Polygonum, Mirabilis, Asteraceae)
2) Dissecting microscope
3) Compound microscope
4) Glass slides
5) Coverslips
6) Forceps
7) Scalpel or blade
8) Safranin stain
9) Glycerine

Procedure:

1) **Dissect ovules** from different flower species using forceps and a scalpel.
2) Mount the ovules on a slide with a drop of glycerine.
3) Stain with **safranin** if necessary to enhance visibility.
4) Observe under a **microscope** and classify them based on their shape and orientation.

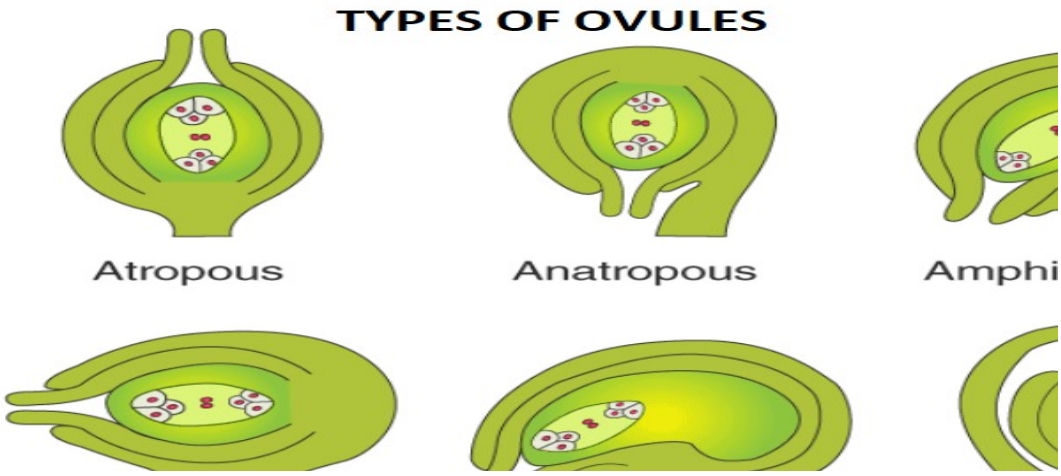
Observations:

Type of Ovule	Description	Example
Orthotropous (Atropous)	Straight ovule with micropyle, chalaza, and funiculus in a straight line.	Piper, Polygonum
Anatropous	Ovule completely inverted, with micropyle near the funiculus.	Pea, Sunflower
Campylotropous	Ovule slightly curved, with micropyle and chalaza	Brassica,

Type of Ovule	Description	Example
	not aligned.	Capsella
Amphitropous	Ovule curved more than campylotropous, with embryo sac also curved.	Poppy
Hemitropous	Ovule partially inverted, with micropyle and chalaza at an angle.	Ranunculus
Circinotropous	Ovule rotates during development, forming a complete circle.	Opuntia (Cactus)

Conclusion:

1) Different plants have **different types of ovules**, adapted to their reproductive strategies.
2) **Anatropous ovules** are the most common in **angiosperms**.
3) The **position of the ovule** affects fertilization and seed development.



13. Experiment: To Study Special Ovular Structures

Aim:

To observe and study **specialized structures in ovules**, including **nucellus, integuments, micropyle, and obturator**.

Materials Required:

1) Ovules from different plant species
2) Compound microscope
3) Glass slides
4) Coverslips
5) Forceps
6) Scalpel
7) Safranin stain
8) Glycerine

Procedure:

1) Dissect mature ovules from flower buds.
2) Stain the ovules with **safranin** and mount in glycerine.
3) Observe under a **microscope** and identify special structures.

Special Ovular Structures Observed:

Structure	Function	Example
Nucellus	Nutritive tissue that nourishes the embryo sac.	Found in all ovules
Integuments	Protective layers covering the nucellus.	Present in ovules with seed coats
Micropyle	Small opening in the integuments for pollen tube entry.	Seen in all ovules
Obturator	A guiding tissue that helps in pollen tube	Present in some plants like

Structure	Function	Example
	entry.	**Mangifera** (Mango)
Aril	Extra seed covering, often fleshy.	Litchi, Pomegranate
Caruncle	Outgrowth on seed for water absorption.	Castor (Ricinus)
Perisperm	Persistent nucellus in the seed, providing nourishment.	Black pepper (Piper nigrum)

Conclusion:

Special ovular structures play a **critical role in fertilization, seed protection, and dispersal**.

The **micropyle** allows sperm entry, while the **nucellus** nourishes the developing embryo.

14. Experiment: To Study Monosporic, Bisporic, and Tetrasporic Types of Embryo Sac Development

Aim:

To understand the different types of **female gametophyte (embryo sac) development** based on the number of functional megaspores.

Materials Required:

1) Flower buds at different developmental stages
2) Compound microscope
3) Glass slides
4) Coverslips
5) Forceps
6) Scalpel
7) Acetocarmine stain
8) Glycerine

Procedure:

1) **Dissect developing ovules** from flower buds at different stages.
2) Stain with **acetocarmine** and mount in glycerine.
3) Observe embryo sac development under a **microscope**.
4) Identify whether the embryo sac is **monosporic, bisporic, or tetrasporic**.

Types of Embryo Sac Development Observed:

Type	Number of Functional Megaspores	Division Pattern	Example
Monosporic (Polygonum Type)	1 functional megaspore (3 degenerate)	Standard 3 mitotic divisions → 8-nucleate embryo sac	**Pea, Sunflower**
Bisporic (Allium	2 functional	Both megaspores undergo	**Onion**

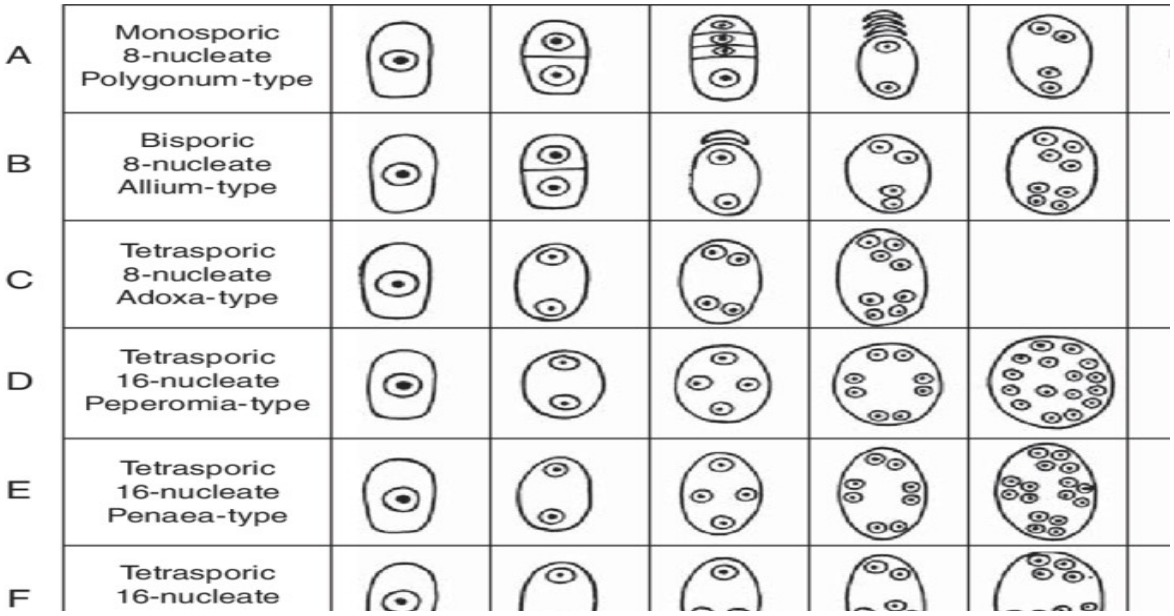
Type	Number of Functional Megaspores	Division Pattern	Example
Type)	megaspores degenerate)	(2 mitosis → 8-nucleate embryo sac	**(Allium)**
Tetrasporic (Peperomia Type)	All 4 megaspores functional	No cytokinesis → 8-16 nuclei embryo sac	**Peperomia, Atriplex**

Observations:

1) **Monosporic development** is the most common in **angiosperms**.
2) **Bisporic and tetrasporic embryo sacs** have **more genetic variation** as multiple megaspores contribute to the embryo sac.
3) **Tetrasporic development** leads to a **larger embryo sac with multiple nuclei**, seen in Peperomia.

Conclusion:

1) The **monosporic (Polygonum) type** is **dominant in angiosperms** and follows the standard **8-nucleate, 7-celled embryo sac structure**.
2) **Bisporic and tetrasporic** types result in **genetic diversity** due to contributions from more than one megaspore.


A
Monosporic
8-nucleate
Polygonum-type
B
Bisporic
8-nucleate
Allium-type
C
Tetrasporic
8-nucleate
Adoxa-type
D
Tetrasporic
16-nucleate
Peperomia-type
E
Tetrasporic
16-nucleate
Penaea-type
F
Tetrasporic
16-nucleate

15. Experiment: To Estimate the Number of Ovules in a Flower

Aim:

To count and estimate the **total number of ovules per flower** in different species.

Materials Required:

- Fresh flowers (e.g., Hibiscus, Datura, Pea, Sunflower)
- Scalpel and forceps
- Microscope
- Glass slides and coverslips
- Acetocarmine stain

Procedure:

1) **Dissect the ovary** carefully using forceps and a scalpel.
2) Remove the **placenta** and count the **number of ovules** per locule.
3) Multiply the **number of ovules per locule** by the **number of locules in the ovary** to estimate **total ovules per flower**.

Observations:

Plant Species	No. of Ovules per Ovary	Placentation Type
Hibiscus	Many	Axile
Datura	Many	Axile
Pea	2–6	Marginal
Sunflower	1	Basal

Conclusion:

Ovule number varies across species depending on **reproductive strategy**.

Hibiscus and Datura have many ovules, while **Sunflower has only one per ovary**.

16. Experiment: To Assess the Receptivity of Ovules Using Toluidine Blue 'O' Test

Aim:

To determine the **receptivity of ovules** using the **Toluidine Blue 'O' (TBO) test**, which detects the **presence of callose** at the micropyle.

Materials Required:

1) Freshly collected flowers at **different stages**
2) Toluidine Blue 'O' (TBO) stain
3) Microscope
4) Glass slides and coverslips
5) Forceps and scalpel

Procedure:

1) **Collect ovules** from flowers at **different developmental stages**.
2) Stain with **0.05% Toluidine Blue 'O'** for **10–15 minutes**.
3) Rinse with water and observe under a **microscope**.
4) **Receptive ovules** will show **blue-stained micropyle** due to the presence of **callose deposits**.

Observations:

Stage of Flower	Micropyle Staining	Ovule Receptivity
Young Bud	No staining	Not receptive
Pre-anthesis	Weak staining	Low receptivity
Anthesis (Flower Opening)	Strong blue staining	Highly receptive
Post-Anthesis	Faint staining	Reduced receptivity

Conclusion:

- **Strong blue staining** at the **micropyle** indicates **high ovule receptivity**.
- Ovules are most receptive at **anthesis (flower opening stage)**, which is **optimal for fertilization**.
- The **Toluidine Blue 'O' test** is useful in **breeding programs** to determine the best time for pollination.

* * * * *

Lesson Writer

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