Choice Based Credit System Syllabus To be implemented from Academic Year 2019-2020

SEMESTER-I:

PAPER-II BO-112: PLANT MORPHOLOGY AND ANATOMY

By

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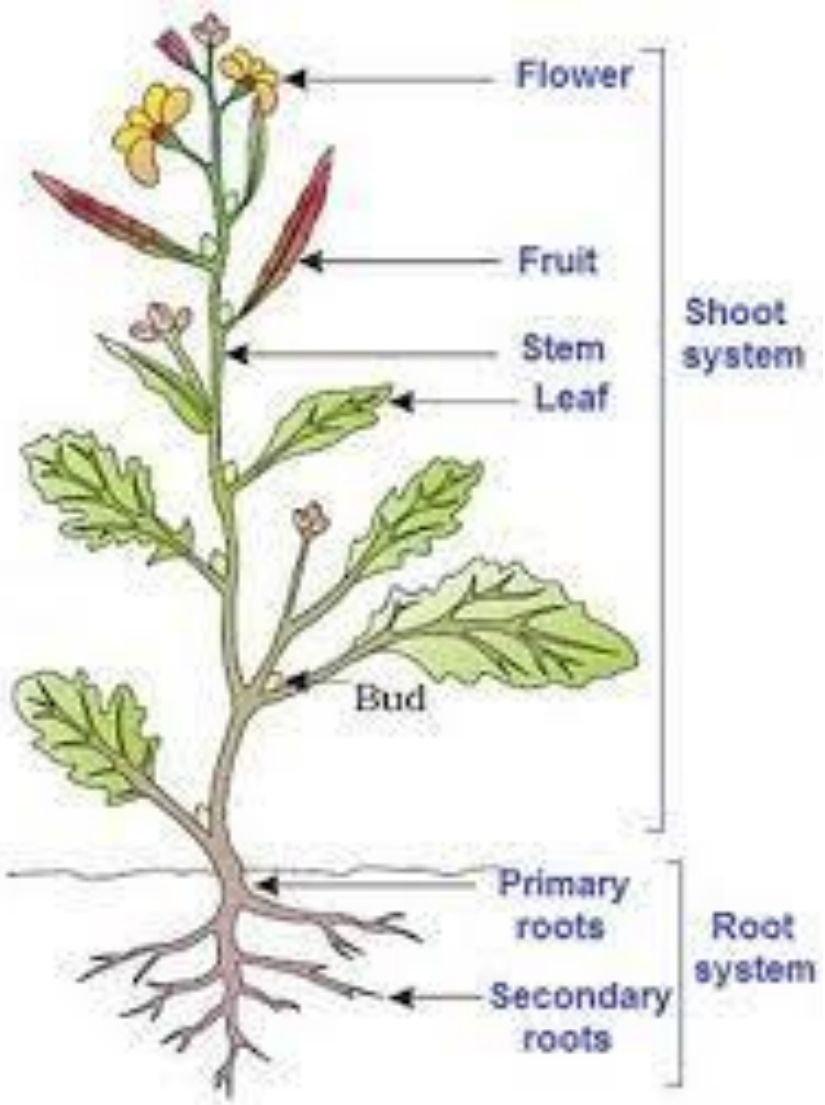
CREDIT-I

- 1. MORPHOLOGY:
- 2. MORPHOLOGY OF REPRODUCTIVE PARTS:
- 2.1: INFLORESCENCE:
- 2.2: FLOWER:
- 2.3: FRUITS:

Chap -1 MORPHOLOGY:

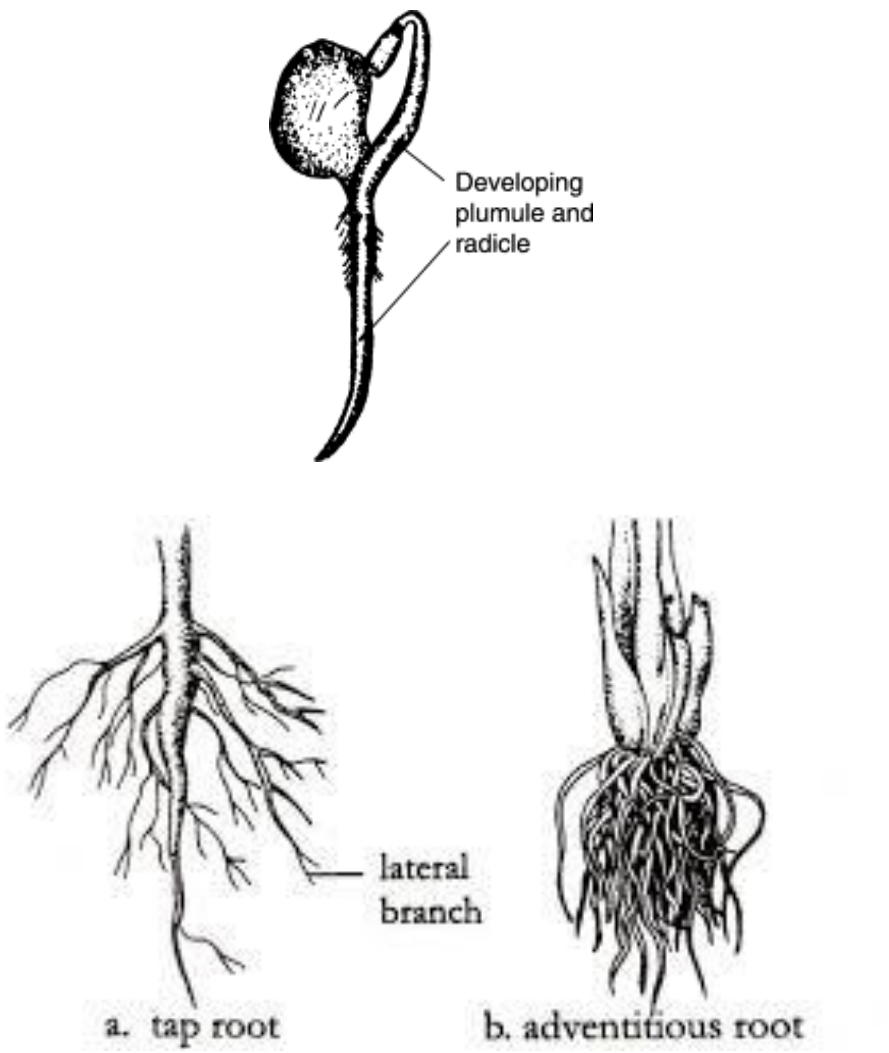
- Learning objects:
- 1.1: Introduction, definition, descriptive and interpretative morphology.
- 1.2: Importance in identification, nomenclature, classification, phylogeny and Plant breeding.

1.1: Introduction and Definition,



- Morphology – (Morphe = form + logos = study). It deals with the study of forms and features of different plant organs like roots, stems, leaves, flowers, seeds, fruits etc.
- The body of a typical angiosperm plant is differentiated into :
- ✧ an underground root system
- ✧ an aerial shoot system.
- The shoot system consists of stem (including branches), leaves, flowers and fruits.
- The roots, stems and leaves are vegetative parts, while flowers constitute the reproductive part.

ROOT



- Radicle comes out/arise from the seed coat in the form of soft structure and move toward the soil. It develops and forms primary root.
- General Characters : Roots are non green, underground, (+) geotropic, (–) phototropic and (+) hydrotropic. Roots do not bear buds. Buds present for vegetative propagation in sweet potato (Ipomea) and Indian red wood (Dalbergia) Roots do not bear nodes and internodes. Roots have unicellular root hairs.
- TYPES OF ROOTS
- Roots are of two types : ✧ Tap root ✧ Adventitious root
- Tap root : It develops from radicle and made up of one main branch and other sub branches. The primary roots and its branches constitute tap root system. e.g. Dicot roots.
- Adventitious roots : In some plants, after sometime of the growth of tap root which arises from radicle, stops and then roots, develop from other part of plant, which are branched or unbranched, fibrous or storage, are known as adventitious roots and constitute fibrous root system. e.g. Monocot roots.

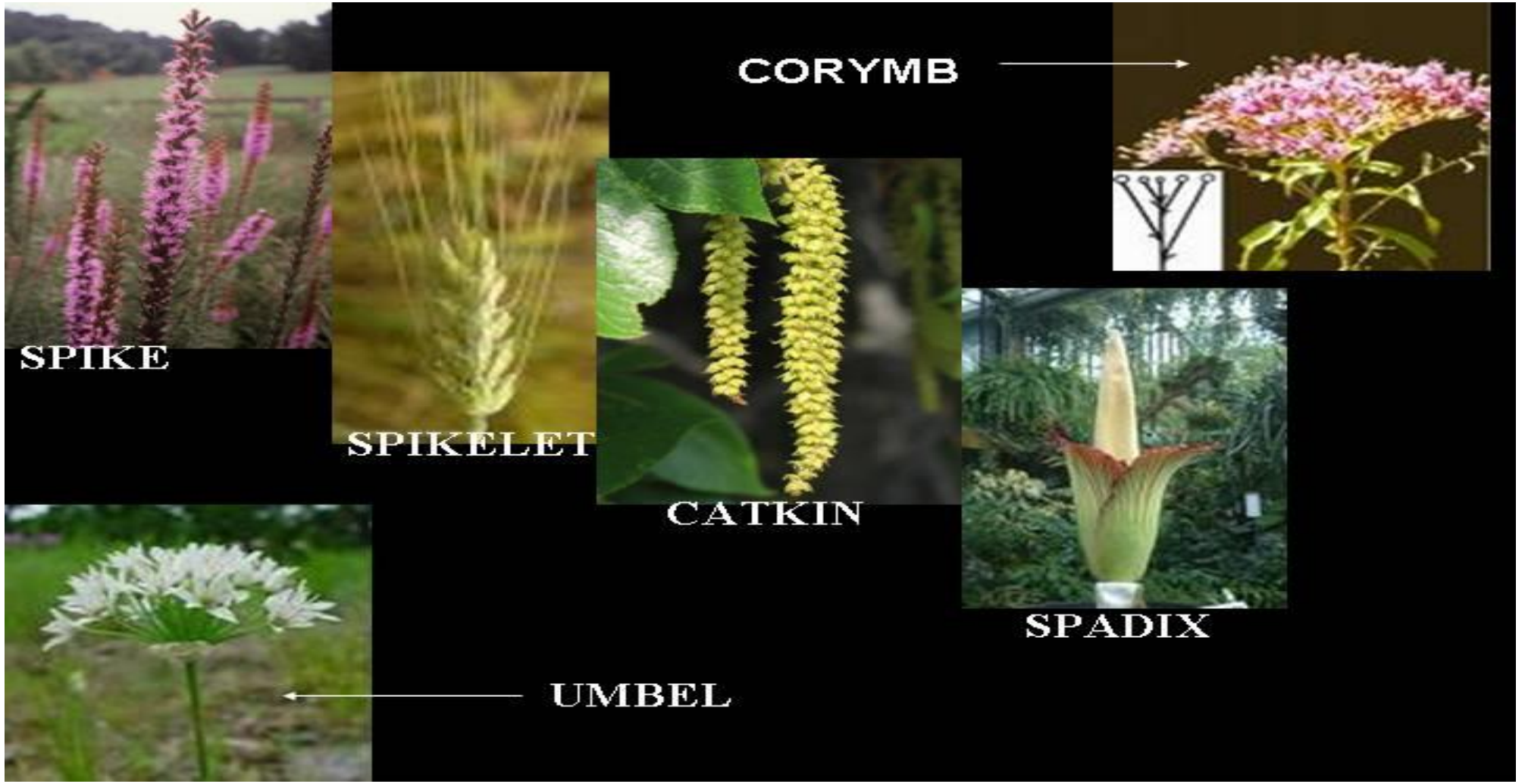
STEM

- Stem is a part of plant which lies above from surface of soil i.e. it shows negative geotropic growth. It has nodes and internodes. Branches, leaf, flower bud and bracts are developed from nodes. Stem arises from plumule.
- FORMS OF STEM
- Caudex : It is unbranched, erect, cylindrical stout stem and marked with scars of fallen leaves. Crown of leaves are present at the top of plant. eg.: Palm
- Culm : Stem is jointed with solid nodes & hollow internodes. eg. Bamboo (Graminae)
- Excurrent : The branches arise from the main stem in acropetal succession and the tree assumes a cone like appearance e.g. Pinus, Eucalyptus, Casuarina, etc.
- Decurrent (Deliquescent) : The lateral branches grow more vigorously and outcompetes the main trunk, giving a dome-shaped appearance, e.g., mango (Mangifera indica), shishem (Dalbergia sissoo) and banyan (Ficus bengalensis)

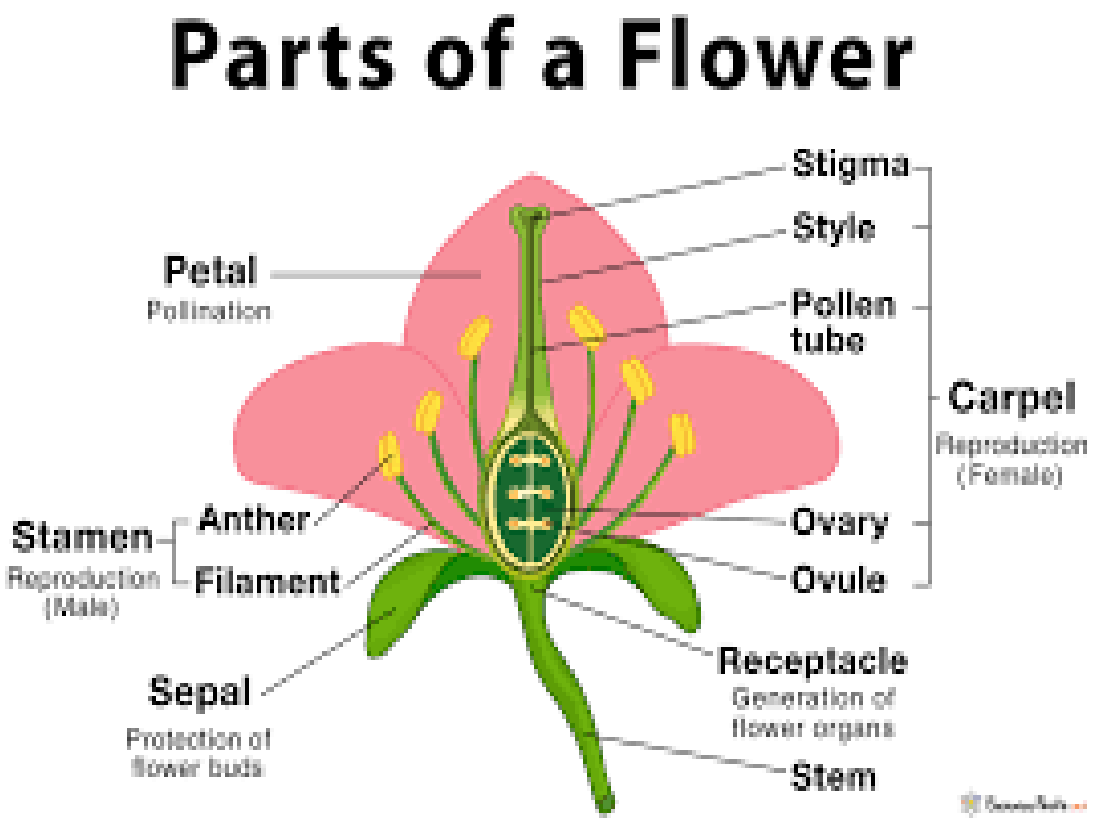
LEAF (PHYLLOPODIUM)

- The leaf is a lateral generally flattened structure borne on the stem. The leaves develop from the nodes. Their main function is photosynthesis and food making, axillary buds are found in its axil. All the leaves of a plant is known as phyllome. Axillary bud later develops into a branch. Leaves originated from shoot apical meristem and are arranged in acropetal order.

INFLORESCENCE -Arrangement of flower on floral axis is called inflorescence.

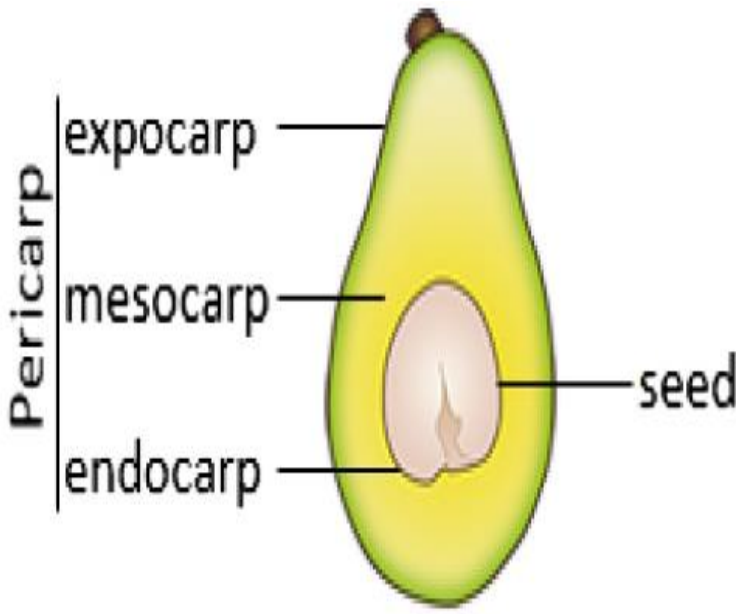


FLOWER



- Flower is defined as highly condensed and modified reproductive shoot. The part from where flower arise is called bract. Flower has short or long flower stalk which is called pedicel. The upper part of pedicel is swollen, spherical shaped or conical which is called thalamus / Receptacle.
- Floral leaves are present on it. In a flower there are 4 type of floral leaves are found. ✧ Sepal ✧ Petal ✧ Stamen ✧ Carpel

FRUIT



- Fertilized and ripened ovary is fruit. A Fruit consist of (i) Pericarp (fruit wall), (ii) seed. The seeds are protected inside fruit. But in some fruits. seeds are not found like in grapes, banana and such type of fruits are seedless fruit. If a fruit is formed without fertilization of the ovary it is known as parthenocarpic fruit.
- Pericarp : After ripening, the ovary wall change into pericarp. This pericarp may by thick and fleshy or thick and hard or thin and soft.
- Pericarp is differentiated in 3 layers
- Epicarp :- It is the outermost layer, which is also called rind
- Mesocarp :- It is the middle layer.
- Endocarp : It forms the innermost layer.
- TRUE FRUIT : When the fruit is developed only from the ovary, the fruit is called as true fruit. eg. Mango, Coconut, Zizyphus
- FALSE FRUIT OR PSEUDOCARP : In some fruits, in place of ovary, some other parts of flower like thalamus, inflorescence, calyx are modified to form a part of fruit. These types of fruit are called false fruits. eg. Apple, Strawberry, Pear.

Types of Morphology: Descriptive and Interpretative morphology.

- **Descriptive morphology:**
- Descriptive Morphology is the branch of biology that deals with the form and structure of organisms without consideration of function. In descriptive morphology, the morphological characters or features of the plant are broadly described in morphological terms.
- Descriptive morphology gives the detailed description of plant body in general, including its root, shoot, flower fruit and seed. Minor details like scales, hairs, ornamentations, spines, colours, pigmentations, outgrowths, variation pattern, spore structure and the like are also studied in descriptive morphology Mostly general or very common description of plants without any quantification, comparisons or any type of interpretation is given in descriptive morphology
- . Descriptive morphology includes morphology of vegetative (somatic) as well as reproductive structures. Reproductive morphology is more varied and still very specific to a particular group or family. The detailed study of descriptive morphology of reproductive parts led to discovery of the alternation of generation found in all plants. This is commonly observed in algae. The broad description of a plant in nature or in open fields is taken as field notes and is very helpful for taxonomists in classification and naming of plants. Descriptive morphology indicates the overall architecture of the plant.

- **Interpretative morphology.**
- Interpretative Morphology is the study of morphological characters with interpretation of origin, development, phylogeny, growth pattern etc. On the basis of knowledge of interpretative morphology, plant origin and development is analysed, correlated and interpreted and assigned to their taxonomic group eg particular species or variety or cultivar eg. Tree in desert and Tree in Kashmir.
- The outcome of interpretative morphology is the manifestation of environmental or ecological conditions and physiological status of a plant. The specific morphological variations are interpreted and analyzed to deduce certain conclusions. The similarities and differences in morphological structures between plant groups, e.g. bryophytes, pteridophytes, gynmosperms and angiosperms indicate that bryophytic group has given rise to primitive pteridophytes and some pteridophytic lines may be the ancestors of gymnosperms. For instance, the morphological similarities between the gymnospermic groups such as reticulate venation in leaf, male and female flowers, anatomy (primitive vessels) in Gnetum helps us to interpret that angiosperms have evolved from Gnetalian group, which is known as proangiosperms.

IMPORTANCE OF MORPHOLOGY IN IDENTIFICATION

- Identification of plants and their classification into different families is primarily based on morphological features, as they are easily seen differentiated and even practiced in field or in nature. Morphology is the basic stepping stone of taxonomy and it is the simplest as well as the easiest source of data collection, which is further used in taxonomy.
- In fact, the first system of plant classification was based on habit and morphological characters.
- Theophrastus 370 - 285 BC) who is known as the "Father of Botany" had classified the plants into four groups as herbs undershrubs, shrubs and trees.
- English Botanist John Ray (1628 – 1705) published the system of classification based on forms and gross morphological structure of plants. He divided the plant kingdom as Herbae and Arobores.
- The most commonly used morphological characters are (1) Plant height, (ii) Habit, (iii) Root (iv) Stem bark, (v) Branching, (vi) Phyllotaxy, (vii) Size and shape of the leaves, types, its margin, types of venation, apex, (vii) Inflorescence, (ix) Flower-calyx, corolla, androecium, gynoecium, (x) Pollen grains, (xii) Fruit, (xii) Seed-size, colour, shape. All these morphological characters have immense value in identification of plants.

IMPORTANCE OF MORPHOLOGY IN CLASSIFICATION

- Linnaeus (1707 - 1778) known as the "Father of Taxonomy or "Father of Modern Botany" proposed an artificial sexual system of classification, based on morphological characters of plants.
- The best natural system of classification of plants proposed by Bentham and Hooker (1800 - 1884) is also based on comparative morphology, which is very important to decide the forms and relationships existing among plants in nature.
- Presence or absence of flower was the main criteria which divided the whole plant kingdom into Phanerogams and Cryptogams.
- The phanerogams were classified into angiosperms and gymnosperms mainly on the basis of whether the seeds are enclosed into vary or exposed outside.
- The complete division of Angiosperms was classified into two classes as monocotyledons and dicotyledons on the basis of single or two cotyledons

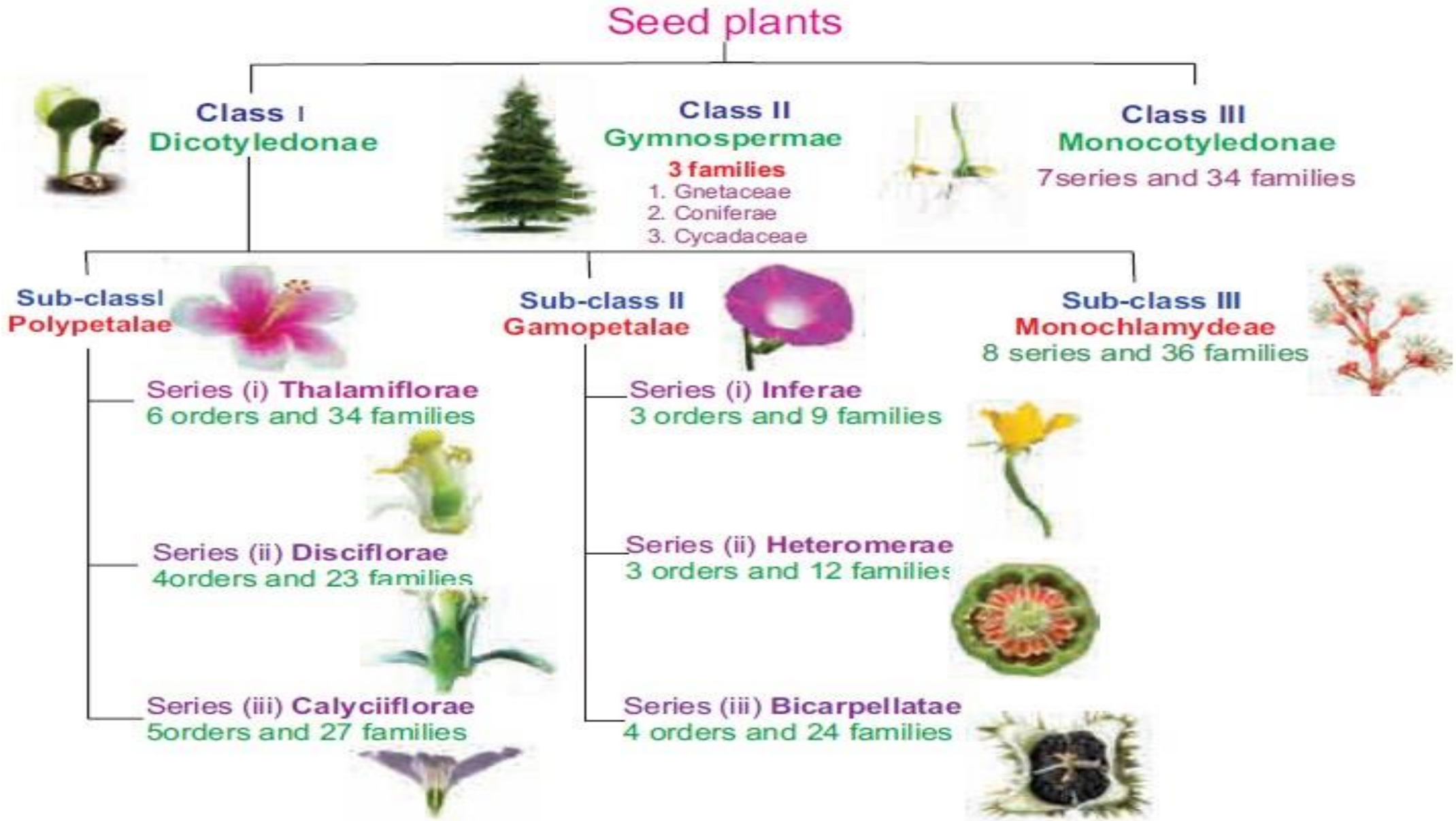


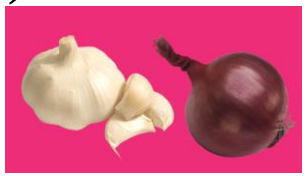
Figure 5.6: Bentham and Hooker system of classification

- Class I Dicotyledonae: Plants contain two cotyledons in their seed, leaves with reticulate venation, tap root system and tetramerous or pentamerous flowers come under this class. It includes three sub-classes – Polypetalae, Gamopetalae and Monochlamydeae.
- Sub-class 1. Polypetalae: Plants with free petals and dichlamydeous flowers come under polypetalae. It is further divided into three series – Thalamiflorae, Disciflorae and Calyciflorae.
- Series (i) Thalamiflorae: Plants having flowers with dome or conical shaped thalamus and superior ovary are included in this series. It includes 6 orders and 34 families.
- Series (ii) Disciflorae: Flowers having prominent disc shaped thalamus with superior ovary come under this series. It includes 4 orders and 23 families. Series
- (iii) Calyciflorae: It includes plants having flowers with cup shaped thalamus and with inferior or sometimes with half inferior ovary. Calyciflorae includes 5 orders and 27 families
- Sub-class 2. Gamopetalae: Plants with united petals, which are either partially or completely fused to one another and dichlamydeous are placed under Gamopetalae. It is further divided into three series – Inferae, Heteromerae and Bicarpellatae.
- Series (i) Inferae: The flowers are epigynous and with inferior ovary. Inferae includes 3 orders and 9 families.
- Series (ii) Heteromerae: The flowers are hypogynous, superior ovary and with more than two carpels. Heteromerae includes 3 orders and 12 families.
- Series (iii) Bicarpellatae: The flowers are hypogynous, superior ovary and with two carpels.Bicarpellatae includes 4 orders and 24 families.

- Sub-class 3. Monochlamydeae: Plants with incomplete flowers either apetalous or with undifferentiated calyx and corolla are placed under Monochlamydeae. The sepals and petals are not distinguished and they are called perianth. Sometimes both the whorls are absent. Monochlamydeae includes 8 series and 36 families.
- Class II Gymnospermae: Plants that contain naked seeds come under this class. Gymnospermae includes three families – Gnetaceae, Coniferae and Cycadaceae.
- Class III Monocotyledonae: Plants contain only one cotyledon in their seed, leaves with parallel venation, fibrous root system and trimerous flowers come under this class. The Monocotyledonae has 7 series and 34 families.

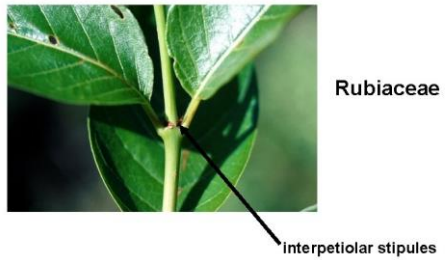
The following characters are useful to mark out particular plant or family of plant

- 1) Habit - The characters from habit are useful in the following ways.
- a) In Pinus, bark characters are used for identification of species. b) Woody and herbaceous characters among plants were used by Hutchinson (1926, 1973) for his classification system. He separated dicots in two groups woody plants as lignosae and herbaceous plants as herbaceae.
- 2) Underground Parts - The character of bulb is important in separation and identification of genus *Allium* in two species, eg. the bulb is clustered on rootstock as in *sativum* (garlic) and bulb is not clustered in rootstock in *Allium cepa* (onion)



- 3) Leaves : Leaves are important for identification in palms, Salix and Popular
- b) The genus Azadirachta has been separated from Melia on the basis of variations in leaves Azadirachta has unipinnate leaves and Meta has bipinna leaves

- c) Leaf venation is important for the identification of the species
- d) Interpetiolar stipules are useful for identification of family Rubiaceae.



- 4) Reproductive sources-
- a) Inflorescence is also significant in identification of plant families. Eg. Racemose and Cymose are the main inflorescence types. However, some of the plant families are recognised by special types of inflorescence. These are cyathium – Euphorbiaceae, verticillaster – Lamiaceae, hypanthodium - Moraceae, capitulum - Asteraceae, umbel - Umbelliferae.
- b) Other floral characters are also important in taxonomy, e.g. fusion of petals separated dicots into two subclasses polypetalae and gamopetalae. However presence of perianth is a striking feature of monochlamydeae (Apetalae).
- c) In some families, presence of calyx modifications is significant as taxonomic source e.g. pappus calyx in Asteraceae, persistent calyx in Solanaceae, petaloid calyx in some members of Rubiaceae.
- d)Stamen number, fixation of anthers, adhesion and cohesion of stamens are important sources for taxonomic studies, e.g. epipetalous stamens in gamopetalae, presence of gynostegium and staminal corona in Asclepiadaceae.
- e) Type of placentation is also an important source for the separation of certain categories and groups of plants.
- f) Flowers – Floral characters are more important characters than other morphological characters, these include calyx of Lamiaceae, corolla of Fabaceae (Papilionaceae), diadalphous stamens of Fabaceae, carpels in Caryophyllaceae. A gynobasic style is characteristic of Lamiaceae. The gynostegium is characteristic of family Asclepiadaceae. Family Euphorbiaceae is characterized by cyathium inflorescence, where female flower is covered by a cluster of male flowers, one stamen represents one male flower.
- g) Fruits - Fruit characters are also widely used in identification.

IMPORTANCE OF MORPHOLOGY IN NOMENCLATURE

Binomial Nomenclature

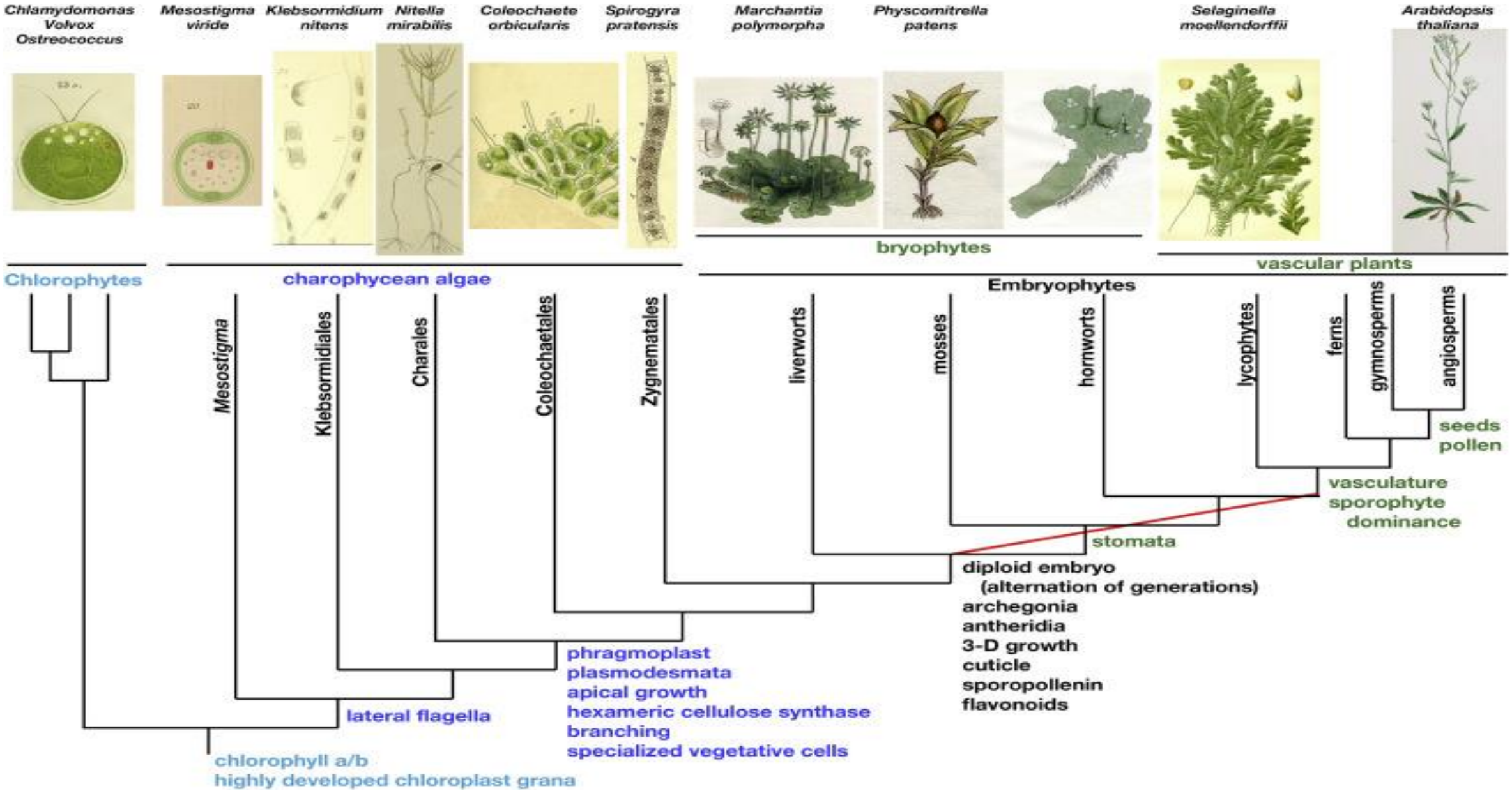
Binomial Nomenclature- System of providing two names in a scientific name for an organism

Carolus Linnaeus- Formalised the system of naming organisms by binomial nomenclature

Two elements in a scientific name →
- **Generic name** (Genus)
- **Specific epithet** (Species)

- a)The names of the species of genera are given in a different manner. These names may * according to the place of origin, eg *Mangifera indica* (Mango) indicates that the origin of mango is in India
- There are several examples in plant kingdom where lead morphology is used to name the species or genus. Some important examples are given below
- b) in Ginkgo, the leaves are bilobed. Hence the name of its species is Ginkgo biloba
- 1) In *Ipomea*, the leaves are simple as compared to other genera which have compound leaves, hence the name of its species is *Ipomea simplicifolia*. In other species, the leaves are palm like, hence the species is *Ipomea palmata*
- In Capparis, the leaves are totally absent, hence the name of species is Capparis aphylla
- In the genus *Polyalthio*, the leaves are long, hence the name of species is *Polyottha longifolia* - In one species of Rubio, the leaves are heart shaped, hence its named as Rubia cordifolia

IMPORTANCE OF MORPHOLOGY IN PHYLOGENY



IMPORTANCE OF MORPHOLOGY IN PLANT BREEDING

- Plant breeding and hybridisation is of great importance in crop improvement. Thousands of high yielding and disease resistant hybrid varieties in cereals, millets, pulses, oilseed plants, fibre plants, horticulture, floriculture, fruits and vegetables is the gift of technology of plant breeding. In fact, this branch is the basis of green revolution in India.
- The selection of male and female parents in breeding is the first and foremost step, which is based on their important morphological features.
- The traits considered are generally the height of the plant, nature of branching and foliage phyllotaxy, and more specifically nature of flower, corolla, stamens, (androecium) carpels (gynoecium), stigma and the most important is the type of pollination i.e. cross pollination or self pollination.
- The ultimate aim of breeding is improvement in yield and its quality. If the yield is considered, the breeder concentrates on size of ear head, grains, pods, fruits, etc. which are almost all the morphological characters. In short, plant breeding also gives emphasis on morphological features.