Origin of Angiosperms

ORIGIN OF ANGIOSPERMS.

- Sudden Appearance in Cretaceous age.
- Charles Darwin described it as "abominable mystery" due to poor records.
- Many considerable differences of opinion among botanists.
- About their age (late Jurassic or early cretaceous).
- Place of origin (Artic or pacific basin).
- Possible ancestors (various theories).

ISOETES MONOCOTYLEDON THEORY

- Put forth by Campbell in 1928.
- Herbaceous angiosperms are primitive, inherited from filicinean ancestor.
- Isoetales, Lycopodales, ferns possess characteristics same with monocotyledons.
- *Isoetes* grows in aquatic or amphibious environment indicating relationship v monocotyledons.
- Similarity in structure and position of embryo.
- No intervention of seeds disappoints this theory.

CONIFER-AMENTIFERAE THEORY

- Put forth by Engler (1882) and later Rendle (1904).
- Found similarity of angiosperms with Conifers.
- Considered Amentiferous group as primitive angiosperms.
- Covered nature of seeds in araucaria.
- Naked inflorescence of amentifers compared to conifers.
- Fertilization in araucaria, pollen are deposited on the scale and only pollen tube enters the micropyle.

- According to modern classification amentiferae is regarded as advanced plants.

BENNETTITALEAN THEORY

- Put forth by Saporta and Marion (1885) and Arber and Parkin (1907).
- Benettitales as possible ancestor of angiosperms for similarities between the strobili of *Cycadeoidea* and *Magnolia*.
- Strobili and flower both are bisexual.
- Elongated central axis having bracts, micro and megasporophylls.
- Carpel bear single ovule.
- Contradiction with stem anatomy disappoints this theory.

Fig. 4.7. Cycadeoidea dacotensis. Apical part with

PENTOXYLALEAN THEORY

- Meeuse (1961) proposed pentoxylales (fossil) as probable ancestor of angiosperms.
- Affinities of pentoxylales to *pandanus*.
- Plants are erect and dioecious.
- Stem slender and cylindrical.
- Stem bears a terminal tufts of strap- shaped leaves arranged spirally;
- Seeds enclosed in sarcotesta.
- Later, Pant and Kidwai (1971) stated that the above similarity appears as a result of parallel evolution

GNETALES-ANGIOSPERM THEORY

- Wettstein (1901) emphasised relationship between Gnetales and angiosperms.
- Supported by Markgraf (1930) and Fagerlind (1947) who proposed that gnetales and angiosperm evolved from single ancestor.
- Presence of two cotyledons.
- Vessels in the secondary wood.
- Stamens apparently similar to angiosperms.
- Bitegmic ovules of gnetales.
- Evidence from vascular anatomy strongly refuse relationship between gnetales and angiosperms.

Similarities between Gnetales and Angiosperms:

i. Presence of two cotyledons.

ii. Vessels in the secondary wood.

Gnetum wood cross section

iii. Venation – reticulate.

Gnetum leaf

iv. Unisexual inflorescence (similar to catkin of many Amentifers).

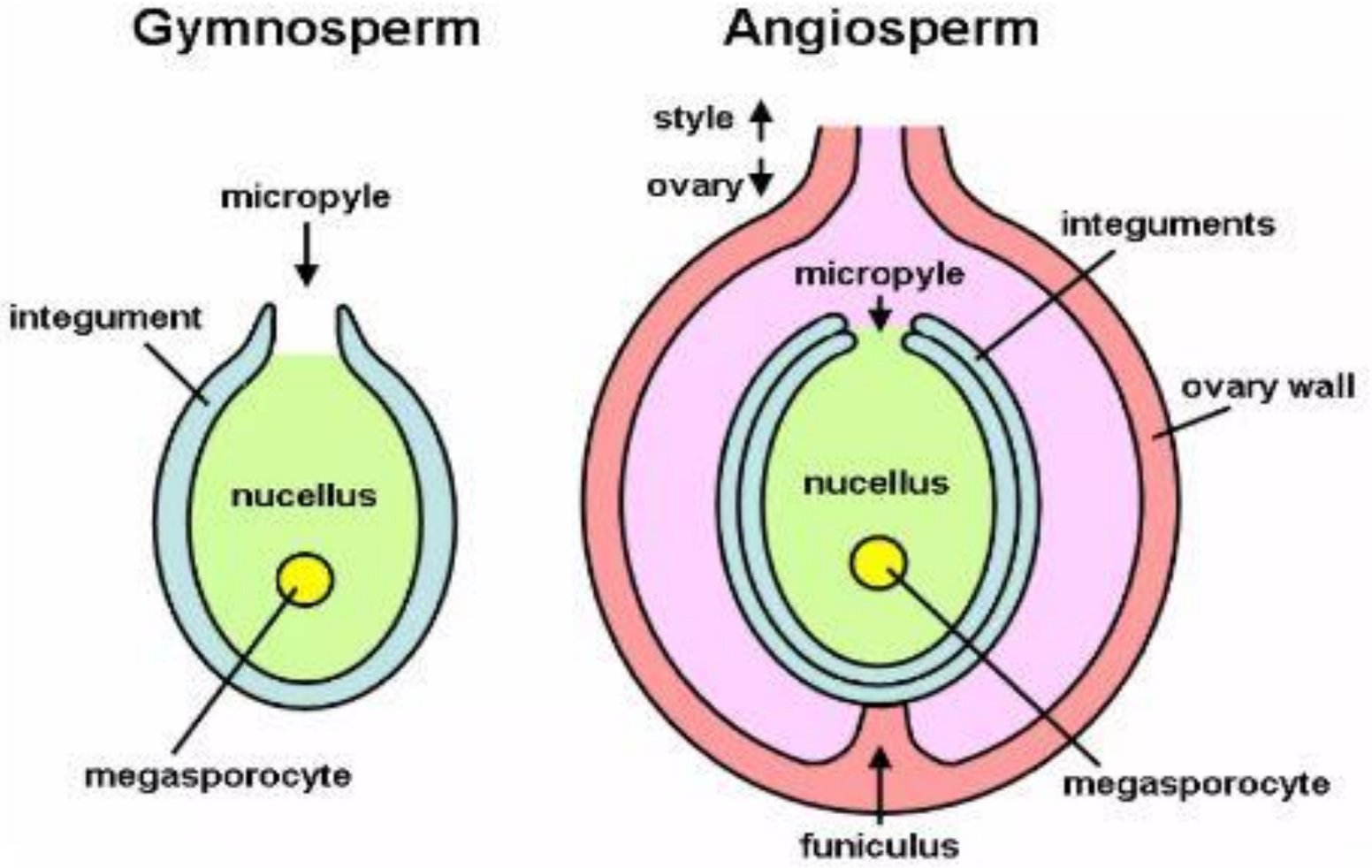
v. In *Welwitschia*, the male flowers are actually bisexual formed by reduction of female organs.

Welwitschia plant

Welwitschia male flowers

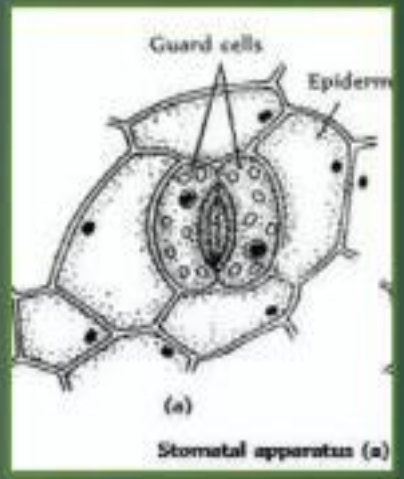
vi. Stamens of *Ephedra*, *Welwitschia* and *Gnetum* are apparently similar to angiosperms.

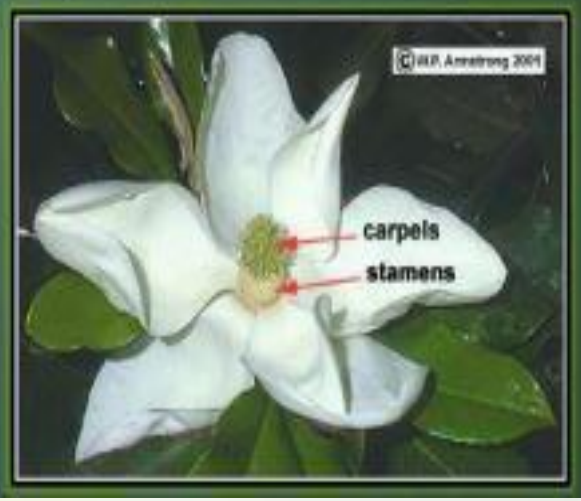
vii. The female flowers of all the above three genera have 2 or more envelops around the nucellus like the perianth of angiosperms.



EVOLUTION OF ANGIOSPERMS

- Different groups of angiosperms reveals different lines of evolution.
- Primitive to highly advanced characters.
- Primitive characters:-
  - Simple persistant leaves.
  - Stomata with subsidiary cells.
  - Floral parts free.
  - Solitary flowers.
  - Actinomorphic and hypogynous conditiom.
  - Carpels with large orthotropous ovules.
  - Large endospermic seed with small embryo.
  - Stamens with 4 microsporangia and pollen grains with 1 aperture.





- Advanced characters:-
- Cyclic or whorled floral parts.
- Compound leaves with tendrils and spines.
- Gamopetalous, epipetalous, syncarpous, condition.
- Special Infloresence.
- Zygomorphic with epigynous condition.
- Carpels few with anatropous ovule.
- Non endospermic seeds.
- Reduce no. of v.b 2º thickening.
- Stomata without guard cells.
- Extreme morphological, anatomical and physiological adaptation.

WHAT IS TAXONOMY ?

The term taxonomy (Gk. Taxis = arrangement; nomos = rules or laws that means "arrangement by rules) was **coined by A. P. de Candolle** (1813) for the branch of science concerned with the **identification, nomenclature giving a name) and classification** (placing in a particular systematic position on the basis of their affinities or relationships) of organisms.

Turril (1938) by taking into account various taxonomical studies recognized three phases of taxonomy-

(a) Alpha taxonomy: This branch of taxonomy includes **collection and identification of organisms on the basis of gross morphological features leading to compilation of monographs and floras**

(b) Beta taxonomy: This branch includes **collection and identification of organisms on the basis of gross morphology in addition to evidences from genetics, cytology, anatomy, palynology, embryology. physiology, biochemistry and other related branches.**

(c) Omega taxonomy: This branch is regarded as an ultimate goal of taxonomy which considers **all ocular (visual), microscopic, ultramicroscopic observations and biochemical evidences in a perfect grouping of the organisms.**

The term omega taxonomy has been used by Turril (1938) for the present day biosystematics or neosystematics.

FUNDAMENTAL COMPONENTS OF TAXONOMY

There are five basic components of plant taxonomy - identification, description, nomenclature, phylogeny and classification.

1. **Identification:** It is the determination or recognition of an unknown specimen (or plant) by comparing its characters with already known plants. That means identification is the working of finding a name for an unknown specimen. This can be achieved by comparing it with already identified specimens given in the keys for identification, stored in the herbarium, described in Floras, Monographs or Manuals.

2. Description: It is listing of maximum possible characteristic features of a taxon, individual plant or plant part in a semi-technical language. The characters, on the basis of which a taxon is identified, are called **diagnostic characters.** These characters are used for diagnosis of a taxon. The listing of **diagnostic characters** is done in a set pattern (Le., habit, stem, leaves, inflorescence, flower sepals, petals, androecium, gynoecium, etc.). **Some special characteristic features may be mentioned separately such as, colour of petals, large bracts, smell, texture, etc.**

3. Nomenclature. It deals with determination of a correct scientific name for a taxon. There are set rules and regulations to name different groups of organisms. Nomenclature of plants (including fungi) is based on rules and regulations of International Code of Botanical Nomenclature (ICBN).

4. Phylogeny. It is evolutionary and genealogical history of a group of organisms usually represented by its hypothesized **ancestor-descendant relationships). This relationship is depicted through a diagram knows as phylogram**. Phylogram is same as cladogram with a slight difference. Both are tree like branching diagrams showing phylogenetic ancestor-descendant relationships.

In case of **phylogram the branch lengths are proportional to the amount of inferred evolutionary change** whereas in case of **cladogram the branches are of equal length and do not indicate the amount of evolutionary time separating taxa**.

5. Classification. It is an arrangement of plants in a series of groups or sub-groups according to particular system of classification (ie., artificial, natural or phylogenetic) and in accordance with the rules of nomenclature.

- ✓ **The basic unit of classification is species.**
- ✓ Species having similar characters are placed in a genus.
- ✓ Similar genera are grouped into a family.
- ✓ Similar families are placed in an order and similar orders are grouped into a class.
- ✓ The classes having close similarities are grouped into a division.
- ✓ Therefore, classification is the grouping of those plants which show more similarities than differences.

AIMS AND OBJECTS OF TAXONOMY

The aims and objectives of plant taxonomy (ie.. systematic botany) are listed below:-

- ✓ One of the most important aim of systematic botany is **to prepare a scheme of classification of plants that provides phenetic, natural or phylogenetic relationships among them.**
- ✓ Plant taxonomy aims to **establish a proper method of identification, nomenclature and description of plant taxa.**
- ✓ The important aids for plant identification and nomenclature are-
- (a) **Properly identified, described and arranged herbarium specimens in different berbarias**
- **(b) Keys for identification;**
- **(c) Computer-aided identification keys; and**
- **(d) International Code of Botanical Nomenclature (ICBN).**
- ✓ Another important objective of plant taxonomy is to reconstruct the evolutionary history of the plant kingdom. In phylogenetic classifications, the plants are arranged in such a way as to give an idea about the sequence of their evolution from simpler, earlier and more primitive types to more complex, more recent and more advanced types.

AIMS AND OBJECTS OF TAXONOMY

- ✓ Plant taxonomy also aims to provide **valuable scientific information regarding distribution. habit, habitat, economic value and distinct characteristic features of plants and plant groups to the scientific investigators of other fields of biology.**
- ✓ Plant taxonomy gives training to the students of plant science regarding the collection and preservation of specimens, use of identification keys, use of manuals and monographs, and to understand the diversity of organisms and their relationships with other branches of biology.
- ✓ **Plant taxonomy provides significant valuable information concerning endangered species. genetic variations and ecological diversity.**

TAXONOMIC KEYS

- ✓ Taxonomic keys- used for identification of plant or animal
- ✓ Defined as devices consisting of a series of contrasting / contradictory statements or propositions requiring the identifier to make comparisons and decisions based on statements in the key as related to the material to be identified
- ✓ Helps in quick identification of unknown plant
- ✓ Always a choice between two contradictory statements is provided, one can be accepted and the other rejected
- ✓ A single pair of contradictory characters is named as a **couplet**
- ✓ Each statement in the couplet- termed as a
  - ✓ **lead**
- ✓ By making the correct choice at each level one can arrive at the name of the correct plant

Proper Use of keys

1. Appropriate keys to be selected from floras, manuals, handbook, monograph, revision etc.Cultivated plants- not usually given in floras. So for these- manuals treating such plants to be used
2. Introductory comments to be properly read first
3. Both leads should be read before making a choice. Sometimes the first lead may seem to be correct, the second lead may be more appropriate.
4. The meaning of unknown terms should be checked using the glossary
5. When measurements are used such as the length of leaf, fruit etc. several materials/ specimens to be measured
6. No decision to be taken based on single observation
7. Results should be verified by reading a description, comparing the specimen with illustration or an authentic herbarium specimen

Construction of keys

- ✓ Always use constant characters, not variables
- ✓ Never use terms such as large/small, instead make correct measurements
- ✓ Characters always available are to be used rather than seasonal characters
- ✓ Always use positive terms. Eg. *Stipule Is present* -
- ✓ can be used but not- *stipule is not present*
- ✓ As far as possible both choices of a pair to be started with the same word-

- **eg.** **Seeds round**
  Seeds oblong

- **If possible different pairs of choices should start with different words**
- **Flowers white**

  sepals free sepals fused

  Flowers red

  corolla 1-2 mm long corolla 3-5mmlong

Types of keys

- ✓ Dichotomous keys- choice is made only between 2 alternate couplet are called dichotomous keys
- ✓ Contrasting characters are chosen which divide the full set of sps into smaller groups
- ✓ Each time number of sps are eliminated so that the choice is narrowed down to the correct sps
- ✓ Dichotomous- Greek origin: *dich*- two; *temnein*- to cut

Types of dichotomous keys

- ✓ **Indented key/ yoked key-** indents the leads of the couplet a equal distance from the left margin
- ✓ The two choices are labelled 1 and1’ or 1a and 1b
- ✓ **Bracketed key-** both choices are given side by side
- ✓ Choices are numbered/lettered

Indented key on *Rhododendron*

1a.Flowers in shades of red

2a. Flowers blood red, leaves oblong-ovate, leathery and thick matty texture- *R.sikkimense*

2b.Fowers crimson red, leaves broad, oval to elliptic oblong, shiny green above- *R.fulgens*

1b.Flowers in shades of rose pink

3a. Calyx 3-5 mm long, leaf undersurface covered by brown hair- *R.wallichi*

3b. Calyx 1-2 mm long, leaf undersurface glabrous- *R.campanulatum*

Bracketed key on *Rhododendron*

1a. Flowers in shades of red--------go to 2

1b. Flowers in shades of rose pink------go to 3

2a.Flowers blood red, leaves oblong-ovate, leather and thick matty texture……*R.sikkimense*

2b.Fowers crimson red, leaves *broad, oval to elliptic oblong,shiny green above-* R.fulgens

3a. Calyx 3-5 mm long, leaf undersurface covered by brown hair- *R.wallichi*

3b. Calyx 1-2 mm long, leaf undersurface glabrous- *R.campanulatum*

Drawbacks

- ✓ The key may not include all potential variations in the sps
- ✓ May rely on features not present in the season
- ✓ May not include all sps of interest
- ✓ One may misinterpret and make a mistake

MULTIACCESS OR MULTIENTRY KEYS

These keys are prepared by making use of specific cards which are punched at definite places. Therefore, these keys are also called **Punched cards keys**. These keys are prepared by two kinds of punchings in the cards-

(a) Body punched cards and **(b) Edge punched cards.**

(a) Body punched cards:

- ✓ Preparation of such key involves as many number of cards as the attributes (characters such as plant herbaceous, plant woody, fruit achene, fruit follicle, etc.) selected.
- ✓ For example, one card is taken for herbaceous attribute, the other is taken for woody character, the next is taken for some other attribute and so on.
- ✓ Like wise the number of cards taken will be equal to the number of attributes selected for the purpose of identification.
- ✓ Moreover, each such card has all the taxa (for which the key is prepared) printed in a vertical row. Suppose we have to prepare a key for Ranunculus, Adonis, Anemone Clematis, Caltha and Delphinium, all the names are printed in each card.

(a) Body punched cards:

- ✓ Now write one attribute on the top of one card, second attribute on the top of second card, and so on. Take one card and punch a hole against each taxa which shows the attribute printed at the top of the card. Suppose the attribute is herbaceous character, so all the taxa are punched except clematis which is woody. In this way a complete identification key is prepared.
- ✓ Now note down the attributes present in the unknown plant (which has to be identified) and prepare a list. Pick up one card which shows first attribute of the list. Choose the second card having second attribute and place it over the first card. Some holes will get closed. Pick up the third card and repeat this process untill only one hole remains visible.
- ✓ Now plant is identified. It is the same plant against which the hole is visible.

PLANTS HERBACEOUS	
1. Ranunculus	O
2. Adonis	O
3. Anemone	O
4. Clematis	O
5. Caltha	O
6. Delphinium	O

(b) Edge punched cards:

Edge punched cards are same as body punched cards with the following differences;

I. One card is meant for one taxon.

II. All the attributed are printed in one vertical row on each card.

III. one circular hole is punched for each attribute along the margin of the card.

IV. The circular holes of those attributes which are shown by the particular taxon to which the card belongs are cut and connected with the edge.

V. Unknown plant is identified with the help of this key by inserting a needle in the hole.

INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (ICBN)

This code is called the **International Code of Botanical Nomenclature** Since then, regular modifications and amendments in the code are made in every **International Science Congress** which are published for the use by botanists in all countries.

The code is divided into three

1. Principles.
2. 2. Rules and Recommendations,
3. 3. Provisions of modification of the code.

Principles and Rules of ICBN

The International code of Botanical Nomenclature is based on the following six principles-

1) Botanical Nomenclature is independent of Zoological and Bacteriological Nomenclature. i.e. There are separate codes for naming plants, animals and micro organisms. They are International Code of Botanical Nomenclature (for naming plants); International code of Zoological Nomenclature (for naming animals); and International code of Bacteriological Nomenclature (for naming bacteria).

2) The application of names of taxonomic groups is determined by means of nomenclature types."[i.e. Certain representative of the group is the source of the name for the group, e.g., Brassica is the type for the family Brassicaceae).

Principles and Rules of ICBN

3) The nomenclature of a taxonomic group is based upon priority of publication." [e. If more than one legitimate names are available for a taxonomic group, single correct name is selected on the basis of earliest date of publication.

4) Each taxonomic group with a particular circumscription, position, and rank can bear only one correct name, the earliest that is in accordance with the Rules, except in specific cases."[i.e. The name of a particular taxonomic group, including generic name, appears only once whereas specific name may figure many times.

Principles and Rules of ICBN

5. Scientific names of taxonomic groups are treated as Latin, regardless of derivation."

[i.e., The name of genus and species should be drawn from Latin. When a name is derived from some other language, it should be latinized.]

6. The rules of nomenclature are retroactive, unless expressly limited.“

There is a separate code for naming cultivated plants called international code of Nomenclature for cultivated plants (ICNCP).

The ICBN can only be changed or modified by an **International Botanical Congress**, with the International Association for plant taxonomy.

TAXONOMIC RANKS

- ✓ In classification, the plants that closely resemble one another are placed in a group, the group which have close similarities are placed together into larger groups, and these into still larger groups various grouping levels are called **taxonomic ranks.**
- ✓ Species, genus, family, order, class and division the six main ranks of the classification of plants in an ascending order.
- ✓ **Species is the smallest rank considered as the basic unit of taxonomy.**

Series of taxonomic ranks and endings provided by the International Code of Botanical Nomenclature:

Rank	Ending	Example
Kingdom	-	Plantae
Phylum = Division	-phyta	Magnoliophyta
Subphylum = Sub division	-phytina	Magnoliophytina
Class	-opsida	Asteropsida
Sub class	-idea	Asteridea
Order	-ales	Asterales
Suborder	-ineae	Asterineae
Family	-aceae	Asteraceae
Sub family	-oideae	Asteroideae
Tribe	-eae	Heliantheae
Genus	-	Helianthus
Sub genus	-	*Helianthus* subg. *Helianthus*
Series	-	*Helianthus* ser. *Helianthus*
Species	-	*Helianthus annuus*

1. **Species.** Species is the lowest taxonomic rank regarded as basic unit of taxonomy, subordinate to genus. It occupies a key position in classification.

According to International Code of Botanical Nomenclature, a species may be defined as It is a group of similar individuals which resemble with each other in morphology, breed among themselves but not with others and probably descended from a common ancestor

Name of an individual plant consists of two words (ie., binomial). a generic name and a specific epithet (L.e. species). Both words are printed in Italics or underlined if typed or hand written. The initial letter of a specific epithet should always be spelled with a small initial letter (For example in case of *Mangifera indica*, the word *indica* always starts with small i).

2**. Genus.** A genus a group of closely resembling species having a common ancestry. As per the rules of ICBN, a species cannot be without assigning it to a genus. A genus may have one (monotypic genus) or several species.

3) **A Family.** A family represents a larger group of closely related genera. It is composed of one or more genera. The name of a family is a plural adjective and ends in-aceae. However, the old traditional names of eight families have been sanctioned by the code because of their traditional usage.

Traditional names and their alternate names of eight families are given below-

TRADITIONAL NAME	ALTERNATE NAME
Palmae	Arecaceae
Gramineae	Poaceae
Cruciferae	Brassicaceae
Leguminosae	Fabaceae
Guttiferae	Clusiaceae
Umbelliferae	Apiaceae
Labiatae	Lamiaceae
Compositae	Asteraceae

Some large families are further divided into subfamilies, tribe and subtribes. The name of a subfamily ends in-oideae, tribe name ends in-eae and subtribe name ends in -inae.

4. Order. An order is a group of closely related families. Names of order end in-ales (Examples, Ranales, Lamiales, Rubiales, etc). Sometimes an order is divided into suborders which end in – ineae (Example, Rosine)

5. Class. A class is a group of related orders. The names of classes end in - opsida. Sometimes classes are further divided into subclasses which end in - idae (Example, Rosidae).

6. Division. A division is a group of related classes. The name of division ends in-phyta. Sometimes a division is divided into subdivisions which end in-phytina.

7. Kingdom. Kindgom is the highest taxon of classification of plants.

TYPE CONCEPT

Correct name of a new taxonomic group (taxon) or an individual organism is assigned on the basis of certain representative of the group, called nomenclatural type (or simply the type).
The methodology is called typification .
According to International Code of Botanical Nomenclature, the type of a genus is a species and type of a family and the higher taxa is ultimately a genus,
For example, Aster is the type of the family Asteraceae and Rosa is the type genus of family Rosaceae and order Rosales; the species Poa pratensis is the type for the genus Poa.
The type of name of a species is a single type specimen. The type specimen may be a herbarium sheet, a photograph or a drawing along with the description.
The ICBN recognises following kinds of types-

1. **Holotype:** It is a particular specimen or illustration used by the author in the original publication Naming and description of new species depends on the holotype.

2. Isotype: A duplicate specimen of holotype collected by the same person from the same place and same time is called an isotype.

Syntype. It is any one of the two or more specimens cited by the author of a species as types when no holotype was designated.

Paratypes: If the type exist in the form of two or more specimen cited by the specimens are called paratypes. It is also called 'co-type.

Lectotypes: It is a specimen or other element selected by competent worker from the origin material cited by

Neotype. It is a specimen chosen as a replacement of the holotype when all material, on which the

4. Paratype. If the type exists in the form of two or more specimens, the remaining cited specimens 5. Lectotype. It is a specimen or other element selected by a competent worker from the original material cited by the author of the species, when no holotype was designated or when it is destroyed or

name of taxon was based, is lost or destroyed. 7. Topotype. It is a specimen collected by a competent worker from the same locality from which

the original holotype was collected.

THANK YOU