

**BOTANY**

# **Flowering Plants Identification & Aesthetic Characteristics**

*for*

## **B.Sc. Sem. III**

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**Very Short Answer Type Questions with Answers**

**Short Answer Type Questions with Answers**

**Long Answer Type Questions with Answers**

# UNIT 1

## Taxonomic Resources & Nomenclature

### Introduction

Plant taxonomy is one of the oldest branches of Botany, started as “Folk Taxonomy”. Scientific taxonomy started in Greece some hundred years BC and was in its peak in 18-19 AD. The most important works are cited and the progress of plant taxonomy is described up to the era of the Swedish botanist **Carl Linnaeus**, who is considered **founder of modern taxonomy** and **father of binomial nomenclature**. The development after Linnaeus is characterized by a taxonomy that increasingly has come to reflect the paradigm of evolution. The used characters have extended from morphological to molecular. The Nomenclatural rules have developed during the 19th and 20th century by **International Botanical Congress** organized by taxonomists from all over globe, and during the last decade traditional nomenclature has been challenged by advocates of the **PhyloCode** and **BioCode**. The history of taxonomy can be divided into pre Linnaean and post Linnaean taxonomy.

- **Aristotle (384–322 BC)** was the first to classify all living things. He is known as Father of Biology and Zoology.
- **Theophrastus (370–285 BC)**, a student of Aristotle, classified 480 species of plants in his book *De Historia Plantarum*, and is called **Father of Botany**.
- **Pliny (23–79 AD)** was involved in the Roman army and wrote *Naturalis Historia*, in which he described several plants and gave those Latin names.
- **Andrea Caesalpini (1519–1603)**, who is sometimes called “the first taxonomist”, wrote *De Plantis*, a work that contained 1500 species.
- Two Swiss brothers **Jean Bauhin (1541–1631)** and **Gaspard Bauhin (1560–1624)** wrote the work *Pinax Theatri Botanici* in 1623. The word Pinax means register, and the work is a listing of 6,000 species.
- The English naturalist and philosopher **John Ray (1627–1705)** wrote several important works through his life. His most significant contribution was the establishment of species as the basic taxonomic unit and published *Methodus Plantarum Nova* (1682), which contained around 18,000 plant species, a result of a relatively narrow species concept.
- For nomenclatural reasons two works of **Carl Linnaeus (1707–1778)** are regarded as the starting points of modern taxonomy: the **Species plantarum (1753)** and **Systema Naturae (1758)** and introduced binomial system of classification.
- **Antoine L. de Jussieu (1748–1836)** published his book *Genera Plantarum* in 1789 contained complete system of classification, in which he launched a natural system based on many characters that came to be a foundation of modern classification
- **Augustin Pyramus de Candolle (1778-1841)** a Swiss botanist published **Historia Plantarum Succulentarum**, established a new genus Senebiera, and

he went on to document hundreds of plant families and create a new natural plant classification system with modification of Linnaeus system.

- **Bentham and Hooker (1864)** published a monumental work **The Genera Plantarum** in which they have given natural system of classification of great practical use.
- **Charles Darwin (1859)** published **On the Origin of Species**, based on natural selection and evolutionary concept.
- The evolutionary concept is basis of Phylogenetic classification and started by **Endichler (1804-1849)** and **Eichler (1837-1887)**.
- **Engler and Prantl (1887-1915)** proposed phylogenetic system of classification in the book *Die Naturlichen Pflanzengruppen*.
- The first purely phylogenetic system of classification was given by **Bessey**

**(1845-1915)** on the basis of Dictas or guiding principles of phylogeny later improved by **Hallier (1868-1938)**.

- **John Hutchinson (1955)** put forth 24 principles for determining primitiveness and advance characters and suggested value of phylogenetic classification in his book *"The Families of Flowering Plants"*.
- The phylogenetic system was later improved by contemporary Botanists like **Takhtajan, Cronquist, Stebbins, Throne** etc.
- **Huxley (1940)** proposed the term **New systematics** and Camp and Gilly (1943) proposed the term **Biosystematics** to new systematics
- Most recently **De Queiroz and Gauthier (2000)** developed the theoretical foundation of the **phylo-Code** in a serial publication of papers in 1990, 1992 and 1994. This is published in version form first time in 2000.

## COMPONENTS OF PLANT TAXONOMY



Plant taxonomy involves the systematic **identification, nomenclature, and classification** of plants based on shared characteristics and evolutionary relationships.

### Identification

**Definition:** The process of determining a plant's identity by analyzing its morphological, anatomical, and molecular traits.

Methods of Identification

| Method        | Tools/Techniques                      | Example                                                                  |
|---------------|---------------------------------------|--------------------------------------------------------------------------|
| Morphological | Dichotomous keys, herbarium specimens | Identifying <i>Rosa canina</i> by its prickly stems and compound leaves. |

|            |                                             |                                                         |
|------------|---------------------------------------------|---------------------------------------------------------|
| Anatomical | Microscopy (stomata, trichomes)             | Distinguishing $C_3$ vs. $C_4$ plants via leaf anatomy. |
| Molecular  | DNA barcoding (rbcL, matK genes)            | Sequencing ITS region to identify fungal endophytes.    |
| Chemical   | Phytochemical tests (alkaloids, flavonoids) | Detecting Menthol in <i>Mentha</i> species.             |

### Tools Used:

- Floras (regional plant guides) and e-floras
- Herbaria (reference collections)
- AI Apps (e.g., PlantNet, iNaturalist)

## Nomenclature

**Definition:** The standardized system for naming plants, governed by the **International Code of Nomenclature for algae, fungi, and plants** (ICN).

### Binomial System (Linnaean)

- Botanical Name in consist of two word i.e. Gencus and Species
- **Format:** Genus species (italicized, genus capitalized).
  - **Example:** *Triticum aestivum* (wheat), *Pinus sylvestris* (Scots pine).
- **Author Citation:** Includes the scientist who first described the species.
  - **Example:** *Oryza sativa* L. ("L." for Linnaeus).

### Key Rules

- **Priority:** The earliest validly published name is accepted.
- **Type Specimen:** A preserved specimen serves as the reference.
- **Hybrids:** Denoted by "x" (e.g., *Mentha × piperita*).

### Special Cases:

- **Cultivars:** Named with single quotes (e.g., *Rosa* 'Peace').
- **Fungi:** Follows separate rules in the Fungal Code.

## Classification

**Definition:** Organizing plants into hierarchical groups based on evolutionary relationships (phylogenetics).

### Taxonomic Ranks

| Rank           | Example (Wheat)                | Example (Tomato)         |
|----------------|--------------------------------|--------------------------|
| <b>Kingdom</b> | Plantae                        | Plantae                  |
| <b>Phylum</b>  | Tracheophyta (vascular plants) | Tracheophyta             |
| <b>Class</b>   | Liliopsida (monocots)          | Magnoliopsida (dicots)   |
| <b>Order</b>   | Poales                         | Solanales                |
| <b>Family</b>  | Poaceae (grasses)              | Solanaceae (nightshades) |
| <b>Genus</b>   | <i>Triticum</i>                | <i>Solanum</i>           |
| <b>Species</b> | <i>T. aestivum</i>             | <i>S. lycopersicum</i>   |

### Modern Systems

- **APG IV (Angiosperm Phylogeny Group):** Classifies flowering plants using DNA data.
- **Phylogenetic Trees:** Show evolutionary splits (e.g., monocots vs. eudicots).

## TAXONOMIC RESOURCES

Taxonomic resources are essential for plant identification, classification, and research. The three major resources are Herbaria, Botanical Gardens, and Floras.

### Herbarium (Pl. Herbaria)

**Definition:** A collection of preserved plant specimens (dried, pressed, and mounted on sheets) used for scientific study.

### Functions of a Herbarium

- **Reference Collection:** Serves as a permanent record of plant diversity.
- **Taxonomic Research:** Helps in species identification, description, and classification.
- **Documentation of Biodiversity:** Records plant distribution and ecology.
- **Type Specimens:** Stores original specimens used for naming new species.

- **Education & Training:** Used in botany courses and research.
- **Climate Change Studies:** Tracks shifts in plant distribution over time.

#### Important Indian Herbaria

Most of the herbaria in India are managed by **Botanical Survey of India**. The **Central National Herbarium (CNH)** is India's oldest herbaria with about 2 million plant species. It is one of the largest herbaria in the world. **William Roxburgh** established this herbarium in 1795 at his office cum-residence. This building, located on the bank of the river Hooghly, is now called Roxburgh House. In 1883 the herbarium was shifted to a specially built building. More than 15,000 type specimens are housed in it.

#### List of major Indian herbaria

| S. No. | Name                                             | Established | Location   |
|--------|--------------------------------------------------|-------------|------------|
| 1.     | Central National Herbarium                       | 1793        | Howrah     |
| 2.     | Forest Research Institute (FRI)                  | 1816        | Dehradun   |
| 3.     | Botanical Survey of India (BSI), Eastern Circle  | 1956        | Shillong   |
| 4.     | Botanical Survey of India (BSI), Southern Circle | 1956        | Coimbatore |
| 5.     | Botanical Survey of India (BSI), Northern Circle | 1956        | Dehradun   |
| 6.     | National Botanical Research Institute (NBRI)     | 1948        | Lucknow    |

#### Preparation and Preservation of Herbaria

The dried, pressed plant specimens and their associated collections data preserved in the

herbaria are remarkable and irreplaceable sources of information about plants and the world they inhabit. Since these records provide the comparative material that is essential for various plant studies so the herbarium records should be carefully collected, prepared, preserved and maintained.

#### Field Equipments and Collection

Numbers of instruments are required by plant collector, for the excursion. A pair of secateurs for cutting woody twigs, khurpi for digging up roots and underground stems, knife, pair of forceps, vasculum for keeping the collected plants and their twigs, blotting papers and newspapers, a field book and pocket lens. The entire healthy typical specimens, of almost all natural phases should be collected with all above ground and below ground parts. The single specimen may be collected in the late flowering stage having both flowers and young fruits. Collection should be done from different localities and habitats. Take photograph of rare and only plant species of the locality instead of collection. In certain cases, the roots and other underground parts of the plant are necessary for identification. For collection of the plants one should go out on excursion several times in a season.

#### Pressing and Drying of Specimens

Generally the plants are pressed flat. To get good specimens, the plants must be pressed before their wilting. The plants should be placed in between the sheets of newspaper which are alternated between sheets of blotting paper. Since the wooden presses are too heavy to carry them in the fields, therefore presses with aluminium covers are preferred. The standard size of the press is 12" x 18". The blotting sheets or newspaper sheets which have been used for pressing the plant materials must frequently be changed after every 24, 48 or 72 hours. The changing depends very much upon the weather conditions.

Generally the plants are collected in a cork lined tin vasculum, and then they are pressed after the day's trip. To get the finest specimens the plants must be pressed directly in the plant press, then and there, as soon as they are collected in the field.

### Mounting and Labelling of Specimens

After drying, the plant specimens are mounted on herbarium sheets. The sheets must be of heavy white paper to give support to the plants in handling. The **standard size of the herbarium sheet is 28 cm X 42 cm (11.5 X 16.5 inches)**. The specimens are fastened to the sheets by glue or gummed cellophane tape. Usually one specimen, no matter how small it is, should be mounted on one herbarium sheet.

### Storage of Herbarium Sheets

After mounting the plant specimens on herbarium sheets they are usually kept in specially constructed herbarium cases. The wooden or steel cabinets with shelves slightly bigger than the size of the herbarium sheets are used for keeping the mounted plant specimens. The keeping of mounted plant specimen for further record is known as filing the specimen.

### Important Herbaria of the World

| Herbarium                                | Location | Specimens (Approx.) | Notable Collections          |
|------------------------------------------|----------|---------------------|------------------------------|
| Royal Botanic Gardens, Kew (K)           | UK       | 7 million           | Type specimens, global flora |
| Harvard University Herbaria (A, GH)      | USA      | 5 million           | Largest in Americas          |
| Muséum National d'Histoire Naturelle (P) | France   | 6 million           | Historic collections         |

|                                                     |              |             |                           |
|-----------------------------------------------------|--------------|-------------|---------------------------|
| Komarov Botanical Institute (LE)                    | Russia       | 7 million   | Eurasian plants           |
| Central National Herbarium (CAL)                    | India        | 2 million   | Indian subcontinent flora |
| South African National Biodiversity Institute (PRE) | South Africa | 1.2 million | African flora             |

## Botanical Gardens

**Definition:** Institutions that maintain living plant collections for research, conservation, and public education.

A botanical garden is a garden dedicated to the collection, cultivation and display of a wide range of plants labeled with their botanical names. It may contain specialist plant collections such as cacti and other succulent plants, herb gardens, tropical plants, alpine plants or other exotic plants. Thus "botanical gardens are institutions holding documented collections of living plants for the purpose of scientific research, conservation, display and education."

The world's first botanical garden was created in Padua in 1545. Botanical gardens are important centers for conserving endemic and endangered plant species. A display garden that concentrates on woody plants (shrubs and trees) is often referred to as an arboretum. It may be a collection in its own right or a part of a botanical garden. A major contemporary objective of botanical gardens is to maintain extensive collections of plants, labeled with common and scientific names and regions of origin.

### Functions of Botanical Gardens

- **Ex Situ Conservation:** Protects endangered species.
- **Research:** Studies plant taxonomy, genetics, and ecology.
- **Education:** Offers workshops, guided tours, and citizen science programs.
- **Reintroduction Programs:** Restores rare plants to the wild.
- **Public Awareness:** Promotes plant conservation.

### Famous Botanical Gardens

| Garden                           | Location  | Specialization                                  |
|----------------------------------|-----------|-------------------------------------------------|
| Royal Botanic Gardens, Kew       | UK        | Largest seed bank (Millennium Seed Bank)        |
| New York Botanical Garden (NYBG) | USA       | Extensive herbarium & living collections        |
| Singapore Botanic Gardens        | Singapore | Orchid hybridization                            |
| Indian Botanic Garden, Howrah    | India     | Giant banyan tree ( <i>Ficus benghalensis</i> ) |
| Rio de Janeiro Botanical Garden  | Brazil    | Atlantic rainforest species                     |

## Flora

**Definition:** A comprehensive book or database describing all plant species in a specific region.

### Types of Floras

- **Local Flora:** Covers a small area (e.g., Flora of Delhi).
- **Regional Flora:** Covers a state/country (e.g., Flora of British India by J.D. Hooker).
- **Continental Flora:** Covers a continent (e.g., Flora Europaea).

- **Thematic Flora:** Focuses on specific groups (e.g., Orchid Flora of the Western Ghats).

### Important Floras

| Flora                        | Region Covered     | Author                      |
|------------------------------|--------------------|-----------------------------|
| Flora of North America (FNA) | North America      | Collaborative project       |
| Flora Malesiana              | Southeast Asia     | Dutch botanists             |
| Flora of China               | China              | Chinese Academy of Sciences |
| Flora of Australia           | Australia          | Australian government       |
| Flora of Maharashtra         | Maharashtra, India | M.R. Almeida                |

## Artificial Keys

Artificial keys are tools used for quick identification of plants based on easily observable, non-evolutionary characteristics (e.g., leaf shape, flower color). Unlike natural keys (which reflect phylogenetic relationships), artificial keys prioritize user convenience over evolutionary accuracy.

### Types of Artificial Keys

#### A. Dichotomous Key

##### Structure:

- Presents two contrasting choices (couplets) at each step.
- User selects the best match until reaching the species.

Example:

1. Leaves needle-like → *Pinus*
  - Leaves scale-like → *Cupressus*
2. Flowers yellow → *Helianthus*
  - Flowers blue → *Centaurea*

##### Advantages:

- Simple for beginners.
- Works even without detailed taxonomic knowledge.

**B. Multi-Access (Polyclave) Key****Structure:**

- Uses multiple characteristics simultaneously (e.g., leaf arrangement + flower color).
- Often computerized (e.g., DELTA, Lucid).

Example:

| Feature      | Rosa     | Tulipa     |
|--------------|----------|------------|
| Leaf Type    | Compound | Simple     |
| Flower Shape | Radial   | Cup-shaped |

**Advantages:**

- Flexible (users can start with any feature).
- Efficient for large datasets.

**C. Pictorial Key****Structure:**

- Uses images (e.g., leaf shapes, flower diagrams) for visual matching.

**Example:**

<https://example.com/plant-key.jpg>

**Advantages:**

- Ideal for field guides and non-specialists.

**Advantages of Artificial Keys**

- **Speed:** Faster than natural keys for preliminary identification.
- **Accessibility:** Requires minimal botanical expertise.
- **Versatility:** Can be adapted for specific regions or groups (e.g., "Weeds of California").

**Limitations**

- May group unrelated plants (e.g., cacti and euphorbias due to similar spines).
- Fails if key features are missing (e.g., a leafless plant in a leaf-based key).
- Requires constant updates if new species are discovered.

**How to Use a Dichotomous Key**

1. Start at the first couplet.
2. Choose the best-fitting option.
3. Proceed to the next indicated couplet.
4. Repeat until reaching the species.

Example: Identifying a tree with:

- Opposite leaves → Go to couplet 5.
- Pinnate compound leaves → *Acer negundo* (Box Elder).

**Comparison: Artificial vs. Natural Keys**

| Feature     | Artificial Key                      | Natural (Phylogenetic) Key     |
|-------------|-------------------------------------|--------------------------------|
| Basis       | Convenient morphological traits     | Evolutionary relationships     |
| Accuracy    | Low (may misgroup species)          | High (reflects true phylogeny) |
| Ease of Use | High (beginner-friendly)            | Low (requires expertise)       |
| Example     | Key to desert plants by spine count | APG IV system for angiosperms  |

## BINOMIAL NOMENCLATURE

**Introduction**

The **International Code of Botanical Nomenclature (ICBN)** which is now called **International Code of Nomenclature for algae, fungi, and plants (ICN)** is the set of rules and recommendations dealing with the nomenclature of plants, fungi and a few other

groups of organisms, all those "traditionally treated as algae, fungi, or plants". The name International Code of Botanical Nomenclature (ICBN) was changed to International Code of Nomenclature for algae, fungi, and plants (ICN) after **XVIIIth International Botanical Congress** held in **Melbourne** in July 2011 as

part of the **Melbourne Code** which replaces the **Vienna Code** of 2005. The Vienna Code, based on the decisions of the XVII IBC at Vienna was preceded by the **St Louis Code** (1999) and the **Tokyo Code** (1993). The name of the Code is partly capitalized and partly not. The lower-case for "algae, fungi, and plants" indicates that these terms are not formal names of clades, but indicate groups of organisms that were historically known by these names and traditionally studied by phycologists, mycologists, and botanists. There are special provisions in the ICN for some of these groups, as there are for fossils. Its intent is that each taxonomic group ("taxon", plural "taxa") of plants has only one correct name that is accepted worldwide. The value of a scientific name is that it is an identifier; it is not necessarily of descriptive value, or even accurate.

The ICN can only be changed by an International Botanical Congress (IBC), with the International Association for Plant Taxonomy providing the supporting infrastructure. Each new edition supersedes the earlier editions and is retroactive back to 1753, except where different starting dates are specified. For the naming of cultivated plants and bacteria there are separate codes, the **International Code of Nomenclature for Cultivated Plants**, (ICNCP, also known as the Cultivated Plant Code) and **International Code of Nomenclature of Prokaryotes** (ICNP, formerly known as **International Code of Nomenclature of Bacteria** (ICNB) or Bacteriological Code (BC), which gives rules and recommendations that supplement the ICN.

The ICBN is divided into three parts (i) Principles, (ii) Rules and Recommendations and (iii) Provisions. The objective of principle is to guide decisions concerning the International Code of

Botanical Nomenclature (ICBN). The objective of the rules is to bring past nomenclature into order and to follow rules for future nomenclature. The objective of the recommendations is to bring uniformity and clearness in future nomenclature. The objective of provisions is to provide opportunity for the modification of code and appendices.

### There are six principles

- I. Botanical nomenclature is independent of zoological nomenclature. The code applies equally to names of taxonomic groups treated as plants whether or not these groups were originally so treated (Plants do not include Bacteria).
- II. Application of names of taxonomic groups is determined by means of nomenclature types.
- III. The nomenclature of a taxonomic group is based upon priority of publication.
- IV. Each taxonomic group with a particular circumscription, position, and rank can bear only one correct name, the earliest that is in accordance with the rules, except in specific cases.
- V. Scientific names of taxonomic groups are treated as Latin regardless of their derivation.
- VI. The rules of nomenclature are retroactive unless expressly limited.

The International Code of Nomenclature for algae, fungi, and plants (ICN) governs the formal naming of plants, fungi, and algae. Below are its core principles and rules:

## Binomial System Basics

- **Format:**

- Genus (capitalized, italicized) + species epithet (lowercase, italicized).
- Example: *Rosa canina*, *Pinus sylvestris*.

- **Authority Citation:**

- Includes the name of the scientist who first validly published the species.
- Example: *Oryza sativa* L. (L. = Linnaeus).

## Key Principles of ICN

### A. Principle of Priority

- The earliest validly published name (after 1753, Linnaeus' *Species Plantarum*) has priority.

**Example:** If *Taraxacum officinale* (1780) and *Leontodon taraxacum* (1763) refer to the same plant, the older name (*Leontodon taraxacum*) takes precedence unless conserved.

### B. Type Method

- Each taxon is linked to a type specimen (preserved in a herbarium).
- **Holotype:** Single specimen, may be whole plant or a part of it with which the name of taxon is permanently attached, is known as holotype.
- **Isotype or Cotype:** An isotype is a biological specimen duplicate of the holotype collected in the same place and at the same time (in the type locality).
- **Paratype:** A paratype is any of one or more biological specimen other than the holotype listed as representative and used for the development of the original description of a species or subspecies.
- **Syntype:** The specimen which is the basis of new taxon when no holotype is designated by author is known as syntype. If author studies collection from different localities and by different collectors and decides to establish a new

species, labels all of them as types, all these specimen become syntypes.

- **Lectotype:** It is type chosen to serve as Holotype, when either an earlier designated holotype was lost or destroyed or holotype was never designated and from the isotype, paratype or syntype a specimen is chosen by a specialist to serve as the type.
- **Neotype:** If holotype, isotype, paratype or syntype are lost or not available a Neotype is selected from other specimens, to serve as Type. Some taxonomists call it Standard Specimen.
- **Topotype:** When no original type material is available and a specimen is collected from type locality is chosen to serve as type it is called Topytype.

### C. Valid Publication

For a name to be valid, it must:

1. Be published in a peer-reviewed journal or book.
2. Include a Latin diagnosis (or English + Latin after 2012).
3. Designate a type specimen.
4. Follow ICN formatting rules (e.g., italics).

### D. Author Citation

The scientist(s) who named the species are cited after the binomial.

#### Example:

- *Mangifera indica* L. (Linnaeus named it).
- *Ficus benghalensis* L. var. *krishnae* (C.DC.) Corner (Candolle named the variety; Corner revised it).

## Taxonomic Ranks & Naming Rules

### A. Ranks in Plant Taxonomy

| Rank            | Example                        |
|-----------------|--------------------------------|
| Kingdom         | Plantae                        |
| Division/Phylum | Tracheophyta (vascular plants) |

|         |                          |
|---------|--------------------------|
| Class   | Magnoliopsida (dicots)   |
| Order   | Rosales                  |
| Family  | Rosaceae                 |
| Genus   | Rosa                     |
| Species | Rosa canina              |
| Variety | Rosa canina var. inodora |

### B. Rules for Naming Taxa

1. Family Names: End in -aceae (e.g., Rosaceae, Fabaceae).
  - Exceptions: Traditional names like Compositae (Asteraceae) are allowed.
2. Genus Names: Singular, capitalized, italicized (e.g., Quercus).
3. Species Epithets:
  - Can describe traits (alba = white), habitats (montana = mountain), or honor people (hookeri = after Hooker).
  - Must agree grammatically with the genus (e.g., \*-us\* → \*-a\*: Cedrus deodara).

## Special Cases & Exceptions

### A. Hybrids

- Denoted by × before the name (e.g., *Mentha × piperita*).
- If unnamed: Parental species listed (e.g., *Salvia officinalis* × *S. lavandulifolia*).

### B. Cultivated Plants

- Use cultivar names in single quotes (non-italicized).
- Example: *Rosa* 'Peace'.

### C. Fungi & Algae

- Follow the same rules but have separate governance under the Fungal Nomenclature Code.

## Rejection of Names

(a) A name is rejected if name is illegitimate:

- (i) Nomenclature superfluous

(ii) If published in contravention of specific rules (duplicate/invalidly published)

(iii) If it is rejected generic name.

(iv) If tautonym.

(b) If owing to its use with different meaning source of confusion. e.g. *Quercus rubra* L. American oak. *Quercus falcata* Michx. Spanish oak. *Quercus borealis* Michx. f. Red oak. Reder proposed that *Quercus rubra* L. as nomen ambigua and rejected *Quercus falcata* and *Quercus borealis* as valid name.

(c) name of taxon must be rejected if the characters derived from 2 or more entirely discordant element, unless it is possible to select one of these element as site factory type of the name. e.g. *Actinotinus* established by Oliver 1888 a specimen derived from *Viburnum* and *Aesculus* rejected.

### The rules for rejection of names are

- (i) **Nomen nudum (nom. nud):** Name without description, without typification and Latin diagnosis etc is rejected.
- (ii) **Tautonym:** Botanical nomenclature does not allow tautonym (repetition of generic name), e.g., *Malus malus*. Repetition of specific epithet in infra specific epithet does not constitute tautonym.
- (iii) **Later homonym:** If a name which already exists is given to other taxa once again then the later homonym is rejected.
- (iv) **Nomen ambiguum (nom. ambig):** The name is rejected in different sense by different authors.
- (v) **Nomen confusum (nom. confus):** The name should not be confusing.
- (vi) **Nomen dubium (non. dub):** Dubious name, i.e., with uncertain application is also rejected.

### **Names of Cultivated Plants**

The name of the cultivar is not analogous to the botanical variety and according to ICNCP the names are written with a capital letter preceded by abbreviation CV or placed in a single inverted comma. The name may be used after generic, specific or common names e.g. *Citrullus lanatus* CV Sugar baby. *Camelia japonica* CV. Purple Dawn etc.

It is recommended that cultivar names be registered with a recognised registration authority which undertakes to keep a list of cultivars for plants concerned. Registration is a precaution against duplication, misuse or fraudulent usage of cultivar names.

### **Names of Hybrids in Cultivation**

The names of hybrids may follow the pattern of monohybrid crosses of Mendel between the species may be connected by multiplication sign (X). Again the name of the plant may be used in Latin for *Salix aurita* X *Salix caprea*, *Agrotis* X *Polypogon* X *Andropogon* etc.

## **Phylo-Code**

The Linnaean system of binomial nomenclature is landmark for today's taxonomists but now failed to govern the naming of clade and species. A group of organisms which members show a common

ancestry called clade. A clade is a group having all the descendants of the last common ancestor of the members of the group. De Queiroz and Gauthier developed the theoretical foundation of the phylo-Code in a serial publication of papers in 1990, 1992 and 1994. In version form phylo-Code first time published in 2000.

## **Bio-Code**

As information on the world's biota becomes increasingly integrated across different groups of organisms, from bacteria and fungi to animals and plants, there is concomitant rising need for a consistent and harmonized approach to the regulation of scientific names. The Bio-Code initiative represents a concerted effort by biologists intimately involved in the operation of the current system of separate codes, to devise a unified approach to the future naming of organisms of all kinds. This need has become pressing in view of common issues that the separate organismal codes now have to address, consequent on the rapid changes taking place in global informatics, database architecture, molecular systematics and ecology, and electronic publication.

## QUESTIONS

### Section A Very Short Answer Type Questions

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1. Name the three main components of taxonomy. (CCSU 2022)

**Ans:** The three fundamental components are:

1. **Identification:** Determining the identity of an unknown plant by comparing its characteristics with known specimens or descriptions using keys, herbaria, or molecular tools.
2. **Nomenclature:** Assigning a scientific name to the identified plant following the rules of the International Code of Nomenclature (ICN) to ensure uniformity.
3. **Classification:** Arranging plants into hierarchical groups (taxa) based on their relationships and evolutionary history.

2. What is the primary function of a herbarium? (CCSU 2023)

**Ans:** A herbarium serves multiple critical functions:

- **Preservation:** Stores dried, pressed plant specimens with collection details (date, location, habitat) for centuries.
- **Reference:** Provides type specimens for taxonomic studies and resolving naming disputes.
- **Research:** Serves as a database for studies in plant distribution, ecology, and climate change impacts.
- **Education:** Used as teaching material in botany courses.

3. Name two important herbaria in India. (CCSU 2021)

**Ans:**

1. Central National Herbarium (CAL), Kolkata:
  - Asia's largest herbarium, established in 1795.
  - Houses ~2 million specimens, including type specimens of Indian flora.
2. Forest Research Institute Herbarium (DD), Dehradun:
  - Specializes in Himalayan flora and economically important plants.
  - Maintains ~150,000 specimens used for forestry research.

4. Give an example of a famous botanical garden in India. (CCSU 2020)

**Ans:** Indian Botanical Garden (Acharya Jagadish Chandra Bose Indian Botanic Garden), Howrah, West Bengal (India).

- Established in 1787, spreads over 109 hectares.
- Houses the iconic 250-year-old Great Banyan Tree (*Ficus benghalensis*).
- Maintains living collections of 12,000+ plant species, including rare and endangered taxa.

**5. What is a flora?** (CCSU 2019)

**Ans:** A flora is a comprehensive scientific document that provides:

- Descriptions of all plant species in a defined geographical region.
- Identification keys, distribution maps, and ecological notes.
- **Examples:** "Flora of British India" by J.D. Hooker, "Flora of Delhi" by J.K. Maheshwari.

**6. What is an artificial key?** (CCSU 2018)

**Ans:** An artificial key is a identification tool that:

- Uses a few easily observable characters (e.g., flower color, leaf shape).
- Follows a dichotomous (couplet-based) format for quick identification.
- **Example:** Key to separate monocots and dicots based on seed leaf number.

**7. Who proposed binomial nomenclature?** (CCSU 2017, 2022)

**Ans:** Carolus Linnaeus introduced binomial nomenclature in:

- **Species Plantarum (1753):** First consistent application of the system.
- **Format:** Genus species (e.g., *Mangifera indica*).

**8. What are the two parts of a scientific name?** (CCSU 2021)

**Ans:**

1. **Generic name (Genus):** Always capitalized (e.g., *Rosa*).
2. **Specific epithet (species):** Always lowercase (e.g., *sinensis* in *Rosa sinensis*).

**9. Explain the Principle of Priority in ICN.** (CCSU 2020)

**Ans:**

- The earliest validly published name (after 1753) has nomenclatural priority.
- **Example:** If a species is named twice, the older name is retained.

**10. What is the "Type Method"?** (CCSU 2019)

**Ans:**

- A type specimen (herbarium voucher) serves as the permanent reference for a species name.
- **Holotype:** Single specimen designated in the original publication.

**11. Define valid publication.** (CCSU 2023)

**Ans:** A name is validly published when:

1. Published in a peer-reviewed journal.
2. Includes a Latin diagnosis/description.
3. Designates a type specimen.

## Section B Short Answer Type Questions

**12. Define identification in taxonomy.** (CCSU 2021)

**Ans:** The process of determining the identity of an unknown organism by comparing its characteristics with known specimens or descriptions using keys, herbaria, or molecular tools.

**13. What is the purpose of nomenclature in taxonomy?** (CCSU 2022)

**Ans:** To assign standardized scientific names to organisms following the International Code of Nomenclature (ICN) to ensure uniformity and avoid confusion.

**14. Differentiate between natural and artificial classification.** (CCSU 2020)

**Ans:**

| Natural Classification                          | Artificial Classification         |
|-------------------------------------------------|-----------------------------------|
| Based on evolutionary relationships             | Based on a few superficial traits |
| Considers multiple traits (morphology, anatomy) | Example: Linnaeus' sexual system  |

**15. List three functions of a herbarium.** (CCSU 2023)

**Ans:**

1. Preservation of dried plant specimens.
2. Reference for plant identification.
3. Documentation of plant biodiversity.

**16. Name two major herbaria in India with their locations.** (CCSU 2019)

**Ans:**

1. Central National Herbarium (CAL), Kolkata
2. Forest Research Institute Herbarium (DD), Dehradun

**17. What is the role of botanical gardens in conservation?** (CCSU 2021, 2 marks)

**Ans:** They conserve endangered species (ex situ conservation), conduct research, and educate the public (e.g., Indian Botanical Garden, Howrah).

**18. What is a flora? Give one example.** (CCSU 2020, 2 marks)

**Ans:** A scientific book documenting all plant species in a region (e.g., Flora of British India by J.D. Hooker).

**19. Why are artificial keys used in plant identification?** (CCSU 2022)

**Ans:** They provide quick identification based on easily observable traits (e.g., flower color, leaf shape).

**20. Who introduced binomial nomenclature? Write the correct format for *Mangifera indica*.** (CCSU 2021)

**Ans:** Carolus Linnaeus (1753). Format: Genus species (e.g., *Mangifera indica* L.).

**21. Explain the Principle of Priority in ICN. (CCSU 2023)**

**Ans:** The earliest validly published name (after 1753) for a taxon is accepted as the correct name.

**22. What is a holotype? (CCSU 2020)**

**Ans:** A single specimen designated as the permanent reference for a species name in its original publication.

**23. Why is author citation important in botanical names? (CCSU 2019)**

**Ans:** It credits the scientist who first validly published the name (e.g., *Ficus benghalensis* L. for Linnaeus).

**24. List two conditions for valid publication of a plant name. (CCSU 2022, 2 marks)**

**Ans:**

1. Publication in a peer-reviewed journal.
2. Inclusion of a Latin diagnosis or description.

## Section C Long Answer Type Questions

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**25. Compare natural, artificial, and phylogenetic classification systems with examples. (CCSU 2022)**

**Ans:** Taxonomic classification systems have evolved to reflect our understanding of plant relationships:

- Artificial System
  - Based on few easily observable characteristics
  - **Example:** Linnaeus' sexual system classifying plants by stamen number
  - **Limitation:** Ignores evolutionary relationships
- Natural System
  - Considers multiple morphological features
  - **Example:** Bentham & Hooker's system grouping plants by overall similarity
  - **Limitation:** Doesn't reflect true evolutionary history
- Phylogenetic System
  - Based on evolutionary relationships using molecular data
  - **Example:** APG IV classification of angiosperms
  - **Advantage:** Most accurate reflection of plant ancestry

| System       | Basis                         | Example                   | Limitation                 |
|--------------|-------------------------------|---------------------------|----------------------------|
| Artificial   | Few superficial traits        | Linnaeus' sexual system   | Ignores evolutionary links |
| Natural      | Multiple morphological traits | Bentham & Hooker's system | Doesn't reflect phylogeny  |
| Phylogenetic | Evolutionary relationships    | APG IV (DNA-based)        | Requires molecular data    |

**Key Point:** Phylogenetic classification (e.g., APG IV) is most accurate as it uses DNA evidence.

**26. Describe the functions and importance of herbaria in botanical research. (CCSU 2021)**

**Ans:** Herbaria serve as vital repositories of plant biodiversity with multiple functions:

**Functions:**

- **Preservation:** Dried specimens mounted on sheets with collection data
- **Reference :** Type specimens serve as permanent standards for species names
- **Research:** Enable studies in:
  - Plant distribution patterns
  - Climate change impacts
  - Taxonomic revisions

**Importance:**

- Resolve naming disputes (e.g., establishing correct species names)
- Document rare/endangered species (e.g., *Taxus wallichiana* specimens)
- Provide historical records of flora changes

**Example:** The Central National Herbarium (CAL) in Kolkata, established in 1795, houses over 2 million specimens including types for many Indian species.

**27. Explain the key rules of the International Code of Nomenclature with examples. (CCSU 2023)**

**Ans:** The ICN provides standardized rules for naming plants:

**Core Principles:**

1. Binomial Nomenclature
  - Each species has a two-part Latin name (Genus + specific epithet)
  - **Example:** *Mangifera indica* for mango
2. Principle of Priority
  - The first validly published name (post-1753) has precedence
  - **Example:** *Syzygium cumini* accepted over later synonym *Eugenia jambolana*
3. Type Method
  - Each name linked to a preserved type specimen
  - Holotype = single designated specimen

## 4. Valid Publication Requirements

- Must include:
- Latin description/diagnosis
- Type designation
- Appearance in printed publication

**Exception:** Names published before Linnaeus' Species Plantarum (1753) are not valid.

**28. Illustrate the taxonomic hierarchy under ICN with examples.****(CCSU 2019)**

**Ans:** The standardized classification ranks are:

**Hierarchy with Example (Pea Plant):**

1. Kingdom - Plantae
2. Division - Angiosperms
3. Class - Dicotyledons
4. Order - Fabales
5. Family - Fabaceae
6. Genus - Pisum
7. Species - Pisumsativum

**Key Features:**

- Each rank represents a more specific grouping
- Lower ranks share more characteristics
- Mnemonic: "Kings Play Chess On Fine Green Squares"

**29. Describe the functions and importance of herbaria in botanical research.****(CCSU 2021)**

**Ans:**

**• Functions:**

1. **Preservation:** Dried specimens stored for centuries.
2. **Reference:** Type specimens for nomenclature.
3. **Research:** Study of plant distribution and climate change impacts.

**• Importance:**

- Resolves taxonomic disputes (e.g., Neem = Azadirachta indica).
- Documents endangered species (e.g., Rauwolfia serpentina).

**Example:** Central National Herbarium (CAL), Kolkata houses 2 million specimens.

30. Differentiate between botanical gardens and herbaria.

(CCSU 2020)

**Ans:**

| Feature  | Botanical Garden          | Herbarium               |
|----------|---------------------------|-------------------------|
| Material | Living plants             | Dried specimens         |
| Purpose  | Conservation, education   | Research, documentation |
| Example  | Lalbagh Garden, Bengaluru | CAL, Kolkata            |

31. Explain the key rules of the International Code of Nomenclature (ICN) with examples.

(CCSU 2023)

**Ans:**

1. Binomial Nomenclature:
  - Format: Genus species (e.g., *Oryza sativa*).
2. Principle of Priority:
  - Oldest valid name is accepted (e.g., *Syzygiumcumini* over *Eugenia jambolana*).
3. Type Method:
  - Holotype specimen as reference (e.g., Kew Herbarium for *Ficus religiosa*).
4. Valid Publication:
  - Requires Latin diagnosis + printed publication (e.g., *Species Plantarum*).

**Exception:** Names published before 1753 are invalid.

32. Illustrate the taxonomic hierarchy under ICN with examples.

(CCSU 2019)

**Ans:**

1. **Kingdom:** Plantae
2. **Division:** Angiosperms
3. **Class:** Dicotyledons
4. **Order:** Fabales
5. **Family:** Fabaceae
6. **Genus:** *Pisum*
7. **Species:** *Pisumsativum*