## What is a Tree?

A tree is a woody plant with several distinguishing characteristics:

· Often reaches 15 feet (4.572 m) or more in height at maturity.

· Has a single trunk or dominant multiple trunks.

· Has no normal branches on the lower trunk.

· Has at least a partially defined crown.

· Usually larger than other plants and tend to be long-lived.

The growth form or shape, rather than size, is the feature that distinguishes a tree from other plants such as shrubs (Harris 1992). A shrub is a woody plant with multiple stems that is capable of growing to a height of 15 feet.

## Distribution of woody species:

**trees** (with a strong trunk).

**bushes** (no trunk).

**half-bushes** (odrvenjava only in the lower part).

**climbing plants** (woody plants that can wrap or rely on trees or other substrate).

Broadleaves (*Angiospermae*, usually with a prominent leaf lamina).

Conifers (Gymnospermae, usually needle-like leaves – needles).

**Evergreen**

**Deciduous**

Indigenous (local, the nature of the growth in our country).

Non-native (exotic, do not grow with us from nature).

## Distribution of trees according to height:

Trees I row: over 25 m

Trees II row: from 12 to 25 m

Trees III row: from 5 to 12 m.

## Distribution shrub height:

High bushes: over 2.5 m

Medium height from 1 to 2.5 m

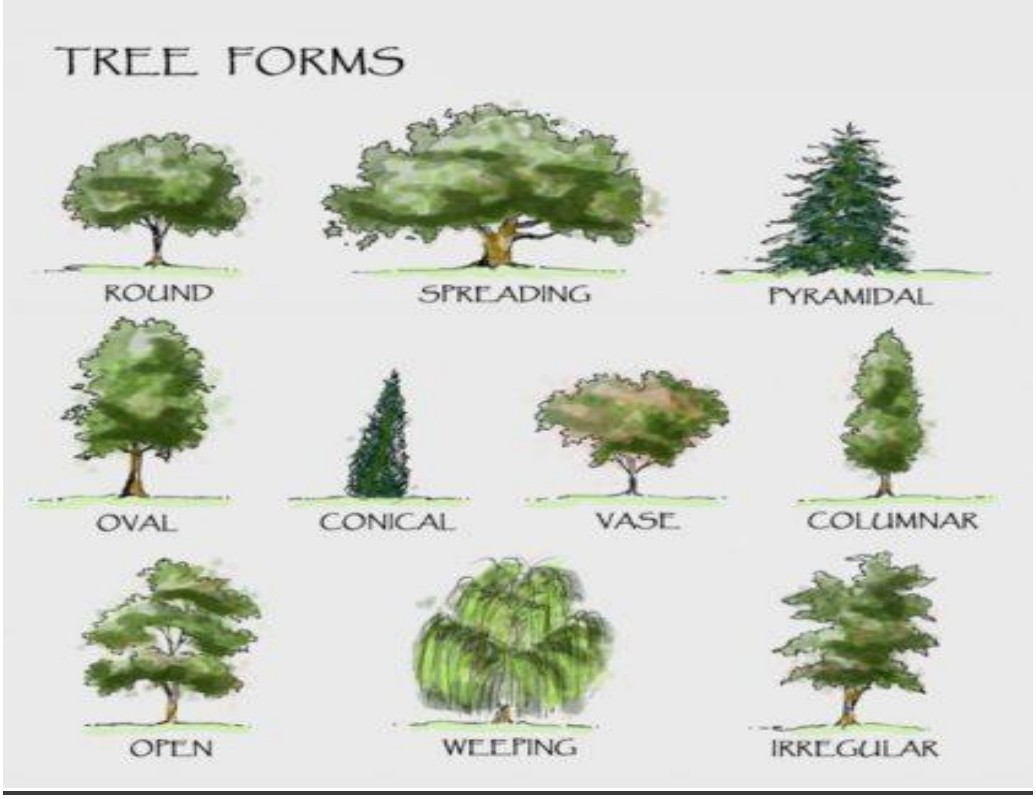
Low bushes: up to 1 m

## Features trees

They are divided into morphological, ecological, biological, etc.

### Morphological characteristics:

Root (shape, depth).
Tree (habitus) – height.
Trunk (diameter, growth direction).
Crown (shape, size, mode of branching).
Bark (color, thickness, structure).
Leaf (shape, size, color, position, hairiness, etc.).
Flower and inflorescence (shape, color, size, etc.).
Fruit (shape, color, size, etc.).
Shoots (color, size, shape and position of the bud).




### Ecological features:

Relationship to environmental factors:

The climate: light, temperature, humidity, wind, rainfall.

Edaphic: soil, parent substrate.

Orographic: relief, exposure, slope, altitude.

Biogeographical distribution – areal.

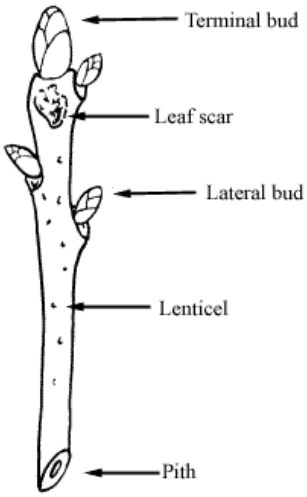
## Leaf surface

The surface and texture of the leaf are other means of identification. The hair, resin glands, waxes, blooms, and scales provide valuable clues in naming a tree. The texture of the leaf may feel like leather or like paper.

## Twigs and Stem

Twigs are useful in identifying trees except for a short period during the spring when the buds are opening and shoots are elongating on these small branches. Several features of twigs, including buds, leaf scars, lenticels, pith, spurs, thorns, spines, and prickles, can help describe them (table 5 and figure 21). Other factors to consider are color, taste, and odor. The color of the bark can be an most important feature on young stems.

| Characteristic | Description |
|---|---|
| **Bud** | • Are one location of growth tissue in a tree. ·<br>• Are usually visible on the twig. ·<br>• May be either lateral, on the side of the twig, or terminal, at the tip of the twig. ·<br>• Are scaly or naked, smooth or fuzzy. |
| **Leaf scars** | • Are where a leaf falls from the twig. ·<br>• Vary in size and shape. ·<br>• Have one or more minute dots or patches that show where the ruptured strands of vascular tissue passed from twig to leaf. |
| **Lenticels** | • Are small, normally lens-shaped patches on the stem that facilitate gas exchange. ·<br>• May be wart-like. |
| **Pith** | • Is the central portion of the twig. ·<br>• Is usually lighter or darker than the wood that surrounds it. ·<br>• Varies in color. ·<br>• Is star-shaped or pentagonal in oaks, triangular in alders, terete or cylindrical-like in ash and elms, and chambered in walnuts. ·<br>• Varies in composition; in most cases is solid, spongy, or hollow. |
| **Spurs** | • Are dwarfed twigs with some internodal development. ·<br>• May grow for several years. ·<br>• Produce the fruit on many apple varieties |
| **Thorns, spines, and prickles** | • Pointed structures that project from the sides of a twig; are important features in some species. ·<br>• Thorns are modified twigs. ·<br>• Spines are modified stipules. ·<br>• Prickles develop from surface tissue and are easily removed. |




Characteristic parts of a twig that help in the identification process.

## Bark

Bark is one of the most important features for tree identification because of its year-round accessibility. It is especially useful when the tree's leaves and twigs are inaccessible or unavailable during the fall and winter. The shape of the bark is characteristic of some species, for example, the small, rectangular plates on flowering dogwood. Bark on young trees differs from that on more mature trees. Experience is the best way to learn bark characteristics.

Bark characteristics that can be used for identifying mature trees. Typical bark textures are illustrated in bellow:

Bark characteristics that help with identification

| Characteristic | Description |
|---|---|
| shape or general appearance | The shape of the bark is often characteristic of some species, for example, the small-rectangular plates on the flowering dogwood. |
| Texture | The feel of the bark , such as the smoothness of cherry trees or the layering or plating of white oaks |
| Thickness | The thickness of the bark can vary within a species as well as between species. |
| Color | Bark color varies with age, location, site, and light conditions. |

Smooth Furrowed Scaly Warty Shaggy

Smooth
Beech
*Fagus sylvatica*

Horizontal lenticles
Cherry
*Prunus avium*

Diamond lenticles
Aspen
*Populus tremula*

Peeling strips
Silver birch
*Betula pendula*

Vertical cracks
Hornbeam
*Carpinus betulus*

Plates
Scots pine
*Pinus sylvestris*

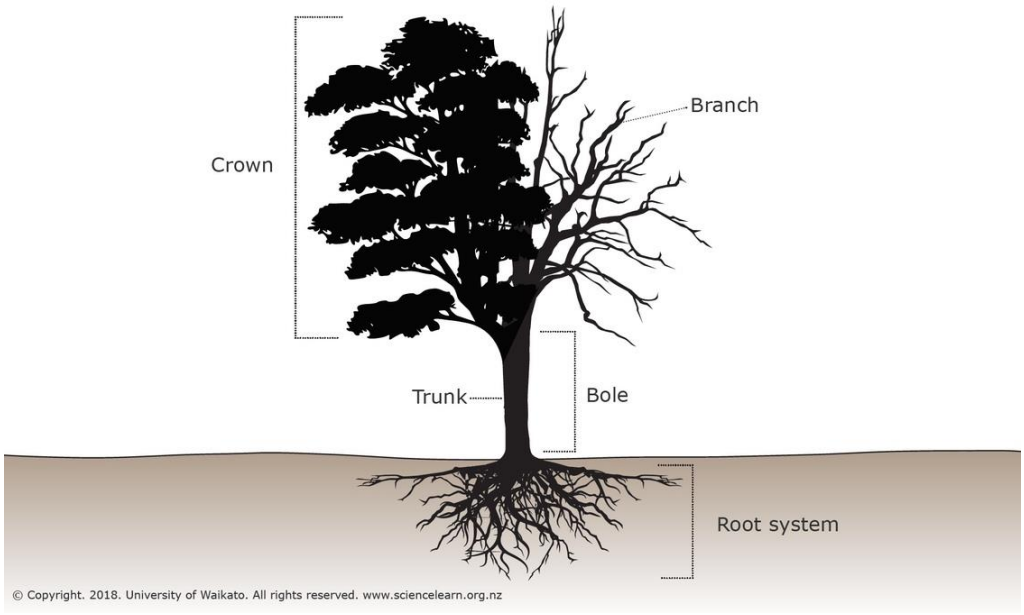
Intersecting ridges
Ash
*Fraxinius*

Ridges broken
horizontallly
Oak *Quercus*

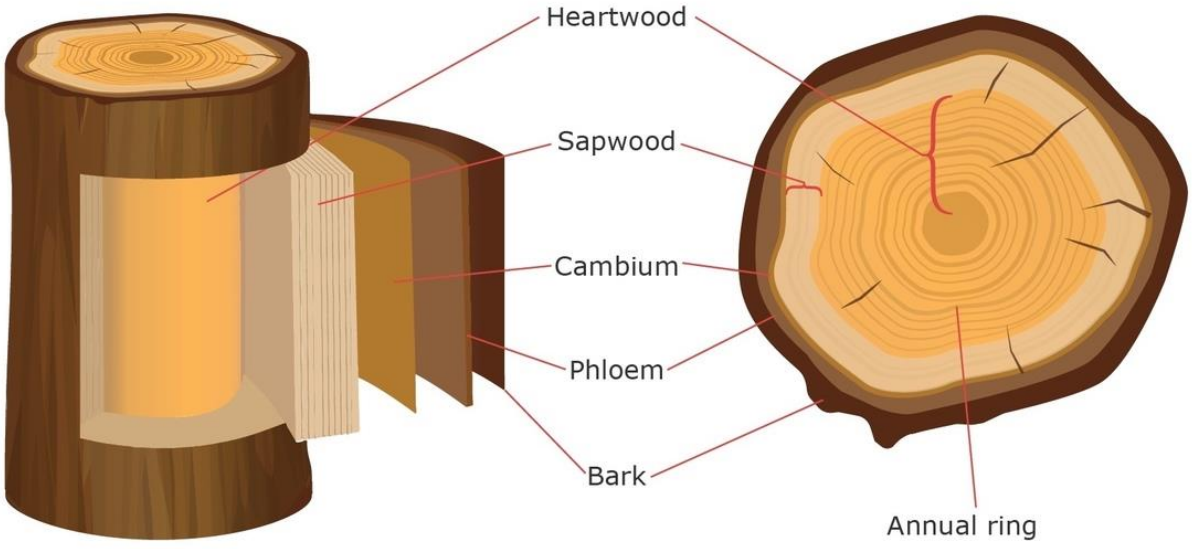
Curved Ridges
Sycamore
*Acer*

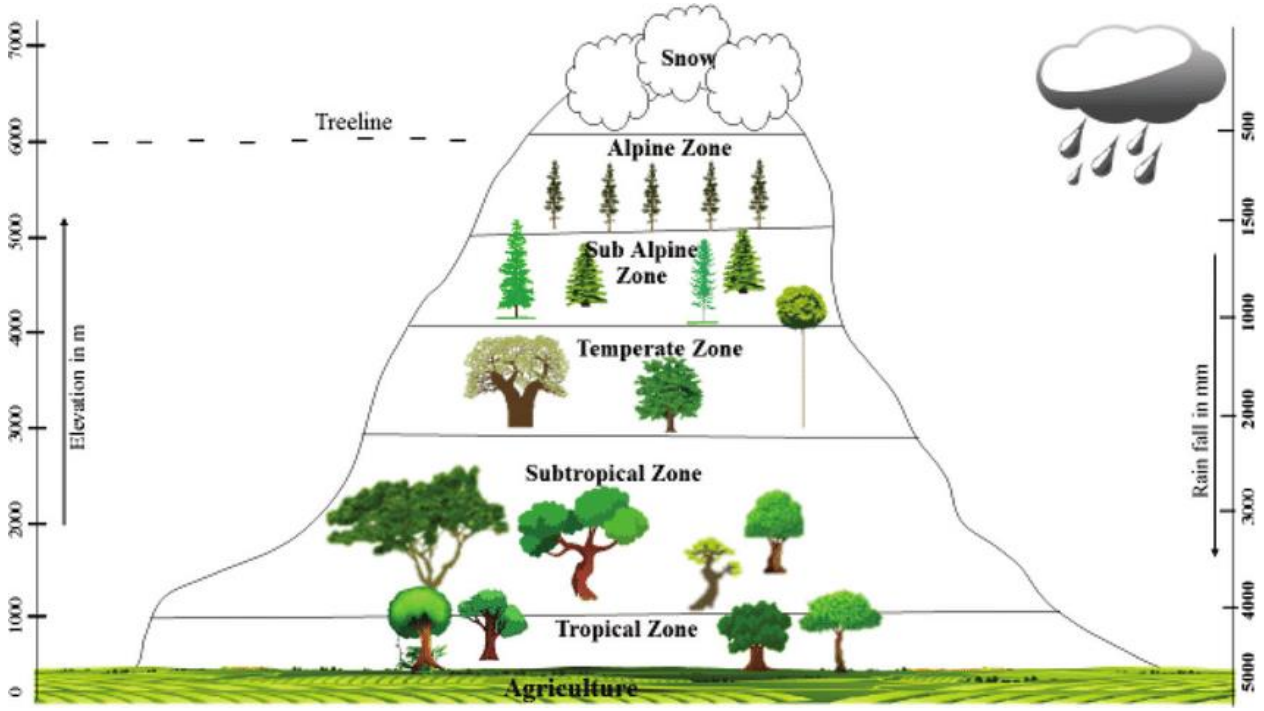
Fibrous
Sequoia
*Sequoiadendron*

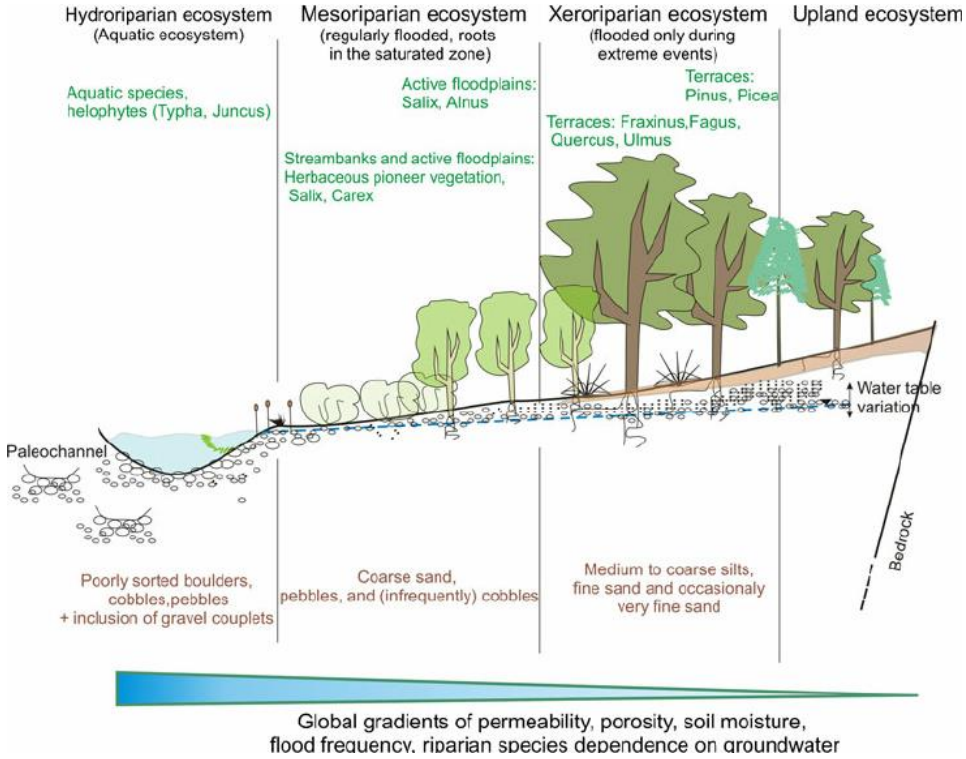
Parts of a tree




Structure of a woody stem




Snow
Treeline
Alpine Zone
Sub Alpine Zone
Temperate Zone
Subtropical Zone
Tropical Zone
Agriculture
Elevation in m
Rain fall in mm
7000
6000
5000
4000
3000
2000
1000
0
500
1500
1000
2000
3000
4000
5000


Hydroriparian ecosystem
(Aquatic ecosystem)
Mesoriparian ecosystem
(regularly flooded, roots in the saturated zone)
Xeroriparian ecosystem
(flooded only during extreme events)
Upland ecosystem
Aquatic species, helophytes (Typha, Juncus)
Active floodplains: Salix, Alnus
Terraces: Pinus, Picea
Terraces: Fraxinus,Fagus, Quercus, Ulmus
Streambanks and active floodplains: Herbaceous pioneer vegetation, Salix, Carex
Water table variation
Paleochannel
Bedrock
Poorly sorted boulders, cobbles,pebbles + inclusion of gravel couplets
Coarse sand, pebbles, and (infrequently) cobbles
Medium to coarse silts, fine sand and occasionaly very fine sand
Global gradients of permeability, porosity, soil moisture, flood frequency, riparian species dependence on groundwater

| What Does That Mean? | | | |
|---|---|---|---|
| **acaulis** | stemless | **micrantha** | small flowered |
| **alba** | white | **microphylla** | with small leaves |
| **angustifolia** | narrow-leaved | **millefolia** | with many (thousands of) leaves |
| **annua** | annual | **montana** | from mountains |
| **argentea** | silvery | **multiflora** | many flowers |
| **arvensis** | of the field | **nana** | small |
| **aurantiaca** | orange | **officinalis** | with herbal uses |
| **aurea** | golden, yellow | **pallida** | cream |
| **australis** | from the south (not necessarily Australia) | **palustris** | from marshes |
| **autumnalis** | of autumn | **parviflora** | small flowered |
| **azurea** | blue | **parvifolia** | with small leaves |
| **caerulea** | blue | **pauciflora** | few-flowered |
| **caespitosa** | dense | **paucifolia** | with few leaves |
| **campanulata** | campanulate, like a bell | **pendula** | hanging |
| **campestris** | of the field | **perennis** | perennial |
| **canadensis** | from Canada | **pinnata** | with pinnate leaves |
| **capensis** | from the Cape, South Africa | **polyphylla** | with many leaves, leafy |
| **chinensis** | from China | **praecox** | early, of spring |
| **chrysantha** | yellow | **prostrata** | prostrate |
| **coccinea** | red | **pumila** | small |
| **compacta** | compact | **punica** | red |
| **decidua** | deciduous | **purpurea** | deep pink |
| **densiflora** | dense-flowered | **pygmaea** | small |
| **digitata** | (leaves) like a hand, with 5 lobes | **quercifolia** | oak-leaved |
| **esculenta** | edible | **rosea** | rose pink |
| **farinosa** | floury, powdery | **rotundifolia** | round-leaved |
| **flava** | yellow | **rubra** | red |
| **flora plena** | with double flowers | **rupestris** | of hills |
| **foetida** | with an unpleasant smell | **sanguinea** | blood-red |
| **glabra** | smooth | **sativa** | cultivated |
| **grandiflora** | large-flowered | **saxatilis** | of rocks |
| **hirsuta** | hairy | **semperviva** | perennial |
| **humilis** | short | **sibirica** | from Siberia |
| **japonica** | from Japan | **spicata** | spiked |
| **lanceolata** | lance-shaped (leaves) | **spinosa** | spiny |
| **latifolia** | wide-leaved | **stellata** | starry |
| **longiflora** | with long flowers | **suphurea** | yellow |
| **longifolia** | with long leaves | **sylvestris** | of woods |
| **lutea** | yellow | **tenuifolia** | with thin, narrow leaves |
| **macrantha** | large flowered | **umbellata** | flowers in an umbel |
| **macrophylla** | with large leaves | **vernalis** | of spring |
| **macrorrhiza** | with large roots | **villosa** | hairy |
| **maculata** | spotted | **viridis** | green |
| **majus** | bigger | **vulgaris** | common |
| **maritima** | near the sea | | |

**Biological Systems of Classification & Branches of Taxonomy**

***Introduction***

- Classification is the process by which anything is grouped into convenient categories (according to a systematic plan or an order) based on some easily observable characters. e.g. We recognize groups / categories like plants, animals, dogs, cats, mammals, wheat etc. on the basis of certain associated characters called as taxa.
- The purpose of biological classification is to organize the vast number of known plants and animals into categories that could be named, remembered and studied.
- The earliest classifications were based on the 'uses' of various organisms because in early days, human beings needed to find sources for their basic needs of food (e.g. oil yielding plants – Coconut, Mustard, Sesame), clothing (Cotton) and shelter (e.g. Medicinal plants – Turmeric, Rauwolfia) which did not fit the scientific approach.
- Over time, an attempt has been made to evolve a classification system that reflects not only the morphological, physiological and reproductive similarities, but is also phylogenetic that is based on evolutionary relationships.

***Biological Systems of classification:***

**Introduction:**

- Biological classification is a scientific method that involves grouping organisms into a hierarchical series of groups and subgroups based on their similarities and differences.
- Three types of systems of classification have been recognized-
  (1) Artificial (2) Natural (3) Phylogenetic

**Detailed explanation:**

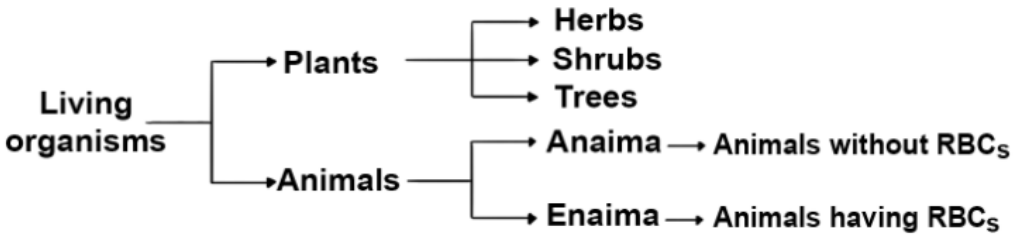
**(1) Artificial system of classification**

- In an artificial system of classification gross, superficial and morphological characteristics are taken into account for classification.
- Vegetative (habit, number ,shape and colour of the leaf) and sexual characters (structure of androecium) give equal importance which is not acceptable as vegetative characters are more easily effected by the environment.
- Some of the important contributions are discussed as follows-

**a. Aristotle:**

i. He used simple morphological characters to classify plants into herbs, shrubs and trees.

ii. He classified animals into Anaima and Enaima, on the basis of absence and presence of RBCs respectively.




**b. Theophrastus**, the inventor of botany, divided plants into four categories based on their habit:

- Herbs
- Under Shrubs
- Shrubs
- Trees

**i.** "Enquiry into plants" (also known as Historia Plantarum) and "Causes of plants" are his two writings on plants.

**ii.** He wrote about almost 500 distinct plant species, naming them by the names that were popular at the time.

**c. Carl Linnaeus** proposed an artificial system of classificationon the basis of few sexual characters like on the androecium structure (number of stamens), in his book Genera Plantarum. He classified plants into 24 classes. Out of them, 23 were of phanerogams and 24th class was of cryptogams.

**- Demerits of artificial system of classification:**

- It uses only one or a few traits for comparison.
- Closely related organisms get separated.
- The grouping is done on the basis of external traits.
- It does not bring out natural and phylogenetic relationships.

**(2) The natural system of classification**

- It is based on the affinities between organisms
- It takes into account not only external but internal features like ultrastructure, anatomy, embryology, and phytochemistry for classification.
- George Bentham and Joseph Dalton Hooker, both of whom were closely involved with the Royal Botanic Garden at Kew, England, proposed a natural system of classification of angiosperms that was published in 'Genera Plantarum' in 3 volumes.
- They classified the plant kingdom into two subkingdoms–Cryptogamia and Phanerogamia. The phanerogamia are classified into three classes–Dicotyledons, Gymnosperms and Monocotyledons.

**The advantages of Bentham's and Hooker's systems are as follows:**

(i) It is practically important, as most of the herbaria of the world are based on this system of classification.

(ii) They placed Ranales (most primitive) in the beginning of classification that is phylogenetically

true.

(iii) They placed monocots after dicots which is similar to phylogenetic systems.

**Demerits of Bentham's and Hooker's classification systems**

(i) They did not use phylogenetic trends in their classification.

(ii) Gymnosperms are placed between dicots and monocots which is not acceptable.

3) Monochlamydeae is placed after gamopetalae which does not seem to be natural.

4) Some of the associated orders are geographically isolated.

5) Groups are not arranged in a consistent manner.

**Phylogenetic Classification (Cladistics):**

- Evolutionary history of the organism is called Phylogeny.
- These systems are based on Phylogenetic relationships of organisms.
- Phylogenetic systems are also called Cladistics (Systematic classification based on evolutionary relationships of organisms in order of their assumed divergence from ancestral forms) and the graphic representation of evolutionary relationships is called family tree or Cladogram.
- Engler and Prantl proposed the phylogenetic classification and published it in their book "Die Natürlichen Pflanzenfamilien" in 23 volumes.
- Engler and Prantl divided plant kingdom into two sub kingdom (1) Cryptogamia: invisible sex organs e.g. Thallophyta, Bryophyta and Pteridophyta.; (2) Phanerogamia: visible sex organs e.g. Gymnosperm and Angiosperm.
- Later on, well-developed phylogenetic systems of classification were created by Hutchinson, Tippo, Takhtajan, Robert Whitaker, Robert Thorne and Cronquist.
- Oswald Tippo proposed the biggest phylogenetic classification of the plant kingdom and it is most accepted for books and study.
- Fossil records are the most important evidence in systematics but if fossil records are not available then other branches of taxonomy like cytotaxonomy, numerical, chemotaxonomy etc. play important roles to find out phylogeny.

**- The merits of the phylogenetic system of classification are-**

a) It tells the evolutionary history of an organism.

b) It gives information about the common ancestor of a group.

c) It tells the relatedness between organisms i.e. how closely two species are related to each other.

***Branches of Taxonomy-***

**Introduction:**

- Characterization, identification, classification and nomenclature are the processes that are basic to taxonomy.
- Based on characteristics, all living organisms can be classified into different taxa. This process of classification is taxonomy.

- External (Morphology) and internal structure (Anatomy), along with the structure of cells (Cytology), development process and ecological information of organisms are essential and form the basis of modern taxonomic studies.

**Detailed explanation:**

**1. Cytotaxonomy:**

- It is a classification based on comparative cytological structure, the number of chromosomes, and the shape and meiotic behavior of chromosomes.
- In order to understand the interrelationship between different organisms the most important parameter is the chromosomal configuration.
- It has wide application in classification of plants as one of the lead parameters, e.g., The chromosomal number is a reliable trait for identifying grasses.

**2. Chemotaxonomy (Biochemical Systematics)**

- It is a classification method based on amino acids, proteins, DNA sequences, alkaloids, crystals, betacyanins, and other chemical elements of organisms. Plant chemical components are often distinct and stable.
- They are not easily swayed. Plants were identified by their scent, flavor, and other chemical qualities in ancient times.
- Only 35 families of calcium oxalate crystals, such as raphides, exist. Similarly, some alkaloids are only found in a few closely related families, such as the benzylisoquinoline alkaloid found in the Papaveraceae, Berberidaceae, and Ranunculaceae families.

**3. Numerical Taxonomy/Phenetics**

- It uses statistical methods to assess resemblances and differences, as well as primitiveness and advancement, based on a huge number of features gathered from several areas of biology.
- In the 1950s, phenetics, often known as numerical taxonomy, was introduced.
- Phenetics is a branch of biology that aims to classify species into higher taxa based on overall resemblance, usually in appearance or other visible qualities, rather than phylogeny or evolutionary relationships. It was developed by Adanson which is based on all observable characteristics and each character is given equal importance. Hundreds of characters can be considered at the same time. Numbers and codes are assigned to all characters and data and then processed using a computer or statistical method.
- Sneath and Sokal (1973) gave various examples of numerical taxonomy being used in several angiosperm taxa, including Apocynum, Crotalaria, Cucurbita, Chenopodium, Oenothera, Salix, Zinnia, Barley cultivars, Maize cultivars, Wheat cultivars, and so on.

***Frequently asked questions (FAQ)***

**Q1. What are the features of numerical taxonomy or Phenetics?**

**Ans.**

- It was developed by Adanson.
- It is based on all observable characteristics.
- Each character is given equal importance.
- Hundreds of characters can be considered at the same time.
- Numbers and code are assigned to all characters and data and then processed using computer or statistical methods.

**Q2.What is the biological system of classification?**

**Ans.**

The biological system of classification is a process of classifying and placing organisms into various groups in the hierarchy of categories based on the similarities and dissimilarities between them.

**Q3. What are the three systems of biological classification?**

**Ans.**

In the living world, organisms are classified based on three systems of biological classification. These are:

a. Natural system of classification

b. Artificial system of classification

c. Phylogenetic system of classification

**Q4. What is the meaning of artificial classification?**

**Ans.**

- The artificial system of biological classification is the procedure of classifying organisms based on their morphological and non-evolutionary characters like the number of carpels or stamen, number, and shape of leaves, etc.
- For example, Linneaus's system of classification.
- Carl Linneaus classified organisms into two groups, plants, and animals, based on their observable features.

**Q5. Who proposed the natural system of classification?**

**Ans.**

- Bentham and hooker proposed the natural system of biological classification.
- They classified the seed-forming plants into various groups based on similarities and dissimilarities between them.
- Their work is also published in a book named 'Genera Plantarum'.

**Q6. What is the phylogenetic system of classification?**

**Ans.**

- The phylogenetic system of classification is the method of grouping organisms based on their evolutionary relations.
- Organisms that are closely related and have a common ancestor are placed in the same group.
- The tree diagram that represents the classification of organisms based on their phylogeny (evolutionary relationships) is called cladogram and each group of cladogram is called a clade.

**Q7. Mention the drawbacks of an artificial system of classification**

**Ans.**

- Artificial system of classification is based on just morphological features of an organism.
- Drawbacks of artificial classification are mentioned below:

  d. The closely related species are placed in separate groups due to the basis of classification.

  e. The vegetative and sexual features were given equal weightage which is not acceptable because the vegetative characters get changed with the change in environment.

**Q8. What are the merits of the phylogenetic system of classification**

**Ans.**

- Phylogenetic system of classification is based on the evolutionary relationship between organisms.
- The merits of the phylogenetic system of classification are

  f. It tells the evolutionary history of an organism.

g. It gives information about the common ancestor of a group.
h. It tells the relatedness between organisms i.e. how closely two species are related to each other.

**Q9. What is cladistics?**

**Ans.**

- Cladistics is the study of the biological classification of organisms on the basis of their evolutionary traits shared.
- The phylogenetically related species and relations between them are shown in the form of a tree diagram called a cladogram.
- Each group of cladogram i.e. group of organisms showing a common ancestor and line of descent is called a clade.

**Q10. What is chemotaxonomy?**

**Ans.**

It is a classification method based on amino acids, proteins, DNA sequences, alkaloids, crystals, betacyanins, and other chemical elements of organisms. Plant chemical components are often distinct and stable. They are not easily swayed. Plants were identified by their scent, flavor, and other chemical qualities in ancient times.