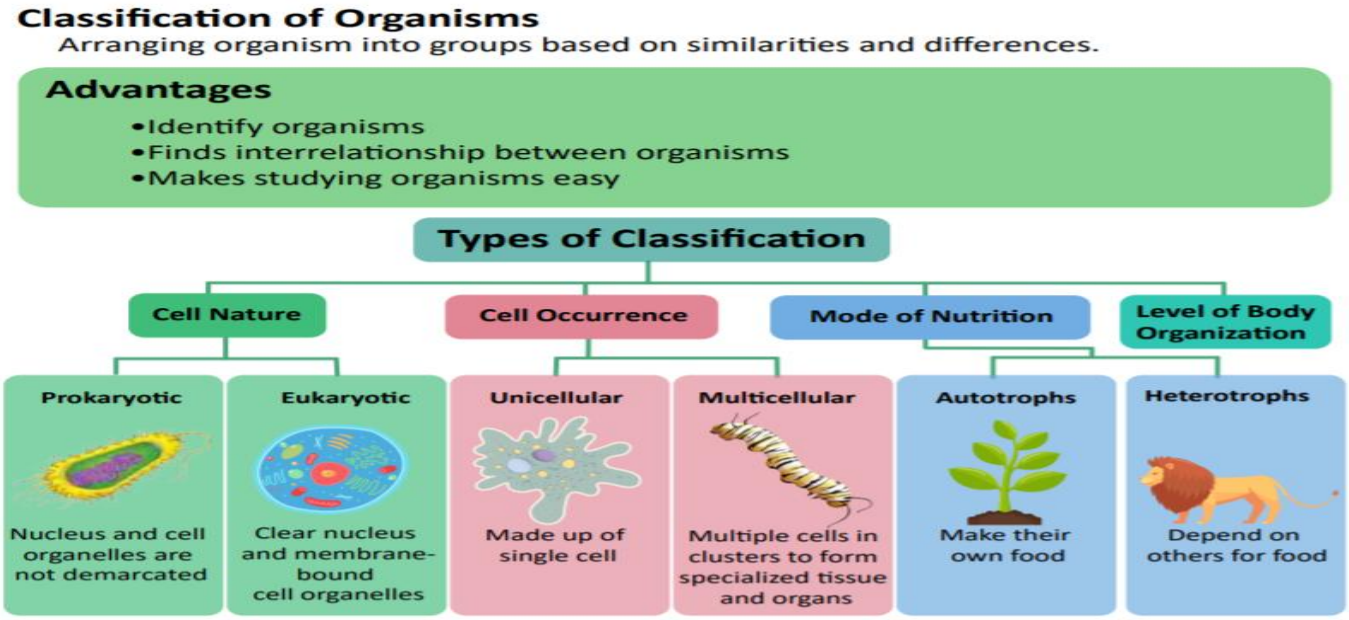
Kingdom

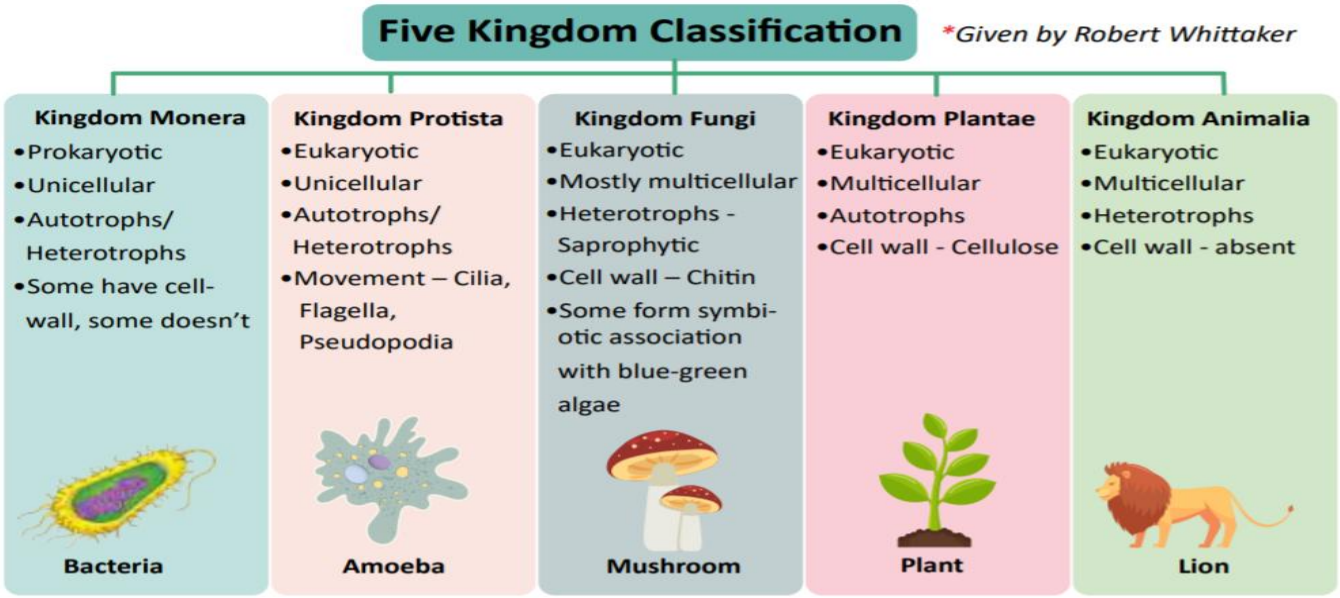
The system of assembling organisms into groups or sets on the basis of likenesses and variances is called classification. It simplifies the study of a wide variety of organisms in a very systematic manner.

R.H. Whittaker proposed the five-kingdom classification in 1969. This classification was based upon certain characters like mode of nutrition, thallus organization, cell structure, phylogenetic relationships and reproduction. This form of kingdom classification includes five kingdoms Monera, Protista, Fungi, Plantae and Animalia.

Kingdoms are divided into subgroups at various levels. The following flowchart shows the hierarchy of classification.

Kingdom → Phylum → Class → Order → Family → Genus → Species





Kingdom Monera

The bacteria are categorized underneath the Kingdom Monera.

Features of Monerans

They possess the following important features:

- Bacteria occur everywhere and they are microscopic in nature.
- They possess a cell wall and are prokaryotic.
- The cell wall is formed of amino acids and polysaccharides.
- Bacteria can be heterotrophic and autotrophic.
- The heterotrophic bacteria can be parasitic or saprophytic. The autotrophic bacteria can be chemosynthetic or photosynthetic.

Types of Monerans

Bacteria can be classified into four types based on their shape:

- **Coccus (pl.: cocci) –** These bacteria are spherical in shape
- **Bacillus (pl.: bacilli) –** These bacteria are rod-shaped
- **Vibrium (pl.: vibrio) –** These bacteria are comma-shaped bacteria
- **Spirillum (pl.: spirilla) –** These bacteria are spiral-shaped bacteria

Monera has since been divided into Archaebacteria and Eubacteria.

Kingdom Protista

Features of Protista

- They are unicellular and eukaryotic organisms.
- Some of them have cilia or flagella for mobility.
- Sexual reproduction is by a process of cell fusion and zygote formation.

Sub-groups of Protista

- **Chrysophytes**: The golden algae (desmids) and diatoms fall under this group. They are found in marine and freshwater habitats.
- **Dinoflagellates**: They are usually photosynthetic and marine. The colour they appear is dependent on the key pigments in their cells; they appear red, blue, brown, green or yellow.
- **Euglenoids**: Most of them live in freshwater habitation in motionless water. The cell wall is absent in them, instead, there is a protein-rich layer called a pellicle.
- **Slime Moulds**: These are saprophytic. The body moves along putrefying leaves and twigs and nourishes itself on organic material. Under favourable surroundings, they form an accumulation and were called Plasmodial slime moulds.
- **Protozoans**: They are heterotrophs and survive either as parasites or predators.

Kingdom Fungi

The kingdom fungi include moulds, mushroom, yeast etc. They show a variety of applications in domestic as well as commercial purposes.

Features of Kingdom Fungi

- The fungi are filamentous, excluding yeast (single-celled).
- Their figure comprises slender, long thread-like constructions called hyphae. The web of hyphae is called mycelium.

- Some of the hyphae are unbroken tubes which are jam-packed with multinucleated cytoplasm. Such hyphae are labelled Coenocytic hyphae.
- The other type of hyphae has cross-walls or septae.
- The cell wall of fungi is composed of polysaccharides and chitin.
- Most of the fungi are saprophytes and are heterotrophic.
- Some of the fungi also survive as symbionts. Some are parasites. Some of the symbiont fungi live in association with algae, like lichens. Some symbiont fungi live in association with roots of higher plants, as mycorrhiza.

Kingdom Plantae

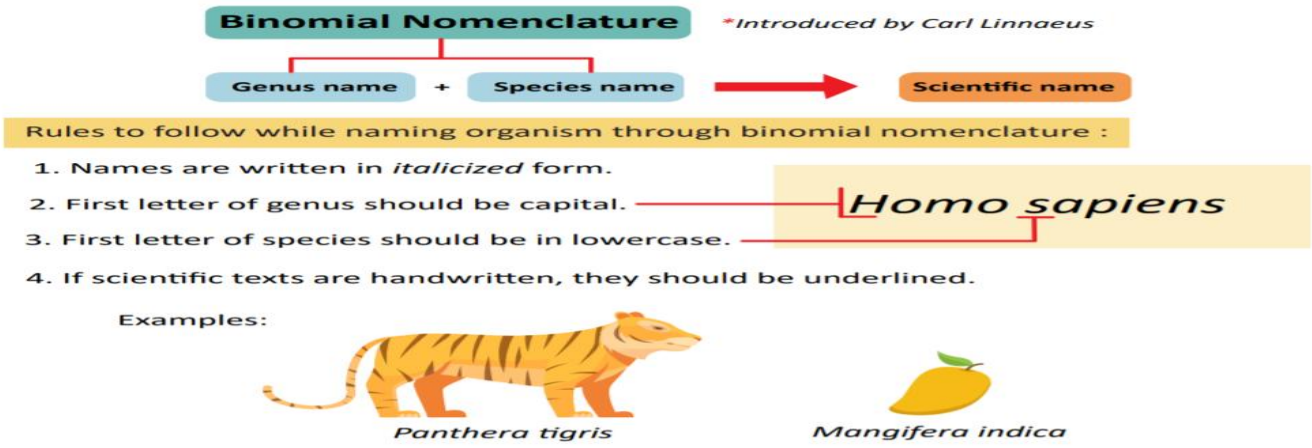
Features of Kingdom Plantae

- The kingdom Plantae is filled with all eukaryotes which have chloroplast.
- Most of them are autotrophic in nature, but some are heterotrophic as well.
- The Cell wall mainly comprises cellulose.
- Plants have two distinct phases in their lifecycle. These phases alternate with each other. The diploid saprophytic and the haploid gametophytic phase. The lengths of the diploid and haploid phases vary among dissimilar groups of plants. Alternation of Generation is what this phenomenon is called.

Kingdom Animalia

Features of Kingdom Animalia

- All multicellular eukaryotes which are heterotrophs and lack cell wall are set aside under this kingdom.
- The animals are directly or indirectly dependent on plants for food. Their mode of nutrition is holozoic. Holozoic nutrition encompasses ingestion of food and then the use of an internal cavity for digestion of food.
- Many of the animals are adept for locomotion.
- They reproduce by sexual mode of reproduction.

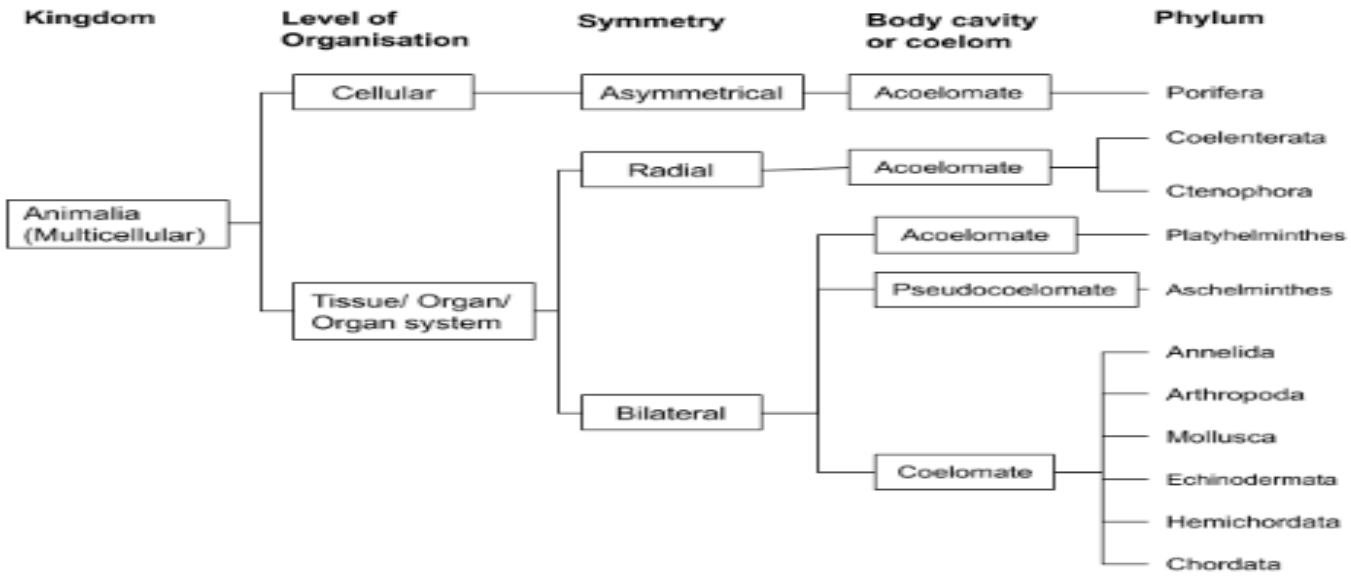


Animal Kingdom

- Animals are classified on the basis of common fundamental features like the cellular arrangement, symmetry of the body, presence or absence of the coelom, specific features of the digestive, circulatory and reproductive system
- **Cellular level of organisation:** cells arranged as loose aggregates, present in Porifera (sponges)
- **Tissue level of organisation:** cells performing the same function form tissues, present in coelenterates

- **Organ level of organisation:** tissues grouped together to form an organ, which performs particular function, e.g. Platyhelminthes
- **Organ system level of organisation:** few organs coordinatively perform a certain physiological function, e.g. Annelids, Arthropods, Molluscs, Echinoderms and Chordates
- **Open circulatory system:** cells and tissue receive directly the blood pumping out of the heart
- **Closed circulatory system:** blood is circulated through arteries, veins and capillaries
- **Diploblastic:** embryo with two germinal layers called external ectoderm and internal endoderm, e.g. Porifera, Cnidaria
- **Triploblastic:** embryo with three germinal layers, mesoderm between ectoderm and endoderm, e.g. Platyhelminthes to Chordates
- **Asymmetrical:** no line of symmetry in the body, e.g. sponges
- **Radial symmetry:** any plane passing through centre divides the body in two symmetrical halves, e.g. coelenterates, ctenophores
- **Bilateral symmetry:** a plane divides the body in symmetrical left and right halves, e.g. annelids, arthropods, etc.
- Echinoderms exhibit radial as well as bilateral symmetry at different stages of their life
- Body cavity between the body wall and gut wall, lined by mesoderm is called **coelom**
- **Acoelomates:** body cavity is absent, e.g. Platyhelminthes
- **Pseudocoelomates:** mesoderm is present as scattered pouches, e.g. Aschelminthes
- **Coelomates:** having coelom (body cavity) e.g. from Annelida to Chordata
- Earthworm's body shows metameric segmentation
- Animals with notochord are called chordates, animals without notochord are called non-chordates, e.g. Porifera to Echinodermata

Classification of Animals



Classification of animal kingdom based on common fundamental features

Phylum – Porifera (Sponges)

- Marine, asymmetrical with the cellular level of organisation
- Food intake, gaseous exchange and excretion occurs through the water transport system

- Water enters through pores called Ostia and goes out through osculum via central cavity known as spongocoel
- Spongocoel is lined by collar cells or choanocytes
- Intracellular digestion
- Body skeleton is made up of spongin fibres or spicules
- Sponges are hermaphrodite
- Reproduce asexually by fragmentation and sexually by the formation of gametes
- Fertilisation is internal and the development of zygote goes through a distinct larval stage
- **Examples:** Spongilla (freshwater sponge), Euspongia (bath sponge), Sycon,

Phylum – Coelenterata (cnidaria)

- Aquatic, sessile or free-swimming, tissue level of organisation, diploblastic and radially symmetrical and acoelomate
- The central gastro-vascular cavity has a single opening called hypostome, which is surrounded by sensory tentacles
- Cnidoblasts are present on the tentacles, which contain nematocysts
- Digestion is extracellular and intracellular
- Corals have calcium carbonate skeleton
- A polyp is a sessile and cylindrical form, e.g Hydra, Adamsia
- Medusa is an umbrella-shaped free-swimming form, e.g. Aurelia (jellyfish)
- In some coelenterates, e.g. Obelia alternation of generation (metagenesis) exist. Polyp form produces medusae asexually and medusae produce polyp sexually
- **Examples:** Meandrina (Brain coral), Adamsia (Sea anemone), Gorgonia (Sea-fan), Physalia (Portuguese man of war)

Phylum – Ctenophora (sea walnuts or comb jellies)

- Marine, tissue level of organisation, diploblastic and radially symmetrical and acoelomate
- Eight rows of ciliated comb plates present externally
- Digestion is extracellular and intracellular
- **Bioluminescence** is present
- Hermaphrodite
- Sexual reproduction, fertilisation is external with indirect development
- **Examples:** Ctenoplana, Pleurobrachia

Phylum – Platyhelminthes (flatworms)

- Mostly endoparasites, dorsoventrally flattened body, triploblastic, bilaterally symmetrical, acoelomate with organ level of organisation
- Hooks and suckers are present in parasites
- Flame cells are present, which help in osmoregulation and excretion
- Hermaphrodite or monoecious
- Internal fertilisation and indirect development through many larval stages
- Planaria can regenerate
- **Examples:** Fasciola (Liver fluke), Taenia (tapeworm)

Phylum – Aschelminthes

- Free-living or parasitic, aquatic or terrestrial
- Round body in cross-section, bilaterally symmetrical, triploblastic, pseudocoelomate with organ system organisation
- The alimentary canal is complete and has a muscular pharynx
- Dioecious, females are longer than males
- Internal fertilisation with direct or indirect development
- **Examples:** Ascaris (roundworm), Wuchereria (Filarial worm), Ancylostoma (hookworm)

Phylum – Annelida

- Bilaterally symmetrical, triploblastic, coelomate, organ system organisation
- Metamerically segmented
- Longitudinal and circular muscles help in locomotion
- Nereis, an aquatic animal has appendages called parapodia, which help in swimming
- Closed circulatory system
- Nephridia is present for osmoregulation and excretion
- Paired ganglia are present, which are connected to double ventral nerve cord by lateral nerves
- Reproduction is sexual. Nereis is dioecious, earthworm and leeches are monoecious
- **Examples:** Pheretima (earthworm), Nereis, Hirudinaria (bloodsucking leech)

Phylum – Arthropoda

- Largest phylum with two-thirds of all known animals
- It contains insects
- Bilaterally symmetrical, triploblastic, coelomate, organ system organisation
- Their body is covered by chitinous exoskeleton
- The characteristic property of the group is jointed legs
- Their body can be divided into three regions; head, thorax and abdomen
- Respiration is by trachea, gills, book gills, book lungs
- The circulatory system is open type
- Statocyst or balancing organs are present
- Eyes are simple or compound
- Malpighian tubules help in excretion
- Mostly dioecious, oviparous and fertilisation is internal
- **Examples:** economically important species- Bombyx (silkworm), Apis (honey bee) Vector for diseases- mosquitoes like Anopheles, Aedes, Culex.Living fossil- Limulus (King crab)

Phylum – Mollusca

- Bilaterally symmetrical, triploblastic, coelomate, organ system organisation
- Unsegmented body covered with a calcareous shell
- Distinct head, muscular foot and the visceral hump is present
- Respiratory and excretory functions are executed by feather-like gills
- The radula is a rasping organ for feeding

- They are dioecious, oviparous with indirect development
- **Examples**: Pila (apple snail), Octopus (devilfish), Loligo (squid), Sepia (cuttlefish), Pinctada (pearl oyster)

Phylum – Echinodermata

- Adult- radially symmetrical, larvae- bilaterally symmetrical
- Triploblastic and coelomate
- Endoskeleton of calcareous ossicles
- The mouth is present on the ventral side and anus on the dorsal side
- The characteristic feature is the presence of **Water vascular system**, which helps in feeding, locomotion and respiration
- Dioecious, external fertilisation with indirect development
- **Examples**: Asterias (starfish), Ophiura (brittle star), Antedon (sea lily), Echinus (sea urchin)

Phylum – Hemichordata

- Presence of stomochord, a structure similar to the notochord
- Bilaterally symmetrical, triploblastic, coelomate, organ system organisation
- Cylindrical body with a proboscis, a collar and a long trunk
- Gills are present and circulation is open type
- Proboscis gland works as an excretory organ
- Dioecious, external fertilisation with indirect development
- **Examples:** Balanoglossus, Saccoglossus

Phylum – Chordata

- Characteristic features are a dorsal hollow nerve cord, a notochord and paired gill slits
- Bilaterally symmetrical, triploblastic, coelomate, organ system organisation
- The circulatory system is closed and the post-anal tail is present
- Three subphylums come under Chordata:
    1. **Urochordata**– notochord present only in the larval tail, e.g. Ascidia, Salpa, Doliolum
    2. **Cephalochordata**– notochord present throughout life from head to tail, e.g. Branchiostoma (Lancelet or amphioxus)
    3. **Vertebrata**– Notochord is present in the embryonic stage, it gets replaced by **Vertebral Column**
- Vertebrata is further divided into two divisions
    a. **Agnatha (without jaws):** Class Cyclostomata
    b. **Gnathostomata (with jaws):** has two Super Class:
        i. **Pisces (bear fins):** two Classes- Chondrichthyes, Osteichthyes
        ii. **Tetrapoda (bear limbs):** four classes- Amphibia, Reptilia, Aves and mammals

Class I – Cyclostomata (Circular Mouthed Fishes)

- Characterised by circular and sucking mouth without jaws
- Ectoparasites on fishes
- 6-15 pairs of gill slits
- Scales and fins are absent

- Cartilaginous vertebral column and cranium
- Closed type circulation
- Marine but migrate to freshwater for spawning where they die, larvae after metamorphosis come back to the ocean
- **Examples:** Petromyzon (Lamprey), Myxine (Hagfish)

Class II – Chondrichthyes (Cartilaginous fishes)

- Cartilaginous endoskeleton, the mouth is on the ventral side
- Gill is without operculum
- The notochord is present throughout life
- Placoid scales are present on the skin which makes it tough
- It swims constantly to avoid sinking as air bladders are absent
- Two chambered heart and poikilothermous (cold-blooded)
- Separate sexes, internal fertilisation and many are viviparous
- Claspers are present on male's pelvic fin
- Electric organs are present in Torpedo and Trygon has poison sting
- **Examples:** Scoliodon (Dogfish), Trygon (Stingray), Pristis (Sawfish), Carcharodon (Great white shark)

Class III – Osteichthyes (Bony fishes)

- Streamlined body, bony endoskeleton, 4 pairs of gills with operculum
- Skin is covered by cycloid scales
- Two chambered heart and air bladder for buoyancy, poikilothermous
- Sexes are separate, oviparous, external fertilisation with direct development
- **Examples:** Marine- Hippocampus (Sea horse), Exocoetus (Flying fish)

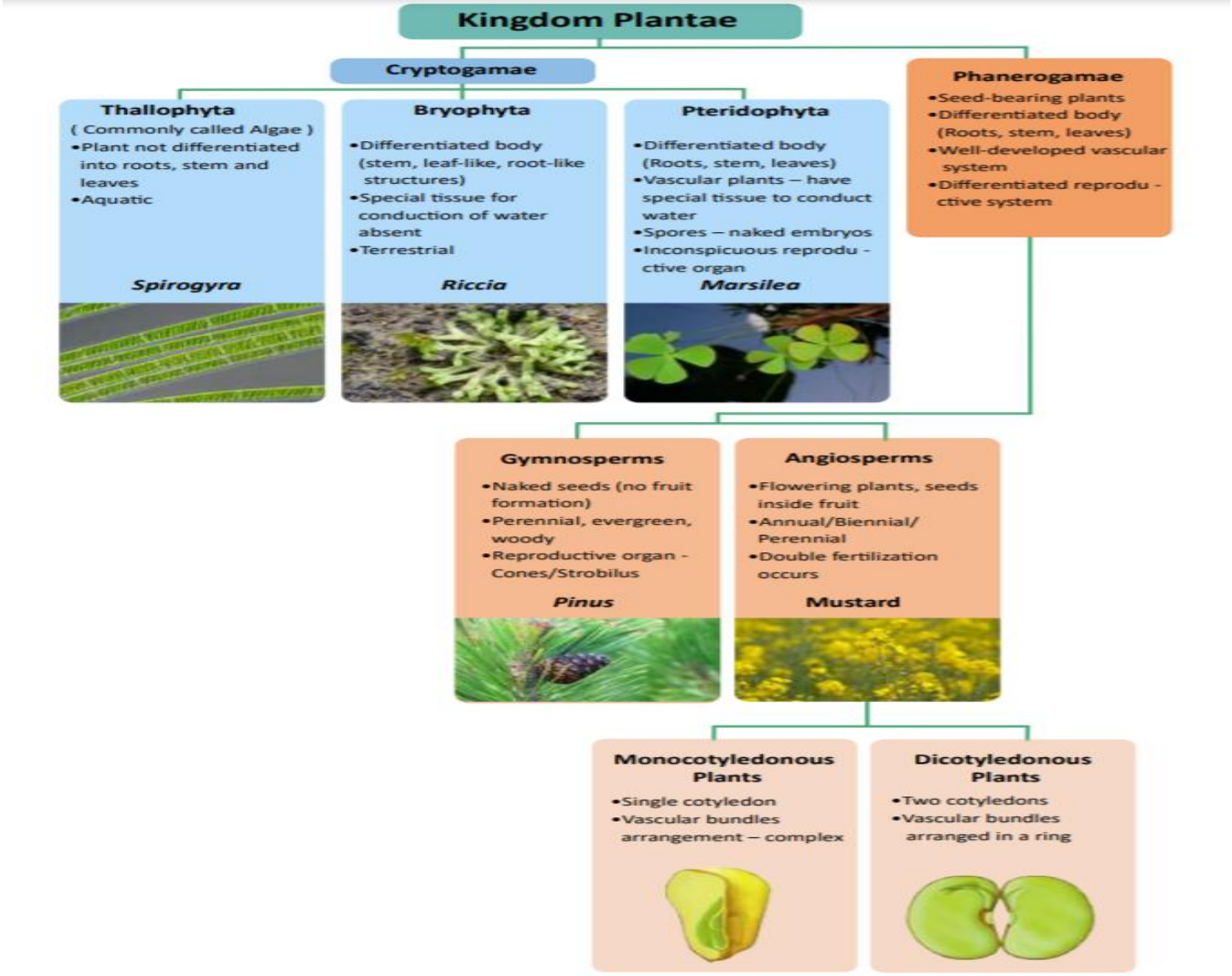
Classification of Kingdom Plantae

A plant kingdom is further classified into subgroups. Classification is based on the following criteria:

1. **Plant body**: Presence or absence of a well-differentiated plant body. E.g. Root, Stem and Leaves.
2. **Vascular system**: Presence or absence of a vascular system for the transportation of water and other substances. E.g. Phloem and Xylem.
3. **Seed formation**: Presence or absence of flowers and seeds and if the seeds are naked or enclosed in a fruit.

The plant kingdom has been classified into five subgroups according to the above-mentioned criteria:

1. **Thallophyta**
2. **Bryophyta**
3. **Pteridophyta**
4. **Gymnosperms**
5. **Angiosperms**



Thallophyta

Thallophytes lack a well-differentiated body structure and the plant body is thallus like.

Thallophyta includes plants with primitive and simple body structure. The plant body is thallus, they may be filamentous, colonial, branched or unbranched. Examples include green algae, red algae and brown algae. Common examples are Volvox, Fucus, Spirogyra, Chara, Polysiphonia, Ulothrix, etc.

Bryophyta

Bryophytes do not have vascular tissues. The plant body has root-like, stem-like and leaf-like structures. Bryophytes are terrestrial plants but known as “amphibians of the plant kingdom” as they require water for sexual reproduction. They are present in moist and shady places. Bryophyta includes mosses, hornworts and liverworts. Some of the common examples are Marchantia, Funaria, Sphagnum, Antheoceros, etc.

Pteridophyta

Pteridophytes have a well-differentiated plant body into root, stem and leaves. They have a vascular system for conduction of water and other substances. Some of the common examples are Selaginella, Equisetum, Pteris, etc.

Gymnosperms

Gymnosperms have a well-differentiated plant body and vascular tissues. They bear naked seeds, i.e. seeds are not enclosed within a fruit. Some of the common examples of gymnosperms are Cycas, Pinus, Ephedra, etc.

Angiosperms

Angiosperms are seed-bearing vascular plants with a well-differentiated plant body. The seeds of angiosperms are enclosed within the fruits. Angiosperms are widely distributed and vary greatly in size, e.g. Wolffia is small measuring about 0.1 cm and Eucalyptus trees are around 100 m tall. Angiosperms are further divided into monocotyledons and dicotyledons according to the number of cotyledons present in the seeds. Some of the common examples are mango, rose, tomato, onion, wheat, maize, etc.

Cryptogams and Phanerogams

The plant kingdom is also classified into two groups:

Cryptogams – Non-flowering and non-seed bearing plants. E.g. Thallophyta, Bryophyta, Pteridophyta

Phanerogams – Flowering and seed-bearing plants. E.g. Gymnosperms, Angiosperms