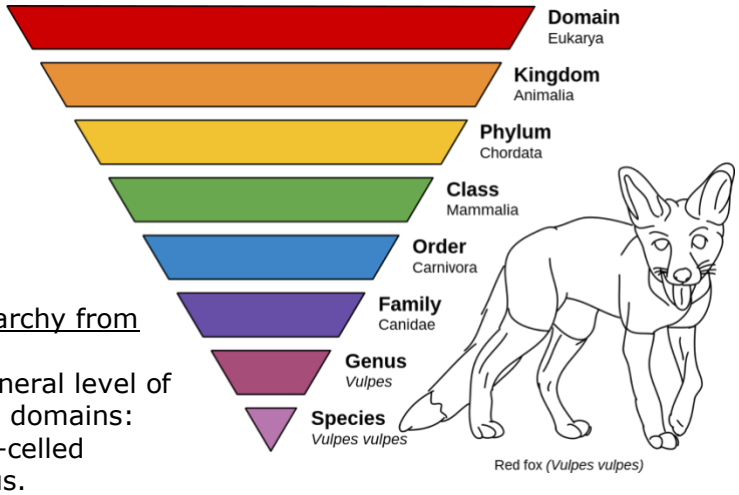
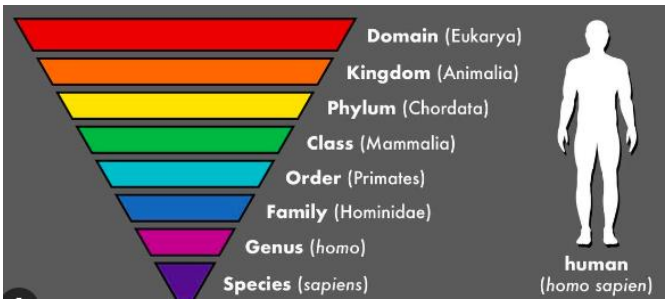
Taxonomic Classfification

Taxonomy is the science of classification, identification, and naming of living organisms. It's a hierarchical system that organizes the vast diversity of life on Earth. The taxonomic classification arranges organisms into a series of ranked categories, each of increasing specificity, based on evolutionary relationships and morphological similarities.



Overview of the taxonomic classification hierarchy from the broadest to the most specific:

1. **Domain**: This is the highest, most general level of classification. There are three primary domains:
    - **Bacteria**: Pro karyotic, single-celled organisms, which lack a nucleus.
    - **Archaea**: Prokaryotic, single-celled organisms, which are distinct from bacteria.
    - **Eukarya**: Organisms with cells that contain a nucleus.
2. **Kingdom**: Historically, there were only two kingdoms—
    - Plantae (plants) and Animalia (animals).
    - With advances in the understanding of molecular biology and genetics, more kingdoms like Fungi, Protista, and Monera (which is often split into Bacteria and Archaea) were added.
    - Thus species are divided in **five Kingdoms Plantae, Animalia, Fungi, Protista and Monera**.



3. **Phylum** (for animals)/**Division** (for plants & fungi):
    - This category organizes life forms based on major structural and functional characteristics.
    - For example, the **phylum Chordata comprises animals that possess a notochord, like vertebrates**.
4. **Class**:
    - Within each phylum or division, organisms are further divided.
    - For example, within **Chordata, one class is Mammalia**, which includes all mammals.
5. **Order**:
    - Classes are further divided into orders based on additional shared characteristics.
    - For example, **Primates is an order within Mammalia, which includes humans, apes, and monkeys**.
6. **Family**:
    - Within orders, there are families.
    - For example, the family **Hominidae** within the order **Primates includes humans and our closest ape relatives.**
7. **Genus**:
    - This is a way to describe organisms that are more closely related than those in broader classifications.

- The genus always has an initial capital letter. For example, in the classification of humans, "Homo" is our genus.

8. **Species**:
    - This is the most specific level of classification and represents a single kind of organism. For humans, the species name is "sapiens".
    - When writing or printing the scientific name (genus and species), it is conventionally italicized, with the genus capitalized and species in lowercase (e.g., *Homo sapiens*).

When used together, the genus and species names form the full scientific name of an organism. This binomial nomenclature system was developed by Carl Linnaeus in the 18th century, and it helps scientists and scholars communicate more effectively about different species, ensuring that they are speaking about the same organisms in the same way. Taxonomic classifications can change with advances in genetics and our understanding of evolutionary relationships. For example, DNA sequencing can reveal previously unknown relationships between species, leading to reclassification.

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/ Division
Man	*Homo sapiens*	*Homo*	Hominidae	Primata	Mammalia	Chordata
Housefly	*Musca domestica*	*Musca*	Muscidae	Diptera	Insecta	Arthropoda
Mango	*Mangifera indica*	*Mangifera*	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	*Triticum aestivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

Organisms with Taxonomic categories

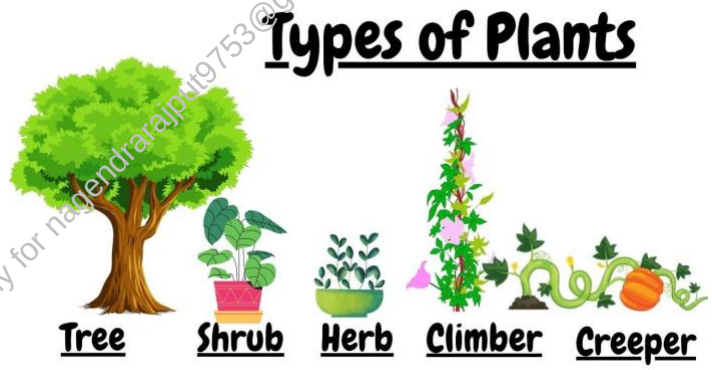
Characters	Five Kingdoms				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Noncellular (Polysaccharide + amino acid)	Present in some	Present (without cellulose)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Cellular	Cellular	Multiceullar/ loose tissue	Tissue/ organ	Tissue/organ/ organ system
Mode of nutrition	Autotrophic (chemosynthetic and photosynthetic) and Heterotrophic (saprophyte/parasite)	Autotrophic (Photosynthetic) and Heterotrophic	Heterotrophic (Saprophytic/ Parasitic)	Autotrophic (Photosynthetic)	Heterotrophic (Holozoic/ Saprophytic etc.)

Five Kingdoms and their characteristics

Plant Diversity (Flora)

Based on size:

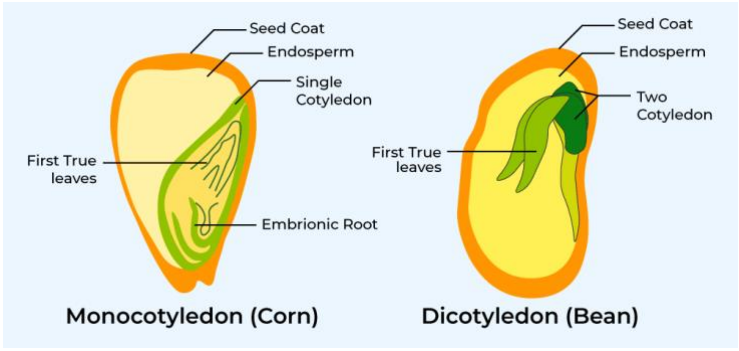
- **Herbs**: Herbs are considered the smallest in size. Their heights are not more than a foot or a few centimetres and consist of soft stems. Generally, they have fewer branches or none. These herbs are filled with vitamins and minerals and are an essential part of a nutritious diet. Some of the major examples of herbs are tomato, ginger, paddy, etc.
- **Shrubs**: 'They are also not very big in size but they are bigger than the herbs, almost a meter and have hard stems. Examples of shrubs are Rosemary, Cherry, Basil, etc.



- **Trees**: As we all know, trees are the biggest of plants and have very hard stems which are known as the trunk. The trunk of a tree has branches that bear fruits, leaves and fruits. They can have great heights, mostly more than a meter. Examples of trees are Mango, Banana, etc.
- **Creepers**: Those plants that creep on the ground have very fragile as well as thin and long stems are referred to as creepers. These creepers cannot stand straight or support their own weight. Some of the major creepers include strawberries, sweet potatoes, watermelon, amongst others.
- **Climbers:** Similar to creepers in their thin, long and weak stems, the Climbers cannot stand erect as well but grow vertically through external supports and can carry their own weight. Some of the examples of climbers are money plants, runner beans, grapevine, etc.

Types of Plants Based on Seeds
Seeds lie the foundation of a plant as their growth mainly relies on the type of seed. Based on the seeds of a plant, we can divide them into two types.

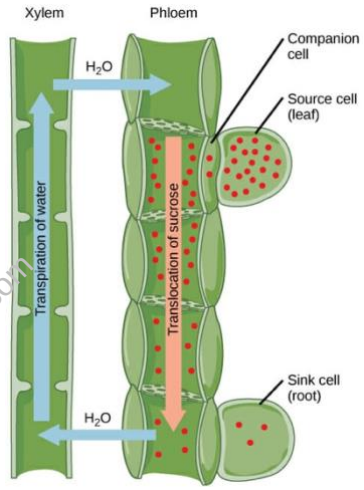
- **Monocotyledon**: Having have their seeds in one piece, Monocotyledon has a single cotyledon as per their name. Examples of these types of plants are Rice, Orchids, Bamboo and so on.
- **Dicotyledon**: These types of plants have two cotyledons within their seeds which can be divided into two equal parts. Examples of Dictyledon are Cashew, Oaks, etc.



Plants can be classified into vascular and non-vascular plants.

Vascular Plants

- Vascular plants are those plants that are green in colour and have tissues which are specialised for the purpose of transporting food, water and minerals to all parts of the plant.



- These special tissues are known as Xylem and Phloem. These plants can grow longer in length.
- **Xylem** carries water and minerals from the roots to the leaves. Whereas, **phloem** carries the food prepared by the leaves to different parts of the plant.
- Examples are Gymnosperms, Pines, Ferns, Angiosperms, Sunflowers and Clubmosses, etc.

Non-Vascular Plants

- Non-vascular plants are those plants which do not have a long height.
- They are short in height and do not have the required transport system for transporting food, water and minerals to other parts of the plant.

- Xylem and Phloem are absent in Non-Vascular plants.
- Such type of plants do not produce fruits, wood or flowers. Examples are **Hornworts, Liverworts and Mosses**.
- Non-vascular plants grow on swampy, shady and moist places.
- The dominating phase in non-vascular plants is gametophyte. The second is sporophyte. Leaves are absent in non-vascular plants. Therefore, they do not have a special function. Non-vascular plants do niot have a true stem.

Terrestrial Autotrophs Terrestrial autotrophs are organisms that produce their own food from inorganic substances using light or chemical energy. In land ecosystems, nearly all autotrophs use photosynthesis.

Types and Classification:

- **Trees**: Large perennial plants with an elongated stem or trunk.
  - *Deciduous*: Trees like oak, maple, and birch that shed their leaves annually.
  - *Coniferous*: Trees such as pines, spruces, and firs that bear cones and usually have needle-like leaves.
- **Shrubs**: Woody plants smaller than trees and often with several main stems arising at or near the ground.
  - Examples include holly, juniper, and rhododendron.
- **Herbaceous Plants**: Non-woody plants.
  - *Grasses*: Like wheat, rice, and bamboo.
  - *Forbs*: Broad-leaved flowering plants like daisies, mint, and sunflowers.
- **Ferns and Clubmosses**: Ancient vascular plants that reproduce through spores.
- **Mosses and Liverworts**: Non-vascular plants that are typically found in moist, shaded locations.
- **Lichens**: Symbiotic associations between a fungus and algae or cyanobacteria. They can grow on soil, rocks, tree bark, and many other substrates.

Marine Autotrophs In marine environments, these are primarily photosynthetic organisms that harness sunlight to convert carbon dioxide into organic matter, though there are some unique exceptions.

Types and Classification:

- **Phytoplankton**: These are microscopic photosynthetic organisms that float in the sunlit waters of the ocean.
  - *Diatoms*: Single-celled algae with silica shells. They are among the most productive autotrophs and can form blooms visible from space.
  - *Dinoflagellates*: Algae Often responsible for red tides. Some species can produce toxins harmful to marine life and humans.
  - *Cyanobacteria*: Also known as blue-green algae. They are some of the oldest known life forms.
- **Macroalgae (Seaweeds)**: Unlike microscopic phytoplankton, these are multicellular and often large.
  - *Green Algae*: Examples include sea lettuce and Ulva.
  - *Red Algae*: Examples include dulse and nori (used in sushi).

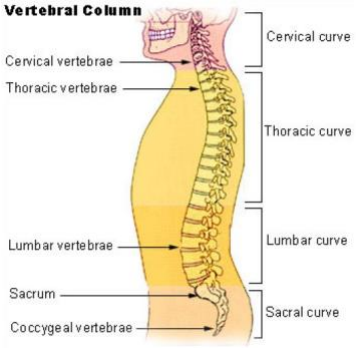
    - *Brown Algae*: Includes kelps and sargassum. Kelp forests create crucial habitats for many marine species.
- **Seagrasses**: Not to be confused with seaweed, seagrasses are flowering plants that have adapted to the marine environment.
- **Chemosynthetic Bacteria**: A unique kind of autotroph, these bacteria produce energy by using chemical reactions, often around hydrothermal vents, instead of photosynthesis.

Primary Consumers Dependent on Marine Autotrophs:

- **Zooplankton**: These are microscopic animals that feed on phytoplankton. Examples include copepods and krill.
- **Herbivorous Fish**: Species like parrotfish, surgeonfish, and some tangs graze on macroalgae and seagrasses.
- **Larger Invertebrates**: Organisms such as sea urchins, some snails, and certain types of sea turtles consume macroalgae or seagrasses.
- **Filter Feeders**: Organisms like mussels, clams, and oysters filter phytoplankton from the water as their primary food source.

<u>Animal Diversity (Fauna)</u>

- **Vertebrates:** Presence of A stiff rod running through the length of the animal (it could either be the vertebral column and/or notochord)



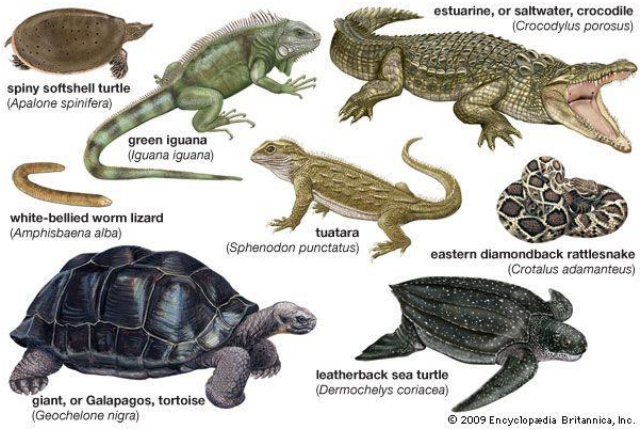
- **Invertebrates :** Doesn't posses vertebral column and notochord, instead they posses an exoskeleton.

Vertebrates: There are following major types based on anatomical and physiological features:

- **Mammals** (Class Mammalia)
    - ability to regulate their body temperature
    - endothermic animals
    - give birth to their younger ones
    - mammary glands that help them produce milk to feed their younger ones
    - most dominant

- **Birds** (Class Aves)
  - Evolutionary relative of avian dinosaurs.
  - characterised by feathers, toothless beaks and a high metabolic rate.
  - Aves lay hard-shelled eggs.
  - Warm blooded
  - Forelimbs as wings

- **Reptiles** (Class Reptilia)
  - First class of organisms to adapt to life on land
  - They are cold-blooded (ectothermic - regulation of body temperature depends on external sources, such as sunlight or a heated rock surface. The ectotherms include the fishes, amphibians, reptiles, and invertebrates.)



  - They usually lay eggs, i.e. oviparous.
    - viviparity is development of the embryo inside the body of the parent. This is opposed to oviparity which is a reproductive mode in which females lay developing eggs that complete their development and hatch externally from the mother.
  - Limbs can be present or absent. For example, snakes don't have limbs.
  - Reptiles include tetrapods such as snakes, crocodiles, lizards and turtles. The characteristic feature of reptiles is that they are ectothermic in nature. Snakes are still considered tetrapods though they have no visible limbs. This is due to the fact that snakes evolved from ancestors that had limbs.

- **Amphibians** (Class Amphibia)
  - They can live on both land and water.
  - Ectothermic (cold blooded)
  - Frogs, toads and salamanders.
  - Breeding behavior: Most amphibians need a body of water to breed as their eggs are shell-less. They undergo metamorphosis where the young ones transform from fully-aquatic larval form (with gills and fins) to terrestrial adult form.

- **Fishes**
  - They live in water, lay eggs and are cold blooded

Invertebrates:

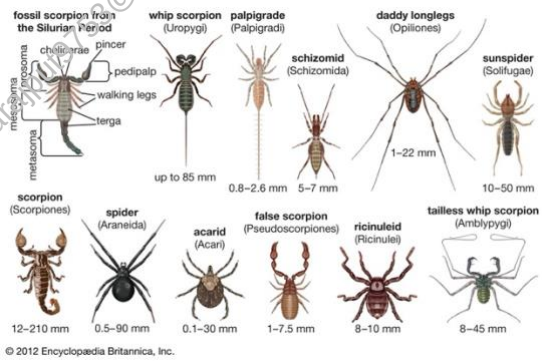
- **Annelids:** characterized by the possession of a body cavity (or coelom), movable bristles (or setae), and a body divided into segments by transverse rings. Examples: Earthworm, Leeches

Nereis Earthworm Leech

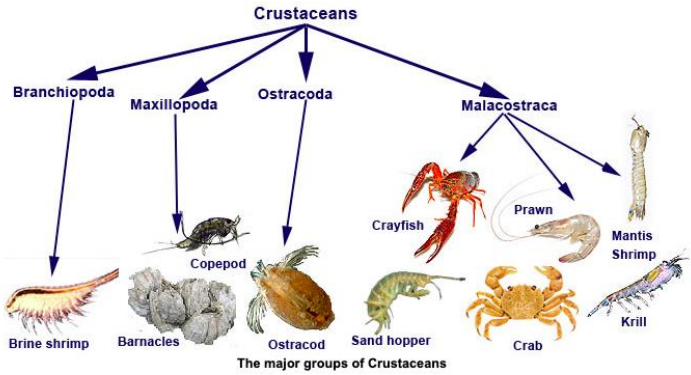
Annelida

- **Arthropods:** It includes insects and spiders. They are invertebrates, which means they do not have an internal skeleton and backbone. Instead, they have a hard exoskeleton on the outside, the top layer of which is known as the cuticle.
    1. **Insects:** Most diverse among animals, they are small with exoskeleton, 6 legs and an antennae. Example: moth, bee, wasp

2. **Arachnids**: 2 body parts, 4 pairs of legs. Such as Spiders, Scorpions, ticks.

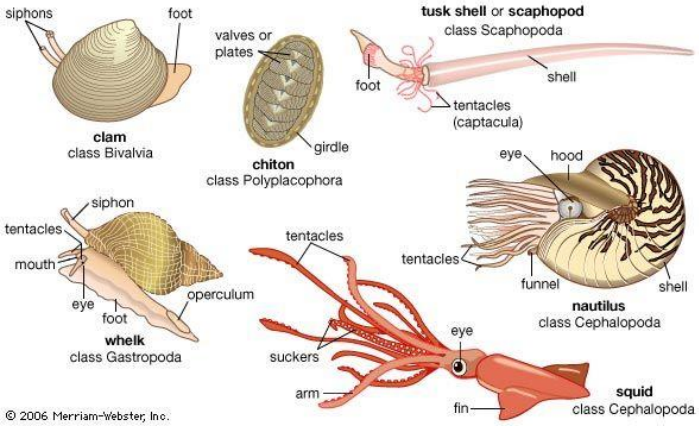


3. **Crustaceans**: generally aquatic and differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws. They have hard external shell. Example: crabs, lobsters , copepods

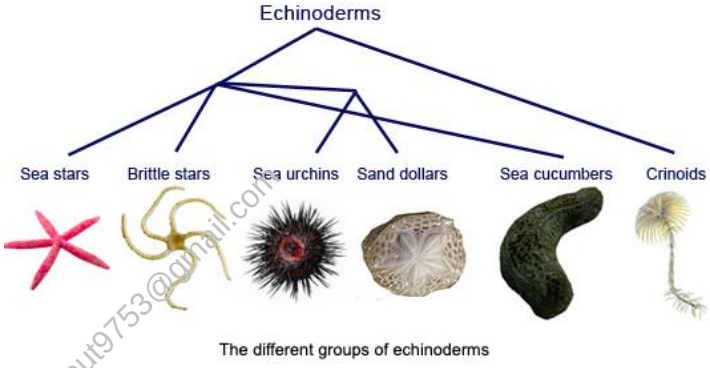


The major groups of Crustaceans

- **Mollusks:** wholly or partly enclosed in a calcium carbonate shell secreted by a soft mantle covering the body. Example: Snails, octopuses, squid, oyster



- **Echinoderms:** Marine animals, known for radial symmetry, internal skeleton. **Example**: include starfish, brittle stars, sea urchins, sand dollars, and sea cucumber



The different groups of echinoderms

- **Cnidarian**: a group made up of more than 9,000 living species. Mostly marine animals, the cnidarians include the corals, hydras, jellyfish, sea anemones
    1. Known for stinging cells called cnidocytes. Each cnidocytes have a long, harpoon-like structure, called a nematocyst to hunt prey.

Evolutionary timeline:

The evolutionary timeline of species on planet Earth is vast and encompasses billions of years. A broad overview of the key milestones in the history of life is as follows:

1. Formation of Earth (4.6 billion years ago):
- Earth forms from dust and gas left over from the formation of the sun.

2. Formation of the Oceans and Continents (~4 billion years ago):
- Rain forms oceans; tectonic activity starts shaping continents**.**

3. Emergence of Life (3.5 - 4 billion years ago):
- The first life forms are simple single-celled organisms, probably similar to bacteria. They arise in the ocean, likely near hydrothermal vents.

4. Photosynthesis Begins (~3 billion years ago):
- Early bacteria called cyanobacteria use sunlight to produce energy (photosynthesis), releasing oxygen into the atmosphere.

5. Oxygen Revolution (~2.4 billion years ago):
- Accumulation of oxygen in the atmosphere leads to the first "mass extinction" of anaerobic organisms. This is called **great oxidation event**.

6. Eukaryotes Appear (~2 billion years ago):
- The first cells with a nucleus (eukaryotes) emerge. These are the ancestors of plants, animals, fungi, and protists.

7. Multicellular Life (~1 billion - 600 million years ago):
- Organisms evolve that consist of more than one cell, leading to greater complexity.

8. The Cambrian Explosion (541 - 530 million years ago):
- An enormous diversification of life occurs in a relatively short period. Many of the major animal groups we recognize today appear during this time.

9. Colonization of Land (500 million years ago):
- Plants, followed by animals, begin to colonize land. This transition reshapes ecosystems.

10. Rise of Fish and First Vertebrates (~500 million years ago):
- Jawless fish, followed by jawed fish, dominate the oceans. The first vertebrates emerge.

11. Evolution of Amphibians (~370 million years ago):
- Some vertebrates evolve the ability to live both in water and on land, becoming the first amphibians.

12. Evolution of Reptiles (~320 million years ago):
- Reptiles evolve from amphibians and become the first fully terrestrial vertebrates.

13. Permian Mass Extinction (252 million years ago):
- The largest mass extinction in history, where an estimated 90% of species go extinct. This paves the way for the rise of the dinosaurs.

14. Age of Dinosaurs (~230 - 65 million years ago):
- Dinosaurs dominate the land. The first birds and flowering plants appear.

15. K-T Extinction (65 million years ago):
- A major extinction event, likely caused by an asteroid impact, leads to the extinction of all non-avian dinosaurs and many other species.

16. Rise of Mammals (65 million years ago to present):
- With dinosaurs gone, mammals diversify and become the dominant large animals on land.

17. Evolution of Primates (~60 million years ago):
- Early primates evolve, leading to the lineage that will eventually give rise to humans.

18. Emergence of Homo sapiens (~300,000 years ago):
- Modern humans appear and, over time, spread across the globe.