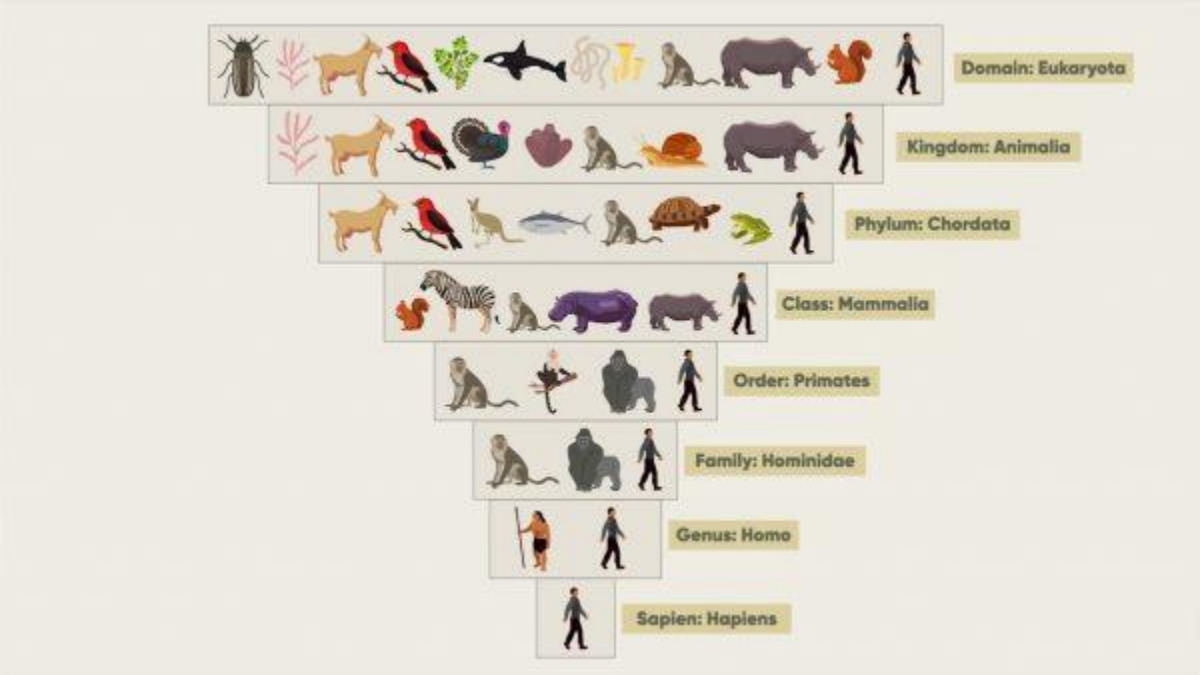
DIVERSITY IN LIVING ORGANISMS



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Diversity: This earth is full of organisms of various shapes and sizes. The largest Phylum of animal kingdom alone contains over a million species. There are varieties of plants, right from small grasses to tall Eucalyptus trees. This variety in living beings is called diversity.

Biodiversity: The variety of animals and plants living in a given geographical area is called biodiversity of that geographical area.

Need for a System of Classification: Because of the huge diversity in living beings it becomes very difficult task to study each of them one by one. To make their study easier animals and plants were categorized in groups and sub¬groups. Thus the system of classification started.

Classification by Aristotle: Aristotle classified animals according to their living environment. So he categorized them as either aquatic or terrestrial.

Drawbacks of Aristotle's Classification: Both in sea as well as on land we can find animals and plants. Moreover, there are very small animals, like sea-horse, along with large animals, like whale. So, this was not a good basis of classification.

Basis of Classification

(a) Presence or Absence of Nucleus in Cells

Prokaryotes: Those organisms which have cells without well defined nucleus are called prokaryotes.
Eukaryotes: Those organisms which have cells with well defined nucleus are Called eukaryotes. Presence of nucleus and membrane-bound organelles gives better efficiency to cells.

(b) Number of Cells in an Organism

Unicellular: Those organisms having single cell are termed as unicellular organisms. In them the single cell is responsible for carrying out all necessary functions to maintain life.
Multicellular: Those organisms having more than one cell are called multicellular organisms. Because of more number of cells there can be some division of labour to gain more efficiency.

(c) Mode of Nutrition

Autotrophs: Organisms producing their own food are called autotrophs. All green plants are autotrophs. They have a pigment (chlorophyll) in green parts which facilitates photosynthesis.
Heterotrophs: Organisms dependent on either plants or animals are called heterotrophs.They don't have chlorophylls. All animals, fungi and certain bacteria and protozoa belong to this group.

(d) Level of Organisation in Body

In multicellular organisms which are small, like hydra particular group of cells are assigned a particular function. But in larger organisms, tissues group to form an organ, which in turn make organ system. For example, in human beings there are separate systems for performing specific tasks.
Even in larger plants there is separate root system for conduction of water and minerals, leaf for photosynthesis and flowers for reproduction. Based on these characters organisms can be further classified into various sub-groups.

Evolutionary Relationship or Phylogenetic Relationship

Charles Darwin wrote a book "Origin of Species' in 1859 and gave his theories of evolution. As per his theories all organisms have evolved from unicellular organisms. Primitive body designs came early in evolutionary history leading to more complex designs. This gave rise to such a huge diversity in life forms. Because of common ancestry, all organisms are related. The closer evolutionary relation between two organisms is also one of the basis of classification of organisms.

Five Kingdom Classification

The five-kingdom classification that we see today was not the initial result of the classification of living organisms. Carolus Linnaeus first came up with a two-kingdom classification which included only kingdom Plantae and kingdom Animalia.

The two-kingdom classification lasted for a very long time but did not last forever because it did not take into account many major parameters while classifying. There was no differentiation of the eukaryotes and prokaryotes; neither unicellular and multicellular; nor photosynthetic and the non-photosynthetic.

Putting all the organisms in either plant or animal kingdom was insufficient because there were a lot of organisms which could not be classified as either plants or animals.

All these confusions led to a new mode of classification which had to take into account cell structure, the presence of cell wall, mode of reproduction and mode of nutrition. As a result, R H Whittaker came up with the concept of the five-kingdom classification.

- **Whittaker's Five Kingdom Classification:**
    - Monera
    - Protista
    - Fungi
    - Plantae
    - Animalia.
- **Further Levels of Classification Beyond Kingdom**
    - Phylum (for animals)/Division (for plants)
    - Class
    - Order
    - Family
    - Genus
    - Species

Thus, by separating organisms on the basis of a hierarchy of characteristics into smaller and smaller groups, we arrive at the basic unit of classification, which is a 'species'. Broadly, a species includes all organisms that are similar enough to breed and perpetuate.

Kingdom Monera

Monera

- All the prokaryotic organisms are placed in this Kingdom.
- Bacteria and their ancient cousin, archaebacteria are the organisms that makeup Kingdom Monera.
- These are prokaryotic, unicellular, autotrophic/heterotrophic organisms.
- Bacteria have a cell wall made up of polysaccharides.

Archea

- The category in the kingdom Monera which consists of the organisms surviving in extremely hot conditions.
- They are considered to be the most ancient living organism present on the planet.

Eubacteria

- Eubacteria is phylum of Monera consists of all the bacteria that survive in a normal environment.
- All the major helpful and pathogenic bacteria we know today fall under this category.

Kingdom Protista

The primary feature of all protists is that they are eukaryotic organisms. This means that they have a membrane-enclosed nucleus. Other characteristic features of Kingdom Protista are as follows:

1. These are usually aquatic, present in the soil or in areas with moisture.
2. Most protist species are unicellular organisms, however, there are a few multicellular protists such as kelp. Some species of kelp grow so large that they exceed over 100 feet in height. (Giant Kelp).
3. Just like any other eukaryotes, the cells of these species have a nucleus and membrane-bound organelles.
4. They may be autotrophic or heterotrophic in nature. An autotrophic organism can create their own food and survive. A heterotrophic organism, on the other hand, has to derive nutrition from other organisms such as plants or animals to survive.
5. Symbiosis is observed in the members of this class. For instance, kelp (seaweed) is a multicellular protist that provides otters, protection from predators amidst its thick kelp. In turn, the otters eat sea urchins that tend to feed on kelp.
6. Parasitism is also observed in protists. Species such as Trypanosoma protozoa can cause sleeping sickness in humans.
7. Protists exhibit locomotion through cilia and flagella. A few organisms belonging to kingdom Protista have pseudopodia that help them to move.
8. Protista reproduces by asexual means. The sexual method of reproduction is extremely rare and occurs only during times of stress.

Classification of Protista

Kingdom Protista is classified into the following:

Protozoa

Protozoans are unicellular organisms. Historically, protozoans were called "animal" protists as they are heterotrophic and showed animal-like behaviours.

There are also parasitic protozoans which live in the cells of larger organisms. Most of the members do not have a predefined shape. For instance, an amoeba can change its shape indefinitely but a paramecium has a definite slipper-like shape. The most well-known examples of protozoans are amoeba, paramecium, euglena. Unlike other members of this group, euglena is a free-living protozoan that has chlorophyll, which means it can make its own food.

The protozoans can be divided into four major groups:

1. **Amoeboid protozoans –** Mostly found in water bodies, either fresh or saline. They have pseudopodia (false feet) which help to change their shape and in capturing and engulfing food. E.g. Amoeba
2. **Flagellated protozoans –** As the name suggests, the members of this group have flagella. They can be free-living as well as parasitic. E.g. Euglena
3. **Ciliated protozoans –** They have cilia all over their body which help in locomotion as well as nutrition. They are always aquatic. E.g. Paramecium
4. **Sporozoans –** These organisms are so-called because their life cycle has a spore-like stage. For example, the malarial parasite, Plasmodium.

Slime Moulds

Slime moulds are saprophytic organisms (they feed on the dead and decaying matter). These are tiny organisms that have many nuclei.

Usually, Slime moulds are characterized by the presence of aggregates called plasmodium and are even visible to the naked eye.

Chrysophytes, Dinoflagellates and Euglenoids

These form another category under kingdom Protista. These are generally single-celled or multicellular organisms. These are photosynthetic, found mostly in freshwater sources or marine lakes. They are characterized by a stiff cell wall.

Example of chrysophytes include diatoms and golden algae. They are characterised by the presence of a hard siliceous cell wall. Diatomaceous earth is formed due to the accumulation of cell wall deposits. They are photosynthetic organisms.

Dinoflagellates are photosynthetic and found in various different colours, according to the pigment present in them. They show bioluminescence and known to cause red tide.

Euglenoids are the link between plants and animals. They lack a cell wall but perform photosynthesis. In the absence of sunlight, they act as a heterotroph and feed on small organisms. The outer body covering is a protein-rich layer known as a pellicle. E.g. Euglena, Trachelomonas, etc.

Kingdom Fungi

To name a few – the appearance of black spots on bread left outside for some days, the mushrooms and the yeast cells, which are commonly used for the production of beer and bread are also fungi. They are also found in most of the skin infections and other fungal diseases.

If we observe carefully, all the examples that we cited involve moist conditions. Thus, we can say that fungi usually grow in places which are moist and warm enough to support them.

Let us have a detailed overview of the structure, classification and characteristics of fungi.

Structure of Fungi

The structure of fungi can be explained in the following points:

1. Almost all the fungi have a filamentous structure except the yeast cells.
2. They can be either single-celled or multicellular organism.
3. Fungi consist of long thread-like structures known as hyphae. These hyphae together form a mesh-like structure called mycelium.
4. Fungi possess a **cell wall** which is made up of chitin and polysaccharides.
5. The cell wall comprises protoplast which is differentiated into other cell parts such as cell membrane, cytoplasm, cell organelles and nuclei.
6. The nucleus is dense, clear, with chromatin threads. The nucleus is surrounded by a nuclear membrane.

Characteristics of Fungi

Following are the important characteristics of fungi:

1. Fungi are eukaryotic, non-vascular, non-motile and heterotrophic organisms.
2. They may be unicellular or filamentous.
3. They reproduce by means of spores.
4. Fungi exhibit the phenomenon of alternation of generation.
5. Fungi lack chlorophyll and hence cannot perform photosynthesis.
6. Fungi store their food in the form of starch.
7. Biosynthesis of chitin occurs in fungi.
8. The nuclei of the fungi are very small.
9. The fungi have no embryonic stage. They develop from the spores.
10. The mode of reproduction is sexual or asexual.
11. Some fungi are parasitic and can infect the host.
12. Fungi produce a chemical called pheromone which leads to sexual reproduction in fungi.
13. Examples include mushrooms, moulds, yeast.

Classification of Fungi

Kingdom Fungi are classified based on different modes. The different classification of fungi is as follows:

Based on Mode of nutrition

On the basis of nutrition, kingdom fungi can be classified into 3 groups.

1. **Saprophytic –** The fungi obtain their nutrition by feeding on dead organic substances. Examples: Rhizopus, Penicillium and Aspergillus.
2. **Parasitic –** The fungi obtain their nutrition by living on other living organisms (plants or animals) and absorb nutrients from their host. Examples: Taphrina and Puccinia.
3. **Symbiotic –** These fungi live by having an interdependent relationship association with other species in which both are mutually benefited. Examples: Lichens and mycorrhiza. Lichens are the symbiotic association between algae and fungi. Here both algae and fungi are mutually benefited as fungi provide shelter for algae and in reverse algae synthesis carbohydrates for fungi.

Based on Spore Formation

Kingdom Fungi are classified into the following based on the formation of spores:

1. **Zygomycetes –** These are formed by the fusion of two different cells. The sexual spores are known as zygospores while the asexual spores are known as sporangiospores. The hyphae are without the septa.
2. **Ascomycetes –** They are also called as sac fungi. They can be coprophilous, decomposers, parasitic or saprophytic. The sexual spores are called ascospores. Asexual reproduction occurs by conidiospores. Example – Saccharomyces
3. **Basidiomycetes –** Mushrooms are the most commonly found basidiomycetes and mostly live as parasites. Sexual reproduction occurs by basidiospores. Asexual reproduction occurs by conidia, budding or fragmentation. Example- Agaricus
4. **Deuteromycetes –** They are otherwise called imperfect fungi as they do not follow the regular reproduction cycle as the other fungi. They do not reproduce sexually. Asexual reproduction occurs by conidia. Example – Trichoderma.

Reproduction in Fungi

Reproduction in fungi is both by sexual and asexual means. The sexual mode of reproduction is referred to as teleomorph and the asexual mode of reproduction is referred to as anamorph.

Vegetative reproduction – By budding, fission and fragmentation

Asexual reproduction – This takes place with the help of spores called conidia or zoospores or sporangiospores

Sexual reproduction – ascospores, basidiospores, and oospores

The conventional mode of **sexual reproduction** is not always observed in the kingdom Fungi. In some fungi, the fusion of two haploid hyphae does not result in the formation of a diploid cell. In such cases, there appears an intermediate stage called the dikaryophase. This stage is followed by the formation of diploid cells.

Kingdom Plantae

Plantae

- All plants and trees we see around us come under this Kingdom.
- All of them are autotrophic with chloroplast in their cell.
- Their cell wall is made up of cellulose.
- The plant kingdom is classified into two major divisions as Cryptogams and Phanerogams.

Cryptogamae

- Cryptogams literally mean 'plants with hidden reproductive parts'
- Cryptogams are plants that produce spores to reproduce instead of seeds.
- So these plants do not have flowers or fruits.
- Cryptogams are further classified as thallophytes, bryophytes and pteridophytes.

Phanerogamae

- Phanerogams are plants that produce seeds for reproduction.
- Some of them do not produce flowers, while the others produce flowers.
- Phanerogams are further classified as gymnosperms and angiosperms.

Thallophyta

- Thallophyta is the first division of plant kingdom.
- It consists of red, green and brown algae.
- They don't have a lot of differentiated structure.

Bryophyta

- Bryophyta is the 2nd division of plant kingdom.
- These are the first plants to have differentiated roots and shoots.

Pteridophyta

- Pteridophyta is the 3rd division of plant kingdom.
- These plants have proper differentiation of roots, stem and leaves.

Gymnosperms

- Gymnosperm stands for naked seed.
- They are the first phanerogams since they produce seeds, which is not enclosed in a fruit.

Angiosperms

- Angiosperm is the last division of plant kingdom and has what scientist assume, the most evolved organisms on the planet.
- They bear flowers and fruits, inside which the seeds are found.

Cotyledons

- Cotyledons are structures present in seeds for nutrition during germination when leaves are not yet developed.
- Angiosperms either have two cotyledons making them dicots or only one, making them monocot.

Dicots and Monocots

- Angiosperms, the highly evolved plants on the planet Earth, are further classified based on the number of cotyledons their seeds have.
- When seeds have two cotyledons, they are called dicots.
- Dicots have tap root system and reticulate venation. Examples: Mango, Pea, Beans, etc.
- If seeds have only one cotyledon, they become monocots.
- Monocots show fibrous root system and parallel venation.
- Examples: all grains like wheat, maize, rice etc.

Kingdom Animalia

Animalia

- Kingdom Animalia is made up of eukaryotic, multicellular, heterotrophic organisms.
- Mode of nutrition is holozoic and they are either herbivores or carnivores.
- Most animals are motile, they can move independently in search of food, shelter or mate.
- Animals are made up of many organ systems, that aids in performing specific functions that are necessary for the survival of the organism.
- Most of the animals are bilaterally symmetrical, while primitive animals are asymmetrical and cnidarians and echinoderms are radially symmetrical.

Porifera

- This phylum consists of the **sponges**.
- They are mostly marine, very few are freshwater.
- All the animals are sessile (fixed in one place).

- Cells are loosely arranged (cellular grade of the organization).
- Animals are diploblastic with outer ectoderm and inner endoderm held with jelly-like mesoglea.
- Exoskeleton in the form of spicules made up of silica or calcium carbonate.
- Sponges have pores all over the body. Body pores are called Ostia.
- Water from outside enters the body through Ostia and leaves through one large opening called the osculum.

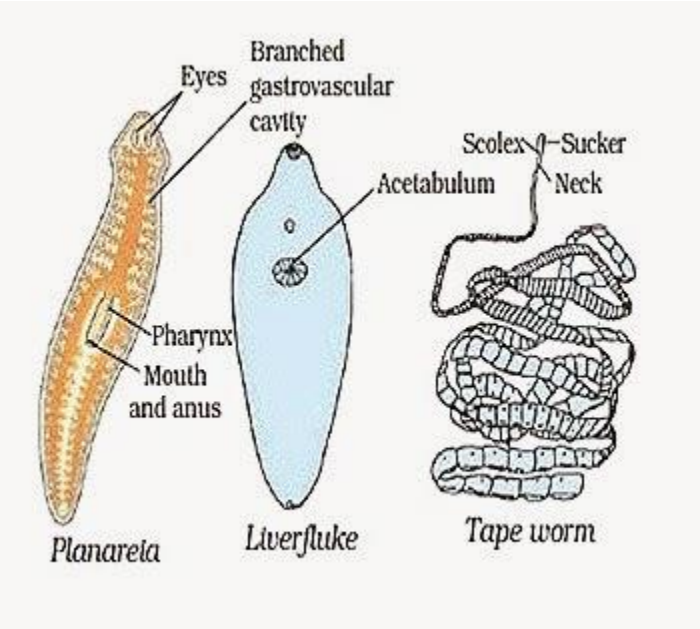
Coelenterata

- These animals are aquatic, mostly marine.
- They are solitary or colonial. Each individual is known as zooid.
- Animals are radially symmetrical.
- Sessile forms are called **Polyps** and free-living forms are called **Medusa**
- Cells are organized into tissues (tissue grade of the organization).
- Animals are diploblastic, outer ectoderm and inner endoderm. Mesogloea separates these two layers.
- The body has a single opening called hypostome surrounded by sensory tentacles.
- Body cavity (coelom) acts as gastrovascular cavity i.e. coelenteron.
- special types of cells called Nematocysts are present for capturing and paralyzing pray, present in tentacles.
- Examples: Hydra, Jellyfish, Corals, Obelia, Sea-anemone.

Platyhelminthes

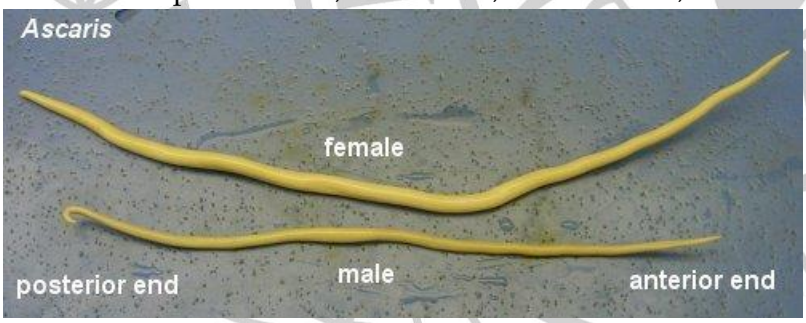
- This phylum consists of the organisms are bilaterally symmetrical, triploblastic and flattened.
- Organ- system grade of the organization is seen.
- Animals are triploblastic with outer ectoderm, middle mesoderm and inner endoderm.
- Acoelomate i.e No body cavity.
- The digestive system is incomplete or absent.
- Mostly parasites, a few are free living.

- Examples: Liver fluke, Tapeworm.



Nemotoda

- These organisms have bilaterally symmetrical, triploblastic and cylindrical body.
- Organ system grade of the organization is seen.
- Pseudocoelom is present.
- Have a tubular digestive system with openings at both the ends.
- They are endoparasites.
- Mouth is provided with hooks and suckers.
- Examples: Ascaris, hookworm, filarial worm, etc.



Annelida

- These organisms have bilateral symmetry and triploblastic.
- They are mostly aquatic, few are terrestrial.
- These are the first organism to have a true coelom.
- Coelome is compartmentalized by intersegmental septa.
- Body long and metamerically segmented (segmentation from outside and inside of the body).
- Examples: leech, earthworm, etc.

Arthropoda

- This is the largest phylum with 80% of all known living animals.
- Animals with jointed appendages (in Greek Arthron: jointed, poda: legs).
- The body has three segments/regions as head, thorax and abdomen.
- Body is covered by an exoskeleton made of chitin.
- They are bilaterally symmetrical and have an open circulatory system.
- Compound eyes are present
- Examples: insects, scorpions, spiders, millipedes, centipedes, crabs, lobsters, etc

Mollusca

- They are bilaterally symmetrical, with a reduced coelomic cavity and little segmentation.
- They have an open circulatory system and kidney like organs for excretion.
- Body is soft and usually enclosed in a shell. The shell may be external or internal.
- They show the presence of Foot, Mantle and Mantle cavity.
- Examples: pearl oysters, bivalves, sepia, octopus, snail, slug, etc.

Echinodermata

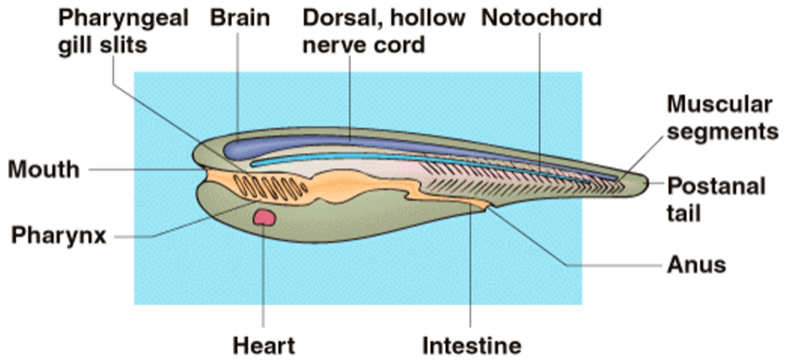
- They are spiny skinned and free-living, exclusively marine.
- The animals are usually pentamerous.
- They are triploblastic and have a coelomic cavity.
- They have a water driven tube system for moving forward.
- Examples: starfish, sea urchin, sea cucumber, sea lily, etc.

Hemichordates

- Hemichordata is bilaterally symmetrical and triploblastic.
- In addition to these, they have a notochord that runs along the back of the animal and separates the nervous tissue from the gut.
- They are marine animals and bridge non-chordates to chordates.
- Porifera to Echinodermata are non-chordates/invertebrates.
- Example: Balanoglossus, also called acorn worm.

Chordata/Vertebrata

- Presence of dorsal, tubular, hollow nerve cord.
- Presence of notochord.
- Presence of pharyngeal gill slits.
- Presence of post-anal tail.
- Bilaterally symmetrical body.
- Presence of three germ layers.
- Organ-system level of organization.
- Presence of ventral heart and hepatic portal system.
- Presence of well developed endocrine glands
- Except for a few primitive forms, the animals have vertebral column instead of the notochord. These animals are called vertebrates.



Pisces

- Class Pisces include all bony and cartilaginous fishes.
- They are exclusively aquatic.
- Body is streamlined with paired and unpaired fins.
- These are cold-blooded vertebrates.
- Heart is two-chambered.
- Lateral line system is well developed.
- Examples: Sharks, Rays, Rohu, Mrigal, Green carp, etc

Amphibia

- Amphibians live both, on land and in water and lay their eggs in water.
- Respiration is through gills in the larval stage and through lungs in adults.
- They are cold-blooded animals.
- They have a three-chambered heart.
- Examples: frog, toads, salamander, etc

Reptilia

- These are the first completely land animals.
- Reptiles are cold-blooded and breathe through their lungs.
- They have a three-chambered heart (exception crocodile) and lay eggs with tough coverings.
- Body is covered with scales, scutes or hard plates.
- Examples: snakes, crocodiles, turtles, lizards etc.

Aves

- All birds belong to this class.
- They are warm-blooded, have a four-chambered heart and breathe through lungs.
- They have their forelimbs modified into wings which help in flight.
- Jaws are modified into beaks.
- Bones are hollow and most of them are fused to reduce body weight.
- An exoskeleton is in the form of feathers.

Mammalia

- They are warm-blooded, breath through lungs and have a four-chambered heart.
- Presence of hair on their body, sweat and oil glands are exclusive characters of mammals.
- Presence of pinna i.e external ear is also seen only in mammals.
- They also have the mammary glands to feed their young ones.
- They usually give birth to live young ones.
- Examples: humans, cattle, etc