

Unit 1: Biodiversity & Classification

Long Questions

DESCRIPTIVE QUESTIONS

THREE-DOMAIN SYSTEM OF CLASSIFICATION

Q1. Explain Three-Domain System of Classification. How is it different from the Five-Kingdom system?

Ans. Five-Kingdom Classification

- This system was proposed by **American ecologist Robert Whittaker** in 1969.
- According to this system all living organisms were classified into **five kingdoms**.
- **Monera, Protista Fungi, Plantae and Animalia.**
- The kingdom **Monera** included all **prokaryotes** (organisms **without a nucleus**).
- The other four kingdoms included **eukaryotes** (organisms **with a nucleus**).

Three-Domain Classification

- An American microbiologist, **Carl Woese** in 1990 proposed the **three domain system** based on **molecular and genetic studies**. His three domain system provides a more **accurate** picture of **evolutionary relationships** of organisms.
- **Woese** discovered that prokaryotes are not all the same, they exist in **two** very different forms:

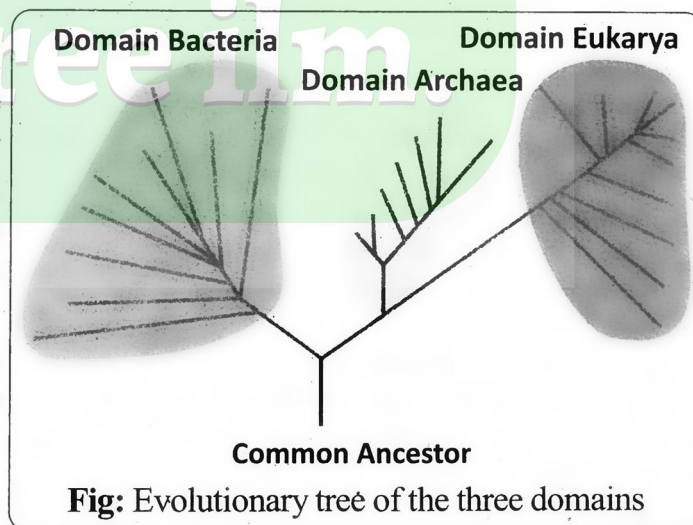
1. Bacteria
2. Archaea

- He introduced three domains instead of kingdoms:

1. **Domain Bacteria** – True bacteria (**prokaryotes**)
2. **Domain Archaea** – Ancient bacteria-like organisms (**prokaryotes**)
3. **Domain Eukarya** – All **eukaryotes** (Protists, Fungi, Plants, Animals)

Key Differences

- The **five-kingdom system** grouped all prokaryotes into **one kingdom** (Monera).



★ **Note:** All questions and paragraphs marked with a star ★ are explanations of the Box Information provided in the textbook.

- The **three-domain system** separates **prokaryotes** into **two** distinct domains: Bacteria and Archaea.

Molecular evidences suggest Archaea are more closely related to eukaryotes than to bacteria. Which means Eukarya evolved from Archaea, after archaea split off from bacteria.

Q2. Describe distinguishing unique characteristics of Domain Archaea. Write their major groups. / Explain how archaea are unique from bacteria and eukarya?

Ans. Characteristics of Domain Archaea

In the five-kingdom system, this domain was included in kingdom Monera. The name Archaea comes from the Greek *archaios* ("ancient"). They are prokaryotes which diverged from bacteria in very ancient times.

★ **Archaeobacteria:** Archaea were initially classified as a group of bacteria, and were called archaeobacteria.

Size: Individual archaeans range from **0.1 μm to over 15 μm** in diameter, some form aggregates or filaments up to **200 μm in length**.

Morphology

They occur in various shapes, such as spherical, rod-shape, spiral, lobed, or rectangular.

Reproduction: Archaea reproduce asexually by **binary or multiple fission, fragmentation, or budding**. Mitosis and meiosis do not occur in archaea.

Archeans are unique because;

1. Cell Membrane

- Archaeon's cell membrane contains lipids with **ether-linkage** between **glycerol** and **fatty acid chains**. The fatty acid chains are branched. That's why their cell membranes are more resistant to extreme conditions.
- Bacteria and Eukarya** have membrane lipids with fatty acids attached to glycerol by **ester linkages**. The fatty acid chains are **unbranched**.

2. Cell Wall Composition

- The cell walls of **archaea** lack cellulose and peptidoglycan. Instead, they contain distinct polysaccharides and proteins.
- Some archaea have pseudopeptidoglycan.
- On the other hand, **bacterial cell walls** contain peptidoglycan, a polymer consisting of sugars and amino acids that provides structural support.
- In **Eukarya**, the cell walls, if present, are composed of cellulose (in plants) or chitin (in fungi).

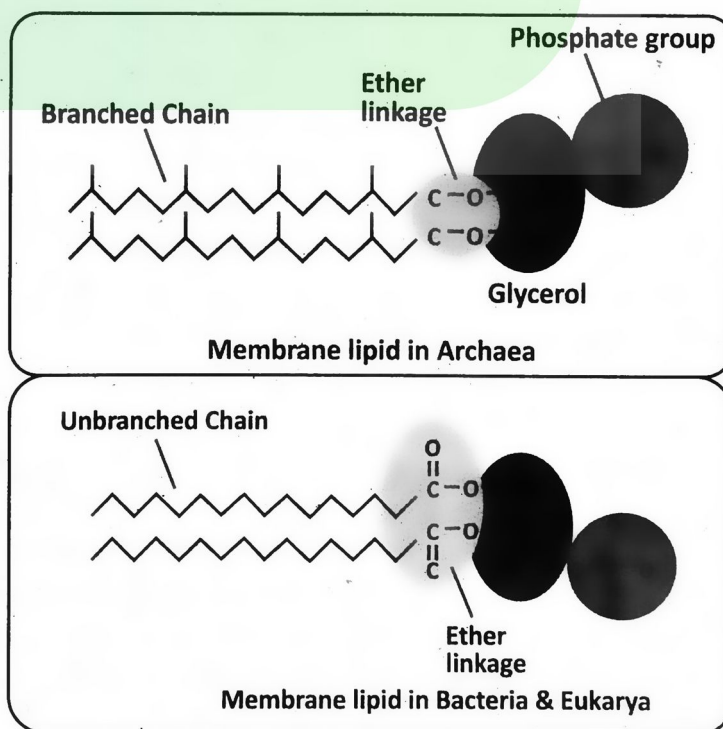


Fig: Difference in membrane lipids of Archaea and other organisms

3. Genetic Differences

Archaea share several genetic sequences and regulatory features with eukaryotes, highlighting their closer evolutionary relationship.

4. Metabolism

- **Archaea** have unique metabolic processes like **methanogenesis** (production of methane), which is not found in bacteria or Eukarya.
- **Bacteria** exhibit metabolic pathways, including photosynthesis, nitrogen fixation and fermentation.
- In **Eukarya**, the metabolic processes are often more complex and include cellular respiration, photosynthesis (in plants and algae), and various forms of fermentation.

Major Groups of Archaea

The major groups of Archaea include;

- **Methanogens**-produce methane as a metabolic byproduct.
- **Halobacteria**-live in extremely saline environments.
- **Thermococci**-found in hot environments.
- **Thaumarchaeota** involved in nitrogen cycle.

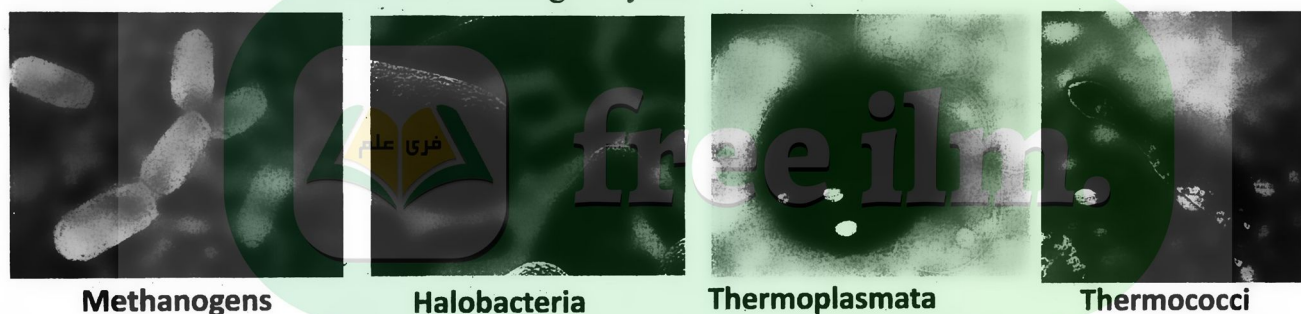


Fig: Major groups of Archaea

Q3. Describe the general characteristics of Domain Bacteria. / Describe the characteristics which distinguish bacteria from other domains.

Ans. General characteristics of Domain Bacteria

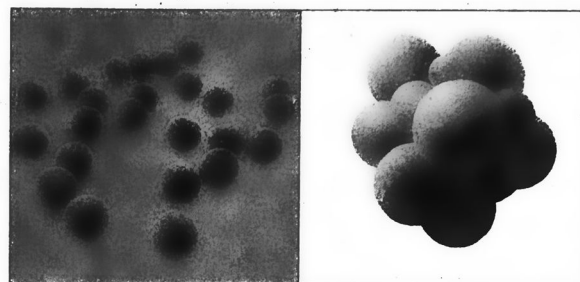
In the five-kingdom system, this domain was included in kingdom Monera. They are the **true bacteria**. They possess several distinct characteristics that differentiate them from other domains i.e., Archaea and Eukarya.

General Characteristics

Here are the general characteristics of the domain Bacteria:

- **Cell Structure:** Like archaea, bacteria possess prokaryotic cell i.e., **lack a true nucleus** and membrane-bound organelles.
- **Cell Wall Composition:** Bacteria have a cell wall composed of **peptidoglycan (murein)**, a unique polymer that provides structural support and shape.
- **Genetic Material:** Like Archaea, bacteria possess a **single, circular chromosome** composed of DNA, located in the nucleoid region.

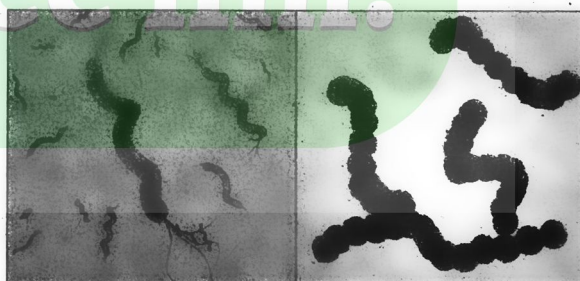
- **Plasmids:** Most bacteria have **small, circular DNA** molecules that can be transferred between bacteria, aiding in genetic diversity and adaptation.
- **Reproduction:** Bacteria primarily reproduce asexually through binary fission, a process where a single cell divides into two identical daughter cells.
- **Nutritional Modes:** Include **autotrophs** (self-feeding, e.g., photosynthetic bacteria) and **heterotrophs** (feeding on organic matter, e.g., decomposers).
- **Morphology:** Bacteria exhibit a variety of shapes, such as cocci (spherical), bacilli (rod-shaped), spirilla (spiral-shaped), and vibrios (comma-shaped).
- **Arrangement:** Cells may be found singly, in pairs (diplococci), chains (streptococci), clusters (staphylococci), or other arrangements based on species-specific characteristics.
- **Flagella:** Many bacteria have one or more flagella, whip-like structures that enable movement.
- **Pili and Fimbriae:** These are hair-like structures in some bacteria. They help in attachment to surfaces and in exchange of genetic material with other bacteria.
- **Respiration:** Bacteria can be obligate aerobes, obligate anaerobes, facultative anaerobes, microaerophiles or aerotolerant anaerobes. Some bacteria perform **fermentation** to produce energy in the absence of oxygen.
- **Extremophiles:** Some bacteria thrive in extreme conditions, such as high temperatures (**thermophiles**), high salinity (**halophiles**), and low pH (**acidophiles**).
- **Pathogenicity:** Some bacteria cause diseases in humans, animals, and plants, producing toxins or other virulence factors.
- **Symbiosis:** Many bacteria live in symbiotic relationships with other organisms, including mutualism (both benefit) and commensalism (one benefits, the other is not harmed).



Cocci (Spherical)



Bacilli (rod-shaped)



Vibrio (Comma-shaped) Spirilla (spiral-shaped)

Fig: Different forms of Bacteria

Major Groups of Bacteria

- The domain Bacteria is divided into numerous groups. For example; Proteobacteria (Gram negative) e.g., *Escherichia coli*, *Rhizobium*, *Helicobacter pylori*.
- Firmicutes (Gram positive) e.g., *Bacillus subtilis*, *Lactobacillus*, *Clostridium botulinum*.
- Actinobacteria e.g., *Streptomyces*, *Mycobacterium tuberculosis*.
- Cyanobacteria e.g., *Anabaena*, *Spirulina*.
- Spirochaetes e.g., *Treponema pallidum*.
- Acidobacteria e.g., *Acidobacterium*.
- Aquificae e.g., *Aquifex pyrophilus*.

Q4. Explain the general characteristics of Domain Eukarya.**Ans. General characteristics of Domain Eukarya**

The domain Eukarya encompasses all organisms with eukaryotic cells, which are fundamentally different from the prokaryotic cells of Bacteria and Archaea.

General Characteristics

Here are the general characteristics of the domain Eukarya that justify its classification as a separate domain.

- **Cell Structure:** They possess eukaryotic cells - with true **nucleus** enclosed by a nuclear membrane. Cells have **membrane-bounded organelles** e.g., mitochondria, chloroplasts (in plants and algae), endoplasmic reticulum, Golgi apparatus, lysosomes and peroxisomes. Cells also have **cytoskeleton** i.e., a complex network of microtubules, microfilaments, and intermediate filaments that provides structural support, enables cell movement and facilitates intracellular transport.
- **Genetic Material:** Their DNA is organized into multiple **linear chromosomes** within the nucleus. DNA is associated with **histone proteins**, which help in the organization and regulation of genetic material.
- **Reproduction:** Most eukaryotes undergo sexual reproduction involving meiosis and fertilization, leading to genetic diversity. Some eukaryotes can also reproduce asexually through mitosis, producing genetically identical offspring.
- **Complex Cellular Organization:** In multicellular eukaryotes, cells differentiate into specialized types forming tissues and organs with **specific functions**.
- **Evolutionary Relationships:** Eukaryotes are believed to have originated through endosymbiosis, where certain prokaryotic cells such as aerobic bacteria (mitochondria) and cyanobacteria (chloroplasts) were engulfed by anaerobic prokaryotic amoeboid cell (a host cell), leading to a symbiotic relationship.

TAXONOMIC HIERARCHY**Q5. Elaborate the hierarchical system for the classification of living organisms.**

Ans. The classification of living organisms is organized into a hierarchical system that allows scientists to categorize and understand the relationships between different forms of life. This system includes several levels, known as **taxa** (singular: **taxon**), each representing a rank in the biological classification system. The primary levels of this hierarchy are: kingdom, phylum, class, order, family, genus, and species. Below is a detailed description of each level.

1. Domain

It is the **highest level of classification**. Currently, there are three domains: Archaea, Bacteria and Eukarya.

2. Kingdom

The kingdom is one of the highest taxonomic ranks, just below domain. It groups together all forms of life that **share fundamental characteristics**.

- **Example:** In the domain Eukarya, there are several kingdoms, such as Animalia (animals), Plantae (plants), Fungi (fungi), and Protista (protists).

3. Phylum

Phylum is the next level of classification below kingdom. Organisms within a phylum **share a basic body plan** and significant structural features.

- **Example:** In the kingdom Animalia, the **phylum Chordata** includes all animals with a notochord, such as **mammals, birds, reptiles, amphibians, and fishes.**

4. Class

Class further divides organisms within a phylum **based on more specific common traits.**

- **Example:** Within the phylum Chordata, the class Mammalia includes all mammals, which are characterized by having hair and mammary glands.

5. Order

Order categorizes organisms within a class based on **additional shared characteristics and evolutionary history.**

- **Example:** Within the class Mammalia, the order Primates includes humans, monkeys, and apes, characterized by their **large brains** and **opposable thumbs.**

6. Family

Family groups organisms within an order that are even **more closely related, sharing more precise common attributes.**

- **Example:** Within the order Primates, the family Hominidae includes great apes and humans.

7. Genus

Genus is a **more specific** rank within a family, grouping species that are **very closely related** and often visually similar.

- **Example:** Within the family Hominidae, the genus *Homo* includes humans and closest extinct relatives.

8. Species

Species is the **most specific level** of classification, representing a **single type of organism.** Members of a species can interbreed and produce fertile offspring.

- **Example:** Within the genus *Homo*, the species *Homo sapiens* refers to modern humans.

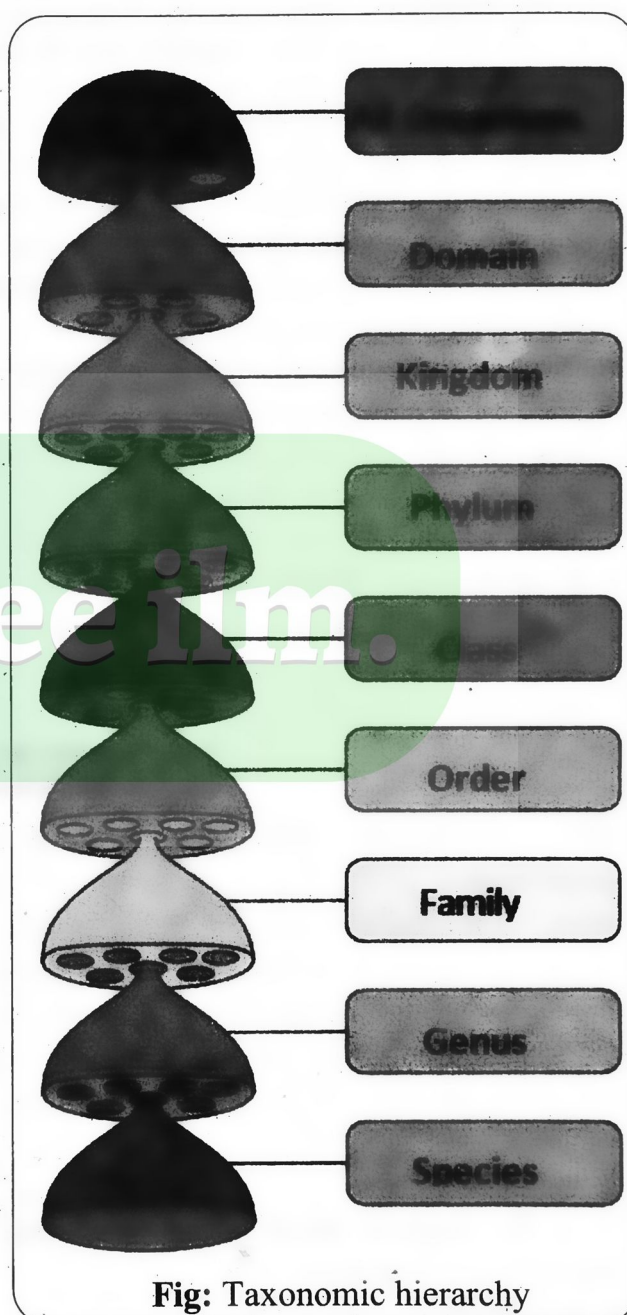


Fig: Taxonomic hierarchy

Taxonomic Rank	Human (<i>Homo sapiens</i>)	Sparrow (<i>Passer domesticus</i>)	Onion (<i>Allium cepa</i>)
Domain	Eukarya	Eukarya	Eukarya
Kingdom	Animalia	Animalia	Plantae
Phylum	Chordata	Chordata	Angiosperms
Class	Mammalia	Aves	Monocots
Order	Primates	Passeriformes	Asparagales
Family	Hominidae	Passeridae	Amaryllidaceae
Genus	Homo	Passer	Allium
Species	<i>Homo sapiens</i>	<i>Passer domesticus</i>	<i>Allium cepa</i>

SALIENT FEATURES OF KINGDOMS OF DOMAIN EUKARYA

Q6. What are the salient features of kingdoms of domain Eukarya? / Describe main characteristics of kingdom protista, fungi, plantae and animalia. Provide examples for each kingdom.

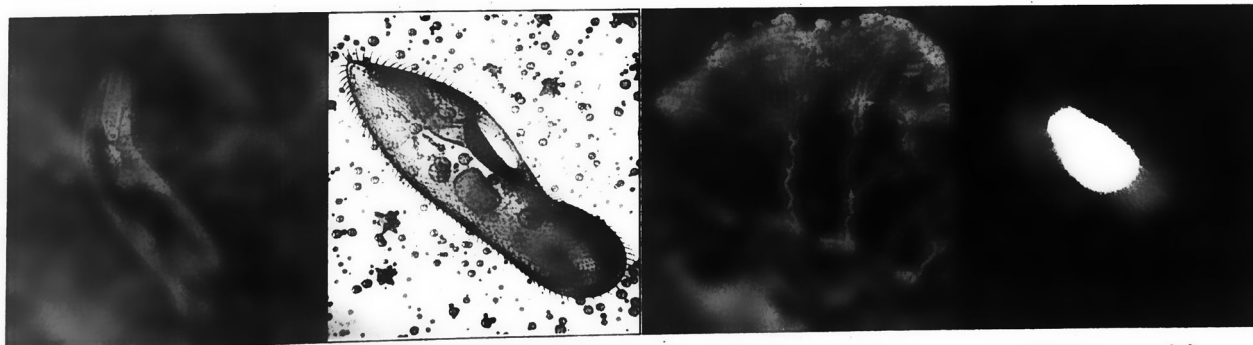
Ans. Eukarya consists of kingdoms protista, fungi, plantae and animalia. It includes all eukaryotes which consist of complex, **eukaryotic cells**, containing **nucleus** and other **membrane-bound organelles**.

1. Kingdom Protista

Kingdom Protista includes eukaryote which are **unicellular or colonial or filamentous** or simple multicellular. Simple multicellular means that they do not have multicellular sex organs. There are three types of protists.

Major Groups or Protists

- **Protozoa:** The group Protozoa includes **animal-like protists**. They are unicellular and are heterotrophic. Examples are Paramecium, Amoeba, Plasmodium, and Trypanosoma.
- **Algae:** The group Algae includes plant-like protists. They have cell walls made of cellulose. They have chlorophyll and are autotrophs. Examples include Euglena, diatoms, dinoflagellates, red algae, green algae, brown algae.
- **Fungi-like protists:** The groups Myxomycota and Oomycota include Fungi-like protists. They have hyphae-like structure and are saprophytic e.g., slime molds and water molds.
- ★ **Parasitic protists:** Certain protists are parasitic and cause diseases like malaria (*Plasmodium*), amoebic dysentery (*Entamoeba histolytica*), and sleeping sickness (*Trypanosoma*).



Euglena

Paramecium

Slime mold

Water mold

Fig: Common protists

2. Kingdom Fungi

Fungi are eukaryotic, heterotrophic organisms that are unicellular or multicellular. Their cells are covered by **cell wall made of chitin** (a polysaccharide). Fungi get nutrients in a unique way. They **do not ingest food** like animals and some protists. They **absorb food** from surroundings. Examples are **mushrooms, rusts, smuts and molds**.

★ **Uses:** Some fungi are used in the production of bread, cheese and beer. Others have medicinal properties, such as penicillin, an antibiotic derived from the fungus *Penicillium*.

Major Groups of Fungi

The following are the major groups of fungi:

- **Zygomycota** includes the fungi which **lack septa (aseptate)** in their hyphae. Examples are Rhizopus (bread molds), which grow on moist bread, fruits etc.
- **Ascomycota** includes the largest groups of fungi. They have septate hyphae. Examples include common molds, morels, truffles, cup fungi, neurospora and yeasts.
- ★ **Lichens and mycorrhizae:** There are about 100,000 known species of fungi. Most of the Ascomycetes are found in lichens and some are found in mycorrhizae.
- **Basidiomycota** includes the fungi with septate hyphae. Examples are mushrooms, toadstools, puffballs, jelly fungi and bracket/shelf fungi, rusts and smuts.



Smut fungi on leaf

Toadstool

Bracket fungi

Sweet tooth fungi

Fig: Common fungi

3. Kingdom Plantae

It includes plants which are **eukaryotic, multicellular** organisms with cell walls made of **cellulose**. They are autotrophic and prepare food through **photosynthesis**. All plants **develop** from **embryos**. Examples are mosses, ferns, conifers and flowering plants.

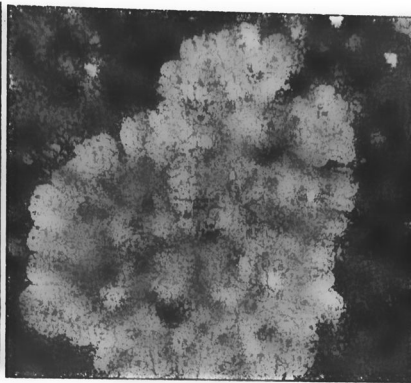
Major Groups of Plants

Plants are divided into two major groups:

- **Non-vascular plants** or **bryophytes** lack conducting tissues (xylem and phloem). Examples include liverworts, hornworts, and mosses.
- **Vascular plants** or **tracheophytes** have conducting tissues. Vascular plants are of two types i.e., seedless plants (e.g., ferns) and seed plants (e.g., conifers and flowering plants). Seed producing vascular plants are **Gymnosperms** (naked seeds) i.e., cone-bearing, **no flowers or fruits** (e.g., Pine and Spruce) whereas **Angiosperms** (flowering plants) are the most diverse plant group (235000 species) which produce seeds enclosed in fruits (**Monocots** e.g., grass, corn and **Dicots** e.g., rose and sunflower).



Moss



Liverwort

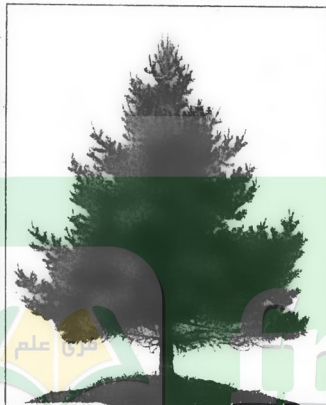


Hornwort

Non-Vascular (bryophytes)



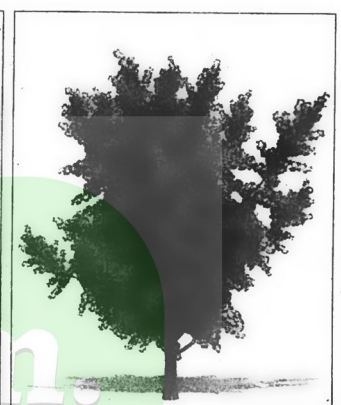
Sago palm



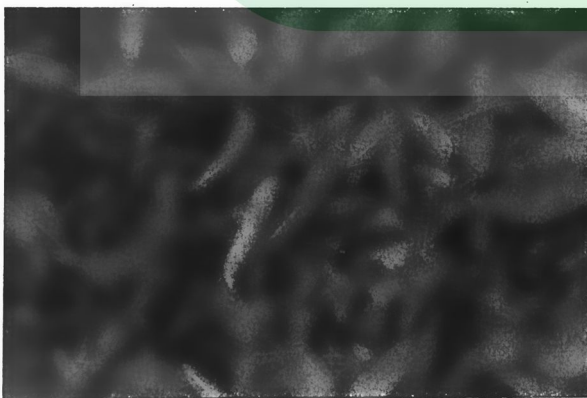
Pine



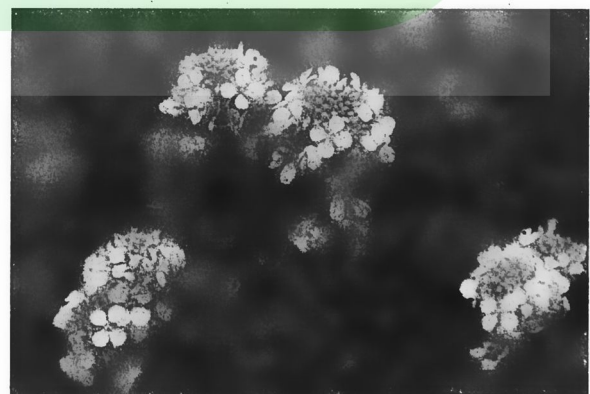
Cedrus



Ginkgo bilobai



Capsicum



Mustard

Vascular plants

Fig: Major groups of Kingdom Plantae

4. Kingdom Animalia

This kingdom of **eukaryotes** includes animals which are eukaryotic, **multicellular** and **heterotrophic**. They develop from embryos. They **ingest** food and digest it within their bodies, e.g., mammals, birds, reptiles etc.

Q7. Draw a table showing distinguishing characteristics of kingdoms of Three domains.

Ans.

Table: Distinguishing Characteristics of the kingdoms of three domains						
Domain	Bacteria	Archaea	Eukarya			
Kingdom	Monera		Protista	Fungi	Plantae	Animalia
Cell Type	Prokaryotic	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Nuclear Envelope	Absent	Absent	Present	Present	Present	Present
Presence of Cell Wall	In all	In all	In some, Absent in animal like protists	In all	In all	Absent
Composition of cell wall	Peptidoglycan	Various Chemicals	Polysaccharides and proteins	Chitin	Cellulose and other polysaccharides	No Cell wall
Mode of Nutrition	Autotroph or heterotroph	Autotroph or heterotroph	Photosynthetic or heterotroph, or combination	Absorptive heterotroph	Photosynthetic autotrophs	Ingestive heterotrophs
Multi-cellularity	Absent	Absent	Absent in most forms	Present in most forms	Present in all forms	Present in all forms

Basic terminologies related to kingdom animalia

The animals (multicellular = metazoa) are subclassified into:

- i. **Parazoa** (phylum Porifera) these animals lack tissues organized into organs and have indeterminate shape, and are asymmetrical.
- ii. **Eumetazoa** includes animals of other phyla, these animals have tissues organized into organs and organ systems. These include radially symmetrical animals (grade **Radiata**) and bilaterally symmetrical animals (grade **Bilateria**).
 - (a) **Grade Radiata** includes simplest of the Eumetazoa (phylum **Cnidaria**), they are much simpler in their organization.
 - (b) **Grade Bilateria** includes the animals where the right side is approximately the same as the left side and where there is a distinct anterior end is said to have bilateral symmetry. The animal can be divided into two equal parts by an imaginary line only in one plane.

Diploblastic animals

The body of these animals consists of two layers of cells, ectoderm and endoderm. Animals show lesser degree of specialization and do not form specialized organs. There is no special transport system. No central nervous system. Sac like digestive system is present.

Triploblastic animals

The body of these animals is made from three layers' ectoderm, mesoderm and endoderm. The cells of these animals show greater degree of specialization and have specialized organ

and organ system. Special transport systems i.e. blood vascular system is present. Central nervous system is present. Tube like digestive system is present.

The body of these animals is made of three layers' ectoderm mesoderm and endoderm. After embryonic development these layers in most triploblastic animals are not distinct as separate layers of cells, but are represented by the structures formed from them. The cells of these animals show greater degree of specialization. These have specialized organs and organs systems. Special transport systems i.e. blood vascular system is present in most of the cases.

Ectoderm: The germinal layer that develops into systems such as integumentary and nervous system.

Mesoderm: The germinal layer that develops into muscular, skeletal and reproductive systems.

Endoderm: The germinal layer that forms the lining of digestive tract and forms other glands of digestive system, such as liver.

Triploblastic animals may be acoelomate, pseudocoelomates or coelomate.

Acoelomates

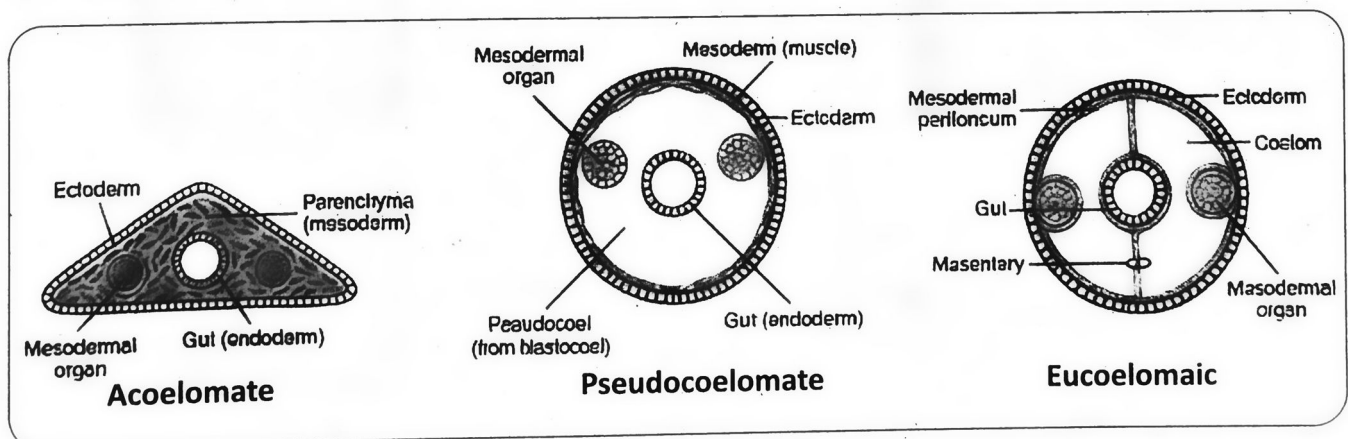
In phylum Platyhelminthes there is no body cavity or coelom, and the mesoderm forms a loose, cellular tissue called mesenchyma or parenchyma which fills the space between the ectoderm and endoderm. It forms a packing around the internal organs of the animals to support and protect them. Such animals are called acoelomates.

Pseudocoelomates

In Aschelminthes the space between the body wall and the digestive tube is called pseudocoelom (false body cavity). Pseudocoelom is not homologous to true coelom because: is not lined by coelomic epithelium. It has no relation with the reproductive and excretory organs. It develops from the blastocoel of the embryo and it is bounded externally by the muscles and internally by the cuticle of the intestine. The animals having pseudocoelom are called pseudocoelomates.

Coelomates

Coelom is cavity present between the body wall and the alimentary canal and is lined by mesoderm. The mesoderm splits into outer parietal layer which underlines the body wall and the visceral layer which covers the alimentary canal and the cavity between them is the true coelom. It is filled with fluid called coelomic fluid. The animals which possess coelom or true body cavity are called coelomates e.g., animals from annelids to chordates.



The coelomates are further divided into;

i. Proterostomes

In protostomes, the blastopore (the first opening in the developing embryo) becomes the mouth. Coelom or body cavity is formed due to splitting of mesoderm (schizocoelous). This series includes animals belonging to phyla Aschelminthes, annelida, mollusca and arthropoda.

ii. Deuterostomes

The mouth is formed at some distance anterior to the blastopore and blastopore forms the anus. Coelom is developed as an outpouching of archenterons (enterocoelous). This series includes animals belonging to phyla Echinodermata, hemichordate and chordata.

CLASSIFICATION OF KINGDOM ANIMALIA

Q8. Discuss the general characteristics of Phylum Porifera.

Ans. General characteristics of Phylum Porifera (literal meaning: pore bearing)

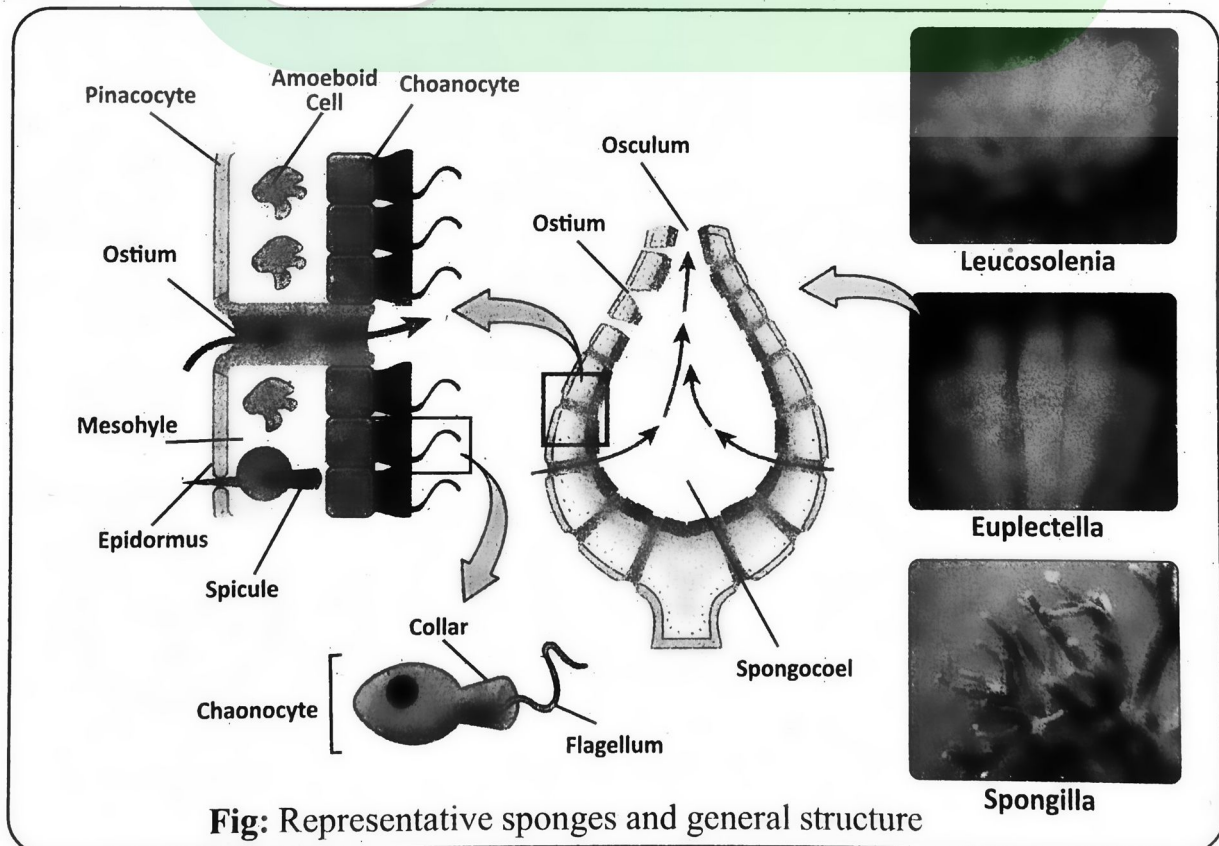
This phylum contains sponges.

1. Habitat: Most of them are marine while some live in freshwaters. *Leucosolenia* and *Euplectella* (Venus flower basket) are marine sponges. *Spongilla* is a common freshwater sponge.

2. Level of Organization: Sponges **do not have tissue level** organization. Most sponges are asymmetrical but some have radial symmetry.

3. Nervous System: They do not have nervous system.

4. Water Flow System: There are numerous pores in body wall called **ostia**. Through ostia, water enters the body. The larger pore through which water leaves the body is called **osculum**.



5. Body Structure

- The outer layer (**pinacoderm**) of body is made of thin, flat cells called **pinacocytes**.
- The middle layer is jelly-like and is called **mesohyle**. It contains **amoeboid cells**.
- The inner layer (**choanoderm**), which lines the spongocoel, is made of **choanocytes** or **collar cells**.
- They have **skeleton** in the form of minute needles of **calcium carbonate** or **silica**.

6. Reproduction

Most sponges reproduce asexually by budding or regeneration. Some sponges form resistant capsules, called **gemmules**. When parent sponge dies, it releases its gemmules. In favourable environment, amoeboid cells come out of the gemmules and form a new sponge.

Q9. Describe the general characteristics of Phylum Cnidaria.

Ans. General characteristics of Phylum Cnidaria

1. Habitat

Almost all cnidarians are marine, although a few are found in freshwater e.g., hydra and jellyfish. Most cnidarians are colonial e.g., obelia, corals, sea fans etc. Most of them are sessile e.g., hydra, coral, obelia etc. Some cnidarians are motile e.g., jellyfish.

2. Symmetry

They are radially symmetrical animals and are diploblastic.

3. Body Structure

The adult body contains two tissue layers i.e., the **epidermis** and the **gastrodermis**, derived from ectoderm and endoderm respectively. Between the epidermis and gastrodermis, a jelly-like **mesoglea** is present. It contains amoeboid cells that have originated either from ectoderm or endoderm.

4. Defense System

They possess special cells, called **cnidocytes**. A cnidocyte contains a special organelle, called **nematocyst**. Nematocysts defend the body and captures prey.

5. Digestive System

Cnidarians have a blind-ending **cavity**, called **gastrovascular cavity** or **enteron**. It opens outside by a single opening, the **mouth**. **Mouth** also acts as anus for the removal of undigested material. Mouth is surrounded by a series of projections, called **tentacles**. This type of digestive system in which there is a single opening for the entry of food and removal of undigested matter, is called **sac-like/sac-type digestive system**.

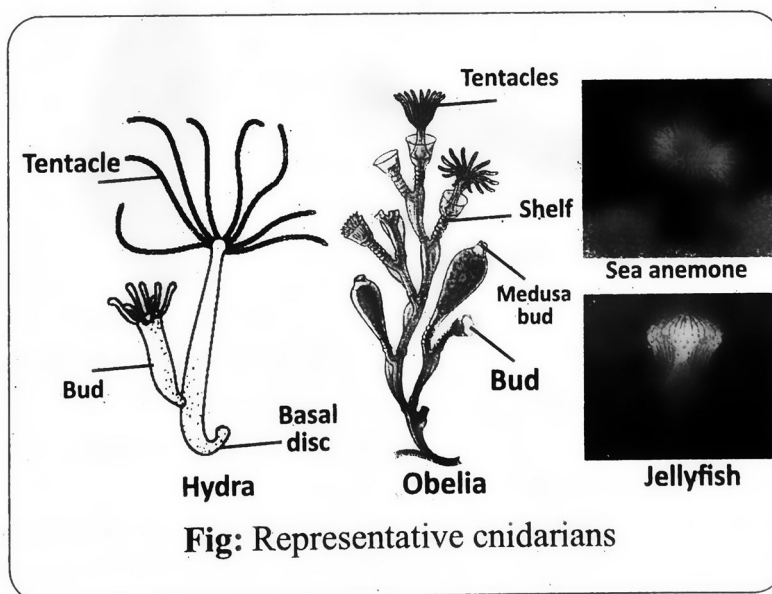


Fig: Representative cnidarians

6. Nervous System

The nervous system is in the form of a network of neurons in the body wall. There is **no central nervous system** (brain and spinal cord), respiratory, excretory and transport systems.

7. Body Forms

There are two body forms in cnidarians i.e., polyps and medusae.

- **Polyps** are cylindrical and are attached to a substrate at the **aboral end**. They reproduce asexually.
- **Medusae** are umbrella-like and are free-swimming. They reproduce sexually.

Q10. Describe the general characteristics of Phylum Platyhelminthes.

Ans. General characteristics of Phylum Platyhelminthes (literal meaning: flat worms)

They are called “flatworms”. They are unsegmented and body is soft and dorsoventrally compressed.

1. Habitat: Most of them are free-living e.g., planaria. Some are endoparasites of humans and other animals e.g., liver fluke, tapeworm, and blood-fluke.

2. Body Organization

They are triploblastic i.e., the tissues of the body are derived from three embryonic layers i.e. **ectoderm**, **mesoderm** and **endoderm**.

★ **Segmented body:** Tape worm belonging to phylum Platyhelminthes are segmented.

3. Body Cavity

They are **acoelomates (no body cavity)**. A loose connective tissue called **parenchyma** fills space between the body wall and body organs.

4. Bilateral Symmetry

They have bilateral symmetry with distinct **left and right** sides as well as **dorsal and ventral** sides.

5. Excretory System

They have a network of tubular **protonephridia**. These tubules have numerous branches. Each branch ends in a bulb-like cell called **flame cell**.

The cilia of flame cells beat to suck surrounding fluid into the tubules. The tubules filter the waste materials from fluid and release them out of body wall through a small opening called a **nephridiopore**.

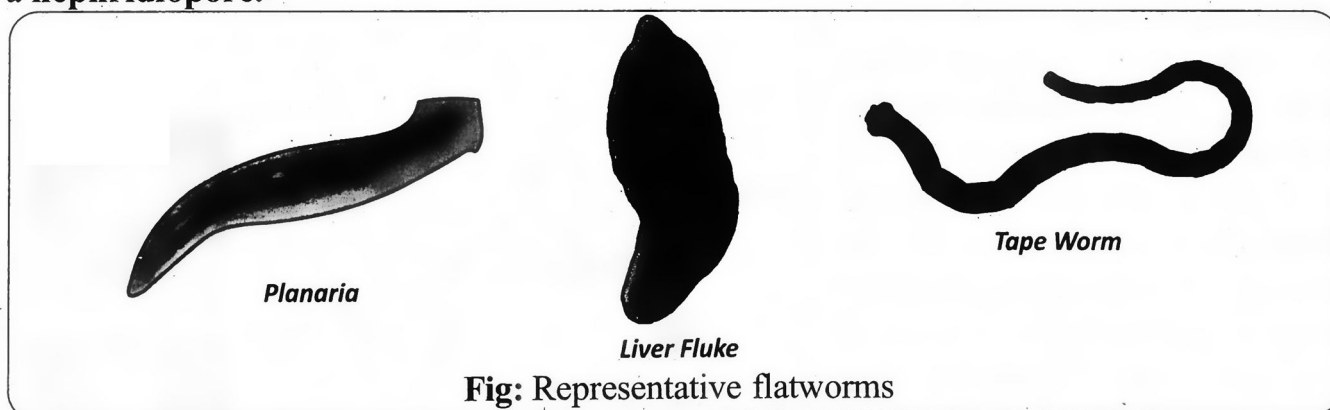


Fig: Representative flatworms

6. Respiratory and circulatory system

They do not have respiratory and circulatory (transport) systems.

7. Nervous System

They have a network of neurons. There are **cerebral ganglia** in the anterior end (head). These ganglia are attached to **longitudinal nerve cords** that are **interconnected across** the body by transverse branches.

8. Eyespots

Most free-living flatworms have two simple eyespots at their anterior end.

9. Reproduction

Flatworms reproduce asexually by “fission” in which the animal constricts in the middle and then divides into two pieces. Each piece then regenerates the missing part. The sexually-reproducing flatworms are hermaphrodites (bisexual).

Q11. Outline the general characteristics of Phylum Nematoda.

Ans. General characteristics of Phylum Nematoda (literal meaning: thread-like)

★ **Aschelminths:** They are roundworms with elongated worm-like (round) body with pointed ends.

The pseudocoelomates are classified in **seven** phyla. These phyla are grouped as a unit called **Aschelminths**. Phylum Nematoda is the **representative phylum** of this group.

1. Habitat: Some roundworms are free-living (in water and soil) e.g., *Caenorhabditis elegans*. Many are parasites e.g., *ascaris*, hookworm, pinworm, and whipworm.

2. Body Organization

They are triploblastic, bilateral symmetrical, and possess unsegmented bodies.

Body Cavity: They are pseudocoelomates because they possess a false body cavity called pseudocoelom filled with fluid.

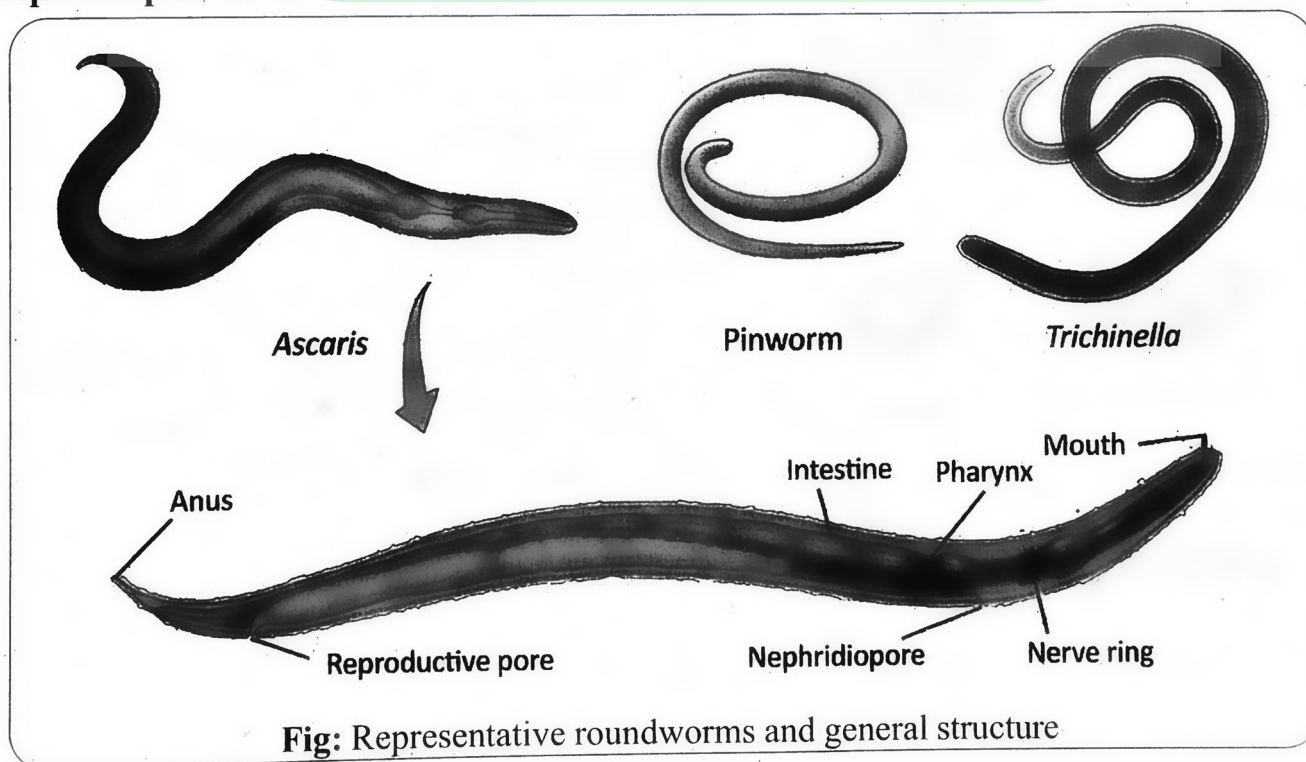
3. Digestive System

They possess tube-like digestive system. It consists of an alimentary canal with two openings; mouth at anterior end and anus at posterior end.

The parasitic roundworms have simplified digestive systems.

4. Excretory System

Their excretory system consists of **protonephridia** and two excretory canals, which unite at the anterior end to form a single canal. The single canal then opens outside through a **nephridiopore** on the ventral surface.



5. Nervous system

They possess a **network of neurons** in body. There is a nerve ring around the pharynx, which is attached to four longitudinal nerve cords.

6. Sense Organ

They have raised **hair-like sense organ** called **sensory papillae**, present on lips.

7. Respiratory and circulatory system

They do not have defined respiratory and **circulatory systems**.

8. Reproduction

They are **unisexual** i.e., male nematodes have testes and female nematodes have ovaries.

Q12. Describe the general characteristics of Phylum Mollusca.

Ans. General characteristics of Phylum Mollusca (literal meaning: soft bodied)

Molluscs have soft un-segmented bodies.

1. Habitat: They are widely distributed in natural habitats. Some of them are exclusively aquatic e.g., mussels, octopus and oyster. The others live in moist places e.g., land snail.

2. Body organization

Molluscs are triploblastic and have bilateral symmetry. They possess true coelom. Among **coelomates**, they are included in the group called **protostomes**.

3. Body Structure

Their body can be divided into **three parts** i.e., **head**, **visceral mass** (contains organs of digestion, excretion and reproduction), and **foot** (attached with visceral mass).

4. Mantle Cavity

They have an epithelial envelope around the visceral mass, called as **mantle**. The space between mantle and visceral mass is called as **mantle cavity**. In most molluscs, the outer surface of mantle secretes a calcareous shell.

5. Radula

All molluscs (except bivalvia) have is a rasping tongue-like organ, called **radula**.

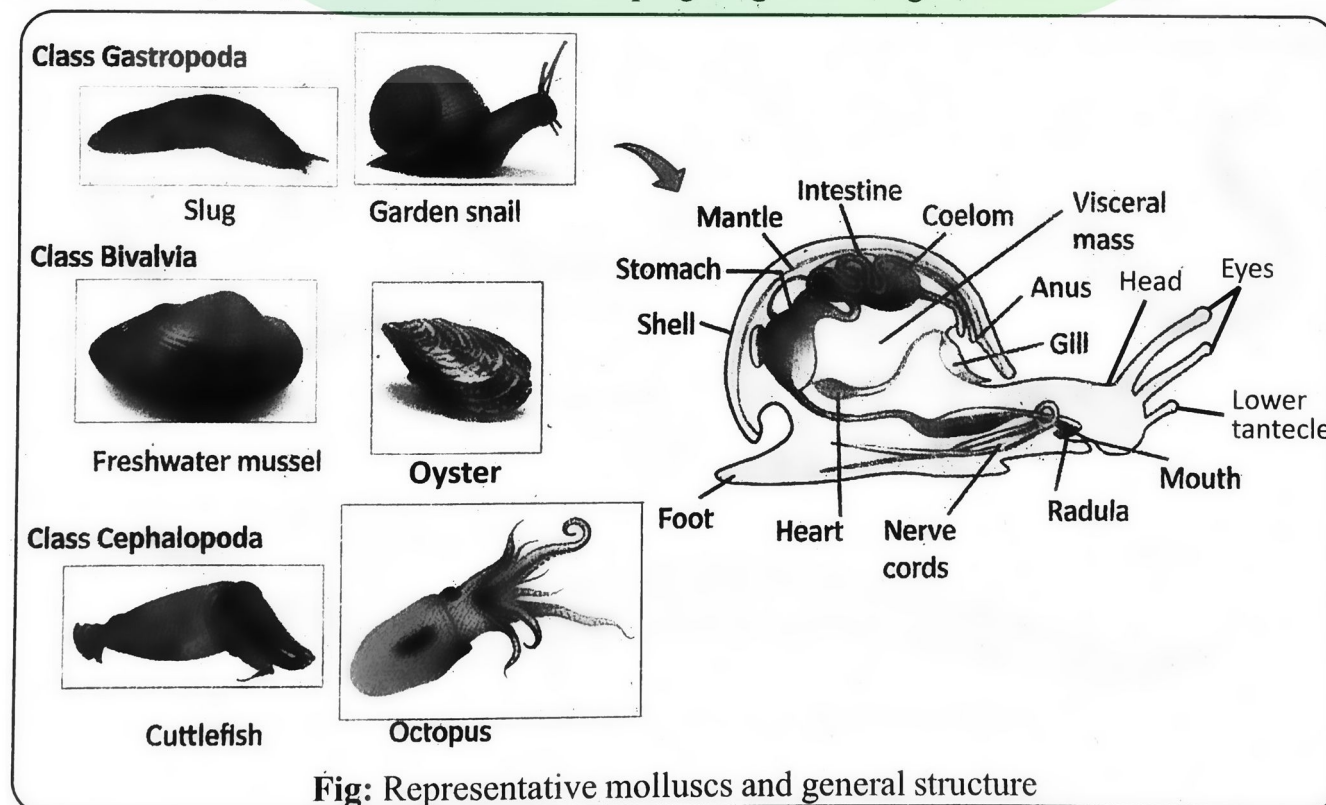


Fig: Representative molluscs and general structure

6. Circulatory System

All of them (except cephalopods) have open type blood circulatory system. Their heart consists of a **single ventricle** and **two auricles**.

7. Digestive System

They possess tube-like digestive system in which the gut has two openings, i.e., mouth and anus.

8. Excretory System

Their excretory system consists of paired tubular structures called **nephridia**. Wastes are gathered from sinuses and discharged into coelom around the heart. The nephridia open in this coelom. They have **tiny cilia** around their openings, which move the fluid from coelom into the nephridia. Nephridia discharge waste materials in mantle cavity, from where they are expelled out.

9. Respiratory System

In molluscs, gills work for the exchange of gases.

10. Nervous System

They have **three pairs of interconnected ganglia** present in the head, visceral mass and foot. The ganglia are interconnected by means of nerve cord.

11. Locomotion

They move with the help of **muscular foot**. Some molluscs are sessile. Most molluscs are unisexual.

12. Classes of molluscs

- i. Class Gastropoda e.g., slug, garden snail.
- ii. Class Bivalvia e.g., fresh water mussel, oyster.
- iii. Class Cephalopoda e.g., octopus, cuttle fish.

Q13. Describe the general characteristics of Phylum Annelida.

Ans. General characteristics of Phylum Annelida (literal meaning: little rings)

Annelids are commonly called segmented worms.

1. Habitat

They are found in marine water (e.g., nereis), freshwater (e.g., leech), and in damp soil (e.g., earthworm). Some annelids are ectoparasites e.g., leeches.

2. Body organization

Annelids are bilaterally symmetrical and triploblastic. They are **protostome coelomates**.

3. Metameric Segmentation

Their body is divided transversely into a number of similar parts called **segments**. Internally, the segments are separated from each other by cross walls called **septa**. Each segment is provided with its own **circulatory, excretory and neural elements**. This type of segmentation in body is called **metameric segmentation**.

4. Setae

Annelids have special parts called **setae**. Setae are chitinous bristles in the ventral wall of each segment. They are used for **anchoring** the worm during movement. Setae are absent in leeches. Their body wall is surrounded by a moist, acellular cuticle secreted by epidermis.

5. Digestive System

They possess **tube-like** digestive system. The digestive tube is divided into distinct parts, each performing a specific function. The parasitic annelids have simplified digestive system.

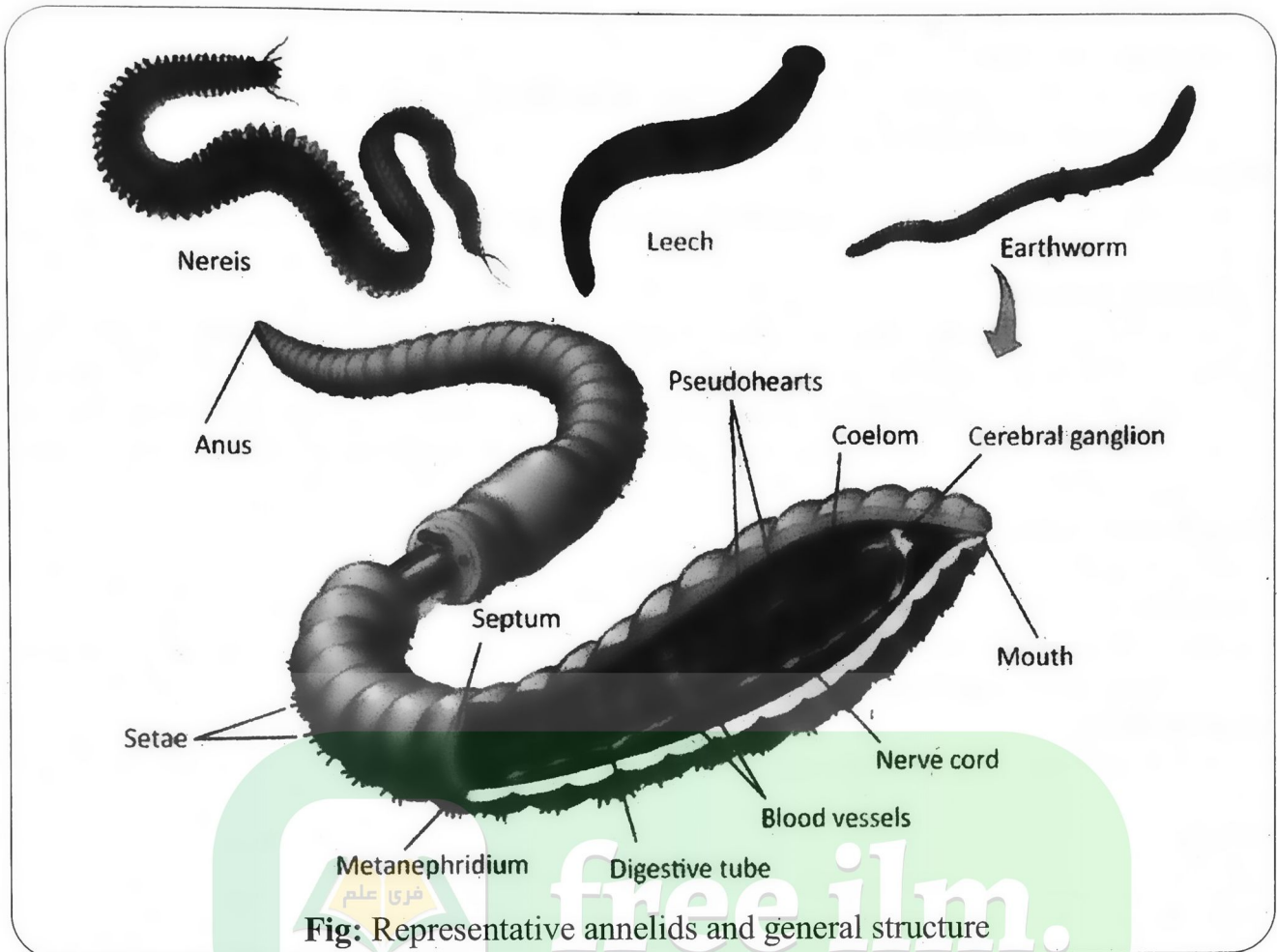


Fig: Representative annelids and general structure

6. Excretory System

Their excretory system consists of ciliated, funnel-shaped **metanephridia**. Each segment has **one pair** of metanephridia.

7. Circulatory System

They possess a **closed-type circulatory system**. Blood always flows in blood vessels. They have specialized pulsating blood vessels (**pseudohearts**). Blood of most annelids has respiratory pigment, haemoglobin, dissolved in blood plasma.

8. Respiratory System

Gaseous exchange occurs through the skin.

9. Nervous system

There is a **cerebral ganglion** or **brain** in the anterior segment. A **double, longitudinal ventral nerve cord** arises from brain and gives nerves in each segment. **Ganglia** are also present in each segment.

10. Receptors

They have **tactile receptors**, **chemoreceptors**, **balance receptors**, and **photoreceptors**. Some annelids also have well-developed eyes with lenses.

11. Reproductive System

Most annelids are **hermaphrodite** (e.g., earthworm, leech) and some are **unisexual** (e.g., nereis).

Q14. Elaborate the general characteristics of Phylum Arthropoda.

Ans. General characteristics of Phylum Arthropoda (literal meaning: jointed legs)

1. Habitat

Diverse groups such as insects, crustaceans, spiders, scorpions, and centipedes are included in this phylum. They are found in **every type of habitat**. Many of terrestrial members can also fly.

2. Body Symmetry

They are **triploblastic, bilateral symmetrical, protostome coelomates**. The coelom is reduced and is present only around reproductive and excretory systems.

3. Jointed Appendages

They have jointed appendages which are **modified for specialized functions** e.g., running, crawling swimming, capturing prey, respiration, reproduction etc. In different arthropods, the jointed appendages around the mouth, are modified in different ways and form mouth parts.

4. Body Structure

The body is **segmented**. Some segments are fused to form specialized body regions called **tagmata**. These include **head, thorax and abdomen**.

5. Exoskeleton and Ecdysis

They have exoskeleton or cuticle, which is **secreted** by the **epidermis** of body wall. It is made chiefly of **chitin**. In young arthropods, exoskeleton is **shed** from time to time. After shedding the exoskeleton, the animal grows at a fast rate and then re-secretes new exoskeleton. This process is called **ecdysis or molting**. This process is carried out by a hormone called **ecdysone**.

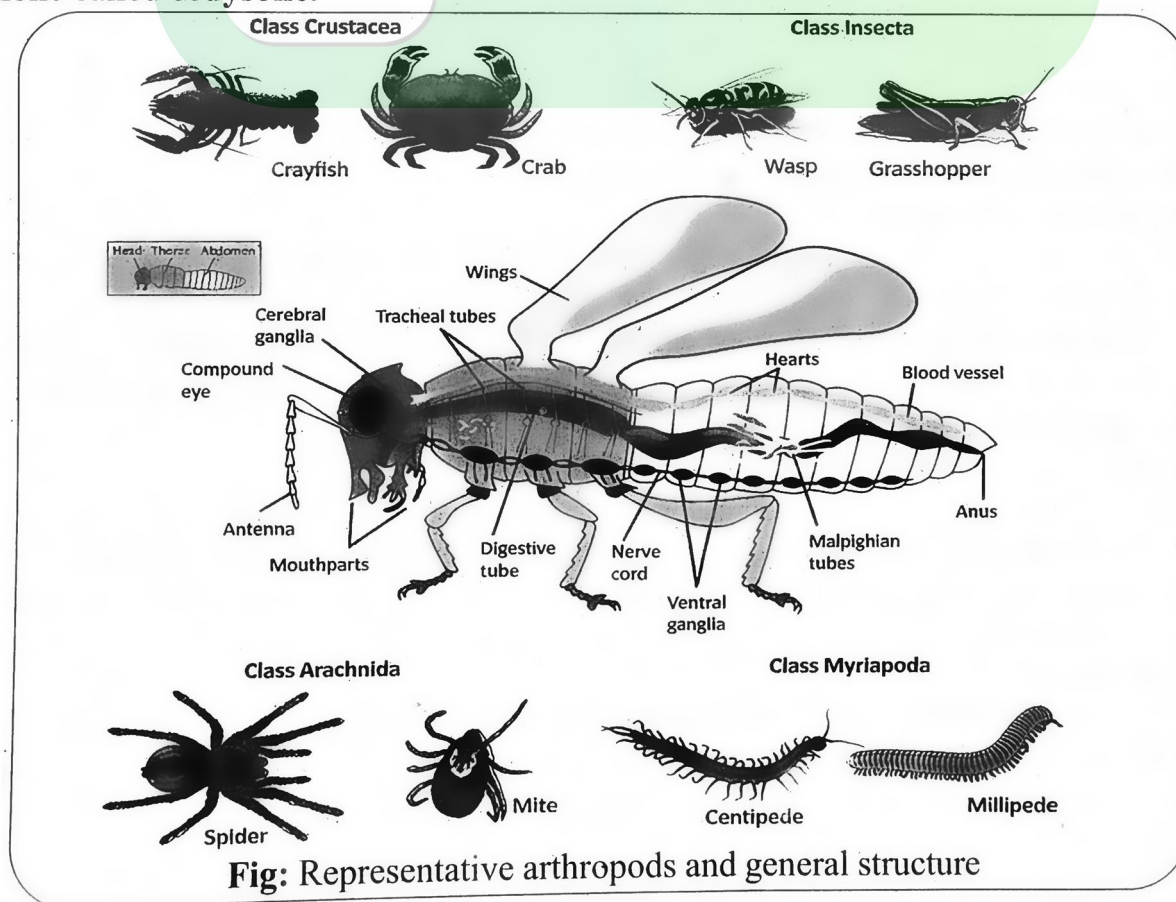


Fig: Representative arthropods and general structure

6. Circulatory System

They possess open-type circulatory system. Most of the time, blood flows in hemocoel, which is derived from an embryonic cavity called **blastocoel**. Their blood is colourless as it is without haemoglobin and is known as **haemolymph**.

7. Respiratory System

Most arthropods possess a respiratory system that consists of air tubes called **trachea**. Main tracheal tubes open out through openings called **spiracles**. Aquatic arthropods respire through gills.

8. Digestive System

Arthropods have **tube-like digestive system**. The alimentary canal is divided into different parts. (i.e. mouth, esophagus, crop, gizzard, mesenteron, ileum, colon, rectum and anus).

9. Excretory System

Their excretory system comprises of **Malpighian tubules**. These are narrow tubules projected from the alimentary canal, attached at the junction of midgut and hindgut. The nitrogenous wastes are excreted in the form of **solid uric acid crystals**.

10. Nervous System

They have well-developed **central nervous system** with three fused pairs of cerebral ganglia (brain) in head. There is a double ventral nerve cord which has ventral ganglia in each segment. Smaller nerves arise from ventral ganglia in each segment. They have well developed compound eyes and antennae. They can swim, crawl or fly depending on their habitat.

11. Reproductive System

They are unisexual and lay eggs.

12. Classes

- i. Class Crustacean e.g., cray fish, crab.
- ii. Class Insecta e.g., fly, mosquito, butterfly.
- iii. Class Arachnida e.g., spider, mite, scorpion.
- iv. Class Myriapoda e.g., centipede, millipede.

13. Important arthropods

Include insects (e.g., mosquito, butterfly, moth, wasp, beetles, grasshopper), crabs, lobsters, prawn, shrimps, crayfishes, spider, tick, mite, scorpion, centipedes and millipedes.

Q15. Explain the general characteristics of Phylum Echinodermata.

Ans. General characteristics of Phylum Echinodermata (literal meaning: spiny skinned animals)

1. Habitat

They are exclusively marine animals. Some are flattened like **biscuit** (e.g., cake urchin), some are **star-shaped** with short arms (e.g., sea star or starfish), some are **globular** (e.g., sea urchin), some are star-shaped with long arms (e.g., brittle star), and some are **elongated** (e.g., sea cucumber).

2. Organization

They are **triploblastic** and **deuterostomes coelomates**. Their larvae are bilateral symmetrical but the adults show radial symmetry. In their radial symmetry, the body parts are arranged in five, or multiple of five, around an oral-aboral axis.

3. Skeleton

They possess a **calcareous endoskeleton** in the form of plates called ossicles. These plates are derived from mesoderm but come out of skin also and make spines on the skin.

4. Water-Vascular System

They have water-vascular system consisting of tubes and spaces present in the coelom. A ring canal surrounds the mouth. It opens outside through a sieve-like plate, called **madreporite**. Five (or a multiple of five) radial canals branch from the ring canal. Many lateral canals emerge from each radial canal and each lateral canal ends at a tube foot. Tube feet are the extensions of water vascular system.

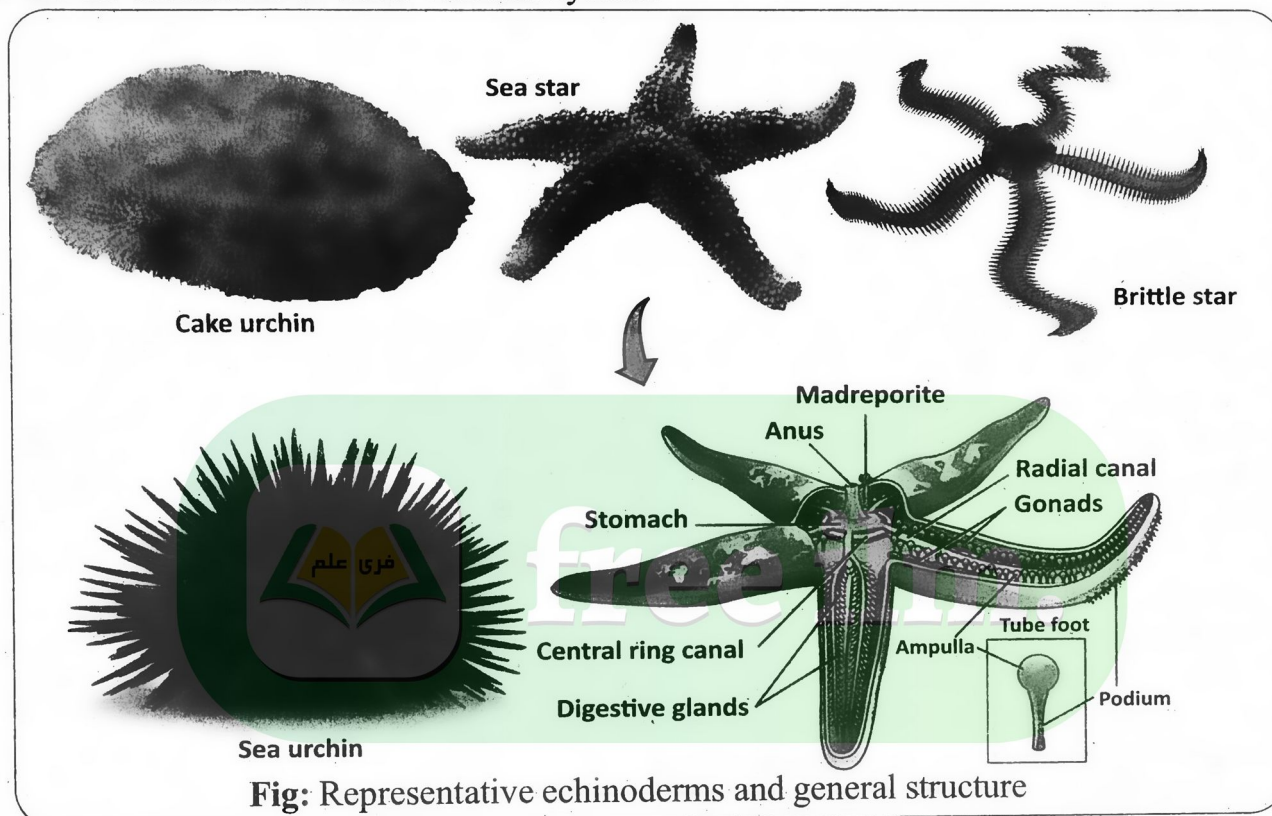


Fig: Representative echinoderms and general structure

5. Tube Feet

The tube feet extend and attach with some substrate. When water is drawn back from the sucked tube feet, they contract and body is pulled.

6. Digestive System

Echinoderms possess **tube-like digestive system**. The mouth leads to oesophagus, stomach, intestine and rectum. The rectum opens out through anus.

7. Respiratory and excretory system

There are no specialized organs for respiration and excretion.

8. Nervous system

They possess a poorly developed nervous system made of a nerve net, a nerve ring, and five (or multiple of five) radial nerves. Most **sensory receptors** are distributed over the surface of the body and tube feet.

9. Reproduction

Asexual reproduction involves division of the body, followed by the regeneration of each half. Echinoderms are unisexual.

★ **Regeneration in Echinoderms:** Many echinoderms are able to regenerate the lost parts, and some, especially sea stars and brittle stars, drop various part when they are under attack and then regenerate the lost parts.

Q16. Outline the major four characteristics to Chordata, also describe their major groups.

Ans. Chordates are bilateral symmetrical, triploblastic, deuterostome coelomates. The following four characteristics are unique to chordates, present at some stage in development.

1. Notochord: All chordates develop notochord during embryonic life. It is a **rod-like semi rigid body of vacuolated cells**. It extends throughout the length of body between gut and dorsal nerve cord. The lower chordates retain this notochord throughout life. While, in vertebrates it is partly or entirely replaced by vertebral column, during development.

2. Pharyngeal slits: These are a series of openings in the lateral walls of pharynx. All chordates develop paired gill slits in embryonic stage. In some chordates (e.g., Amphioxus and fishes), these develop into gills. In some (e.g., most amphibians), these are functional for some period in their life history. In others (e.g., reptiles, birds and mammals), these are modified for various purposes.

3. Tubular nerve cord: In all chordates, a tubular nerve cord runs through the longitudinal axis of the body, just dorsal to the notochord. It expands anteriorly as a brain.

4. Post anal tail: All chordates develop a tail, posteriorly beyond the anal opening. Some chordates retain it throughout life while others degenerate it during embryonic life.

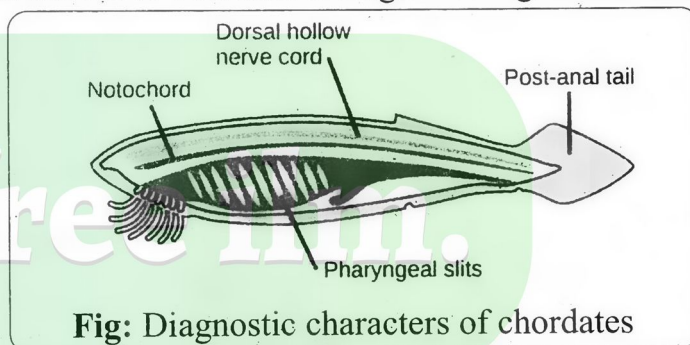


Fig: Diagnostic characters of chordates

Classification

Phylum Chordata includes two major groups i.e., **invertebrate chordates** and **vertebrates**.

Invertebrate Chordates (Lower Chordates)

i. Subphylum Urochordata includes the invertebrate chordates in which notochord and nerve cord are present only in their free-swimming larvae. Sea squirts are the examples of Urochordata.

ii. Subphylum Cephalochordata includes the invertebrate chordates in which notochord persists throughout life. Amphioxus is a common cephalochordate.



Fig: Sea squirts

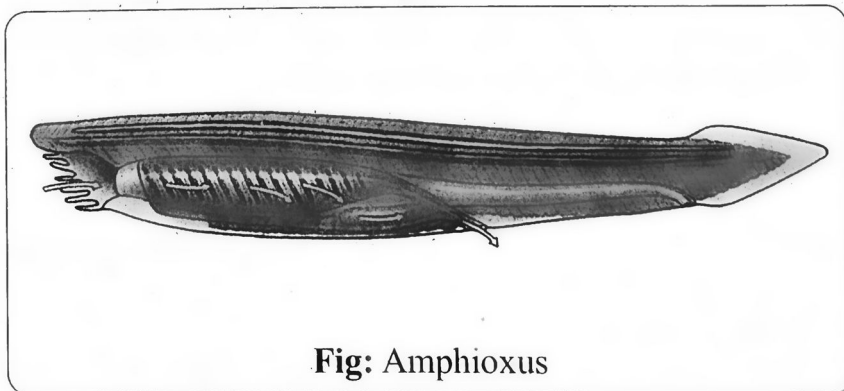


Fig: Amphioxus

Higher Chordates

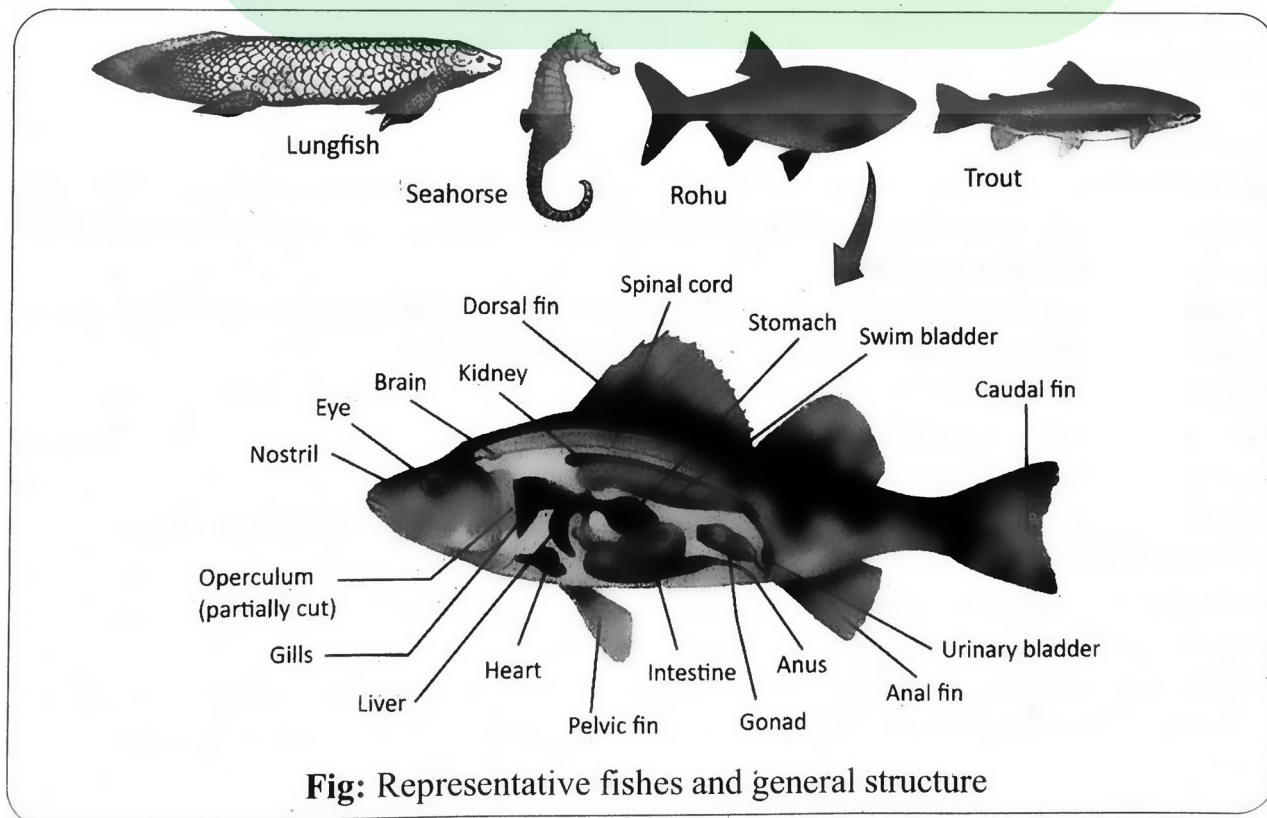
Vertebrates: They have a vertebral column and cranium. Vertebrates are divided into seven classes which are placed into two groups.

CLASSIFICATION OF VERTEBRATES

Q17. Describe the basic characteristics of group Pisces.

Ans. Basic characteristics of group pisces are as follows:

- 1. Habitat:** Members of Class Pisces are aquatic vertebrates, meaning they live exclusively in freshwater or marine environments.
- 2. Streamlined Body:** Their bodies are **streamlined** or **fusiform** (spindle-shaped) which helps in reducing water resistance during swimming.
- 3. Scales:** The body is covered with scales (dermal in origin), such as **placoid**, **cycloid** or **ctenoid scales**, depending on the type of fish.
- 4. Skeleton:** Skeleton can be **cartilaginous** (as in sharks and rays) or **bony** (as in most modern fish).
- 5. Respiratory System:** Respiration takes place through **gills**. Gills are usually covered by an **operculum** in bony fishes.
- 6. Circulatory System:** They have a **closed circulatory system**. The heart is **two-chambered** (one auricle and one ventricle). Blood circulation is **single** and **incomplete**.
- 7. Fins:** Locomotion is achieved with the help of **paired** and **unpaired fins**. Fins also provide balance and direction during swimming.
- 8. Reproduction:** Mostly are **oviparous** (egg-laying), but some are **viviparous** (give birth to young ones). Fertilisation may be **external** (common in bony fishes) or **internal** (common in cartilaginous fishes).
- 9. Ectothermic:** Pisces are **ectothermic** (cold-blooded), meaning their body temperature varies with the environment.



	Class	Key Characteristics	Examples
Agnathans (Jawless Fishes)	Class Myxini	Mouth with four pairs of tentacles; five to fifteen pair of pharyngeal slits.	Hagfish
	Class Cephalispidomorphi	Sucking mouth, seven pair of pharyngeal slits	Lamprey
Gnathostomes (Jawed Fishes)	Class Chondrichthyes	Cartilaginous skeleton, tail fin with large upper lobe and lack swim bladder or lungs.	Sharks, skates ratfish
	Class Osteichthyes	Bony skeleton, pneumatic sac function as lungs or swim bladder.	Lungfish, Coelacanth

Q18. Describe the common traits of Class Amphibia.

Ans. Common traits of Class Amphibia

It is the first class of tetrapods.

1. Skeleton: They have bony endoskeleton. Unlike fishes, amphibians have a neck. The first vertebra (cervical vertebra) moves against the back of skull and allows the skull to nod vertically.

2. Skin: Their skin is smooth (without scales) and moist. It helps in gas exchange, temperature regulation, and absorption and storage of water.

3. Heart: Their heart is **double-circuit**. It is **three-chambered**, with two atria and one ventricle.

4. Respiration: They respire by gills in the larval stage and by lungs and skin in the adult stage.

5. Ectotherms: They depend on external heat source and so are ectotherms. They cannot regulate their body temperature and cannot maintain it constant, so, they are **poikilothermic** animals and **hibernate in winter**.

6. Examples: Salamander, newts, and mud puppies are **tailed** amphibians. Frogs and toads are **tail-less** amphibians, and caecilians are **legless** amphibians.

7. Reproductive System: Amphibians are unisexual. Fertilization is usually external.

Q19. Discuss the common characteristics of reptiles.

Ans. Common traits of Class Reptiles

1. Amniotic Eggs: Reptiles are the first animal group that possess **amniotic eggs**.

2. Extra-Embryonic membranes: Amniotic eggs make protective extra-embryonic membranes i.e., **amnion**, **allantois**, and **chorion**. These membranes protect the embryo from drying out, nourish it and enable it to develop on land.

3. Food: The amniotic eggs also contain a large amount of yolk, the primary food supply for the embryo. Such eggs have abundant albumin, which provides additional nutrients and water.

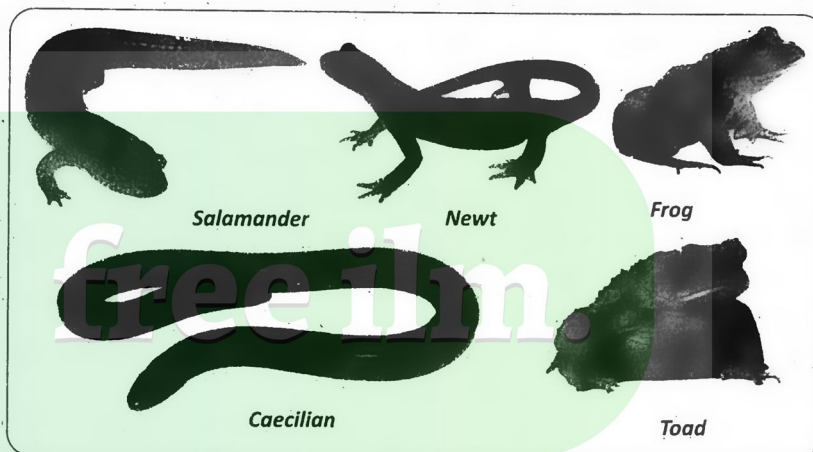
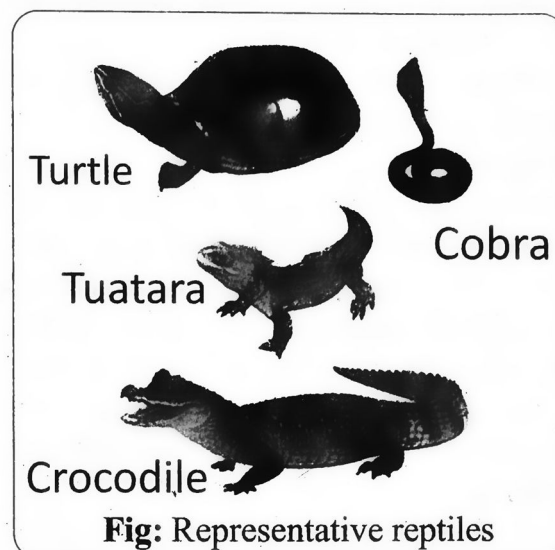
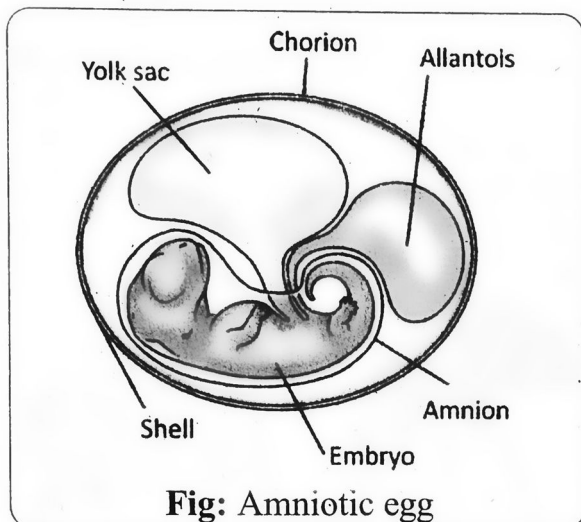


Fig: Representative amphibians

4. Shell: The amniotic eggs are also covered with leathery calcareous shell which is partly permeable to gases but not to water.



5. Skin: Reptiles have **dry** scaly skin.

6. Endoskeleton: The bony endoskeleton of reptiles is harder than amphibians. The skull is longer than amphibians. In reptiles, first two cervical vertebrae (atlas and axis) allow more movements of head.

7. Heart: In their heart, ventricle is incompletely partitioned, into left and right ventricles.

8. Thermoregulation: Reptiles, like amphibians, are **ectothermic** and use external heat source for thermoregulation. They cannot keep their body temperature at constant, and are **poikilotherms**.

9. Fertilization: Fertilization is internal, and are **oviparous** (egg-laying).

10. Examples: The present-day reptiles are lizards, snakes, tuatara and crocodiles.

Q20. Explain in detail the specific traits which belong to all Aves (birds).

Ans. Common traits of Class Aves

1. Feathers

Birds have a covering of feathers on the body. Feathers form the flight surfaces that provide lift and aid in steering. Feathers also prevent heat and water loss.

2. Thermoregulation

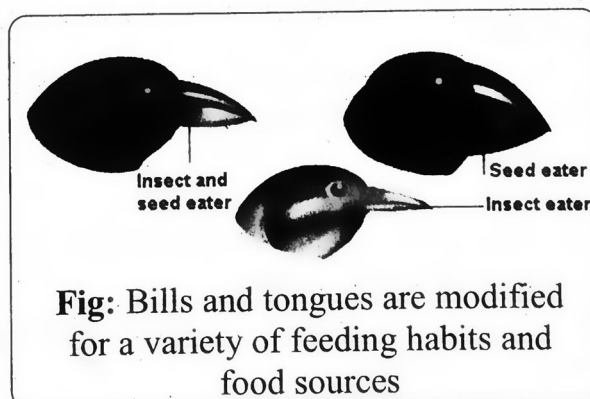
Birds are **endotherms**. It means that they can obtain heat from cellular processes. A source of internal heat allows them to maintain a nearly constant core temperature. The animals who can maintain their core temperature are known as **homeotherms**.

3. Body Plan

The body of birds is **streamlined** and **spindle shaped**. The forelimbs are modified into wings. Their bones are light due to **large air spaces**. The **sternum** (chest bone) bears a large bone called **keel** for the attachment of flight muscles.

4. Digestive System

In many birds a **diverticulum** of the oesophagus, called **crop**, is a storage structure that allows birds to quickly ingest large quantities of food. A



region of stomach, called **gizzard**, has muscular walls to crush food.

5. Heart: Their heart is **four chambered**, with complete separation of atria and ventricles, and have right aortic arch.

6. Nervous System: Birds have well developed nervous system. **Vision and hearing** are important senses for most birds.

7. Respiration

Their external nares open in pharynx through nasal passage ways. The **pharynx** leads to **trachea** and then **bronchi**. The organ of voice, called **syrinx**, is situated at the lower end of trachea. The bronchi lead to a complex system of **air sacs** that occupy much of the body and even extend to some of the bones. The air sacs connect to lungs, which are made of small air tubes called **parabronchi**.

8. Bills

A lighter sheath called bill replaces the teeth. Bills and tongues are modified for a variety of feeding habits and food sources.

9. Fertilization

In birds, fertilization is internal and development is external i.e., they are **oviparous**.

10. Amniotic eggs: Like reptiles and egg laying mammals, birds have amniotic eggs with large amounts of yolk and albumin, covered with leathery shell.

11. Running Birds: Some birds have secondarily **lost** the power of **flight** and are called running birds e.g., ostrich, kiwi, rhea, cassowary, and emu.

12. Flying Birds: Most birds can fly, which include pigeon, parrot, crow, eagle, robin etc.

Q21. How mammals are most advanced class of Chordata?

Ans. Advanced traits of Class Mammalia

1. Mammary glands

Mammalia includes the **group** of vertebrates which are **nourished** by **milk** from the **mammary glands** of **mother**, and have hair on their body. Mammary glands are functional in female mammals.

2. Skin

Mammals have skin glands, developed from epidermis. **Sebaceous** (oil) glands secrete oily secretion. **Sudoriferous** (sweat) glands release watery secretions used in evaporative cooling.

3. Teeth

Most mammals have **two sets** of teeth during their lives i.e., milk teeth and permanent teeth.

4. External ear or pinna

External ear or pinna is present. The middle ear has a chain of three bones i.e., **malleus**, **incus** and **stapes**.

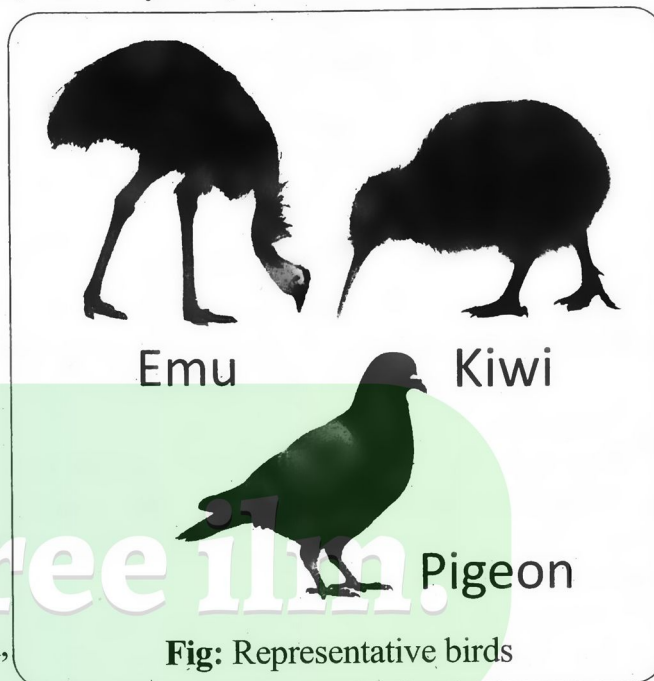


Fig: Representative birds

5. Thermoregulation

Mammals are endothermic and homoeothermic animals.

6. Heart

They possess four-chambered heart, and have left aortic arch.

7. Diaphragm

They have a muscular diaphragm that separates the coelom into thoracic and abdominal cavities.

8. Larynx

They have well developed **voice apparatus** in the form of larynx (with vocal cords) and epiglottis.

9. Fertilization

In mammals, fertilization is internal.

10. Classification: There are three groups of mammals. They are **monotremes**, **placental** and **marsupials**.

i. **Monotremes** are egg-laying mammals that lay eggs in which whole development of their embryo proceeds. They are oviparous e.g., Duckbill platypus and echidna (spiny anteater).

ii. **Marsupials** have a pouch (marsupium) on the abdomen of female. These mammals give birth to immature young ones which complete their development in mothers' pouch. Opossum, kangaroo and Tasmanian wolf are the examples of such mammals.



Duckbill platypus



Spiny anteater

Fig: Representative egg-laying mammals



Qoul



Kangaroo



Opossum

Fig: Representative pouched mammals

3. Placental mammals are the **most advanced mammals**. During development, a structure called placenta, is formed between mother's uterus wall and foetus body. The foetus is nourished and wastes from foetus are removed through this **placenta**. They give birth to young ones i.e. they are **viviparous**. Dolphin, rat, monkey, bat, elephant and human are some examples of placental mammals.

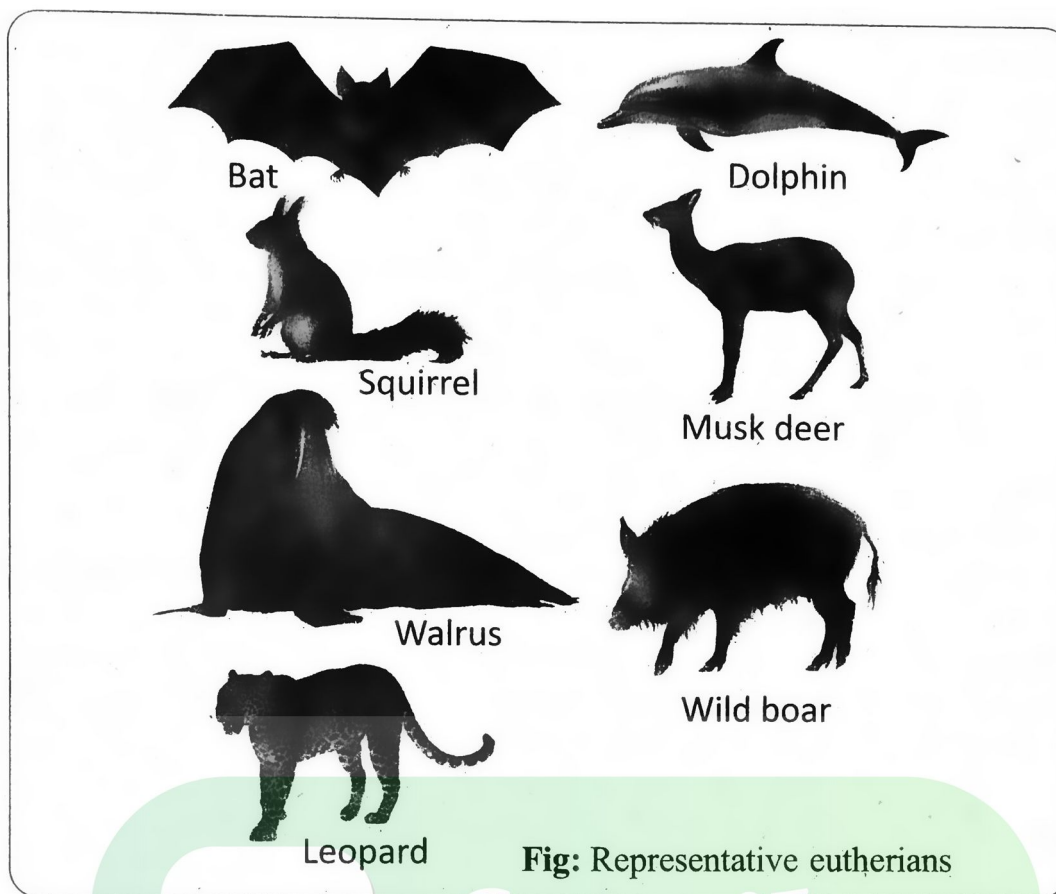


Fig: Representative eutherians

CLASSIFICATION OF VIRUSES

Q22. Why viruses are not the part of any domain/kingdom?

Ans. Acellularity: Viruses are not considered organisms because they are acellular i.e.; not made of cells. They lack any of the characteristics of the three domains of life and are not classified in any domain and kingdom.

Structure of Viruses: A virus consists of **nucleic acid** (DNA or RNA) surrounded by a **protein coat**.

Reproduction: They cannot run any metabolism and depend upon the host cell (including plants, animals, and bacteria) to replicate and synthesize their proteins.

Classification: Viruses are classified based on several characteristics, including their genetic material, replication strategy, morphology, and the hosts they infect. The classification of viruses follows guidelines established by the International Committee on Taxonomy of Viruses (ICTV).

Q23. Write a note on classification of viruses on the basis of host range, morphology and genetic material.

Ans.

1. Classification on the bases of Host Range

i. Animal Viruses: Infect animals, including humans. Examples: Influenza virus, Rabies virus.

ii. Plant Viruses: Infect plants e.g., Tobacco mosaic virus, Potato virus X.

iii. Bacteriophages: Infect bacteria e.g., T4 phage, Lambda phage.

iv. **Archaea Viruses:** Infect archaea e.g., Sulfolobus spindle-shaped virus.

2. Classification on the basis of Morphology

i. **Helical Viruses:** These have a capsid with a helical structure surrounding the nucleic acid.
Examples: Tobacco mosaic virus, Rabies virus.

ii. **Icosahedral Viruses:** These have a capsid with a symmetrical icosahedral shape (having 20 faces).
Examples: Adenoviruses, Herpesviruses.

iii. **Complex Viruses:** These have a complex structure, often with a combination of icosahedral and helical features, and sometimes additional structures like tails.
Examples: Bacteriophages (viruses that infect bacteria).

iv. **Enveloped Viruses:** These have an outer lipid envelope derived from the host cell membrane, surrounding their capsid.
Examples: Influenza virus, HIV.

v. **Non-enveloped (Naked) Viruses:** These lack an outer lipid envelope and consist only of a capsid enclosing the nucleic acid.
Examples: Poliovirus, Adenovirus.

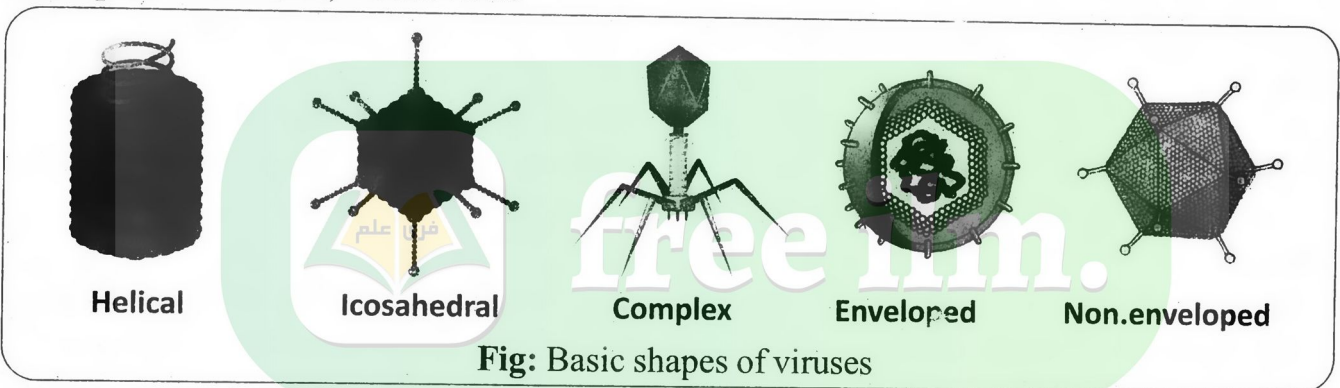


Fig: Basic shapes of viruses

3. Classification on the basis of Genetic Material

i. **DNA Viruses:** Viruses with DNA as their genetic material. This DNA can be single stranded (ssDNA) or double-stranded (dsDNA). Examples include:

- **dsDNA viruses:** Adenoviruses (cause respiratory infections), Herpes viruses (cause herpes, chickenpox).

- **ssDNA viruses:** Parvoviruses (cause gastroenteritis).

ii. **RNA Viruses:** Viruses with RNA as their genetic material. This RNA can be single stranded (ssRNA) or double-stranded (dsRNA). Examples include:

- **ssRNA viruses:** Coronaviruses (cause COVID-19), Influenza viruses (cause flu).

- **dsRNA viruses:** Rotaviruses (cause gastroenteritis).

4. Classification on the basis of Replication Strategy

i. **Positive-Sense RNA Viruses:** The RNA genome is directly translated into proteins by the host cell's ribosomes. Examples include **Poliovirus, Hepatitis C virus**.

ii. **Negative-Sense RNA Viruses:** The RNA genome is transcribed into mRNA by a viral RNA polymerase before translation. Examples include Rabies virus, Ebola virus.

iii. **Reverse Transcribing Viruses:** These viruses replicate through a DNA intermediate using the enzyme reverse transcriptase. They can have RNA or DNA genomes.

Examples:

- **RNA genome:** Retroviruses like HIV (cause AIDS).
- **DNA genome:** Hepadnaviruses like Hepatitis B virus.

★Q24. Describe the concept of an ecosystem and niche.**Ans. Ecosystem**

An ecosystem is a dynamic and interactive system composed of living organisms and their physical environment. It includes all the biotic factors as well as the abiotic factors.

i. Biotic Components

Biotic components include all living organisms including plants and animals supported by biosphere. Biosphere is spread out over the surface of the planet earth extending about 8-10 kilometers to the upper reaches of atmosphere and also the same distance into the depths of oceans.

ii. Abiotic Components

Abiotic components include all **non-living** components **air, water, and soil**. In ecological term they are called as: (a) atmosphere --- (atmo – air, sphere – place) (b) hydrosphere --- (hydro – water, sphere – place) (c) lithosphere --- (litho – earth-soil, sphere – place).

Niche

A niche refers to the role or function of an organism or species within an ecosystem. It includes its habitat, its interactions with other organisms (predation, competition, and symbiosis), and its role in energy flow within the ecosystem.

Factors

- Ecological niche with habitat also specifies how the organism gets its supply of energy and materials – for examples organism's predators, prey and competitor as well as its behaviour and interactions are considered elements of its niche.
- In addition, niche includes all the physical factors of the environment necessary for survival, such as range of temperature, amount of humidity, the pH of the water and soil.

Q25. Define Biodiversity. Explain the different levels at which biodiversity can be assessed. How do these levels contribute to our understanding of biological diversity and conservation efforts?**Ans. Biodiversity**

Biodiversity, a term derived from "biological diversity," refers to the **variety of life forms** present in different ecosystems, encompassing the diversity of species, genes, and ecosystems. It represents the richness and variability of living organisms and their interactions with each other and their environments.

Biodiversity Assessment Levels

The assessment of biodiversity involves multiple levels, each providing unique insights into the complexity of life.

- i. Species Level:** At the species level, biodiversity is assessed by **identifying and counting** the **different species** present within a given area. Species diversity includes not only the number of species but also their relative abundance and distribution.

By assessing biodiversity at species level helps the biologists to know about the threatened or endangered species in area of particular study and to take prompt actions to conserve them.

ii. Genetic Level: At the genetic level, biodiversity refers to the **variety of genetic information** contained within all individual organisms of a species. This genetic diversity is crucial for the adaptability and survival of species, enabling them to cope with environmental changes and challenges.

Assessment at genetic level helps the biologists in conservation of those species which have lesser genetic variety, because of fewer genetic variations in a species increases the risk of extinction.

iii. Ecosystem Level: At this level, biodiversity assessment includes the **range of habitats**, from forests and wetlands to grasslands and deserts. It involves understanding how different ecosystems function and how they contribute to overall ecological health.

It helps the biologists in the protection and conservation of habitats by restoration of degraded ecosystems and protecting those ecosystems which at risk of being degraded.

Q26. What is random sampling? Discuss the importance of random sampling methods in ecological studies.

Ans. Random Sampling

Sampling is a method of **investigation** the abundance and **distribution of species** and populations within a **given time** and in a **specific area**. There are **two** different types of sampling i.e. **random** and **systematic**.

In random sampling the **location of sampling** is selected **randomly** or due to chance.

Importance of Random Sampling in Determining Biodiversity

Random sampling is a fundamental technique in ecological studies for assessing biodiversity within a specific area. This method is crucial for several reasons:

- 1. Minimizes Bias:** It ensures that every part of the study area has an equal chance of being sampled, which provides a more accurate representation of the overall biodiversity.
- 2. Provides Reliable Estimates:** Random sampling allows for the collection of data that can be statistically analyzed to estimate species richness, abundance, and distribution.
- 3. Facilitates Comparisons:** It enables comparisons between different areas or habitats by providing standardized methods of data collection.
- 4. Enhances Representativeness:** By covering different parts of the study area, random sampling ensures that the sample represents the diversity of the entire area.
- 5. Supports Conservation Efforts:** Accurate biodiversity assessments through random sampling are essential for identifying areas of high conservation value and for monitoring changes in biodiversity over time.

Q27. Describe the various methods to assess biodiversity and discuss their importance.

Ans. Methods to Assess Biodiversity

Various methods are employed for assessing the distribution and abundance of organisms in an area:

Methods to Assess Distribution

1. Quadrat Sampling

It involves dividing the **study area into a grid** and sampling within randomly selected squares (quadrats).

Importance: This method is particularly **useful for studying plant populations** or sessile organisms. **For example**, in a forest, a researcher might lay out quadrats of a fixed size and record the presence or absence of each plant species within these quadrats.

2. Transect Sampling

It involves **laying out a line or strip** (transect) across the study area and recording species at regular intervals along this line.

Importance: This method is effective for **studying the distribution of species** across environments. **For example**, in a coastal zone, a transect can be laid from the high tide line to the low tide line, to record the types and abundance of intertidal organisms.

3. Aerial Surveys

Aerial surveys use aircraft or drones to observe and record the **distribution of organisms over large areas**.

Importance: For example, it can be used to track the distribution of bird species across a large wetland area or to monitor large mammal populations in savannas.



Fig: Methods to assess distribution of organisms

Methods to Assess Abundance

1. Point Counts: Point counts involve observing and recording the number of individuals of a species from a fixed point over a specified period. This method is commonly used for birds and other mobile animals.

2. Mark-Recapture: It involves capturing, marking (by tags, painting, bands), and releasing individuals of a species, then recapturing them later to estimate population size and density. This method is useful for animals that are difficult to count directly.

3. Quadrat Counts: In this method, researchers use quadrats to count the number of individuals of a species within each quadrat and then infer these counts to estimate overall abundance.

4. Capture-Recapture Methods: These models account for variables such as varying capture probabilities and movement between areas. This method helps in the estimation of a population size, where organisms (particularly animals) keep on moving between different areas.

5. Remote Sensing: Remote sensing uses **satellite or drone imagery** to assess the abundance and distribution of species, particularly for large-scale or inaccessible areas.

SPECIES AND SPECIATION

Q28. Define species and speciation. Explain the concept of species according to the biological species concept. How does this definition help in understanding species boundaries and the process of speciation? Provide examples to illustrate your points.

Ans. Species

Definition: The term "species" is a fundamental concept in biology. A species is generally defined as a group of individuals that can interbreed and produce fertile offspring under natural conditions.

Characteristics

- Members of the same species **share common characteristics and genetic makeup**, which distinguishes them from individuals of other species. Identification of species by using physical traits and similarities can sometimes be problematic due to the existence of cryptic species - organisms that appear similar but are genetically distinct.
- German-American biologist, Ernst Mayr, emphasized **reproductive isolation** as the key criterion. According to this concept, species are groups of **interbreeding natural populations**. Members of different species do not typically mate or produce viable, fertile offspring.

Speciation

Definition: Speciation is the evolutionary process by which **new species arise** from a common ancestor. It involves the accumulation of genetic changes that lead to reproductive isolation between populations.

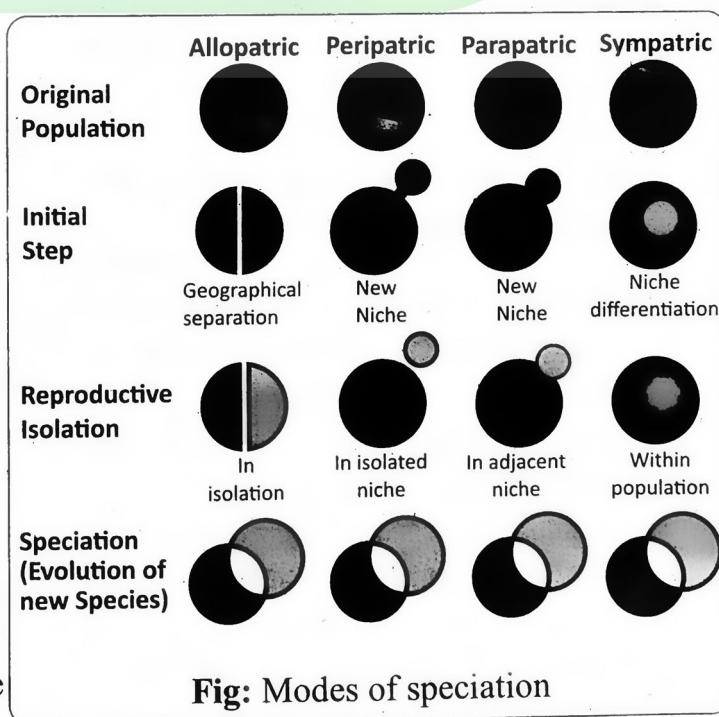
Mechanisms of Speciation

There are several mechanisms of speciation, for example:

1. Allopatric Speciation

It occurs when a population is geographically separated into two or more isolated groups. These groups experience different environments and evolve independently. Over time, the accumulated differences can become significant enough to prevent interbreeding, even if the geographical barrier is removed.

Example: An example is the speciation observed in Darwin's finches on the Galápagos Islands, where different populations adapted to diverse environments.



2. Peripatric Speciation

It involves a small, isolated population at the edge of a larger population. The small population undergoes rapid evolutionary changes, leading to divergence from the original population.

Example: An example can be seen in island species that evolve from a small founding population.

3. Parapatric Speciation

This occurs when populations are adjacent to each other but occupy different environments along a gradient. Gene flow between the populations is limited, and they evolve adaptations to their specific environments. Over time, this can lead to reproductive isolation.

Example: An example is the grass species "*Anthoxanthum odoratum*", which exhibits different adaptations to varying soil conditions across a gradient, leading to reproductive isolation in different soil types.

4. Sympatric Speciation

In this form, **new species** arise within the **same geographical area** without **physical barriers**. Sympatric speciation often occurs through mechanisms such as polyploidy (where an organism has multiple sets of chromosomes) or niche differentiation (where different subpopulations exploit different resources).

Example: For instance, certain plants can undergo polyploidy, leading to immediate reproductive isolation and the formation of new species.



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