

## CHAPTER

# 4

# ANIMAL KINGDOM

## Chapter Objectives

Salient features and classification of animals non-chordates up to phyla level, Chordates up to class level (three to five salient features and at least two examples of each category).

## STUDY MATERIAL

### I. Concept Clarified

#### 1. INTRODUCTION

Everyday you come across a number of animals. If we look at our surroundings, we can see a diverse range of animals. Some fly, some creep, some jump, some walk and some swim. Just observe them, how different they look, how differently they behave, their habits, their habitats, everything is so diverse and different and yes amazing too. Can you imagine that these organisms, varying from sponges to sharks, ants to whales, earthworms to anacondas, all belong to the same group, *i.e.*, **Kingdom Animalia**.

As over a million species have been described till now, the need for classification becomes more important.

#### 2. KINGDOM ANIMALIA: BASIC FEATURES OF ALL ANIMALS

The kingdom Animalia is characterised by **heterotrophic eukaryotic organisms** that are multicellular and their cells lack cell walls.

##### (a) Heterotrophic Nutrition

All animals are heterotrophs. They directly or indirectly depend on plants for food. As we know animals can be herbivores, carnivores or omnivores, on the basis of their nutritional requirements.

##### (b) Holozoic Mode of Nutrition

Nutrition involving engulfment of the whole or part of plant or an animal either in solid or in liquid state is called as animal like or holozoic nutrition. It involves the **ingestion, digestion** (*i.e.*, breakdown by enzymes), **absorption** and **assimilation** to properly utilize the food. Glycogen and fat are the common food reserves in animals.

##### (c) Eukaryotes

All animals are eukaryotes, (the organisms whose body are made up of eukaryotic cells). Unlike plant cells, the animal cells do not have any cell wall. They only have cell membranes to maintain their shape and form.

##### (d) Multicellular

All are multicellular. Their body is made up of more than one cell.

##### (e) Growth

The animals show a definite growth pattern from birth to death. All of them grow into adults that have a definite shape and size. Sometimes, the organism undergo metamorphosis.

##### (f) Locomotion

Most of the animals are capable of locomotion. Animals move from place to place in search of food, shelter, protection, and mates etc. Although, there are some lower animal forms that cannot move from one place to another and are said to be sessile *e.g.*, sponges.

##### (g) Nervous and Sensory Control

Higher animals show elaborate sensory and neuromotor mechanism and are aware of their surroundings. Their nervous, sensory and endocrine systems fully control and coordinate the body.

**(h) Reproduction**

Sexual reproduction is the major mode of reproduction followed by embryological development. Some lower animals also undergo asexual modes of reproduction like fragmentation, budding etc.

**3. BASIS OF CLASSIFICATION**

Following features are used as the basis of animal classification:

**(a) Levels of Organisation:**

Though all members of Animalia are multicellular, all of them do not exhibit the same pattern of organisation of cells. The cells are variously arranged in them to form different levels.

- (i) Cellular level of organisation:** Cells are the basic unit in this level and perform vital functions of an organism. In sponges the cells are arranged as loose cell aggregates but they do not form any tissue. Some division of labour (activities) occur among the cells.
- (ii) In tissue level of organisation** the arrangement of cells is more complex. Here the cells performing the same function or structure and are arranged to form tissues. The tissues perform the various basic functions of animals. This level of organisation is present in **coelenterates** and **ctenophores**.
- (iii) Organ level of organisation:** When tissues are grouped together to form organs, this level is called organ level of organisation. Here, each organ is specialised for a particular function. This level is exhibited by **platyhelminthes**.
- (iv) Organ-system level of organisation:** In higher animals, organs are associated to form functional systems and each system concerned with a specific physiological function. For example, various organs like stomach, intestine, gall bladder, pancreas etc. unite to form the digestive system which is concerned with digestion of food.

Different organ systems depend upon each other to maintain the functioning of an organism. This level is exhibited by **aschelminthes to chordates**.

**(b) Patterns of Complexities of Various Organ Systems**

Organ and organ system levels began in lower animals like **platyhelminthes** and **aschelminthes** but their complexity keeps on increasing from lower to higher phyla. These complexities can be used as a basis of classification of animals.

- (i) Digestive system:** The digestive system of animals can be of two types on the basis of complexity:
  - **Incomplete digestive system:** In this the digestive system has only a **single** opening to the outside of the body that serves as both mouth and anus. **Coelenterates, ctenophores and platyhelminthes** possess incomplete digestive system.
  - **Complete digestive system:** In this the digestive system has **two** openings; mouth for the intake of food and anus for the elimination of faecal matter. **Aschelminthes to chordates**, all possess complete digestive system.
- (ii) Circulatory system:** The circulatory system may be of two types:
  - **Open circulatory system:** In an open type the body cells and tissues are directly bathed in the blood pumped out of the heart as the blood flows in open spaces. Hence, there is a direct contact and exchange of materials between the blood and body cells. *e.g.*, **Arthropods, non-cephalopod molluscs, hemichordates and tunicates**.
  - **Closed circulatory system:** In this system, the blood circulates through a series of the blood vessels without ever coming in direct contact with the body cells. A series of these vessels maintain the continuous flow of blood. The exchange of materials between blood and body cells takes place in the capillaries. *e.g.*, **Annelids, cephalopod molluscs, chordates**.
- (iii) Reproductive system:** Lower animals like sponges, coelenterates undergo asexual reproduction along with the sexual reproduction, while in higher animals, sexual reproduction becomes the predominating mode of reproduction.

The complexity in the structure of reproductive organs keeps on increasing from lower to higher phyla.

**(c) Body Symmetry:**

Animals can be classified on the basis of their symmetry also.

On the basis of body symmetry, the animals can be

- (i) Asymmetric:** When any plane passing through the centre does not divide the body into equal halves, the organism is said to be asymmetric. *e.g.*, sponges.

- (ii) **Radially symmetric:** When any plane passing through the central axis of the body divides the organism into two identical halves, it is called radial symmetry *e.g.*, some sponges, coelenterates, ctenophores, adult echinoderms.
- (iii) **Bilaterally symmetric:** When the body can be divided into identical left and right halves in only one plane, it is called bilateral symmetry. For *e.g.*, Flatworms, crustaceans, and vertebrates etc.

**(d) Germ layers:**

Ectoderm, mesoderm and endoderm are the germ layers which arise during the embryo formation. These layers give rise to all the tissues /organs of the fully formed individuals. Depending upon the number of germ layers in the embryo, the animals can be:

- (i) **Diploblastic:** Those animals in which the developing embryo has only two germinal layers, *i.e.*, an external ectoderm and an internal endoderm, are called diploblastic animals *e.g.*, coelenterates and ctenophores.

An undifferentiated, jelly-like layer mesoglea is present in between the ectoderm and endoderm. The mesoglea is called undifferentiated because this layer is not specialised to form any particular tissue / organ of the body.

- (ii) **Triploblastic:** Those animals in which the developing embryo also has third germinal layer, *i.e.*, mesoderm, in between the ectoderm and **endoderm**, are called triploblastic animals.

*e.g.*, **Platyhelminthes to Chordates**, all animals are triploblastic.

- In sponges, although body cells are aggregated but they do not form the definite layers as cells are loosely arranged. That's why sponges are not regarded as truly diploblastic.

**(e) Coelom or Body Cavity**

A body cavity is any internal space or a series of spaces present inside the body. Whereas coelom or true body cavity generally refers to a large fluid-filled space (cavity) lying between the outer body wall and the inner gut wall (wall of digestive tube).

The coelom contains most of the visceral organs and is lined by mesoderm on all sides. Absence or presence of coelom forms the basis of classification:

- (i) **Coelomate:** The true coelom is a body cavity which arises as a cavity in embryonic mesoderm. In this case, the mesoderm of the embryo provides a cellular lining, called coelomic epithelium or peritoneum, to the cavity. The coelom is filled with coelomic fluid secreted by the peritoneum. True coelom is found in **annelids, echinoderms and chordates**.
- (ii) **Pseudocoelomates:** In some animals, the body cavity is present but it is not completely lined by mesoderm. Instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called pseudocoelom (*pseudo-false, coelom-body* cavity) and the animals possessing them are called pseudocoelomates, *e.g.*, aschelminthes.
- (iii) **Acoelomates:** Those animals in which the true body cavity or coelom is absent are called acoelomates. *e.g.*, sponges, coelenterates, ctenophores and platyhelminthes.

**(f) Segmentation**

Segmentation is defined as the division of body into parts or segments. In some animals, the body is externally and internally divided into segments and these body segments have a serial repetition of at least some organs. This kind of segmentation is called **metameric segmentation** and this phenomenon is known as **metamerism**. The body segments are called metameres. Metamerism is seen in earthworm. Segmentation is seen in **annelids, arthropods and chordates**.

**(g) Notochord**

Notochord is mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals. Animals with notochord are called chordates and those animals which do not form this structure are called non-chordates *e.g.*, Porifera to echinoderms.

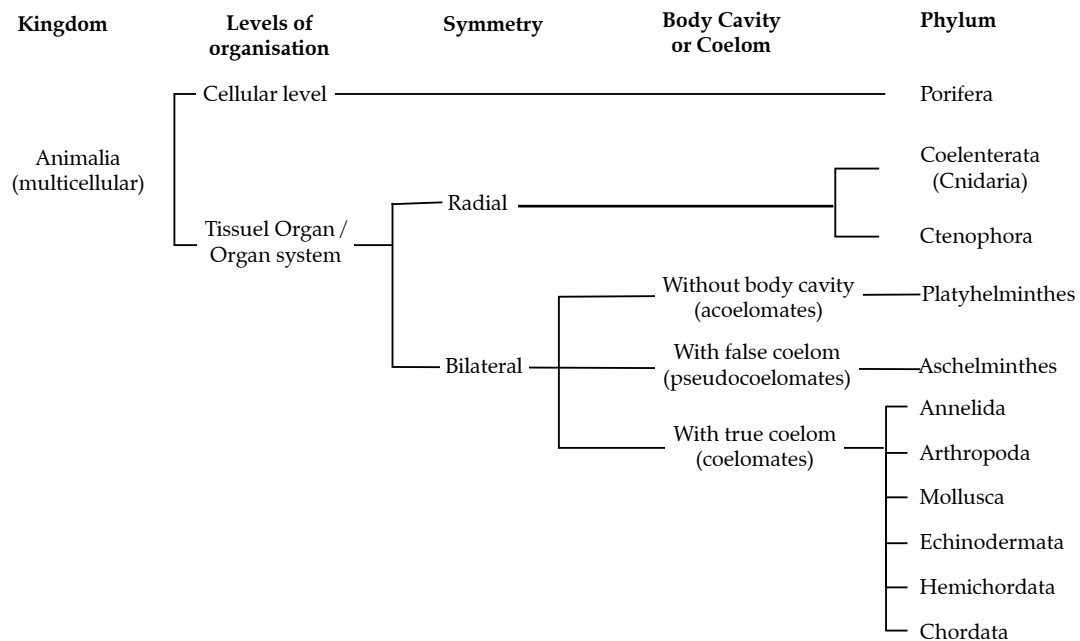
**4. ANIMAL CLASSIFICATION**

The broad classification of animalia based on common fundamental features is given in the following figure:

**5. THE SALIENT FEATURES OF DIFFERENT NON-CHORDATE PHYLA:**

➤ **Phylum - Porifera**

About 5000 species of sponges are known.



### Broad classification of kingdom animalia based on common fundamental features

Members of this phylum are commonly called as sponges. They are also known as **pore bearers** as their body walls possess numerous tiny pores.

#### General Characteristic Features of Porifera:

- Habitat:** All sponges are **aquatic** in their mode of living. Most of them are **marine** as they inhabit the oceans but a few sponges live in fresh-water also. For example, *Spongilla* is a fresh-water sponge. Sponges are **sessile** organisms and remain attached to an underwater object, called substratum.
- Body symmetry:** Sponges are the primitive multicellular animals. Most of them are **asymmetric** as any plane passing through their body centre not divide them into equal halves.
- Level of organisation:** They have cellular level of organisation. The cells in their body do not form the tissues. All cells act more or less independently and show little coordination. However, some division of labour is present among the cells.
- Body form:** Sponges have a water transport canal system because they have a porous body. It is the distinguishing feature of all the sponges. These numerous pores are meant for the entry and exit of water current.

These minute pores (ostia) lead into the single, central and spacious cavity called **spongocoel**; either directly or through other small canals. The water entering through the ostia brings the food and oxygen inside the body of sponge. From spongocoel, this water exits outside through a large opening, the **osculum**. This water takes the waste products and reproductive bodies (sperms) away from the sponge. These pores (ostia), canals, body cavity (spongocoel) and osculum form the **canal system** which is a peculiar feature of porifera.

The canals (if present) and the spongocoel are internally lined by characteristic **flagellated cells** called **choanocytes** or collar cells. The continuous beating of flagella of collar cells maintains the water current (flow) inside the body of sponge.

- Digestion:** Digestion is **intracellular** in sponges as the food is digested within the food vacuoles inside the cells.
- Skeleton:** Almost all sponges possess an internal skeleton, which provides the support to the body of sponge and comprises of **spicules** or **spongin fibres** or both. Further, the spicules may be **calcareous** (made up of calcium) or **siliceous** (made up of silica).
- Reproduction:** All sponges are **hermaphrodite**. Male gametes (sperms) and female gametes (ova) both are produced by the same individual. Hermaphrodite animals are also called **monoecious** and **bisexual**.

**Types of reproduction in sponges:** Both, **asexual** and **sexual** reproduction occur in them. They reproduce asexually by **fragmentation**

Sexual reproduction occurs by the formation of haploid male and female gametes. Fertilisation takes place inside the body of another sponge. As the fertilisation occurs within the body of sponge it is called **internal fertilisation**. It results in the formation of a diploid zygote.

- (h) **Development:** In sponges, the development of adult sponge from diploid zygote is **indirect** which means it is mediated by an **intermediate free swimming flagellated larval stage** for dispersal of species. Larval stage is morphologically distinct from adult.

**Example of sponges:** *Sycon* (**Scypha**), *Spongilla* (fresh water sponge) and *Euspongia* (bath sponge).

➤ **Phylum - Coelenterata (Cnidaria)**

Phylum Cnidaria includes about 9,000 species.

**General Characteristic Features of Animals of Phylum - Cnidaria:**

- (a) **Habitat:** The animals of this phylum possess **aquatic** habitat as they inhabit the water bodies. They are also mostly marine but few are fresh water inhabitants also (*e.g., Hydra*).

- (b) **Habits of living:** The coelenterates can be (i) solitary or (ii) colonial.

Those animals which live singly and are independent, without association of other individuals of the same type are called **solitary** animals *e.g., Hydra*.

Those animals which live in association with other individuals of the same type are called **colonial** animals. *e.g., Physalia, Obelia* are the colonial coelenterates.

The coelenterates can be either (i) sessile or (ii) free-swimming or free-floating.

- (c) **Body symmetry:** The coelenterates are the **radially symmetrical** animals as any plane passing through the central body axis divides these animals into two identical halves.

- (d) **Level of organisation:** First time in the animal kingdom, cells associated to form the tissues in coelenterates. Hence, they exhibit the **tissue level** of organisation.

- (e) **Germ layers:** These are the **diploblastic** animals as cells in their embryonic stages are arranged in two layers, outer ectoderm, inner endoderm with an intervening gelatinous layer mesoglea. This mesoglea provides the jelly-like form to some coelenterates.

- (f) **Digestive tract:** The body of coelenterates bear a central **gastro-vascular cavity** which opens to the outside through a single opening called **mouth** present on the hypostome. Hypostome is a conical elevation present on the free (non-attached) end of the body. Entry of food and exit of waste material takes place through this single opening called mouth.

Externally, the body bears elongated flexible structures called tentacles which help in feeding, feeling and grasping of prey.

- (g) **Cnidoblasts or Cnidocytes:** The name cnidaria is derived from one of the most characteristic of all coelenterates, the **stinging cell** called cnidoblasts or cnidocytes. Cnidoblasts are used for anchorage, defence and for the capture of prey.

Cnidoblasts are present on the tentacles and the body. These specialised cells bear a nucleus which is present near its base and a stinging capsule called **nematocyst**. This capsule is filled with a poisonous fluid called **hypnotoxin** which is injected with the help of a thread tube.

**Functions of Cnidoblasts:**

- (i) In the freely swimming cnidarians, cnidoblasts provide the **anchorage** while locomoting from one place to another. These cells help in the adhesion of cnidarians on to the surface they move.
  - (ii) These help the organism in **capturing the prey**.
  - (iii) Cnidoblasts are also used for **defence** by cnidarians as these cells protect these animals against the attack of other animals by either paralyzing them or killing them with the help of their toxin and spines.
- (h) **Digestion:** The food (prey) captured is directed to the gastro-vascular cavity. The digestive juices released here act upon the ingested food and various enzymes act on this, resulting in its breakdown. This type of digestion occurring in the cavity, outside the cells, is called **extracellular digestion**.
- (i) **Skeleton:** Some of the cnidarians, *e.g.,* corals have a hard skeleton composed of **calcium carbonate**.

**Coral reefs:** Coral colonies grow continuously in size and often form extensive masses known as coral reefs. It is a ridge or mound of limestone, the upper surface of which is near the surface of sea and is formed chiefly of calcium carbonate produced by some of its inhabitant, chiefly corals. Coral reefs form stable marine ecosystem.

- (j) **Body forms:** Two basic body forms are found in cnidarians which differ in the structure and function from one another. These are called **polyp** and **medusa**. Polyp is a **cylindrical** form which remains attached to the substratum (hence sessile) whereas medusa is an **umbrella-shaped** and free-swimming form.

Some cnidarians exist only in polyp form, e.g., *Hydra*, *Adamsia*, while some have medusa as the dominant form in their life cycle (polyp may be reduced or absent), e.g., *Aurelia* (jelly-fish). Some other cnidarians exist in both forms, i.e., polyp as well as medusa, e.g., *Obelia*. Those cnidarians which exist in both the forms show alternation of generation in their life (**Metagenesis**).

The polyps produce medusae asexually and medusae form the polyps sexually.

Examples : *Physalia* (Portuguese man-of-war), *Adamsia* (sea anemone), *Pennatula* (sea-pen), *Gorgonia* (sea-fan) and *Meandrina* (Brain-cora)

#### ➤ Phylum - Ctenophora

The ctenophores are called comb-bearers. The phylum takes its name from two Greek words *ktenes*-comb and *phors*-bearing. They are also called comb-jellies and sea walnuts.

#### General Characteristic Features of Ctenophora:

- (a) **Habitat:** Ctenophores are exclusively **marine** hence found in oceans. They are the free-swimming animals.
- (b) **Body symmetry:** They are **radially** symmetrical animals.
- (c) **Level of organisation:** They exhibit the **tissue level** of organisation.
- (d) **Germ layers:** Ctenophores are the **diploblastic** animals. Embryonic layers are outer ectoderm, inner endoderm with an undifferentiated layer mesoglea in between them.
- (e) **Body form:** They have a transparent body. The body shape varies from flat to oval. The external surface of the body bears eight external rows of ciliated which **comb plates** help in the **locomotion**.
- (f) **Digestion:** Digestion is **both extracellular** and **intracellular**. The food is captured by the tentacles and directed to the gastro-vascular cavity of body. First the digestion takes place in the cavity (extracellular) and then inside the food vacuoles (intracellular).
- (g) **Reproduction:** Ctenophores are **hermaphrodite**. Sperms and ova are produced by the same individual. Asexual reproduction is absent in ctenophores. Reproduction takes place only by sexual means.
- (h) **Fertilisation:** The fertilisation is **external** as fusion of sperm and ovum takes place outside the body of animal in the water.
- (i) **Development:** Following fertilisation, zygote develops into a free swimming larva called **cydippid larva** which later develops into the adult. Hence, the development is **indirect**.
- (j) **Bioluminescence:** Bioluminescence is the property of production and emission of light by a living organism. This property is well marked in ctenophores as they emit light and hence, shine against the dark backgrounds.

**Examples of ctenophores:** *Pleurobrachia*, *Ctenoplana*.

#### ➤ Phylum - Platyhelminthes

**Introduction:** The animals of this phylum have a **dorso-ventrally** flattened body. Their upper (dorsal) and lower (ventral) body surfaces are flat and that's why they are commonly called **flatworms**.

General Characteristic Features of Platyhelminthes:

- (a) **Habit and Habitat:** These are mostly **endoparasites** as they live inside the body of other animals (called hosts) including human beings and thrive nutrition as well as shelter from them, e.g., *Fasciola*, commonly called liver fluke, lives in the liver and bile ducts of higher animals, i.e., vertebrates (sheep, dog and man etc.)  
Some flatworms are free-living also, and are mainly aquatic (marine or fresh water).
- (b) **Body symmetry:** These are **bilaterally symmetrical**.
- (c) **Level of organisation:** They are the first animals to have reached the **organ level** of organisation.

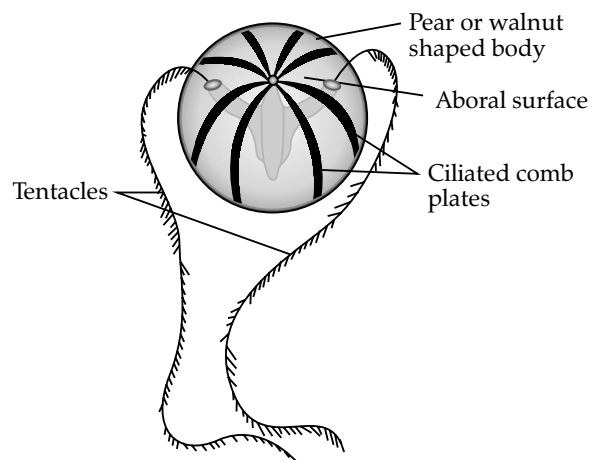


Fig. 1 : Example of ctenophora (*Pleurobrachia*)

- (d) **Germ layers:** Platyhelminthes are the **triploblastic** animals, their body structures are derived from three embryonic germ layers ectoderm, mesoderm and endoderm.
- (e) **Coelom:** Although they are the **triploblastic** animals bearing mesoderm but coelom (*i.e.*, mesoderm - lined body cavity) is lacking in them. Hence, flatworms are the **acoelomate** animals.
- (f) **Body form:** Flatworms have a dorso-ventrally flattened body.
- (g) **Digestive tract:** Digestive system in platyhelminthes has only a single opening to the outside of the body, that serves both as mouth and anus and hence it is incomplete. Digestive tract is absent in tapeworms.
- (h) **Parasitic flatworms:** They have special adaptations in their body to obtain nutrition from their hosts.

**Parasitic adaptations:**

- (i) **Hooks** are the **adhesive structures** which help the worm to attach to the internal body layers of host to obtain the firm adhesion. Hence, hooks act as the organs of attachment, present in *Taenia*.
- (ii) **Suckers** help in the **adhesion as well as ingestion** (of food). Suckers act as the suctorial organs which help in sucking the food from the body of host. Present in *Taenia* as well as *Fasciola*.
- (iii) **Direct absorption of food is through body surface** as seen in *Taenia*.
- (iv) **Thick tegument** is the body is externally a protective layer that protects the parasitic worms from the digestive juices of host.
- (i) **Excretion and osmoregulation:**  
**Flame cells** are the specialised cells of platyhelminthes which help in the excretion as well as osmoregulation.
- (j) **Reproduction:** The flatworms are **hermaphrodite** (monoecious). They mainly reproduce sexually by producing sperms and ova. However, some forms reproduce asexually also. *e.g.*, *Planaria*. It reproduces by **transverse binary fission**.
- (k) **Fertilisation:** The fertilisation is **internal** in flatworms.
- (l) **Development:** It is usually **indirect** with a complicated life cycle involving **many larval stages** and more than one host.  
**Example:** *Taenia* (Tapeworm), *Fasciola* (liver fluke)
- (m) **Regeneration:** Some flatworms possess a tremendous power of regeneration. *e.g.*, *Planaria*.

➤ **Phylum - Aschelminthes /Nemathelminthes**

**Introduction:** The Aschelminthes are commonly called **roundworms**, because the body appears circular in the transverse cross-section.

**General Characteristic Features of aschelminthes:**

- (a) **Habit and Habitat:** They may be free-living or parasitic. Free-living roundworms may be aquatic or terrestrial. Parasitic roundworms live in plants and animals (endoparasites). *Ascaris*, *Wuchereria* etc. are common animal endoparasites.
- (b) **Body symmetry:** Roundworms are **bilaterally** symmetrical.
- (c) **Level of organisation:** Aschelminthes have the **organ-system** level of organisation.
- (d) **Germ layers:** Roundworms are the **triploblastic** animals.
- (e) **Coelom:** Aschelminthes possess the pseudocoelom and hence called **pseudocoelomates**. The body cavity is present but is not lined by the mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm.
- (f) **Body form:** The roundworms have an elongated, cylindrical body which tapers towards both ends.
- (g) **Digestive system:** The digestive system is **complete** extending from mouth at one end to anus on other end of body. They have a well-developed muscular pharynx.
- (h) **Excretory system:** An excretory tube is present in the body of roundworms, which removes the body waste through an excretory pore.
- (i) **Reproductive system:** Sexes are separate, *i.e.*, aschelminthes are dioecious (unisexual). Males and females are distinct externally. Often females are longer than males. Sperms and ova are produced by different individuals. Only sexual reproduction takes place.
- (j) **Fertilisation:** Fertilisation is **internal**.
- (k) **Development:** Some develop through an intermediate larval stage and some directly without any larval stage. Hence, **both direct and indirect** development are seen in roundworms.

**Examples of Aschelminthes:** *Ascaris* (Roundworm), *Wuchereria* (Filaria worm), *Ancylostoma* (Hookworm), *Enterobius* (Oxyuris), *Dracunculus medinensis* (Guinea worm), *Rhabditis* (free living).

### ➤ Phylum - Annelida

The phylum annelida includes over 9,000 species of metamerically segmented animals with true coelom.

#### General Characteristic Features of Annelida:

- (a) **Habits and Habitats:** The annelids may be aquatic (marine and fresh water) or terrestrial. *e.g.*, *Nereis* is marine, Earthworm is terrestrial and *Hirudinaria* is a fresh-water annelid.  
Most of the annelids are free-living and some are parasitic in nature etc. *e.g.*, *Hirudinaria*.
- (b) **Common name:** The annelids are commonly called the segmental worms. Because of the presence of distinct segments in their body.
- (c) **Body symmetry:** The members of phylum annelida exhibit the bilateral symmetry.
- (d) **Level of organisation:** They exhibit the organ-system level of organisation as they possess well developed organ systems like digestive system, excretory system, circulatory system etc.
- (e) **Germ layers:** These are the triploblastic animals and their body tissues are derived from all the three germ layers *i.e.*, ectoderm, mesoderm and endoderm.
- (f) **Segmentation:** The body of annelids is metamerically segmented and the external segmentations of the body correspond to the internal segmentations. They are the first animals to possess true body segmentation. The body segments are called metameres and the segmentation is called metameric segmentation.  
The phylum name annelida is derived on the basis of presence of segmentation in the body of its members.
- (g) **Locomotion:** The annelids have the capability to locomote, whether they are terrestrial or aquatic. Their body wall is muscular two types of muscles are present in the body wall *i.e.*, **circular and longitudinal muscles**.  
Some aquatic annelids such as *Nereis* possess locomotory appendages. They bear fleshy, flattened, laterally projected structures in their body, called parapodia (singular: parapodium).
- (h) **Digestive system:** Digestive system is complete and contains distinct mouth and anus at opposite ends of body. The digestion of food is entirely extracellular, taking place outside the cells in the cavity (lumen) of digestive tract.
- (i) **Circulatory system:** A closed circulatory system is present. The blood is red-coloured due to the presence of respiratory pigment (haemoglobin) dissolved in the plasma. Blood flows in the blood vessels (exception: leech).
- (j) **Excretory system:** Coiled tubes are present in the body, called nephridia (singular: nephridium) which help in removing out the metabolic waste from body. It also help in maintaining the body fluid (water) and salt concentration. Hence, nephridia help in excretion as well as osmoregulation.
- (k) **Nervous system:** Body control is provided by the nervous system consisting of paired ganglia (singular: ganglion) which are connected to the double ventral nerve cord by lateral nerves. These paired ganglia act like the brain of annelids.
- (l) **Reproductive system:** Earthworms and leeches are monoecious (hermaphrodites) as male and female sexes are not separate in them. *Nereis* is dioecious.

Only sexual reproduction is seen in annelids (no asexual reproduction).

**Examples of Annelida:** *Nereis* (Sandworm), *Pheretima* (Earthworm) and *Hirudinaria* (Blood sucking leech).

### ➤ Phylum - Arthropoda

**Introduction:** It is the largest phylum of animal kingdom with about 9,00,000 species. Over two-thirds (about 60 to 70%) of all named species on the earth are arthropods.

**Examples of Arthropoda:** (a) Locust (b) Butterfly (c) Scorpion (d) Prawn

#### General Characteristic Features of Arthropoda:

- (a) **Habit and Habitat:** These animals inhabit a variety of habitats like oceans (*e.g.*, *Limulus*), fresh-water (*e.g.*, *Daphnia*), land (*e.g.*, cockroach, locust), air (housefly, mosquito).
- (b) **Body symmetry:** Arthropods are the **bilaterally symmetrical** animals.
- (c) **Level of organisation:** These animals have the **organ-system** level of organisation.

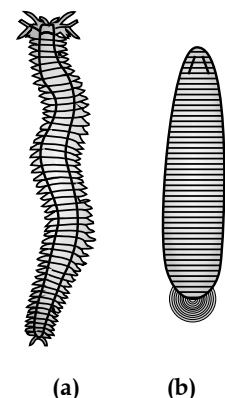


Fig. 2 : Annelidas:  
(a) *Nereis* (b) *Hirudinaria*

- (d) **Germ layers:** Arthropods are the **triploblastic** animals.
- (e) **Segmentation:** The body of arthropods is **segmented**.
- (f) **Coelom:** Arthropods are the coelomates as **true coelom** is present in them. Visceral organs are present in the body cavity (coelom).
- (g) **Body form:** The body of arthropods is covered by a hard, water-proof exoskeleton made up of **chitin**. This **chitinous exoskeleton** is one of the reasons of successful existence of arthropods on the earth. It provides protection and also prevents the loss of water due to evaporation thus, enabling the arthropods to live in relatively dry environments.  
The body of arthropods is divided into 3 well-defined regions, *i.e.*, anterior **head**, middle **thorax** and posterior **abdomen**. Head, thorax and abdomen are further divided into segments making the body segmented.
- (h) **Digestive system:** The digestive tract is **complete** and has glands. The digestive glands release enzymes to aid the process of digestion. The digestion of food is **extracellular**.
- (i) **Respiratory structures:** Various types of respiratory structures are present in different groups of arthropods. Gills as in aquatic arthropods like prawns, crabs, book gills as in *Limulus*; book lungs as in scorpions, spiders, and tracheal system as in insects are the respiratory structures.
- (j) **Circulatory system:** The circulatory system is of **open type** and the blood flows freely within the body cavity. To compensate the poorly developed circulatory system, respiratory system is well-developed in the arthropods.
- (k) **Sensory system:** All the major senses, *i.e.*, touch, smell, hearing, sight are found in arthropods due to various types of sensory organs having receptors for sensing the external stimuli. Different types of sensory organs found in arthropods are: antennae, eyes (compound and simple) and Statocysts or balance organs.
- (l) **Excretory system:** The excretory system consists of fine, long, blind tubules (small tubes) called **malpighian tubules**.
- (m) **Reproductive system:** Arthropods are mostly **dioecious**. Male & female sexes are separate. The females are mostly **oviparous** (egg-laying).
- (n) **Fertilization:** Fertilization is **usually internal** (all land arthropods).
- (o) **Development:** The development is direct in some and indirect in others. Hence, both types of developments are seen in the arthropods. Examples of arthropods undergoing indirect development are *Culex*, *Anopheles* and *Bombyx* and of direct development are **cockroach** and **locust**.

#### Examples of Arthropods:

- (i) **Economically useful insects:** Many insects are economically important to man as they provide various useful products. Some of them are:
  - (a) **Apis (Honey bee):** **Honey** is the most important product of honey bees which is used as food as well as in the medicines. Other product is **bees wax** which is used in cosmetics, paints etc.
  - (b) **Bombyx (Silkworm):** It provides the **silk** which is used in making sarees, shawls and other garments.
  - (c) **Laccifer (Lac insect):** Lac is the secretion of lac insect which acts as a sealing wax and used in making bangles, toys etc.
- (ii) **Vectors:** Many insects act as vectors of deadly diseases. Some of them are:
  - Anopheles:* *Anopheles* mosquito is the vector of **malaria**;
  - Culex:* *Culex* mosquito is the vector of **filariasis** (elephantiasis) which is caused by *Wuchereria*;
  - Aedes:* *Aedes* mosquito spreads the **dengue** fever and chikungunya.
- (iii) **Gregarious (Living in groups) pest: Locusta (locust)** is a pest which is dangerous to the crops.
- (iv) **Living fossil: Limulus** (king crab). It continues to remain unchanged for the past about 190 million years.

#### ➤ Phylum - Molluscs

**Introduction:** Mollusca is the **second largest** phylum of animal kingdom. This phylum includes the **soft-bodied** animals. The name Mollusca is derived from Latin word *mollis* which means soft-bodied.

#### General Characteristic Features of Mollusca:

- (a) **Habitat:** Molluscs are found in all habitats, they are terrestrial as well as aquatic (marine or fresh, water).
- (b) **Body symmetry:** These are the bilaterally symmetrical animals. In some mollusc, like *Pila*, due to torsion (twisting) during growth, the adults become asymmetrical.
- (c) **Level of organisation:** Molluscs have an *organ-system level* of organisation.
- (d) **Germ layers:** They are the **triploblastic** animals.

- (e) **Segmentation:** Segmentation is not found in body of molluscs hence, they have an **unsegmented** body.
- (f) **Coelom:** They possess a true body cavity or coelom lined by the mesoderm. So they are also the **coelomates**.
- (g) **Body form:** Body is covered by a calcareous shell and is unsegmented with distinct **head, visceral hump** and **muscular foot**.

Head is the anterior part of body which bears mouth and other structures like tentacles, eyes, etc. In some molluscs visceral hump contains the digestive tract and some visceral organs. Foot is a large muscular part of the body which is chiefly a locomotory organ.

- (h) **Mantle:** A soft and spongy layer of skin forms a thin and delicate covering over the visceral hump and is called mantle. It is a characteristic feature of molluscs. It serves many functions.

The space below mantle and above hump is called the mantle cavity.

This mantle cavity encloses the feather-like gills which help in the respiration as well as excretion.

- (i) **Digestive system:** The digestive system is complete and bears separate openings for entry of food and exit of waste. The digestive glands are also present. The digestion is extracellular.

The mouth of molluscs contains a file-like rasping (feeding) organ called **radula** which is armed with the transverse rows of chitinous teeth.

- (j) **Respiratory system:** In aquatic molluscs, gills are the respiratory organs present in mantle cavity while in terrestrial forms, lungs are the respiratory structures. The gills are called ctenidia (singular: ctenidium).

- (k) **Circulatory system:** Open circulatory system is present in molluscs in which blood pumped by the heart passes through large vessels into open spaces or body cavities called as sinuses. Respiratory pigment is haemocyanin. Amongst molluscs cephalopods have closed circulatory system.

- (l) **Excretory system:** The gills also perform the function of excretion along with respiration. They separate the nitrogenous waste products from blood as they are richly supplied with blood.

- (m) **Sensory system:** The anterior head region may have sensory tentacles which are sensitive to touch. Alongwith tentacles, other sense organs like eyes (for light detection), statocysts (for balance) and receptors for smell, taste etc. are also present in their body.

- (n) **Nervous system:** It consists of paired ganglia and several nerves to provide nervous supply to the body.

- (o) **Reproductive system:** Molluscs are usually dioecious as sexes are separate in them *e.g.*, Pila, Sepia, Loligo, Octopus etc. Examples of monoecious forms are *Aplysia*, *Doris* etc. Molluscs are usually oviparous (egg-laying).

- (p) **Fertilisation:** Both external and internal fertilisation are seen in molluscs. Usually internal fertilisation occurs in them.

- (q) **Development:** Both direct and indirect development are seen in molluscs but usually indirect development occurs in them which is mediated by a free-swimming larval stage, *e.g.*, Pila and *Aplysia*. Examples of molluscs exhibiting direct development are *Loligo*, *Sepia* and *Octopus*.

**Some common examples of Molluscs are** Pila (Apple snail), *Pinctada* (Pearl oyster), *Sepia* (Cuttlefish), *Loligo* (Squid), *Octopus* (Devil fish), *Aplysia* (Sea-hare), *Dentalium* (Tusk shell) and *Chaetopleura* (Chiton).

#### ➤ Phylum - Echinodermata (Spiny bodies)

**Introduction:** Echinoderms are one of the most beautiful sea creatures. Echinodermata literally means “spiny or prickly skinned” (Greek, *echinos*-spiny, *derma*-skin). The animals of this phylum are spiny-bodied as they possess an *endoskeleton* (internal skeleton) of calcareous ossicles (small bones), embedded in the skin.

#### General Characteristic Features of Echinodermata:

- (a) **Habitat:** All echinoderms are exclusively marine and usually live at the bottom of sea hence they are the bottom dwellers.
- (b) **Habit:** No parasitic form is found in them. They are the free-living animals.
- (c) **Body symmetry:** The adult echinoderms are radially symmetrical but their larvae are bilaterally symmetrical. The echinoderms are unique in this feature that the larvae are bilaterally symmetrical (an advanced feature) while the adults developing from them are radially symmetrical (a primitive feature).
- (d) **Level of organisation:** They possess an organ-system level of organisation.
- (e) **Germ layers:** These are the *triploblastic* animals.
- (f) **Segmentation:** Body is unsegmented.
- (g) **Coelom:** Echinoderms are the *coelomate* animals.

(h) **Body form:** The adult echinoderms have a pentamerous radial symmetry and their body parts are arranged along the five axes.

Body shape varies from star-like (star fish) to globular or globe-like (sea urchin) to cylindrical (sea cucumber).

(i) **Water Vascular System:** It is the most distinctive feature of echinoderms. It consists of a **system of canals** which are filled with watery fluid. It consists of madreporite or sieve plate, stone canal, ring canal, radial canals and tube feet.

**Functions of water vascular system:** This system is called water vascular system because this system acts like the circulatory system of body maintaining the continuous flow of water in and out of the body. Locomotion capture and transport of food and respiration are its important function.

(j) **Digestive system:** Digestive system is **complete** with two separate openings. It lies along the dorso-ventral axis of body. Mouth lies on the lower (ventral) side and anus on the upper (dorsal) side of body.

(k) **Excretory system:** Specialised excretory system is **absent**. The excretory products diffuse from the body tissues into the coelomic fluid from where they are finally eliminated out.

(l) **Reproductive system:** The echinoderms are **usually dioecious** (sexes are separate). The reproduction is sexual.

(m) **Fertilisation:** Fertilisation is **usually external**, takes place in the sea water. Mature gametes (sperms and ova) are shed freely in surrounding sea water where fertilisation takes place.

(n) **Development:** Development is **indirect** with free-swimming bilaterally symmetrical larva.

**Examples of Echinoderms:** *Asterias* (Star fish), *Echinus* (Sea urchin), *Antedon* (sea lily), *Cucumaria* (sea cucumber), and *Ophiura* (Brittle star).

#### ➤ Phylum - Hemichordata

**Introduction:** Hemichordata was earlier considered as a sub-phylum under phylum chordata. But now it is placed as a separate phylum under non-chordata.

#### **General Characteristic Features of Hemichordata:**

(a) **Habitat:** It includes exclusively marine animals (like Echinodermata).

(b) **Body symmetry:** Hemichordates are bilaterally symmetrical animals.

(c) **Level of organisation:** They possess the organ-system level of organisation.

(d) **Germ layers:** These are the triploblastic animals.

(e) **Segmentation:** Segmentation is absent. They possess an unsegmented body.

(f) **Coelom:** These are the coelomate animals possessing mesoderm lined body cavity.

(g) **Body form:** These animals are very soft, fragile and worm-like appearance. The body is cylindrical in shape and is divisible into three distinct regions or parts:

(i) An anterior proboscis

(ii) Middle collar and

(iii) A long posterior trunk

(h) **Digestive system:** Digestive tract is **complete**.

(i) **Circulatory system:** The circulatory system is **open** type.

(j) **Respiratory system:** These are the aquatic animals and respiration takes place through the **gills**.

(k) **Excretory system:** The excretion of nitrogenous waste takes place through **proboscis gland**.

(l) **Reproductive system:** Hemichordates are dioecious (sexes are separate). Reproduction is mainly sexual.

(m) **Fertilisation:** Fertilisation is external, *i.e.*, in the sea water.

(n) **Development:** The development is mainly indirect with a free-swimming larva.

(o) **Examples of Hemichordates:** *Balanoglossus* (Tongue worm), *Saccoglossus* (Acorn worm).

## II. Know the Facts

➤ *Pinctada vulgaris* (Indian Pearl Oyster): Pearl is secreted by mantle on some external particles entangled in skin which causes irritation to animal. Chemically, pearl is calcium carbonate.

➤ **Classification** is placing the different organisms into common groups on the **basis of common fundamental features**.

➤ The cells arranged as loose cell aggregates form the **cellular level of organisation**.

➤ The groups of cells performing the same function are called as tissues which form the **tissue level of organisation**.

- The tissues specialised to perform a particular function are grouped into organs to form **organ level of organisation**.
- The organs concerned with a specific physiological function associated to form **organ-system** level of organisation.
- When any plane passing through the central axis of the body divides the organism into two identical halves the body possesses **radial symmetry**.
- When body can be divided into identical left and right halves in only one plane, it is said to possess **bilateral symmetry**.
- **Mesoglea** is defined as an undifferentiated layer present in between outer ectoderm and inner endoderm in diploblastic organism.
- The body cavity between the body wall and the gut wall, lined by mesoderm is called **coelom**.
- **Metamerism** is defined as the phenomenon of occurrence of external and internal division of body into segments with a serial repetition of at least some organs.
- **Notochord** is a mesodermally derived rod-like structure formed on the dorsal side of body during embryonic development.
- Animals which possess notochord are called **chordates** and those which do not possess notochord are called **non-chordates**.
- The alternation of two basic forms, polyp and medusa in some cnidarians is termed as **metagenesis**.
- **Bioluminescence** is the property of a living organism to emit light and thus shine in dark.
- **Endoparasites** are the organisms that live inside other organisms to thrive nutrition and protection from them.
- **Regeneration** is a form of asexual reproduction in which either the animal regenerates the lost part or produces new individual from a part of its body.
- Animals which remain permanently attached to the substratum and do not move about are said to be **sessile**.
- Animals which do not remain attached to the substratum and freely move are said to be **freely moving** (free-swimming, if aquatic).
- When eggs and sperms are produced by the same individual the animal is said **hermaphrodite**. Also called **monoecious**.
- When sexes are separate, animal is called **dioecious** or **unisexual**.
- Egg-laying animal is called **oviparous** while **viviparous** animals give birth to the young ones directly.
- When animal possesses an intermediate larval stage during its development, it is called **indirect development**.
- When animal does not possess any intermediate larval stage during its development, it is called **direct development**.
- The animals which live on the sea floor are called **Benthic** (e.g., echinoderms, corals and deep sea fishes), **whereas those which swim about actively in sea are called Nektons**.
- The multicellular eukaryotic organisms with holozoic mode of nutrition are called **metazoans**. Based on complexity of organisation, metazoans are further sub-divided into two sub-kingdoms, *Parazoa* and *Eumetazoa*.  
**Parazoa:** Parazoa include the sponges in which the cells are loosely aggregated and do not form tissues or organs.  
**Eumetazoa:** Eumetazoa includes the rest of animals in which the cells are organised into structural and functional units called tissues, organs and organ systems.
- First phylum of animal kingdom to exhibit bilateral symmetry is **platyhelminthes**. It is characteristic of the most successful and higher animals including platyhelminthes, aschelminthes, annelids, arthropods, molluscs, hemichordates and chordates.
- Bilaterally symmetrical animals have two body surfaces, upper or dorsal and lower or ventral and two body ends anterior and posterior.
- **Notochord versus nerve cord:** Notochord should not be confused with the nerve cord, as notochord is a supporting structure, part of the internal skeleton while nerve cord is a part of nervous system. Notochord is found only in chordates while nerve cord is found in chordates as well as non-chordates. Notochord is formed on the dorsal side in chordates while nerve cord is ventral in non-chordates and dorsal in chordates.
- **Choanocytes** are called collar cells because they contain a **central flagellum** surrounded by a **collar of microvilli** which are connected by a thin membrane. These microvilli filter the nutrients and other food materials from the water entering the body. Sponges get the microscopic food particles with the help of these choanocytes as their microvilli are filtering the food. Hence, sponges are the **filter-feeders**.
- *Euplectella* lives in commensal relationship with certain shrimps. *Euplectella* is given as a precious marriage gift in Japan, symbolising the idea 'till death do us part'.

- **Polymorphism:** Occurrence of the same species in more than one type of individuals, which differ in the form (structure) and function from one another, is known as polymorphism. This ensures an efficient division of labour between the several individuals which often get united in the form of a colony, e.g., polyp and medusa are examples of such individuals which differ in structure as well as function (polyps are concerned with feeding, protection and asexual reproduction while medusae are concerned with sexual reproduction) and the cnidarian possessing both of them is said to exhibit polymorphism, e.g., *Obelia*, *Physalia* etc.
- **Jelly-fish:** A jelly-fish is not a true fish which is a vertebrate animal with a backbone. The name jelly-fish is given to *Aurelia* because its body is made up of a jelly-like substance.
- **Life cycle:** *Fasciola* has a digenetic life cycle which is completed in body of two hosts. It is an endoparasite found in bile duct of liver of sheep and goat which serve as primary host and intermediate host is snail.  
Adult worm lives in the body of primary host and numerous larval stages are passed in the body of intermediate host.
- *Taenia saginata* is commonly known as **beef tape worm** where the intermediate host is cow, buffalo and sheep. Rostellum and hooks are absent. It is longer than *T. solium* and it is the most common tape worm of man.
- Earthworm is called as *Nature's Ploughman*. Earthworms perform an important ecological function by their mode of feeding. They cultivate and aerate the soil.
- Leech is a blood sucking animal. It continuously sucks the blood due to the presence of an **anticoagulant hirudin** in its saliva. Hirudin is produced by its salivary glands which prevents the clotting (coagulation) of the blood while the leech is taking its meals thus, ensuring a continuous supply of blood from host.
- In *Nereis*, parapodia serve the dual purpose of locomotion as well as respiration (special organs of respiration are lacking in *Nereis*).
- Four pairs of tubular hearts are present in the earthworm. Hearts pump the blood in earthworm to maintain its flow in the blood vessels.
- Arthropods have **jointed appendages** which is the characteristic feature of all arthropods and gives the phylum its name (*arthros* - joint, *poda* - appendages).
- The chitinous exoskeleton is shed at regular intervals by the arthropods. The process of shedding exoskeleton is called **ecdysis** or **moulting**. It is shed for allowing the growth and development of body to give room/space for the growing organs.
- **Living fossil:** *Neopilina* is a living-fossil which belongs to phylum mollusca. No other mollusc shows the body segmentation except *neopilina* which is a metamerically segmented mollusc.
- **Pearl formation:** Pearl is also called **moti**. It is white, highly shining, globular in shape. Some molluscs are famous for the pearl formation, e.g., *Pinctada*.
- Kokichi Mikimoto of Toba (Japan) is known to be the "Father of Pearl Industry". He discovered a method to induce foreign particle between the mantle and the shell of the pearl oyster. This stimulated the pearl formation in oysters. This method of artificially inducing the foreign particle is used to make artificial pearls.
- The hemichordates are commonly called the **tongue worms** because the shape of proboscis and collar bears a close resemblance to tongue.
- *Balanoglossus* is a "**ciliary feeder**" (or filter-feeder). Its food comprises of microscopic organisms and organic particles present in water and bottom sand in oceans in which it makes its burrows. The food particles enter the body through the gill-slits (pores in the pharynx). These food particles are then filtered by the **cilia** lining the gill-slits.