

CHAPTER 4

ANIMAL KINGDOM

BASIS OF CLASSIFICATION –

a. Levels of Organisation

1. **Cellular level** – cells are arranged as loose cell aggregates. Some division of labour (activities) occur among the cells. e.g., Sponges.
2. **Tissue level** – the cells performing the same function are arranged into tissues. e.g., coelenterates.
3. **Organ level** – tissues are grouped together to form organs, each specialized for a particular function. e.g., Platyhelminthes, ascheminthes.
4. **Organ system level** – organs are associated to form functional systems, each system concerned with a specific physiological function. e.g., Annelids, Arthropods, Molluscs, Echinoderms and Chordates.

b. Symmetry

1. **Asymmetrical** – any plane that passes through the centre does not divide body into equal halves. e.g., Sponges.
2. **Radial symmetry** – When any plane passing through the central axis of the body divides the organism into two identical halves. e.g., Coelenterates, ctenophores and echinoderms (adults only).
3. **bilateral symmetry** – the body can be divided into identical left and right halves in only one plane. e.g., Annelids, Arthropods, Molluscs, Echinoderms (larvae) and Chordates.

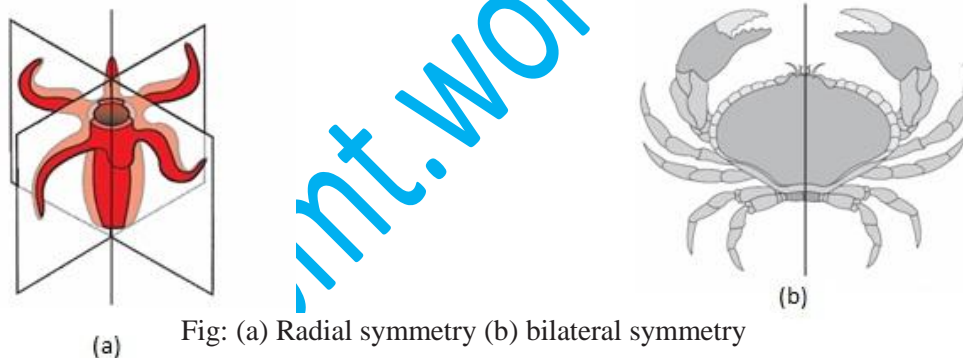


Fig: (a) Radial symmetry (b) bilateral symmetry

c. germ layers

1. **Diploblastic** – Animals in which the cells are arranged in two embryonic layers, an external ectoderm and an internal endoderm. An undifferentiated layer, mesoglea, is present in between the ectoderm and the endoderm. e.g., Sponges, coelenterates.
2. **Triploblastic** – Animals in which the cells are arranged in three embryonic layers, an external ectoderm, an internal endoderm and middle mesoderm. e.g., Platyhelminthes, ascheminthes, Annelids, Arthropods, Molluscs, Echinoderms and Chordates.

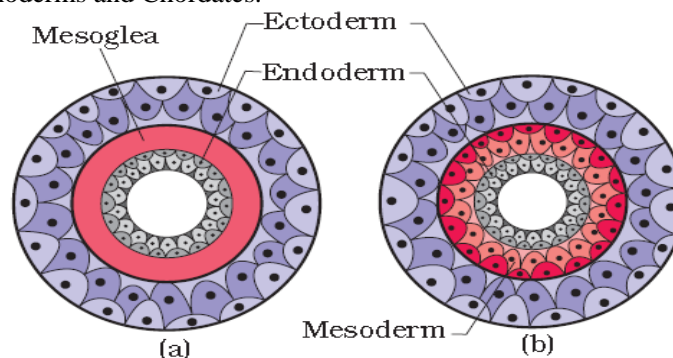


Fig : (a) Diploblastic (b) Triploblastic

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d. Coelom

The body cavity, which is lined by mesoderm on both sides is called **coelom**.

1. **Acoelomates** – animals in which the body cavity is absent. e.g., Sponges, coelenterates, platyhelminthes.
2. **Pseudocoelomates** – In some animals, the body cavity is not lined by mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called pseudocoelom and the animals possessing them are called **pseudocoelomates**, e.g., aschelminthes
3. **Coelomates** – Animals possessing coelom are called **coelomates**, e.g., annelids, molluscs, arthropods, echinoderms, hemichordates and chordates.

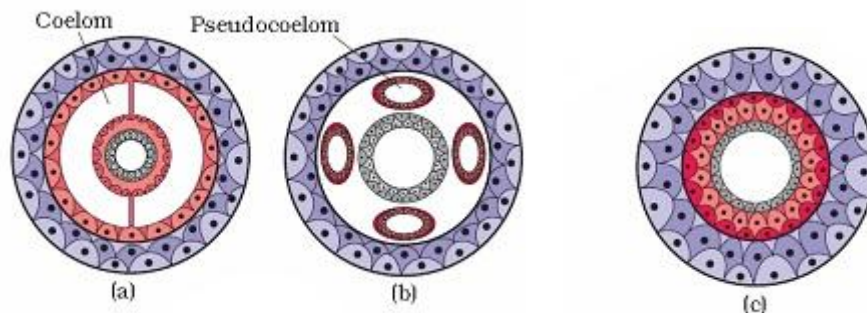


Fig : Diagrammatic sectional view of : (a) Coelomate (b) Pseudocoelomate (c) Acoelomate

e. Segmentation

In some animals, the body is externally and internally divided into segments with a serial repetition of at least some organs. The body shows this pattern called **metameric segmentation** and the phenomenon is known as **metamerism**. e.g., in earthworm.

f. Notochord

Notochord is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.

1. **Chordates** - Animals with notochord in any stage of life. e.g., Fishes, Amphibians, Reptiles, Birds, Mammals etc.
2. **Nonchordates** - Those animals which do not form this structure are called non-chordates, e.g., Porifera to echinoderms.

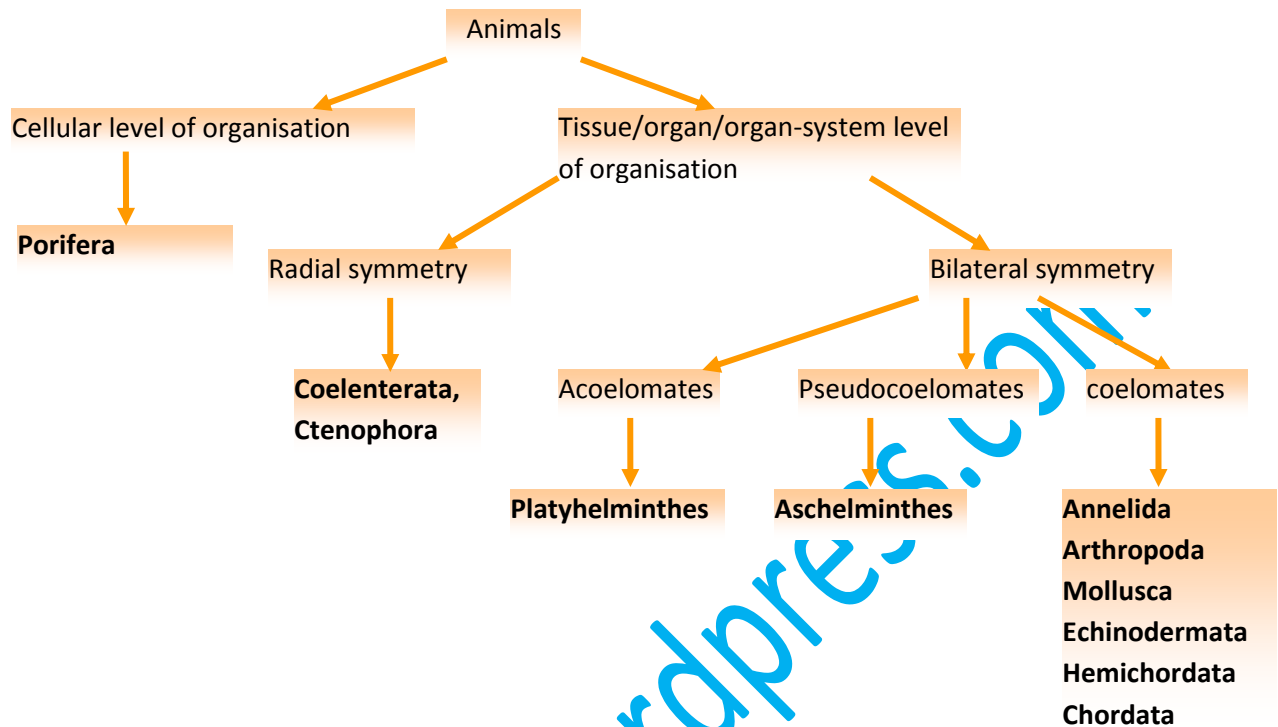
g. Digestive system

1. **Incomplete digestive system** – digestive system has only a single opening to the outside of the body that serves as both mouth and anus. e.g., Coelenterates, Platyhelminthes
2. **Complete digestive system** – digestive system has two openings, mouth and anus. e.g., aschelminthes to chordates.

f. Circulatory system

1. **open type** – Blood is pumped out of the heart and the cells and tissues are directly bathed in it or
2. **closed type** in which the blood is circulated through a series of vessels of varying diameters (arteries, veins and capillaries).

CLASSIFICATION OF ANIMALS



Phylum – Porifera (Sponges)

- **Habitat** – Aquatic - generally marine, some are fresh water.
- **Symmetry** – mostly asymmetric.
- **Organization level** – multicellular with cellular level of organisation.
- **Canal system** – Sponges have a water transport or canal system. Water enters through minute pores (**ostia**) in the body wall into a central cavity, **spongocoel**, from where it goes out through the **osculum**. This pathway of water transport is helpful in food gathering, respiratory exchange and removal of waste.
- **Special cells** – **Choanocytes** or collar cells line the spongocoel and the canals. These cells are flagellated.
- **Digestion** – Intracellular.
- **Skeleton** – Made up of **spicules** or **sponging fibres**.
- **Reproduction** – Bisexual or **hermaphrodite** animals. Sponges reproduce asexually (fragmentation) and sexually.
- **Fertilisation** – Internal
- **Development** – Indirect having a larval stage which is morphologically distinct from the adult.
- **Examples:** *Sycon* (Scypha), *Spongilla* (Fresh water sponge) and *Euspongia* (Bath sponge).

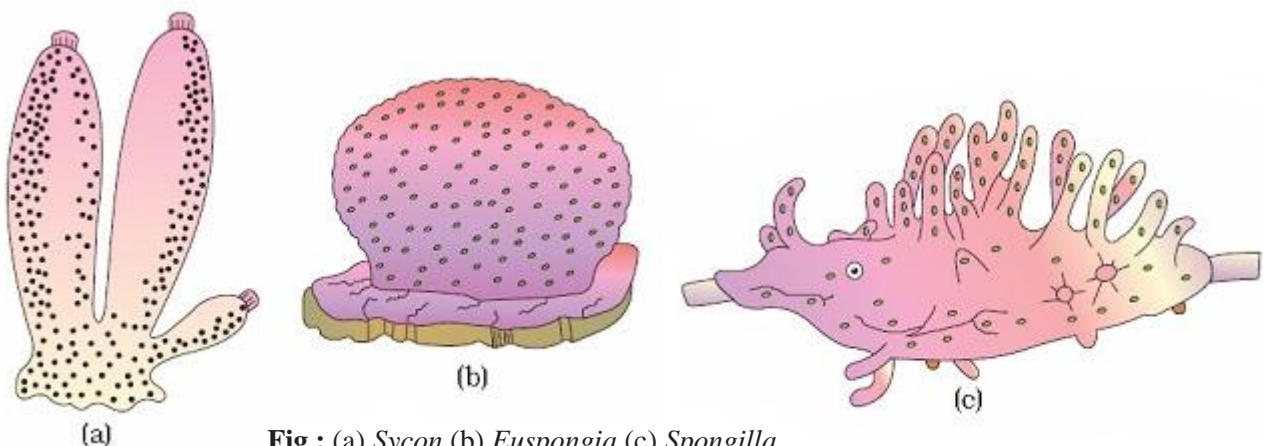


Fig : (a) *Sycon* (b) *Euspongia* (c) *Spongilla*

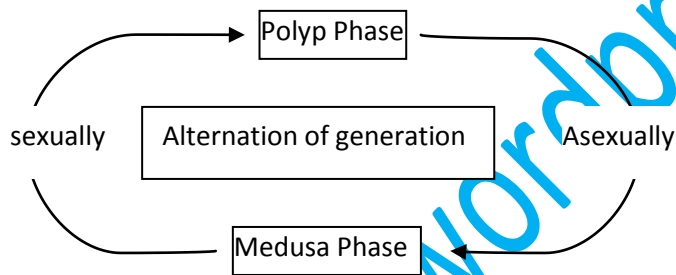
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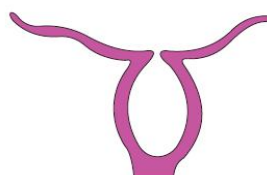
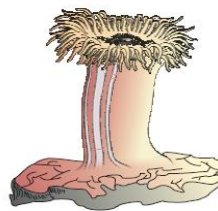
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Phylum – Coelenterata (Cnidaria)

- **Habitat** – Aquatic, mostly marine, sessile or free-swimming,
- **Symmetry** – Radially symmetrical.
- **Special cells** – cnidoblasts or cnidocytes (which contain the stinging capsules or nematocytes) present on the tentacles and the body.
Cnidoblasts are used for anchorage, defense and for the capture of prey.
- **Level of organization** – tissue level of organisation and diploblastic.
- **Body Cavity** – Absent, central gastro-vascular cavity present with a single opening, **hypostome**.
- **Digestion** – both extracellular and intracellular.
- **Skeleton** – Some of the cnidarians – **corals** have a skeleton composed of calcium carbonate.
- **Basic body forms** – Cnidarians exhibit two basic body forms called **polyp** and **medusa**.
Polyp – It is a sessile and cylindrical form like Hydra, Adamsia, etc.
Medusa – it is umbrella-shaped and free-swimming like *Aurelia* or jelly fish.
- **Alternation of generation (Metagenesis)** – some cnidarians exist in both polyp and medusa forms and exhibit alternation of generation (Metagenesis), i.e., polyps produce medusae asexually and medusae form the polyps sexually (e.g., *Obelia*).



- **Examples:** *Hydra*, *Aurelia* (Jelly fish), *Obelia* (Sea Fur), *Physalia* (Portuguese man-of-war), *Adamsia* (Sea anemone), *Pennatula* (Sea-pen), *Gorgonia* (Sea-fan) and *Meandrina* (Brain coral).



(a)

(b)

Fig: Examples of Coelenterata indicating outline of their body form : (a) *Aurelia* (Medusa) (b) *Adamsia* (Polyp)

Phylum – Ctenophora (Sea walnuts or Comb jellies)

- **Habitat** – Exclusively marine.
- **Symmetry** – radially symmetrical.
- **Level of organization** – tissue level of organization and diploblastic.
- **Special organ** – eight external rows of ciliated **comb plates**, which help in locomotion.

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- **Digestion** – both extracellular and intracellular.
- **Special property – Bioluminescence** (the property of a living organism to emit light).
- **Reproduction** – Bisexual animals (Hermaphrodites).
Only sexual reproduction.
- **Fertilisation** – external.
- **Development** – indirect development.
- **Examples:** *Pleurobrachia* and *Ctenoplana*.

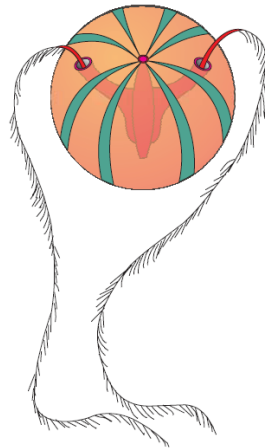


Fig: Example of Ctenophora (*Pleurobrachia*)

Phylum – Platyhelminthes

- **Body shape** – They have dorso-ventrally flattened body, hence are called **flatworms**.
- **Habitat** – Mostly endoparasites found in animals.
- **Symmetry** – bilaterally symmetrical.
- **Body organization** – organ level of organisation and triploblastic.
- **Body cavity** – Absent, acoelomates.
- **Special structures** – Hooks and suckers are present in the parasitic forms for support and absorption. Some of them absorb nutrients from the host directly through their body surface.
- **Excretory cells** – flame cells help in osmoregulation and excretion.
- **Reproduction** – Bisexual animals (Hermaphrodites).
- **Fertilisation** – Internal.
- **Development** – Indirect through many larval stages.
- Some members like *Planaria* possess high regeneration capacity.
- **Examples:** *Taenia* (Tapeworm), *Fasciola* (Liver fluke), *Planaria*.

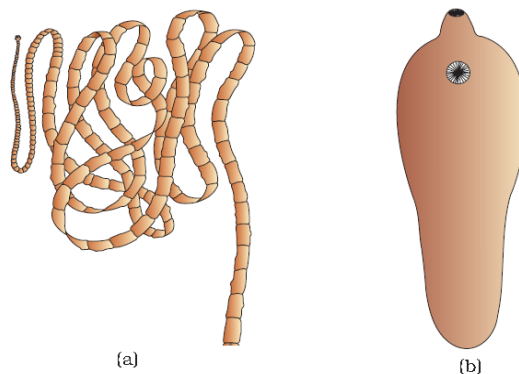


Fig : Examples of Platyhelminthes : (a) Tape worm (b) Liver fluke

Phylum – Aschelminthes

- **Body shape** – Circular in cross-section, hence, the name **roundworms**.
- **Habitat** – They may be free living, aquatic and terrestrial or parasitic in plants and animals.

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- **Level of organization** – organ-system level of body organization and triploblastic.
- **Symmetry** – bilaterally symmetrical.
- **Body Cavity** – Pseudocoelomate animals.
- **Digestive system** – Alimentary canal is complete with a well developed **muscular pharynx**.
- **Excretion** – An excretory tube removes body wastes from the body cavity through the excretory pore.
- **Reproduction** – unisexual or **dioecious**. Also show sexual dimorphism (females are longer than males)
- **Fertilisation** – internal.
- **Development** – direct (the young ones resemble the adult) or indirect (larvae is present).
- **Examples:** *Ascaris* (Round Worm), *Wuchereria* (Filaria worm), *Ancylostoma* (Hookworm).

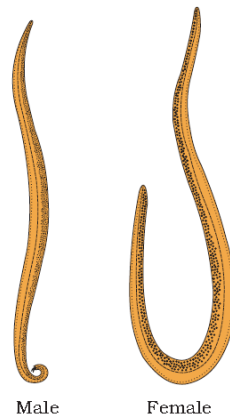


Fig: Aschelminthes – Roundworm

Phylum – Annelida

- Their body surface is distinctly marked out into **segments** or **metameres** (Latin, *annulus* : little ring) and, hence, the phylum name Annelida.
- **Habitat** – aquatic (marine and fresh water) or terrestrial; free-living, and sometimes parasitic.
- **Level of organization** – organ-system level and triploblastic animals.
- **Symmetry** – bilateral symmetry.
- **Body cavity** – present and coelomates.
- **Locomotory organ** – Body wall which has longitudinal and circular muscles. Aquatic annelids like *Nereis* possess lateral appendages, **parapodia** (for swimming).
- **Circulatory system** – closed circulatory system.
- **Excretory organ** – **Nephridia** which help in osmoregulation and excretion.
- **Nervous system** – consists of paired ganglia connected by lateral nerves to a double ventral nerve cord.
- **Reproduction** – some are unisexual or dioecious (*Nereis*) and some are bisexual or monoecious (earthworms and leeches). Reproduces sexually.
- **Examples:** *Nereis*, *Pheretima* (Earthworm) and *Hirudinaria* (Blood sucking leech).

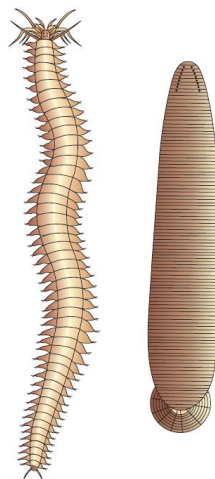


Fig: Examples of Annelida : (a) *Nereis* (b) *Hirudinaria*

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Phylum – Arthropoda

- This is the **largest phylum** of Animalia which includes insects.
- **Level of organization** – organ-system level of organisation.
- **Symmetry, body cavity** – bilaterally symmetrical, triploblastic, segmented and coelomate animals.
- **Skeleton** – exoskeleton made up of chitin.
- **Body division** – The body consists of **head, thorax and abdomen**.
- **Locomotion** – by **jointed appendages** (arthros-joint, poda-appendages), hence name arthropoda.
- **Respiration** – by gills, book gills, book lungs or tracheal system.
- **Circulatory system** – open type.
- **Sensory organs** – antennae, eyes (compound and simple), statocysts or balance organs are present.
- **Excretion** – through **malpighian tubules**.
- **Reproduction** – mostly dioecious animals.
- **Fertilisation** – usually internal. They are mostly oviparous.
- **Development** – direct or indirect.
- **Examples:**

Economically important insects	–	<i>Apis</i> (Honey bee), <i>Bombyx</i> (Silkworm), <i>Laccifer</i> (Lac insect)
Vectors	–	<i>Anopheles</i> , <i>Culex</i> and <i>Aedes</i> (Mosquitoes)
Gregarious pest	–	<i>Locusta</i> (Locust)
Living fossil	–	<i>Limulus</i> (King crab).

Phylum – Mollusca

- This is the **second largest** animal phylum.
- **Habitat** – terrestrial or aquatic (marine or fresh water).
- **Symmetry, coelom** – bilaterally symmetrical, triploblastic and coelomate animals.
- **Body division** – Body is covered by a calcareous shell and is unsegmented with a distinct **head, muscular foot and visceral hump**.
- **Special structure** – A soft and spongy layer of skin forms a **mantle** over the visceral hump.
- **Respiration and excretion** – The space between the hump and the mantle is called the mantle cavity in which feather like gills are present. They have respiratory and excretory functions.
- **Sense organs** – The anterior head region has sensory tentacles.
- **Feeding organ** – The mouth contains a file-like rasping organ for feeding, called **radula**.
- **Reproduction and development** – usually dioecious and oviparous with indirect development.
- **Examples:** *Pila* (Apple snail), *Pinctada* (Pearl oyster), *Sepia* (Cuttlefish), *Loligo* (Squid), *Octopus* (Devil fish), *Aplysia* (Seahare), *Dentalium* (Tusk shell) and *Chaetopleura* (Chiton).

Phylum – Echinodermata

- These animals have an endoskeleton of calcareous ossicles and, hence, the name Echinodermata (Spiny bodied).
- **Habitat** – All are marine.
- **Symmetry** – The adult echinoderms are radially symmetrical but larvae are bilaterally symmetrical.
- **Digestive system** – complete with mouth on the lower (ventral) side and anus on the upper (dorsal) side.
- **Water vascular system** – distinctive feature. Helps in locomotion, capture and transport of food and respiration.
- **Excretory system** – absent.
- **Reproduction** – Dioecious animals, Reproduction is sexual.
- **Fertilisation** – usually external.
- **Development** – indirect with free-swimming larva.
- **Examples:** *Asterias* (Star fish), *Echinus* (Sea urchin), *Antedon* (Sea lily), *Cucumaria* (Sea cucumber) and *Ophiura* (Brittle star).

Phylum – Hemichordata

- Earlier considered as a sub-phylum under phylum Chordata, but now it is placed as a separate phylum under non-chordata.
- **Habitat** – consists of a small group of worm-like marine animals.

- **Level of organization, symmetry, body cavity** – organ-system level of organization, bilaterally symmetrical, triploblastic and coelomate animals.
- **Body shape and division** – The body is cylindrical and is composed of an anterior **proboscis**, a **collar** and a long **trunk**.
- **Circulatory system** – Open type.
- **Respiration** – through gills.
- **Excretory organ** – proboscis gland.
- **Reproduction, fertilisation, development** – Dioecious animals, external Fertilisation, indirect Development.
- Examples: *Balanoglossus* and *Saccoglossus*.

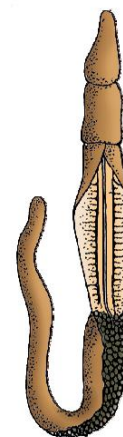


Figure : *Balanoglossus*

Phylum – Chordata

- **Characteristic features** –
 - a notochord,
 - a dorsal hollow nerve cord
 - paired pharyngeal gill slits
 - post anal tail
 - closed circulatory system
- **Symmetry, body cavity, level of organization**
These are bilaterally symmetrical, triploblastic, coelomate with organ-system level of organisation.

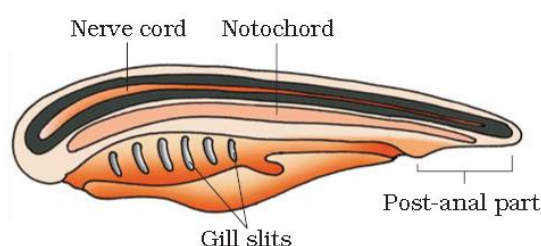


Fig: Chordata characteristics

- Phylum Chordata is divided into three subphyla : **Urochordata or Tunicata, Cephalochordata and Vertebrata.**
- Subphyla Urochordata and Cephalochordata are often referred to as **protochordates.**

Subphylum – Urochordata

- Exclusively marine.
- notochord is present only in larval tail,
- Examples: *Ascidia*, *Salpa*, *Doliolum*.

Subphylum – Cephalochordata

- Notochord extends from head to tail region and is persistent throughout their
- Example: *Branchiostoma* (Amphioxus or Lancelet).

Subphylum – Vertebrata

- Possess notochord during the embryonic period.
- The notochord is replaced by a cartilaginous or bony **vertebral column** in the adult.
- Thus all vertebrates are chordates but all chordates are not vertebrates.
- Vertebrates have a ventral muscular heart with two, three or four chambers, kidneys for excretion and osmoregulation and paired appendages which may be fins or limbs.



Fig: *Ascidia*

life.

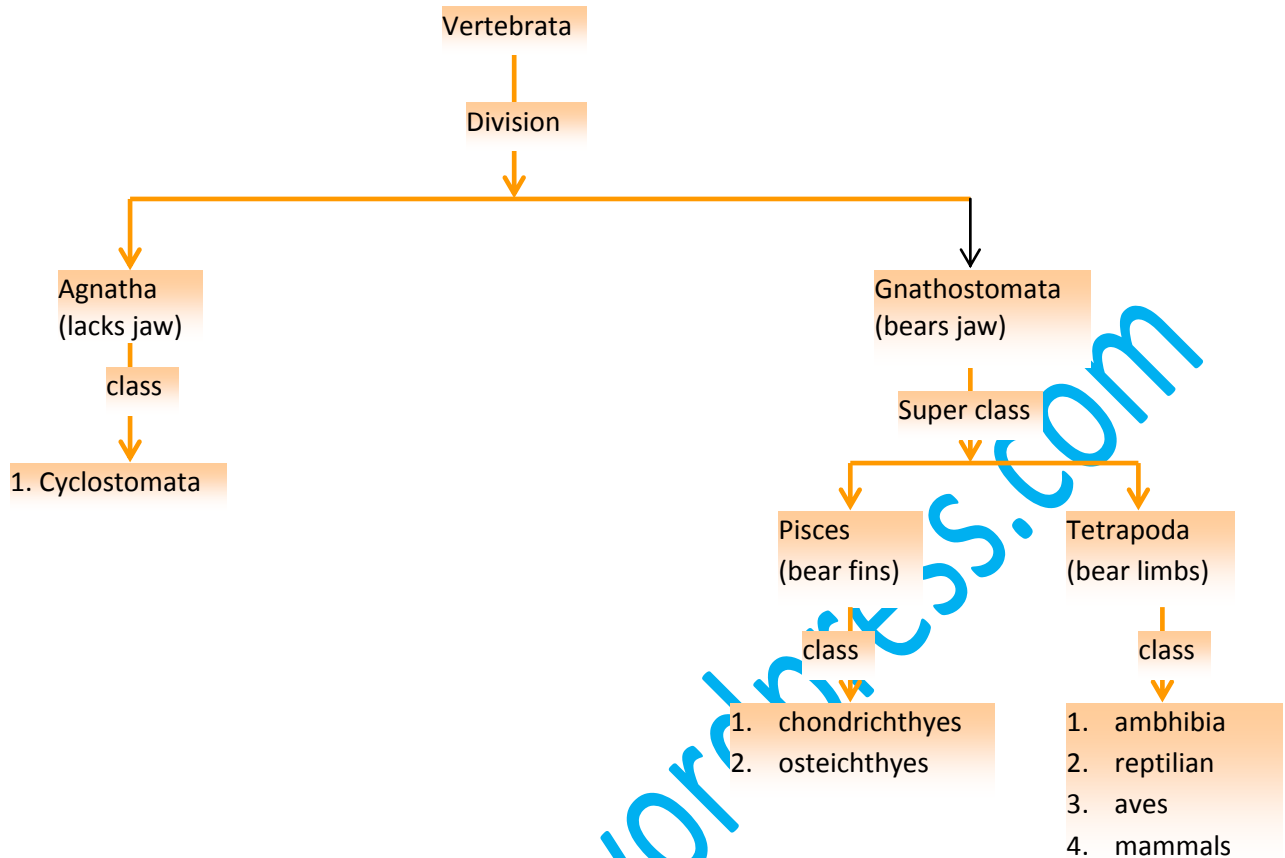
TABLE: Comparison of Chordates and Non- chordates	
Chordates	Non-chordates
Notochord present	Notochord absent
Central nervous system is dorsal	Central nervous system is ventral, solid, hollow and single. and double
Pharynx perforated by gill slits	Gill slits are absent
Heart is ventral	Heart is dorsal (if present).
A post-anal part (tail) is present.	Post-anal tail is absent.

Classification of Vertebrata –

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Class – Cyclostomata

- **Habitat** – ectoparasites on some fishes. Body shape – elongated body
- **Respiration** – 6-15 pairs of **gill slits**.
- **Mouth** – Cyclostomes have a sucking and circular mouth without jaws.
- Scales and paired fins are absent.
- Cranium and vertebral column are cartilaginous.
- Circulation is of closed type.
- Marine but migrate to fresh water for spawning. After spawning, within a few days, they die. Their larvae, after metamorphosis, return to the ocean.
- Examples: *Petromyzon* (Lamprey) and *Myxine* (Hagfish).



Fig: A jawless vertebrate - *Petromyzon*

Class – Chondrichthyes

- marine animals.
- Their body is streamlined and they have cartilaginous endoskeleton.
- Mouth is located ventrally.
- **Notochord** is **persistent** throughout life.
- Gill slits are separate and without **operculum** (gill cover).
- The skin is tough, containing minute **placoid scales**.
- Teeth are modified placoid scales which are backwardly directed.
- Their jaws are very powerful. These animals are predaceous.
- Due to the absence of air bladder, they have to swim constantly to avoid sinking.
- Heart is two-chambered (one auricle and one ventricle).
- Some of them have **electric organs** (e.g., *Torpedo*) and some possess **poison sting** (e.g., *Trygon*).

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- They are cold-blooded (**poikilothermous**) animals, i.e., they lack the capacity to regulate their body temperature.
- Sexes are separate. In males pelvic fins bear claspers. They have internal fertilisation and many of them are viviparous.
- Examples: *Scoliodon* (Dog fish), *Pristis* (Saw fish), *Carcharodon* (Great white shark), *Trygon* (Sting ray), *Torpedo* (electric ray).

Class – Osteichthyes

- Both marine and fresh water fishes
- Their body is streamlined and they have bony endoskeleton skeleton.
- Mouth is mostly terminal.
- They have four pairs of gills which are covered by an **operculum** on each side.
- Skin is covered with cycloid/ctenoid scales.
- **Air bladder** is present which regulates buoyancy.
- Heart is two chambered (one auricle and one ventricle).
- They are cold-blooded animals.
- Sexes are separate. Fertilisation is usually external. They are mostly oviparous and development is direct.
- Examples:

Marine	–	<i>Exocoetus</i> (Flying fish), <i>Hippocampus</i> (Sea horse);
Freshwater	–	<i>Labeo</i> (Rohu), <i>Catla</i> (Katla), <i>Clarias</i> (Magur);
Aquarium	–	<i>Betta</i> (Fighting fish), <i>Pterophyllum</i> (Angel fish).

Class – Amphibia

- amphibians can live in aquatic as well as terrestrial habitats.
- Most of them have two pairs of limbs.
- Body is divisible into **head** and **trunk**. Tail may be present in some.
- The amphibian skin is moist (without scales).
- The eyes have eyelids.
- A **tympanum** represents the ear.
- Alimentary canal, urinary and reproductive tracts open into a common chamber called **cloaca** which opens to the exterior.
- Respiration is by gills, lungs and through skin.
- The heart is three chambered (two auricles and one ventricle).
- These are cold-blooded animals.
- Sexes are separate. Fertilisation is external. They are oviparous and development is direct or indirect.
- Examples: *Bufo* (Toad), *Rana* (Frog), *Hyla* (Tree frog), *Salamandra* (Salamander), *Ichthyophis* (Limbless amphibia).

Class – Reptilia

- Locomotion is creeping or crawling.
- mostly terrestrial animals.
- body is covered by dry and cornified skin, epidermal **scales** or **scutes**
- They do not have external ear openings. Tympanum represents ear.
- Limbs, when present, are two pairs.
- Heart is usually three-chambered, but four-chambered in crocodiles.
- Reptiles are poikilotherms.
- Snakes and lizards shed their scales as skin cast.
- Sexes are separate. Fertilisation is internal. They are oviparous and development is direct.
- Examples: *Chelone* (Turtle), *Testudo* (Tortoise), *Chameleon* (Tree lizard), *Calotes* (Garden lizard), *Crocodylus* (Crocodile), *Alligator* (Alligator). *Hemidactylus* (Wall lizard), Poisonous snakes – *Naja* (Cobra), *Bangarus* (Krait), *Vipera* (Viper).

Class – Aves

- The characteristic features are the presence of **feathers** and most of them can fly except flightless birds (e.g., Ostrich).
- They possess **beak**.
- The forelimbs are modified into **wings**.
- The hind limbs generally have scales and are modified for walking, swimming or clasping the tree branches.
- Skin is dry without glands except the oil gland at the base of the tail.
- Endoskeleton is fully ossified (bony) and the long bones are hollow with **air cavities** (pneumatic).
- The digestive tract of birds has additional chambers, the crop and gizzard.
- Heart is completely four chambered.
- They are warm-blooded (**homiothermous**) animals, i.e., they are able to maintain a constant body temperature.
- Respiration is by lungs. Air sacs connected to lungs supplement respiration.
- Sexes are separate. Fertilisation is internal. They are oviparous and development is direct.
- Examples : *Corvus* (Crow), *Columba* (Pigeon), *Psittacula* (Parrot), *Struthio* (Ostrich), *Pavo* (Peacock), *Aptenodytes* (Penguin), *Neophron* (Vulture).

Class – Mammalia

- They are found in a variety of habitats – polar ice caps, deserts, mountains, forests, grasslands and dark caves.
- Some of them have adapted to fly or live in water.
- The most unique mammalian characteristic is the presence of milk producing glands (**mammary glands**) by which the young ones are nourished.
- They have two pairs of limbs, adapted for walking, running, climbing, burrowing, swimming or flying.
- The skin of mammals is unique in possessing **hair**.
- External ears or **pinnae** are present.
- Different types of teeth are present in the jaw.
- Heart is four chambered.
- They are homiothermous.
- Respiration is by lungs.
- Sexes are separate and fertilisation is internal.
- They are viviparous with few exceptions and development is direct.
- Examples:
 - Oviparous** - *Ornithorhynchus* (Platypus);
 - Viviparous** - *Macropus* (Kangaroo), *Pteropus* (Flying fox), *Camelus* (Camel), *Macaca* (Monkey), *Rattus* (Rat), *Canis* (Dog), *Felis* (Cat), *Elephas* (Elephant), *Equus* (Horse), *Delphinus* (Common dolphin), *Balaenoptera* (Blue whale), *Panthera tigris* (Tiger), *Panthera leo* (Lion).

Table : Salient features of different phyla of Animal kingdom

Phylum	Level of Organisation	Symmetry	Coelom	Segmentation	Digestive System	Circulatory System	Respiratory System	Distinctive Features
Porifera	Cellular	Many	Absent	Absent	Absent	Absent	Absent	Body with pores and Canals In walls.
Coelenterata (Cnidaria)	Tissue	Radial	Absent	Absent	Incomplete	Absent	Absent	Cnidoblasts present
Ctenophora	Tissue	Radial	Absent	Absent	Incomplete	Absent	Absent	Comb plates for locomotion.
Platyhelminthes	Organ & Organ-system	Bilateral	Absent	Absent	Incomplete	Absent	Absent	Flat body, suckers.
Aschelminthes	Organ-system	Bilateral	Pseudo coelomate	Absent	Complete	Absent	Absent	Often worm shaped, elongated.
Annelida	Organ-system	Bilateral	Coelomate	Present	Complete	Present	Present	Body segment ation like rings.
Arthropoda	Organ-system	Bilateral	Coelomate	Present	Complete	Present	Present	Exoskeleton of cuticle, jointed appendages.
Mollusca	Organ-system	Bilateral	Coelomate	Absent	Complete	Present	Present	External skeleton shell usually present.
Echinodermata	Organ-system	Radial	Coelomate	Absent	Complete	Present	Present	Water vascular system, radial symmetry.
Heml-chordata	Organ-system	Bilateral	Coelornate	Absent	Complete	Present	Present	Worm-like with proboscis, collar and trunk.
Chordata	Organ-system	Bilateral	Coelomate	Present	Complete	Present	Present	Notochord, dorsal hollow nerve cord, gill slits with limbs or fins.

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