UG CBCS Semester-II (Chordata)

Protochordata

In the scheme of classification, the Animal Kingdom is divided first into several major animal groups called *phyla* (singular, *phylum).* There are approximately 30 animal phyla currently recognized. The last major group of the Animal Kingdom is known as phylum *Chordata.* It was created by Balfour in 1880. The name of this phylum is derived from two Greek words, the "*chorde"* meaning a string or cord, and "*ata"* meaning bearing. The reference is to a common characteristic feature in the form of a stiff, supporting rod-like structure along the back, the which is found in all the members of the phylum at some stage of their lives. Thus, chordates are animals having a cord, i.e., notochord. The animals belonging to all other phyla of the Animal Kingdom are often termed 'the non-chordates' or 'the invertebrates since they have no notochord or backbone in their body structure.

The organisms belonging to the Protochordate are generally known as the lower chordates. They don't form a "proper" taxonomic group and are only classified as such for convenience purposes. However, they do form a major division of Chordata. They are also known as Acraniata because they lack a true skull. They are divided into three sub-phyla- **Hemichordata, Urochordata, Cephalochordata.**

Fundamental Characteristics of Chordates

All the chordates possess three outstanding unique characteristics at some stage in their life history.
These three fundamental morphological features include:

1. A dorsal hollow or tubular *nerve cord*
2. A longitudinal supporting rod-like *notochord*
3. A series of *pharyngeal gill slits*

Characteristics of Protochordates:

1. They are generally found in marine water.
2. Their body is bilaterally symmetrical, triploblastic, and coelomate.
3. At a certain stage of their lives, their body develops a long, rod-like structure for support called the notochord.
4. They exhibit organ system level of organization.

E.g., ***Herdmania, Amphioxus.***

HEMICHORDATA

Meaning of Phylum Hemichordata:

The animals with notochord constitute the Phylum Chordata. It has a major subdivision, called the Vertebrata or Craniata for possession of vertebral column or cranium. The rest of chordates, namely Hemichordata, Urochordata and Cephalochordata are collectively called the Primitive Chordates or Protochordates. But it is better to divide it into Invertebrate Chordates for Hemichordata, and Protochordata or lower chordates for Urochordata and Cephalochordata for the structural organization of chordate features. The basic chordate features are present in Protochordata.

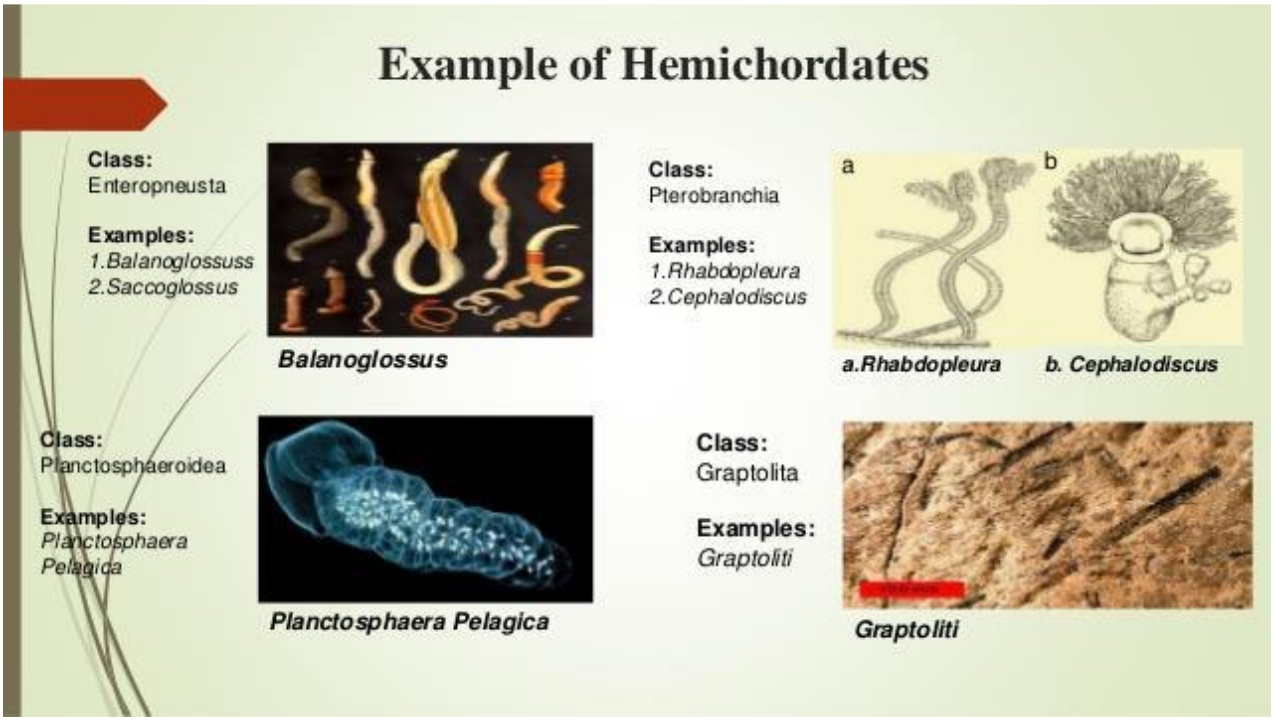
Hemichordata has long been considered as the lowest group of chordates for the construction of notochord, nerve cord and pharyngeal gill-slits, the main features of the Phylum Chordata. Recent workers claim that the notochord of hemichordates is not a true notochord, and the central nervous system containing a longitudinal ventral nerve strand shows the characteristic of major invertebrate phyla. The pharyngeal gill-slits or pharyngotremy is the only chief link between hemichordates and chordates. So, the inclusion of Hemichordata in the Phylum Chordata remains a controversial issue and still remains of uncertain status (incerte sedis). Hemichordates are somewhat close to invertebrates in the body construction. So, the term 'Invertebrate Chordates' for Hemichordata by some zoologists is partially justifiable. The so-called protochordata including Hemichordata, Urochordata and Cephalochordata lead sedentary life in adult stage and perform ciliary mode of feeding to compensate the purpose of locomotion.

Phylum Hemichordata:

The phylum Hemichordata represents a group of lowest chordates having profound phylogenetic significance. The hemichordates furnish a clue to the link between the chordates in general and the non-chordates, especially the echinoderms in particular. The hemichordates have peculiar anatomical organization and the free-swimming larva, tornaria, is strikingly similar to the larval stages of some echinoderms.

Classification of Phylum Hemichordata:

Historical Resume: The first member of the Hemichordata was recorded by Eschscholtz (1825). He named the animal Ptychodera and regarded it as a holothurian. Subsequently, Delle Chiaje (1829) added another member Balanoglossus clavigerus to the group. Since then, many hemichordates have been put on record. All these hemichordates were included under the group Enteropneusti as proposed by Gegenbaur (1870). Since then, this group was called Enteropneusta. Bateson (1885) studied the embryology of some enteropneusts and proposed the name Hemichordata to replace Enteropneusta. The tornaria larva was regarded as an echinoderm larva by Johannes Miller (1850), Krohn (1854), Agassiz (1864) and many others. Metchnikoff (1870) regarded tornaria as the larval stage of Enteropneusta. The work of Kowalevsky needs special mentioning, because he gave the accurate description of *Balanoglossus*. The hemichordate possessing an exceptionally elongated proboscis was named *Saccoglossus* by Schimkewitsch (1892), but Spengel (1893), in his monograph, treated the same animal as subgenus *Dolichoglossus* under the genus *Balanoglossus*. Van der Horst (1939) regarded *Saccoglossus* and *Dolichoglossus* as the synonyms of the same genus. Sars (1867) and Allman (1869) recorded the strange colonial *Rhabdopleura* as a member of Bryozoa. Lankester (1877) introduced the term *Pterobranchia* for *Rhabdopleura*, but still retained it as a subdivision under Bryozoa. Another similar animal, *Cephalodiscus*, was recognised by Mcintosh (1882) which was also regarded as a bryozoan. Hamer (1887) and Fowler (1892) removed *Cephalodiscus* and *Rhabdopleura*, respectively from the group Bryozoa and suggested their inclusion under Hemichordata. Another genus, *Atubaria*, was added to the group by Sato in 1936. Willy (1899) divided the Hemichordata into two classes—Enteropneusta and Pterobranchia. But Harmer (1905) added another class Phoronida under Hemichordata. A peculiar pelagic larval form was discovered by Mortensen in 1910. Spengel (1932) named this larva *Planctosphaera pelagica*.



Important Features:

1. Hemichordates are bilaterally symmetrical deuterostome coelomates.
2. They are either solitary (enteropneusts) or colonial (pterobranchs).
3. The soft body is divided into 3 regions – Proboscis (Protosome), collar (mesosome) and trunk (metasome) – reflecting internally a tri-coelomate organization.
4. A preoral buccal diverticulum is considered as the stomochord rather than notochord.
5. The digestive tube is complete, straight or U-shaped.
6. The pharyngeal-slits are present or absent. When present, variable in number (one or more pairs), found in the trunk.
7. A heart and kidney occur in the proboscis (preoral lobe) and are supported by buccal diverticulum (stomochord).
5. The nervous system is intra-epidermal. The nervous system consists of a dorsal and ventral nerve cord extending to the whole length of the animal. In the collar region, the nerve is dorsal and hollow. This part represents the true chordate feature.
8. Sexes are separate (gonochoristic) but some species like *Cephalodiscus nigrescens* and *C. hodgsoni* are hermaphrodite.
9. Gonads are extra-coelomic.
10. Asexual budding also takes place in a few forms (Balanoglossus capensis, Rhabdopleura) and formation of buds occurs in the posterior end of the body.
11. Fertilization is external (enteropneusts) or internal (pterobranchs).
12. Cleavage holoblastic, radial (enteropneusts), but radial and bilateral in pterobranchs.
13. Planktonik, ciliated tornaria larva in some. Tornaria larvae are lecithotrophic (e.g., the larva is non-feeding and completes its developmental stages utilizing its stored reserved food of the egg). Six hypothetical developmental stages are recognised and these are named after renowned zoologists. 1st and 2nd stages are after the names of Muller and Heider. Other stages are Metschnikoff, Krohn, Spengel and Agassiz respectively.

Fossil Record:
Sufficient data have not been collected except Eocephalodiscus which has recovered from the Upper Cretaceous.

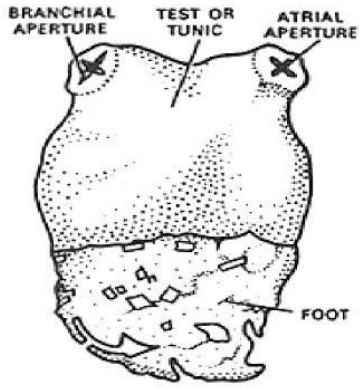
Geographical Distribution:
Hemichordates occur in all seas but may prefer warm and temperate waters. Majority of the species live in the intertidal zone and shallow waters but a few occur at great depths.

Habitat:
Members live in U-shaped burrows in sand, mud or amongst rocks and sea weeds.

The Phylum Hemichordata includes two classes Enteropneusta and Pterobranchia (Lankester, 1877. Authors like Marshall and Williams, 1964; Young, 1981; Romer and Parsons, 1986; Barnes, 1987; Ruppert and Barnes, 1994; Anderson, 1988; Pechemik, 2000; and Kardong, 1998, 2000). But Hyman (1959) and Barrington (1967, 79) include 3 classes – Enteropneusta, Pterobranchia and Planctosphaeroidea in their classification.

Urochordata or Tunicata

1. They are found in the marine environment.
2. They are sessile and filter-feeders.
3. They are also known as tunicates because their body is surrounded by a leathery sheath composed of tunicin (cellulose).
4. The notochord appears in the larval stage in the tail of the larva and disappears in the adult. This is known as retrogressive metamorphosis.
5. The neural tube in the larva is replaced by a dorsal ganglion in the adults.
6. Respiration occurs through gills.
7. They have an open circulatory system.
8. The excretory organs are absent.
9. They reproduce asexually by budding.

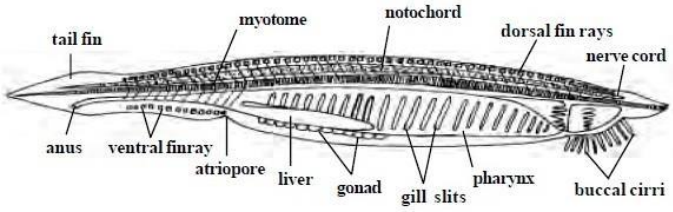


Herdmania

E.g., ***Herdmania, Salpa***

Cephalochordata

1. They are marine and filter-feeders.
2. The notochords remain throughout life and extend up to the head region.
3. The nerve cord and the tail also remain throughout life.
4. Solenocytes are the excretory organs.
5. They respire through gills which open in the atrium.
6. The body wall comprises myotomes.



(a) Amphioxus - Entire

E.g., ***Amphioxus***