

2 | Protochordata

Protochordates are the **first chordates**. They are the **primitive chordates**. They are the **intermediate link** between Invertebrates and Chordates. They are called **invertebrate chordates**.

The phylum **Chordata** is divided into three subphyla, namely **Cephalochordata**, **Urochordata** and **Vertebrata** (Young, 1981). The first two subphyla are collectively referred to as **Protochordates** or **lower chordates** (Burton, 1967). This is because they have no backbone or vertebrae.

They have no brain and cranium (brain case). Hence they are grouped together as **Acrania**, in contrast to vertebrata or **Craniata**.

The Protochordates are **primitive** marine forms with a mixture of **invertebrate** and **vertebrate** characteristics. Hence, they are also termed as '**Invertebrate chordates**' (Villegas et al., 1978).

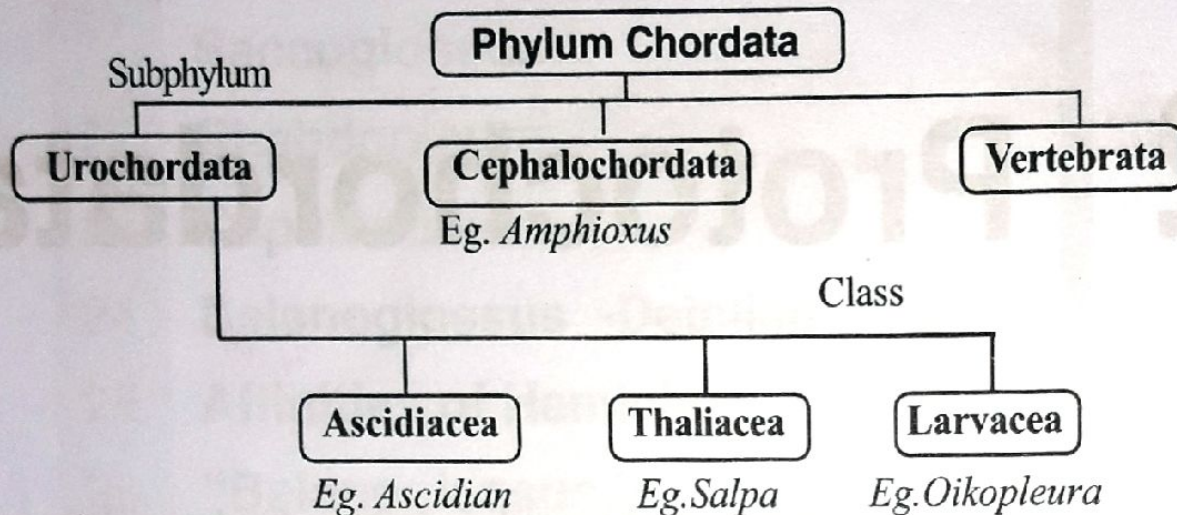
General Characters

- ✓ **Protochordata** are **first** chordates. They are also called **Protochordata**.
- ✓ They are **primitive** chordates.
- ✓ They contain a **notochord** formed of **vacuolated notochordal cells**.
- ✓ They are **marine**.
- ✓ They **do not** contain a **cranium** and **head**. So they are called **Acrania**.
- ✓ They have **no jaws** and **vertebral column**.
- ✓ **Many gill slits** are present.
- ✓ The alimentary canal is **straight** or '**U**'-shaped.
- ✓ Alimentary canal has **endostyle**.

- They exhibit **filter feeding** and **ciliary feeding**.
 - Circulatory system is **open** or **closed type**.
 - Development is **direct** or **indirect**.
 - Many forms exhibit **asexual reproduction**.
- Eg. *Ascidian*, *Amphioxus*, etc.

Classification of Protochordata

Protochordata are **first** primitive chordates containing a **notochord**. It is also called **Protochordata**.



They have no cranium and head. So they are called **Acrania**.

Protochordata is divided into two subphyla, namely

Subphylum 1. Urochordata

Subphylum 2. Cephalochordata.

Subphylum 1. Urochordata

The notochord is present in the **tail** region only. The body is covered by a **test** or **tunic**. Hence it is also called **Testacea** and **Tunicata**.

Atrial and **branchial apertures** are present.

Gills are numerous.

Hermaphrodites.

Urochordata is divided into three classes, namely

Class 1. Ascidacea

Class 2. Thaliacea

Class 3. Larvacea

Ascidacea includes *Ascidians*

Solitary or colonial.

Fixed or free living.

Test is permanent.

Many gill slits.

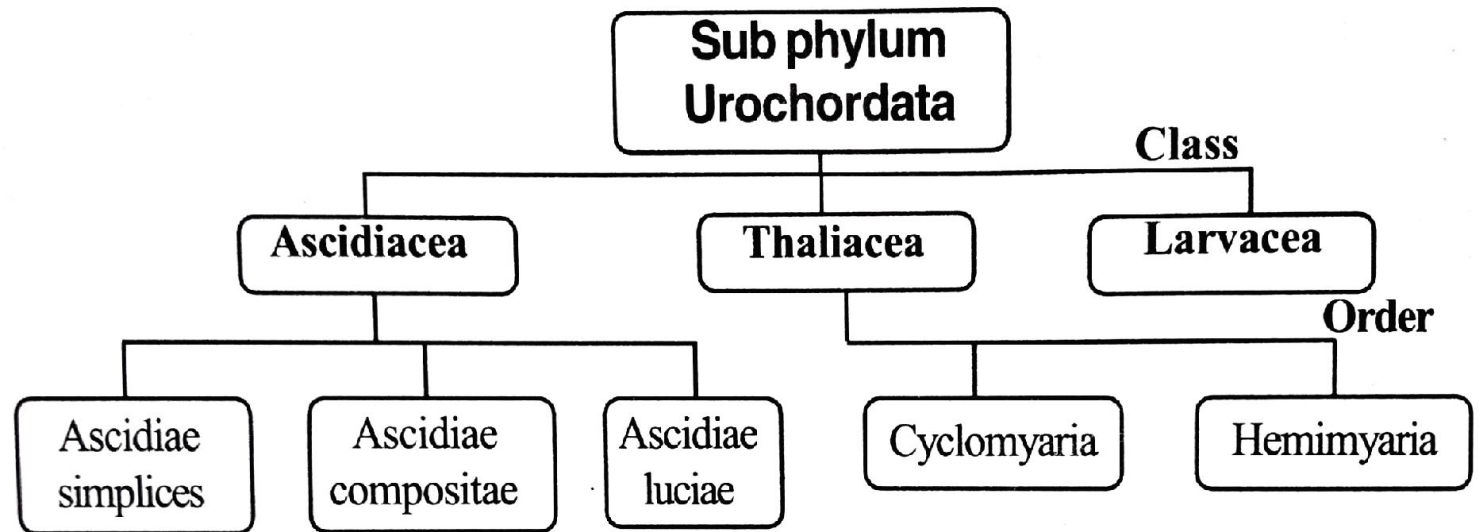
Eg. *Ascidian*, *Botryllus*, *Pyrosoma*, etc.

1. Urochordata

(*Greek.oura*, tail + *Latin.chorda*, cord)

1. Marine; some are free swimming and others become sessile after a free swimming larval period.

2. Presence of *test* or *tunic* (covering of body) composed of a type of cellulose called *tunicin*, hence the name *tunicata*.



3. Presence of incurrent and excurrent siphons.

4. Large pharynx with numerous gill slits.

5. Notochord is present only in the larva and confined to tail region of larva.

6. Nervous system of adult is reduced to a small ganglion.

Classification

The subphylum Urochordata is subdivided into three classes. viz.,

Class 1. *Ascidiacea*,

Class 2. *Thaliacea*

Class 3. *Larvacea*.

1. Herdmania [Ascidian]

Phylum : Chordata

Subphylum : Urochordata

Class : Ascidiacea

1. *Herdmania* is a **Protochordate** and it is commonly called **sea squirt**.

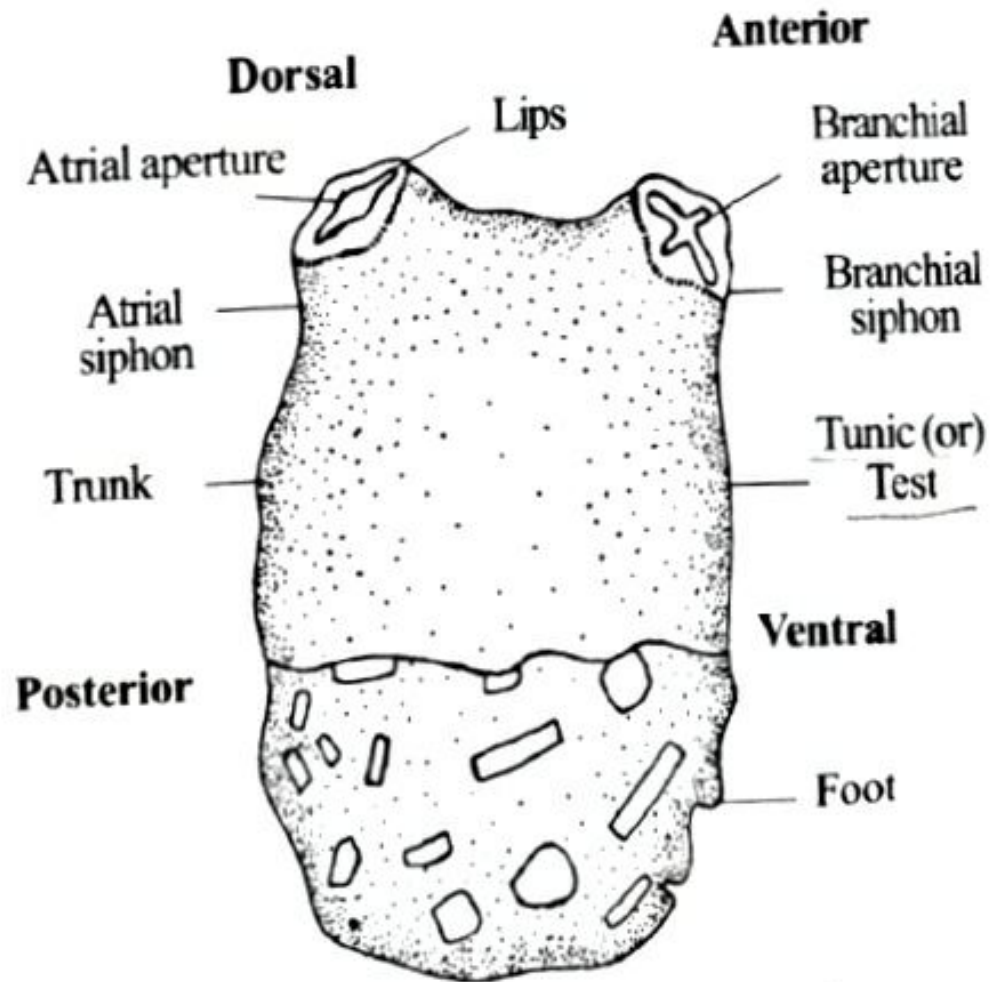


Fig.2.3: *Herdmania* (Ascidian).

2. It is a marine animal.
3. It is a sedentary animal attached to the substratum with the help of a **foot**.
4. The body is covered by a thick covering **tunic** or **test**.
5. The free end of the body is provided with two external openings called **branchial aperture** and **atrial aperture**, situated on branchial siphon and atrial siphon respectively.
6. The **mouth** opens to the outside through the **branchial aperture** and the **anus** opens to the outside by the **atrial aperture**.
7. The branchial and atrial apertures have four **lips**.
8. The alimentary canal is **U-shaped**.
9. The pharynx contains many pairs of **gill slits**.
10. They are **hermaphrodites**.
11. The development is indirect and it includes a free swimming larva called **Ascidian tadpole**.
12. The tadpole contains a **notochord** in the tail region, but the adult has no notochord.
13. The larva undergoes **retrogressive metamorphosis** to become the adult.

1. Ascidian (Herdmania)

Phylum : Chordata
Subphylum : Urochordata
Class : Ascidiacea

Herdmania pallida is a simple *Ascidian*. It is popularly known as *sea squirt* or *sea potato*. The adult *Ascidian* is enclosed in a protective *test* or *tunic*; hence the subphylum is also called *Tunicata*.

The notochord is confined only to the tail of the larva of *Ascidian*; hence it is called *Urochordata*.

Herdmania is a *marine* animal. It is *cosmopolitan* in distribution. *Herdmania pallida* is found on the rocky beds in the coastal waters of the Indian seas.

Ascidian is a *sedentary* animal. It is an *omnivore*. It is a *ciliary feeder* and it feeds on microscopic animals and plants of the sea water.

When disturbed, it emits two jets of sea water; hence the popular name *sea squirt*. The

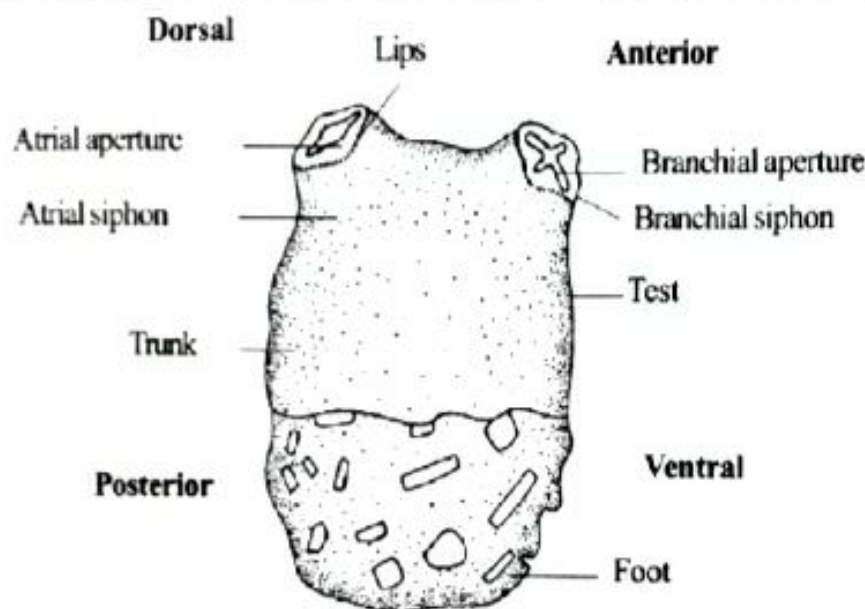


Fig.2.11: *Herdmania*.

development is *indirect*. The *Ascidian* tadpole larva is *free swimming* and undergoes *retrogressive metamorphosis*.

Herdmania is *purse* or *potato* shaped; hence the popular name *sea potato*. It is about 10 cm long and about 6 cm broad.

It is attached to the substratum by means of a *foot* or *base*. At the free end there are two openings; a terminal *mouth* or *branchial aperture* and an *atrial aperture* or *cloacal aperture*.

The branchial and atrial apertures are present on small swellings of the body called *branchial* and *atrial siphons* respectively. Both apertures are bounded by four *lips*.

The *Ascidian* has a *peculiar symmetry*. The branchial aperture represents the *anterior side* and the opposite side represents the *posterior side*.

The atrial aperture represents the *dorsal side* and opposite side represents the *ventral side*.

The body of *Ascidian* is enclosed in a translucent covering called *test*. It is a *leathery*

covering. It is made up of a chemical substance similar to cellulose called **tunicine**. As the test is made up of tunicine, it is also called **tunic**.

All the members of Urochordata are provided with a tunic. Hence this subphylum is also called **Tunicata**.

The tunic is secreted by the ectodermal cells of the underlying body wall (mantle).

The test is composed of a gelatinous matrix. The matrix contains **numerous cells**, **blood vessels** and **spicules**.

4. Salpa

Phylum : Chordata
Subphylum : Urochordata
Class : Thaliacea

1. *Salpa* is an **Urochordate**. It is a **marine Prochordate**. It is **cosmopolitan** in distribution. It is a **pelagic** form.
2. The body is **barrel-shaped**. **Mouth** and **anus** are at opposite ends.
3. The body is covered by a **test**. The body is encircled by seven incomplete **muscle bands**.
4. It has two **gill slits**. The **alimentary canal** has an **endostyle** and a **dorsal lamina**.

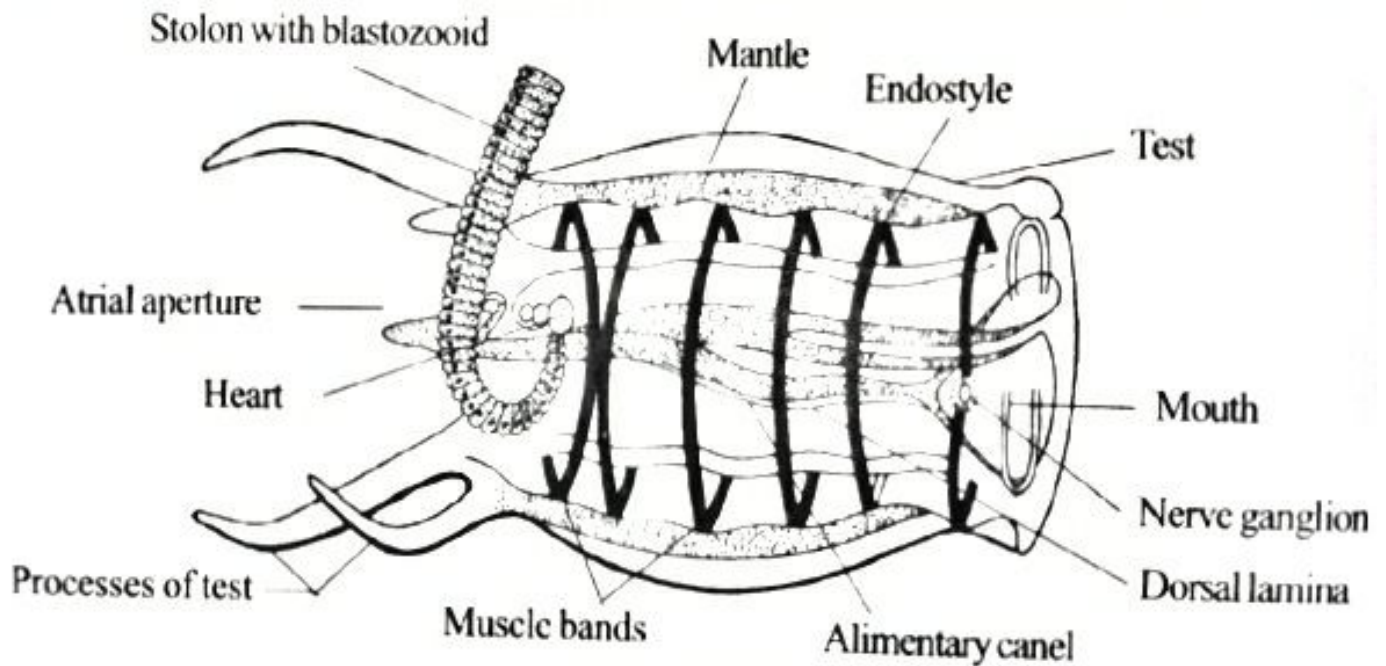


Fig.2.7: *Salpa*.

The alimentary canal is **caroenteric** and forms a nucleus.

5. A **heart**, a **nerve ganglion** and an **eye** are present.
6. *Salpa* exists in two stages, namely an **oozoid** and **blastozoid**. The two forms alternate with each other and hence *Salpa* has **alternation of generation**.
7. The oozoid is the **asexual zooid**. The test has many conical **processes**. It reproduces by **budding**. From the ventral body wall a rope-like outgrowth called **stolon** develops. A chain of buds develop from the stolon. They develop sex organs and break off into the next stage the **blastozoid**.

8. The blastozoid is the **sexual zooid**. It has no conical processes in the test. It is **hermaphrodite**. Fertilization is **internal**. Zygote develops into an oozoid. There is no larva.

6. Oikopleura

Phylum : Chordata
 Subphylum : Urochordata
 Class : Larvacea

1. *Oikopleura* is an **Urochordate**.
2. It is a **marine Prochordate**.
3. It is a **marine pelagic** animal.
4. It remains in a **permanent larval condition**.

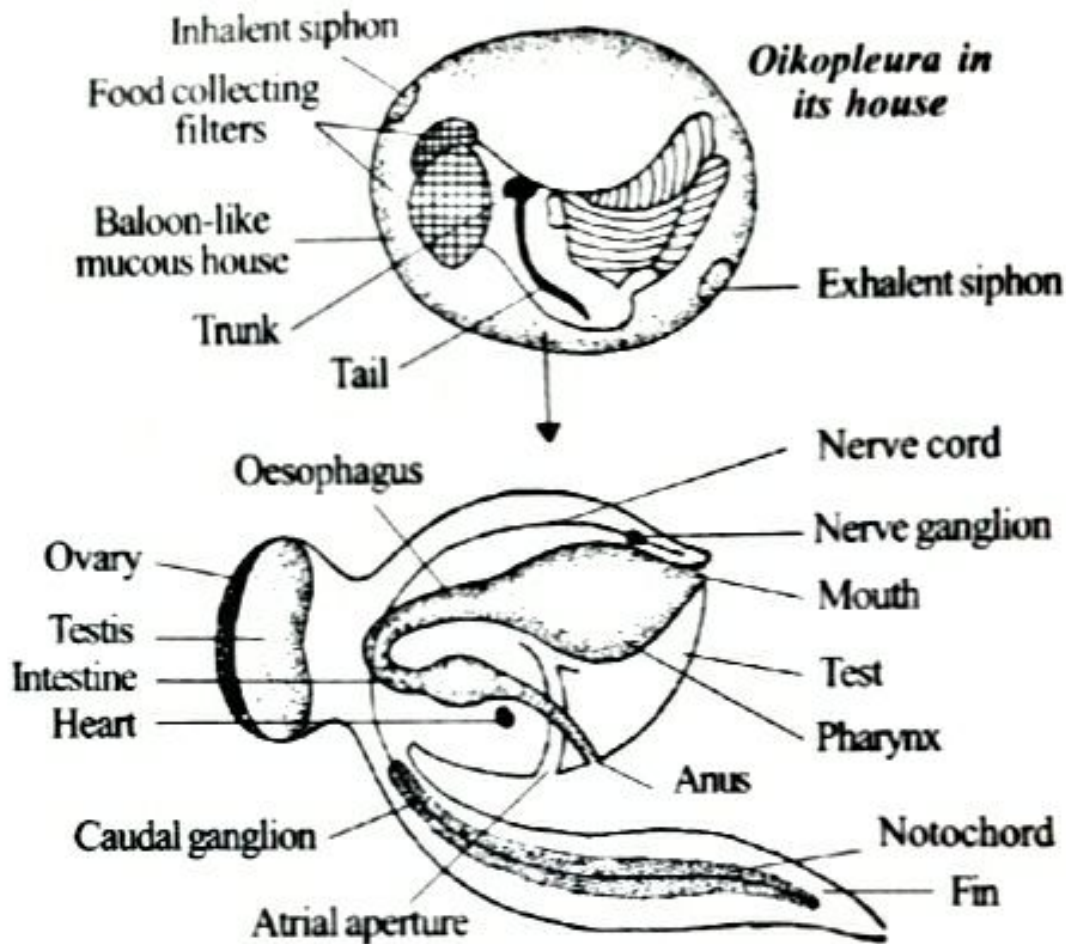


Fig.2.9: *Oikopleura*.

5. The larval life is stretched without undergoing metamorphosis. It is called **neoteny**. It develops gonads in the larval stage.
6. It lives in a balloon-like **mucous house**. (G. *Oikos*, house).
7. The house is a **test** and the animal can freely move inside the house.
8. The house has **food collecting filters**, an **inhalent aperture** and an **exhalent aperture**.
9. The animal consists of a **trunk** and a **tail**.
10. The **tail** is held at an angle to the trunk. The tail has a **tail fin**, a **notochord** and a **nerve cord**.
11. The trunk is **oval** in shape.
12. The trunk has a **mouth**, an **anus**, an U-shaped **alimentary canal**, an **endostyle**, a **heart**, two **gill slits**, a **nerve ganglion**, an **ovary** and a **testis**.
13. It is a **hermaphrodite**.

7. Amphioxus

Phylum : Chordata

Subphylum : Cephalochordata

1. It is a **Protochordate**.
2. It is commonly called ***lancet***.
3. It is a marine fish-like ***burrowing*** animal.
4. The body is laterally compressed and pointed at both ends.
5. The anterior end has a snout called ***rostrum***.
6. The body contains a ***dorsal fin***, a ***ventral fin*** and a ***caudal fin***.
7. On the ventral side there are two folds of the skin called ***metapleural folds***.
8. The ***myotomes*** are arranged on both sides and are separated by ***myocommata***.

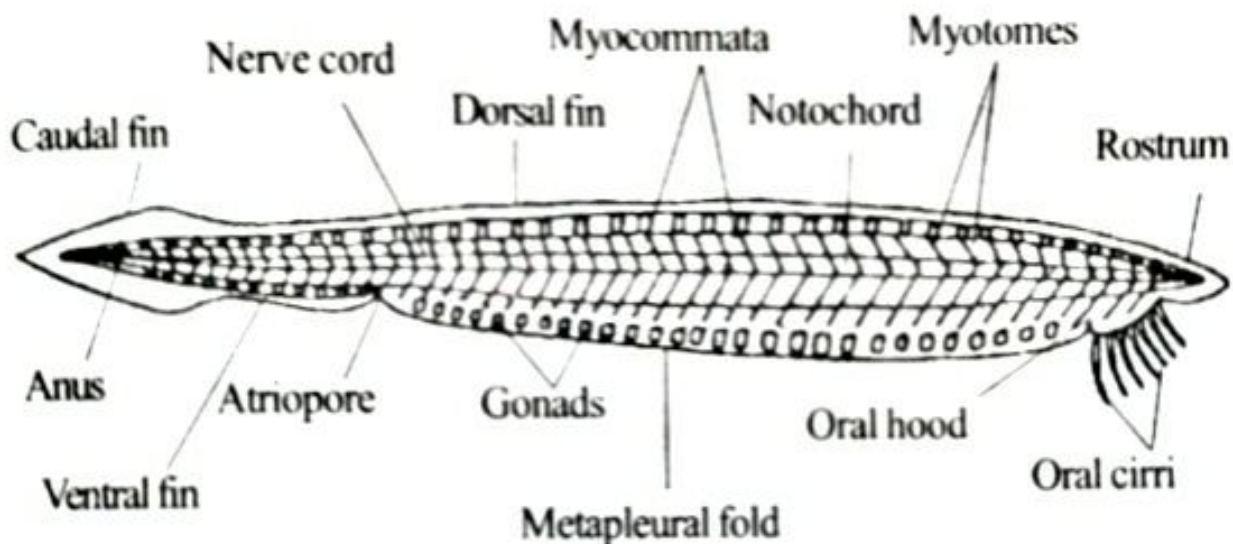


Fig. 2.10: *Amphioxus*

9. The ***mouth*** is situated ventral to the rostrum and is guarded by ***oral hood*** bearing numerous ***oral cirri***.
10. A single ***atriopore*** lies ventrally at the junction of the ***metapleural*** folds and ***ventral fin***.
11. The ***anus*** lies on the left side just in front of the posterior end.
12. The sexes are separate.
13. The ***notochord*** extends from the anterior end to the posterior end.
14. The development is direct.

Affinities of Amphioxus (Phylogenetic Significance)

Branchiostoma was first discovered by **Pallas** in 1778 and he regarded it as a **Mollusc** with a name *Limax*. **Costa** (1834) named it as *Branchiostoma*.

Origin

Garstang (1928), **Berrill** (1955), **Romer** (1959) and **Barrington** (1965) proposed that *Branchiostoma* originated from sessile Urochordate.

The sessile Urochordate produced free swimming tadpole larvae. Some of these larvae gave rise to *Branchiostoma* as well as vertebrates by **neoteny**.

Affinities

Branchiostoma is an interesting animal. It is an assemblage of invertebrate, chordate and unique characters.

1. Affinities with Annelida: *Branchi-ostoma* resembles annelids in the following characters:

1. Bilaterally symmetrical body.
2. Metamerical segmentation.
3. Protonephridia.
4. Coelom.
5. Closed circulatory system.
6. Filter feeding.

But annelids differ from Cephalochordates in the absence of chordate characters and in the presence of **schizocoelic** coelom.

2. Affinities with Mollusca: *Branchi-ostoma* resembles an oyster because it exhibits **ciliary mode of feeding** and respiratory current similar to those of molluscs. This made **Pallas** (1778) to consider it as a slug and named it as *Limax lanceolatus*.

But molluscs differ from *Branchiostoma* in the absence of segmentation. Similarly, *Branchiostoma* differs from molluscs in the absence of foot.

3. Affinities with Echinodermata: *Branchiostoma* resembles echinoderms in the following characters:

1. **Asymmetrical** body.
2. **Enterocoelous** coelom.
3. Perforations in the calyx of fossil crinoids resembling the ***gill slits*** of *Branchiostoma*.
4. The energy-rich compound ***phosphocreatine*** is present both in ophiuroids and *Branchiostoma*.

It is believed that all these similarities are due to a remote common ancestry.

4. Affinities with Chordates: *Branchiostoma* is definitely a chordate because, it possesses the following three chordate characters:

1. Dorsal tubular nerve cord.
2. Notochord.
3. Gill slits.

5. Affinities with Hemichordata: *Branchiostoma* resembles hemichordates in the following characters:

1. ***Gill slits*** and gill bars.
2. ***Filter feeding***
3. **Enterocoelous** coelom.
4. **Numerous gonads** and gonoducts.

6. Affinities with Urochordata: *Branchiostoma* resembles Urochordates in the following features.

1. ***Ciliary*** mode of feeding.
2. Respiratory mechanism.
3. Pharynx with ***gill slits, endostyle, dorsal lamina*** and ***peripharyngeal bands***.
4. An ***atrium*** with atriopore.
5. Early developmental stages.
6. The notochord, the tubular nerve cord and the post anal tail of *Ascidian* tadpole resemble those of *Branchiostoma*.

However, the urochordates differ from the *Branchiostoma* in the following features:

1. Unsegmented body.
2. Test.