

■ Habit and Habitat

Amphioxus also called *Branchiostoma* is a widely distributed marine animal found in the coastal waters of Atlantic Ocean, Indian Ocean, Mediterranean sea and along the southern coast of China.

It is a burrowing animal, greater part of the body is buried and only head or anterior end projecting into water. It burrows in sand with its head first by means of vibratory action of the entire body. It is also able to swim feebly in water by means of lateral strokes of the posterior portion of the body. It comes out of the burrow and swims particularly during night and the breeding season.

Branchiostoma or *Amphioxus* is a typical ciliary feeder. It feeds on planktonic micro-organisms brought along with the water current which constantly enters the mouth placed on its projecting anterior end, and leaves through the atriopore. Male and female individuals are separate. They release their gametes in water where fertilisation takes place. Development is indirect with a free-swimming larval stage which gradually assumes the shape of the adult.

■ External Features

Shape, Size and Colour : *Amphioxus* is a small elongated narrow and fish-like animal 5-8 cm in length. Its body is translucent, laterally compressed,

and pointed at both ends, hence the common name 'lancelet' which means a lance. The stream-lined body is well-suited for burrowing as well as swimming. The posterior end is more tapering and pointed than the anterior end.

Division of Body : A true head is absent. The body is divisible into two regions : the trunk and the tail. The greater anterior region constitutes the trunk and a much smaller posterior region is the tail. The anterior end of trunk extends in front as a pointed snout or rostrum.

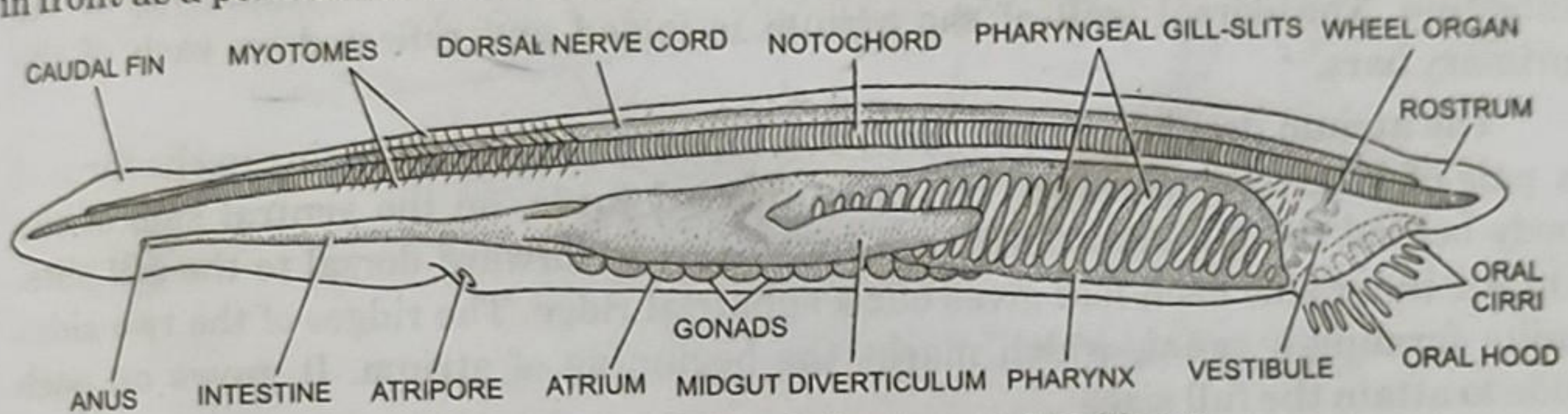


Fig. 1. External and internal structure of *Amphioxus*

Apertures : Trunk bears three apertures : **mouth**, **atriopore** and **anal pore**. Below the rostrum is the oral hood. It is formed by dorsal and lateral projections of the body.

- Mouth is a wide antero-ventral aperture bordered by the free margin of oral hood.
- Atriopore is a small mid-ventral rounded aperture lying just in front of the ventral fin. The atrial cavity surrounding the pharynx opens to outside through atriopore.
- The anus lies somewhat to the left of mid ventral line at the base of caudal fin. The small posterior part of the body behind the anus forms the tail.

Fins and Folds : *Amphioxus* bears three unpaired or longitudinal median fins, *i.e.*, **dorsal**, **caudal** and **ventral**.

The dorsal fin runs along the mid-dorsal line along the entire length of trunk. It is continuous with somewhat broader caudal fin posteriorly around the tail. The ventral fin runs mid-ventrally from the caudal fin upto the median opening, the atriopore. It is slightly wider than the dorsal fin.

The dorsal and ventral fins are supported respectively by one and two series of **fin-ray boxes**. These are formed of a gelatinous substance and connective tissue. However, the structure of fins and fin-ray boxes is different from that in fishes.

Paired fins are absent in *Amphioxus*. Two hollow membranous metapleural folds run longitudinally along the ventro-lateral margins of the anterior two-third part of the trunk. These help in burrowing in sand rapidly due to turgescence caused by flow of body lymph in their cavities.

Myotomes and Gonads : On each lateral side of body is a series of <-shaped muscle bands, called **myotomes** or **myomeres**. These can be seen through the transparent body wall. Below the myotomes is a series of gonads between mouth and atriopore.

■ Atrium or Atrial Cavity

Atrium is a space in *Amphioxus* lined by ectoderm, which encloses and surrounds the pharynx and anterior part of the intestine ventrally and laterally. It opens to the exterior at about the level of 36th myotome by atriopore. The atriopore is a mid-ventral aperture situated immediately in front of caudal fin. The atrium extends far behind the 36th myotome in the form of backwardly directed blind diverticulum as far as anus is situated on the right side of the intestine. The dorsal wall of the atrium is folded and reflected on each of the primary bars.

The atrium develops in the larva at the cost of coelom. It begins in the form of a pair of longitudinal ridges the **melapleural folds**, on the ventral side of the body behind the gill slits. These gradually extend forward dorsal to the gill slits. On the inner side each fold gives out a subatrial ridge. The ridges of the two sides unite forming a canal, which marks the beginning of atrium. It grows on each side to attain the full size.

The atrium receives the mature gametes and expels them out through the atriopore. Similarly, the water current which enters the pharynx passes out through gill slits into the atrium and finally leaves through the atriopore.

cells and thus taste food. The oral hood encloses a cavity behind which is known as the vestibule and its bottom is perforated by mouth. The oral hood helps in locomotion and feeding. While *Amphioxus* is moving swiftly the oral hood remains expanded with cirri radiating out but, at the time of feeding, cirri curve inwards forming a sort of strainer which permits food particles of only definite size to enter the body.

- (a) **Buccal cirri** : The ventro-lateral margins of oral hood are with 10 pairs of stiff oral cirri or **buccal tentacles**. Their number increases with age. These bear **sensory papillae**. The buccal cirri and the margin of oral hood are supported by stiff, gelatinous **skeletal rods**. While feeding, the oral cirri are turned inwards to form a sieve to prevent entry of larger particles.
- (b) **Vestibule** : The oral hood encloses a large funnel-shaped cavity called **buccal cavity** or **vestibule** into which the mouth opens. The cavity of vestibule is lined with ectoderm. So it is regarded as **stomodaeum** and its opening as **mouth**.
- (c) **Wheel organ** : The under surface of oral forms 6-8 pairs of finger-like folds or patches each formed by a ciliated groove bounded by a ciliated ridge. These constitute the **wheel organ** or **Muller's organ** or **ciliated organ**. The cilia of wheel organ set up a whirling water current and sweep the food organisms into the mouth.

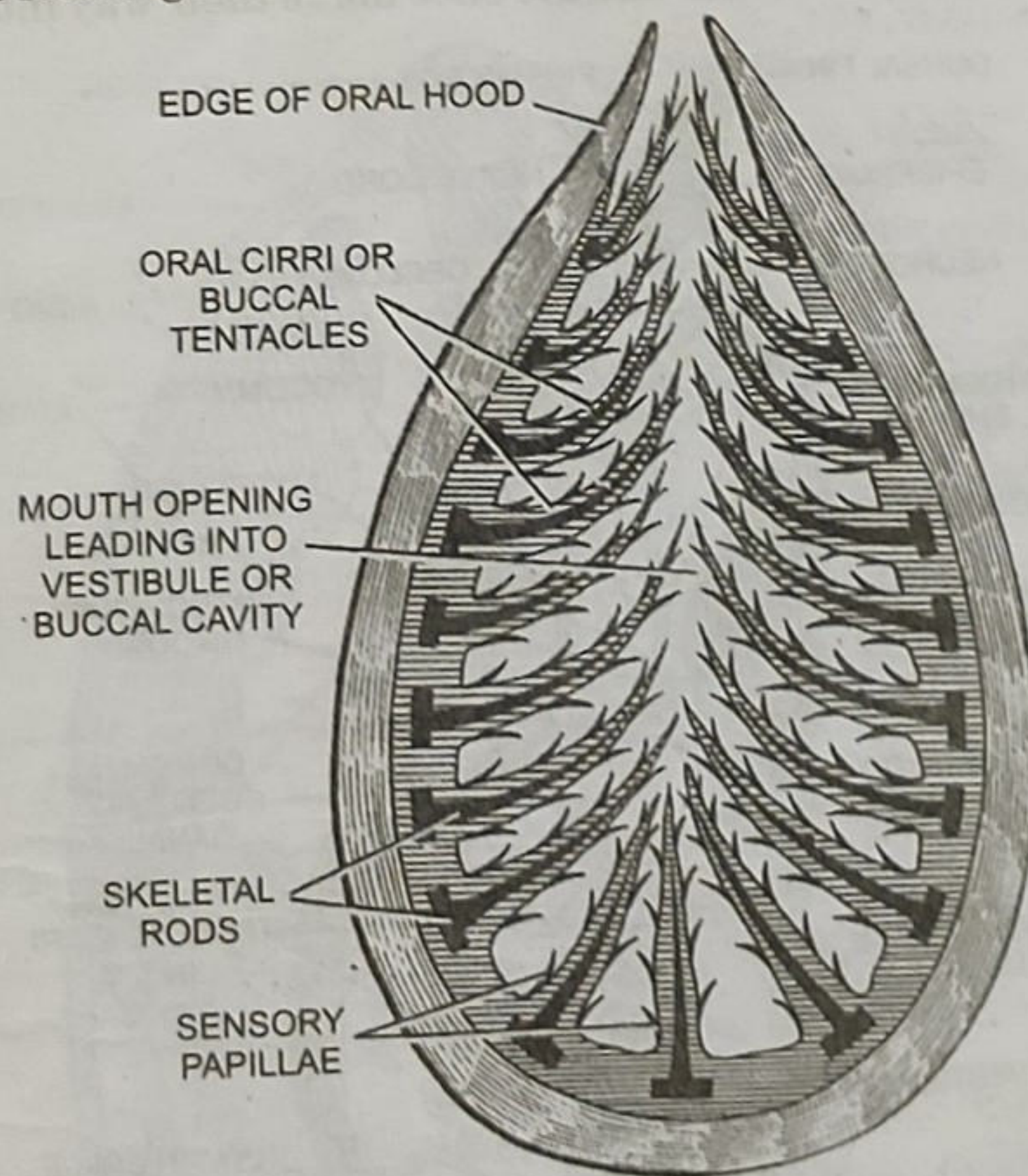


Fig. 5. Oral hood of *Amphioxus*

Each patch of the wheel organ has a groove ending in a pit anteriorly. The mid-dorsal patch has a glandular and ciliated groove called **Hatschek's groove** and a small depression called the **Hatschek's pit**. Both are ciliated, glandular and secrete mucus, while pit is considered to be sensory.

3. **Velum and Enterostome** : Vestibule is bounded posteriorly by a circular, ring-like vertical membrane, the **velum**. It is perforated by a central circular aperture, the **enterostome**, leading into the pharynx behind. The enterostome is erroneously called mouth by some authors. But it does not correspond to the mouth of other chordates because it opens into pharynx lined with endoderm. The true mouth, as a matter of fact, opens into stomodaeum with ectoderm.

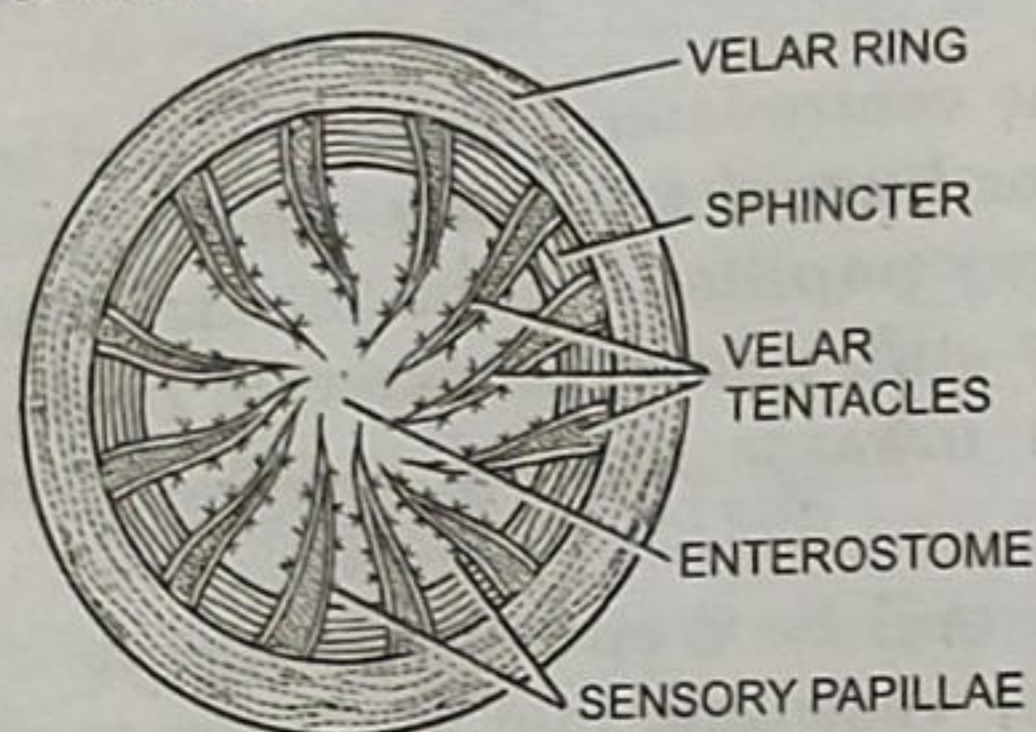


Fig. 6. *Amphioxus* : Velum

The velum is provided with a sphincter to regulate the opening or closing of the enterostome. The posterior border of velum is produced into 10-12 slender **velar tentacles**. These are beset with numerous sensory papillae and cilia. The velar tentacles are directed backwards into the pharynx and form a sort of strainer, and filter the food-laden incoming water current. The bigger food particles are left behind, while the minute ones make their way into the pharynx.

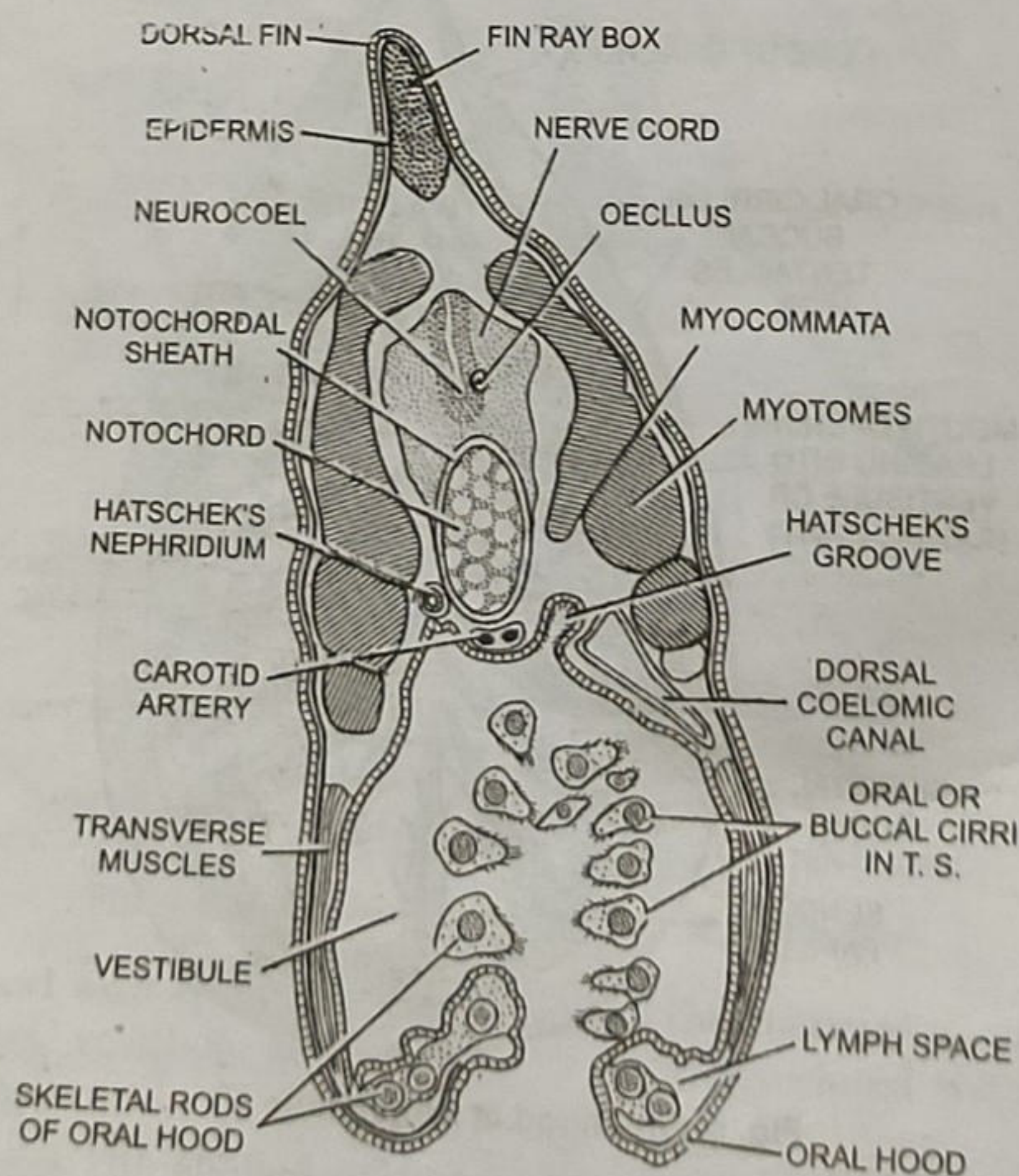


Fig. 7. T.S. *Amphioxus* through oral hood

4. **Pharynx** : It is a large, spacious and laterally compressed chamber forming the largest part of the alimentary canal. It consists of following structures :

(a) **Gill slits** : The lateral walls of pharynx are perforated by 50-200 pairs of narrow and obliquely placed **gill slits** or **gill clefts**, through which the pharyngeal cavity communicates with the atrial cavity. The gill slits bear no gills and their number increases with age at the posterior end.

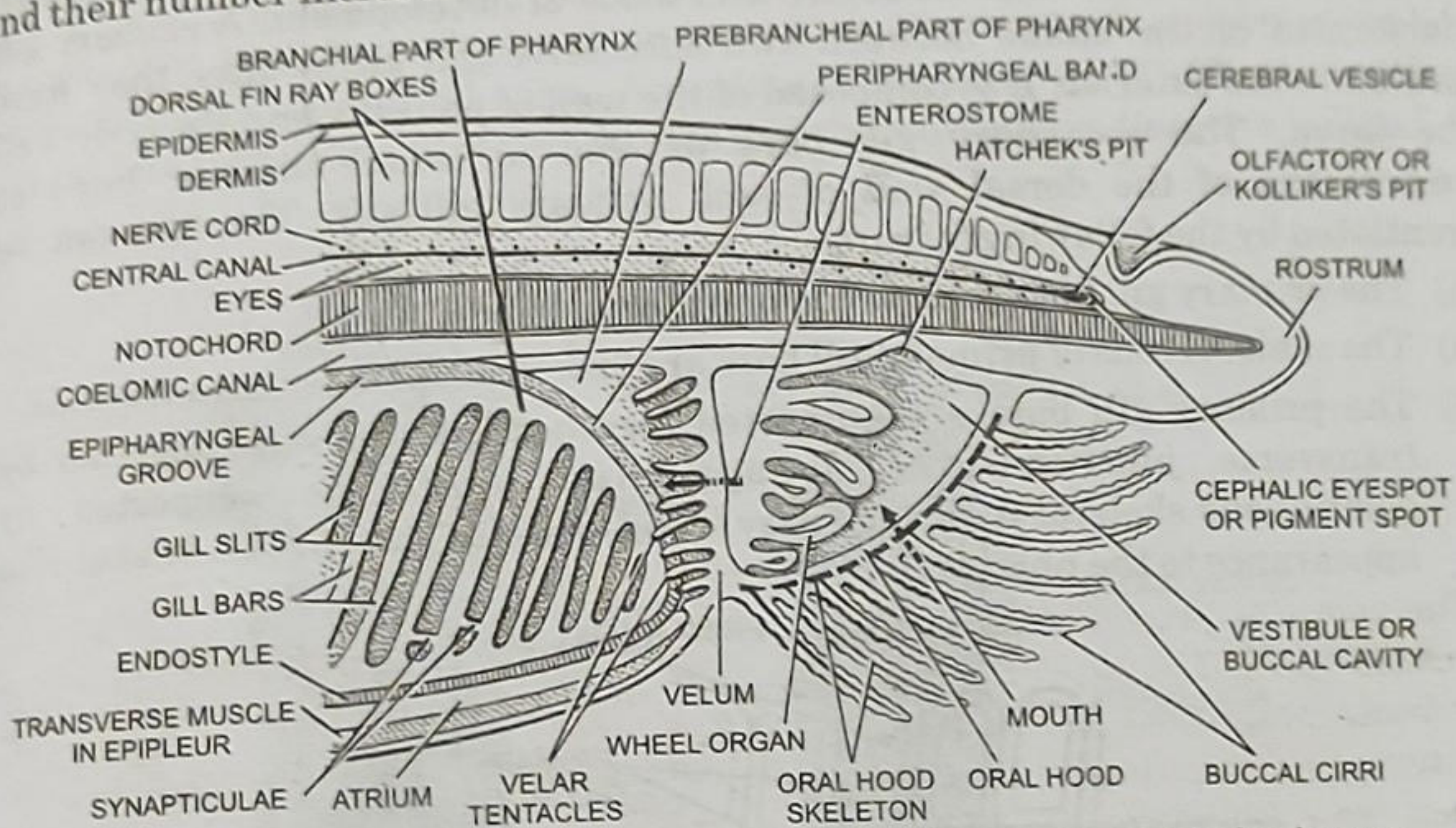


Fig. 8. Anterior part of Amphioxus showing oral hood velum and wheel organ

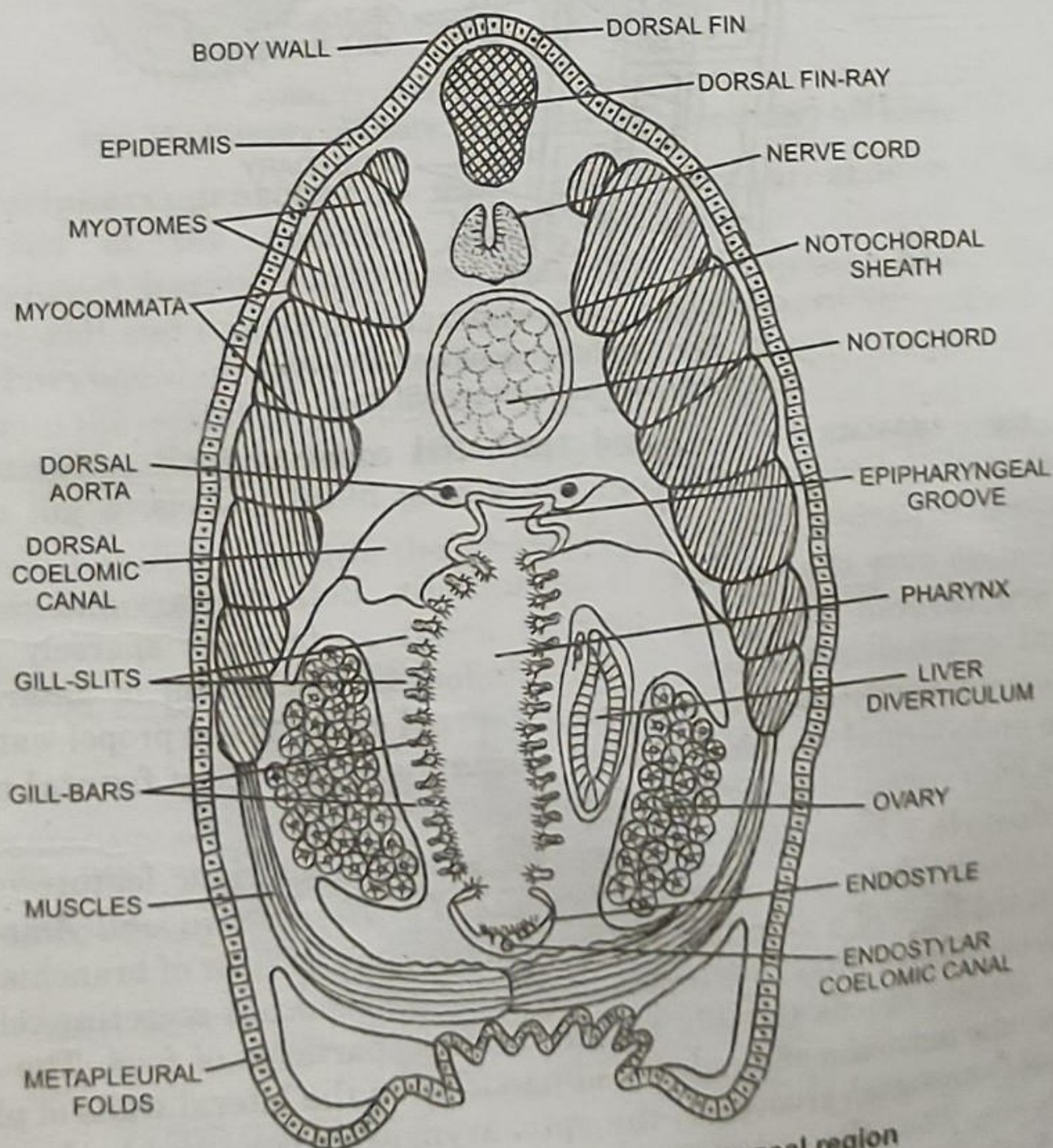


Fig. 9. T.S. Amphioxus through pharyngeal region

(b) **Gill bars** : Between the gill clefts or gill slits the wall of the pharynx is known as **gill bars** or **gill lamellae**. The gill bars are of two types: **primary gill bars** and **secondary gill bars** or **tongue bars** which regularly alternate with each other and differ in their structure and mode of development. A primary gill bar is formed of the tissue between two successive gill clefts after they have perforated to the exterior. It is composed of the wall of pharynx and the body wall of the larva. The secondary gill bars develop as small **tongue bars** or **downgrowths** of the dorsal wall of each primary gill slit. The two can be differentiated by the following features :

- (i) The primary gill bars enclose coelomic space inside.
- (ii) The skeletal rods of primary gill bars are forked in secondary space inside.
- (iii) The primary gill bars are connected together by transverse together by transverse junctions, the **synapticulae** which are supported by gelatinuous skeletal rods and carry blood vessels. This gives a basket-like appearance to the pharynx.

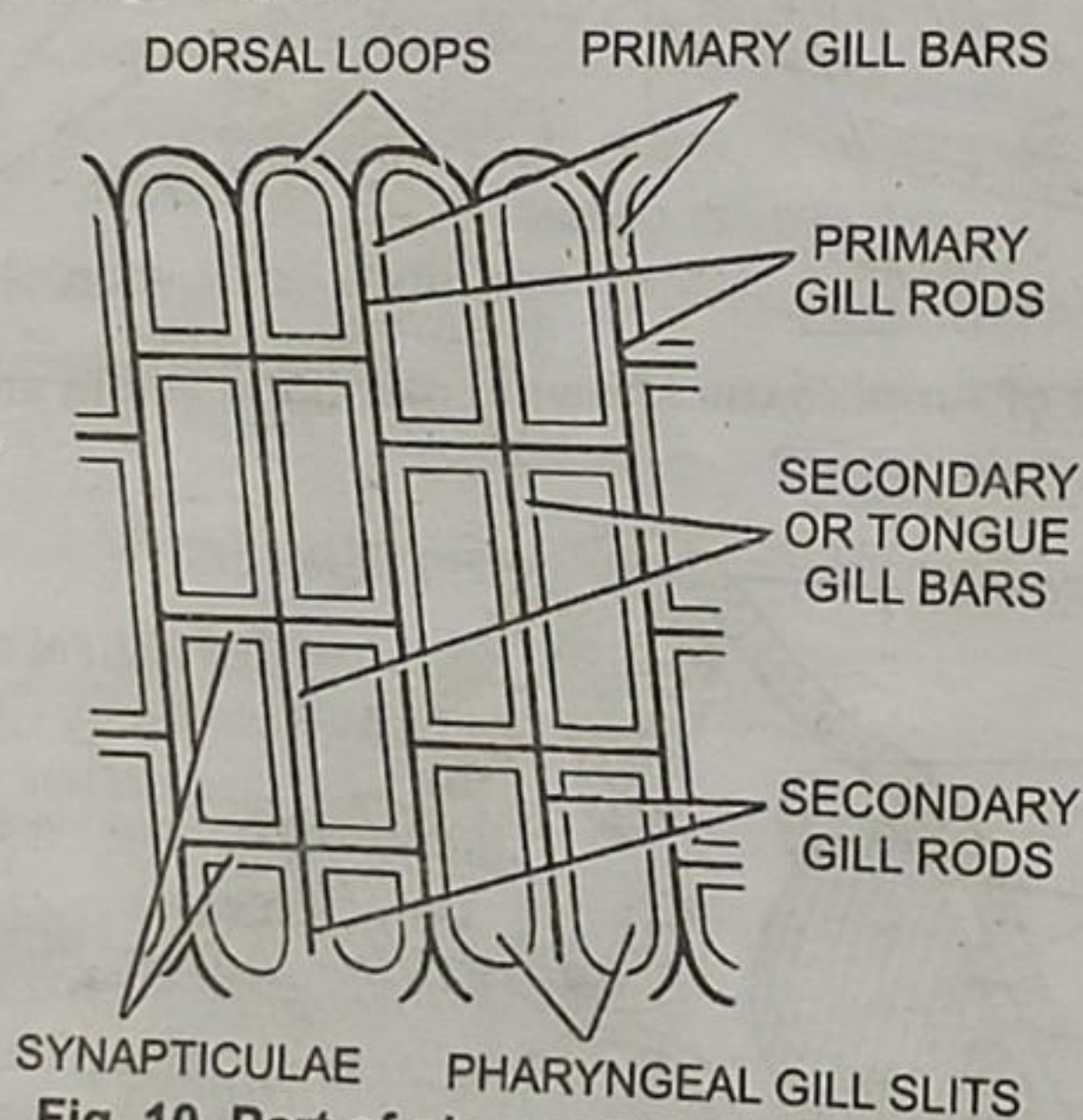


Fig. 10. Part of pharyngeal wall showing primary and secondary gill bars

A gill bars consists of a ciliated epithelial covering both ectodermal and endodermal with a mesodermal core containing blood vessels, a gill rod and fibrous connective tissue.

The ciliation over the gill bars is not uniform. Both primary and secondary gill bars are covered on their outer or atrial surface by sparsely ciliated **ectodermal epithelium**. The cilia on ectodermal epithelium of anterior and posterior regions are dense and long called **lateral cilia**. These propel water. The cilia on the endodermal epithelium form a long, narrow tract of **frontal cilia** on the inner or pharyngeal side and propel mucus.

(c) **Endostyle** : Possession of endostyle is a characteristic feature of lower chordates (Urochordata and Cephalochordata, i.e. *Herdmania* and *Amphioxus*, etc.). It is in the form of a glandular ciliated groove on the floor of branchial sac of pharynx. It consists of alternate bands of ciliated and mucous-secreting cells. The gland cells secrete mucus threads which entangle particles of food. The cilia of the ciliated cells move the entangled food particles on the lateral walls of pharynx through peripharyngeal grooves to the epipharyngeal groove and backward into the oesophagus. Thus the endostyle helps in ciliary mode of feeding by collecting and transporting the food particles from the water current. In *Branchiostoma* the

pharynx has a shallow gutter, the **endostyle** or **hypobranchial tract** along the mid-ventral line of its entire length. It is lined by 5 longitudinal tracts of ciliated cells alternating with 4 tracts of mucus-secreting gland cells. The cilia of the median tract are much longer than those of the lateral tracts. The endostyle is supported by two skeletal plates under which lies the sub-endostyle coelomic canal containing the ventral aorta. According to **Barrington (1968)**, the endostyle changes into thyroid gland of vertebrates and concentrates radioactive iodine.

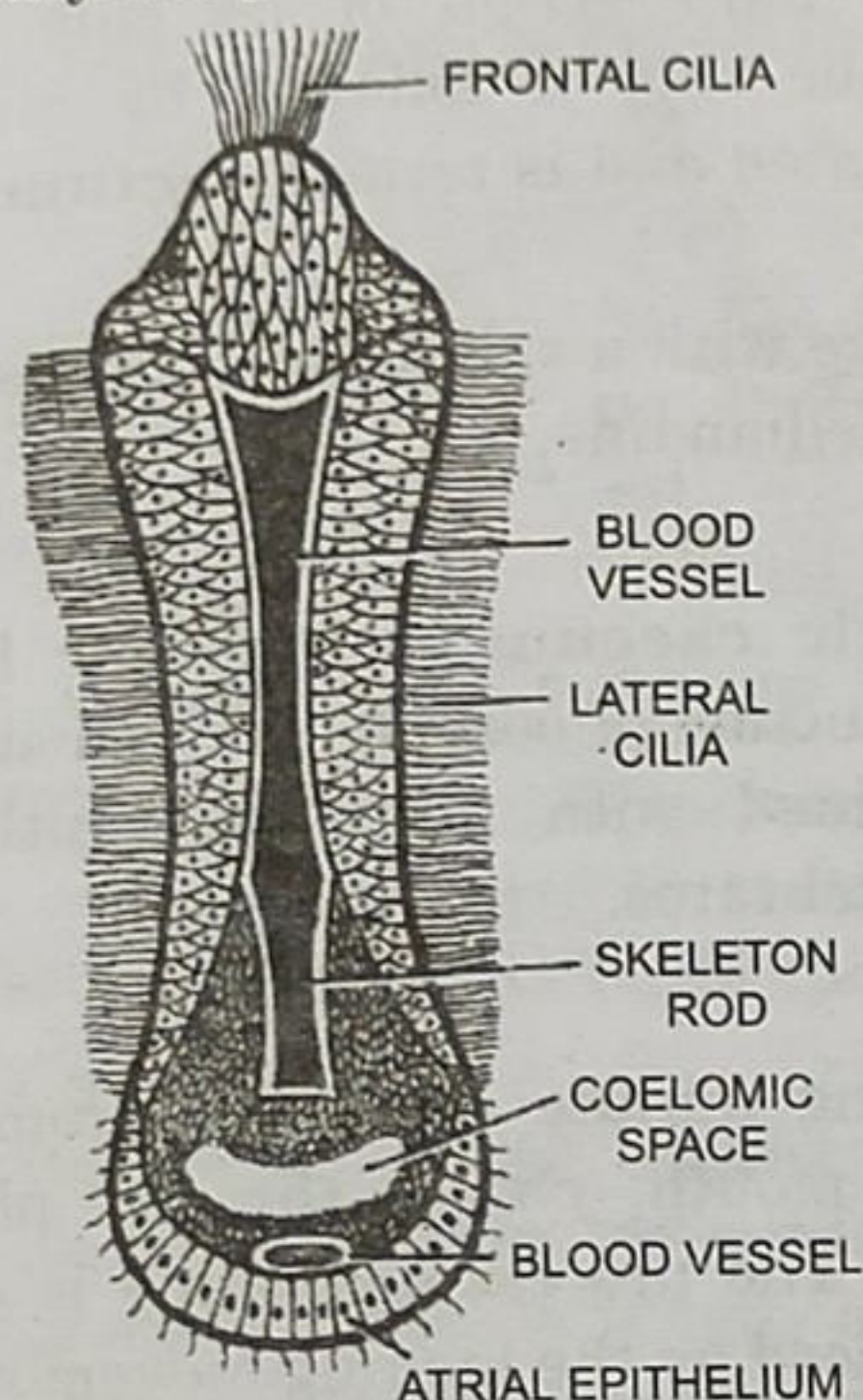


Fig. 11 : Primary gill bars.

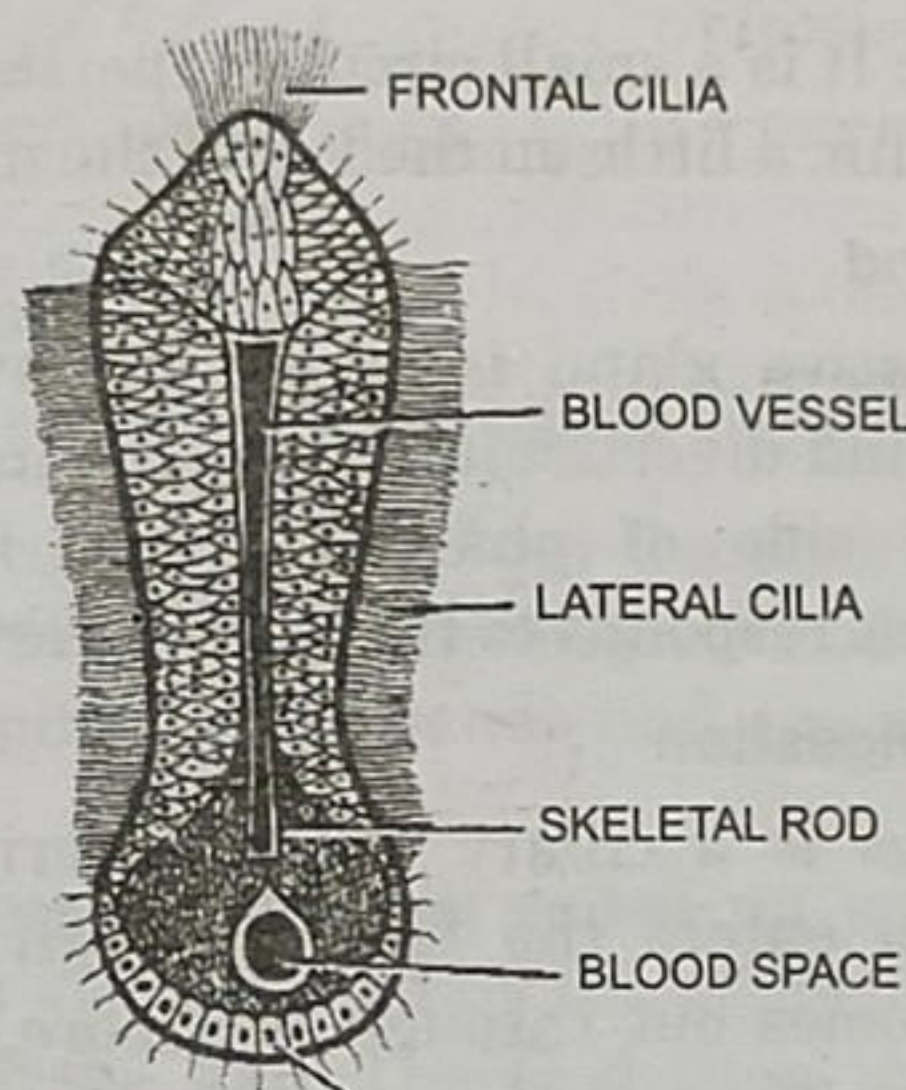


Fig. 12 : Secondary gill bars.

(d) **Peripharyngeal bands and epipharyngeal groove** : From the anterior end of the endostyle start two narrow ciliated tracts, the **peripharyngeal bands**. These pass backward and upward along the lateral pharyngeal wall and meet a dorsal ciliated groove, the **epipharyngeal groove**. The **epipharyngeal groove** runs backward along the mid-dorsal line of the pharynx upto the oesophageal opening. A small region of the pharynx in front of the peripharyngeal bands lacks gill slits and is known as the **prebranchial region**.

5. Oesophagus : It follows the pharynx. It is a short, narrow, ciliated tube that leads into the intestine.

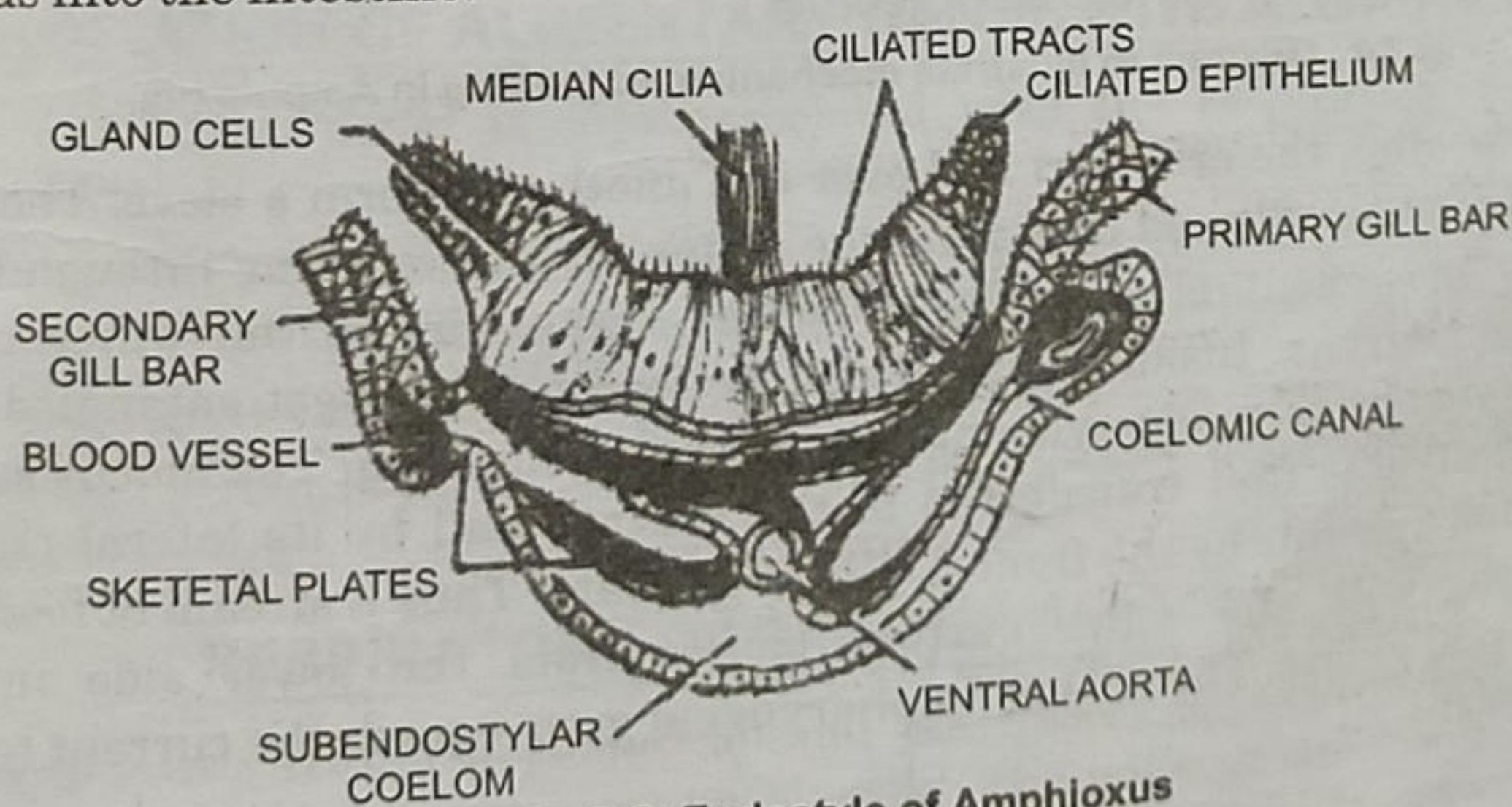


Fig. 13 : T.S. Endostyle of Amphioxus

6. **Intestine** : It is as long as the pharynx. It shows three regions: anterior wide **midgut**, middle **ileo-colic ring** and posterior tapering **hindgut**. A large blind diverticulum arises from the junction of oesophagus and midgut towards right side.

The midgut has a lateral ciliated tract on its right side. Cilia of this tract beat downwards directing food into the midgut diverticulum. Midgut is followed by a densely ciliated **ileo-colic ring**. The ciliary action of its cilia rotates the food-containing mucus cord. The ileo-colic ring is followed by hindgut. It is narrower. Its terminal part is heavily ciliated and is termed **rectum**. It opens to the outside by anus.

7. **Anus** : It is a small circular aperture with a sphincter. It opens at the base of the caudal fin, a little on the left of the median line.

Digestive Gland

The digestive gland is single **hepatic caecum** or **saccular liver** which arises as a blind diverticulum from the junction of oesophagus and stomach, and runs on the side of pharynx. It is lined with glandular epithelium and superficially corresponds to the liver of vertebrates.

Feeding and Digestion

Amphioxus is a ciliary feeder filtering minute organisms from the water current which enters the body through mouth, passes through pharynx and atrium and comes out through atriopore. The process of feeding is complicated but interesting. The water current is produced by the lashing movement of cilia of gill bars. The frontal cilia of gill bars rotate the current inside the pharyngeal cavity from below upwards, so that a stream of watery mucus passes from the endostyle into the epipharyngeal groove and is finally carried on the oesophagus.

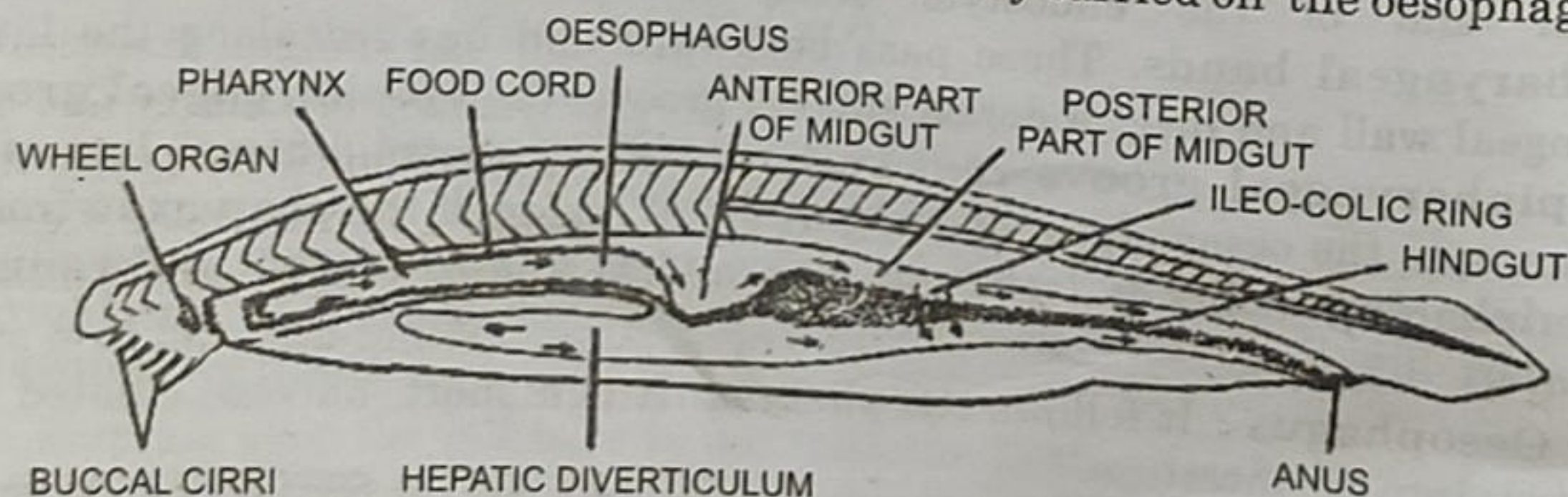


Fig. 14 : Diagram to illustrate mechanism of feeding in *Amphioxus*.

While feeding, the oral cirri fold over one another to form a sieve. The larger particles of food are filtered here from the water current entering through mouth. The rotary movement of the cilia of wheel organ directs the water current towards the pharynx. Inside the pharynx the food particles get entangled in the mucus secreted by the endostyle and pharyngeal epithelium. The mucus secreted by the endostyle is first transferred to the ventral wall by its lateral cilia and then directed upwards by the frontal cilia of gill bars. Thus a stream of food laden mucus along with the water current passes from the lower side into the epipharyngeal groove. The cilia of epipharyngeal groove push the current towards the oesophagus.

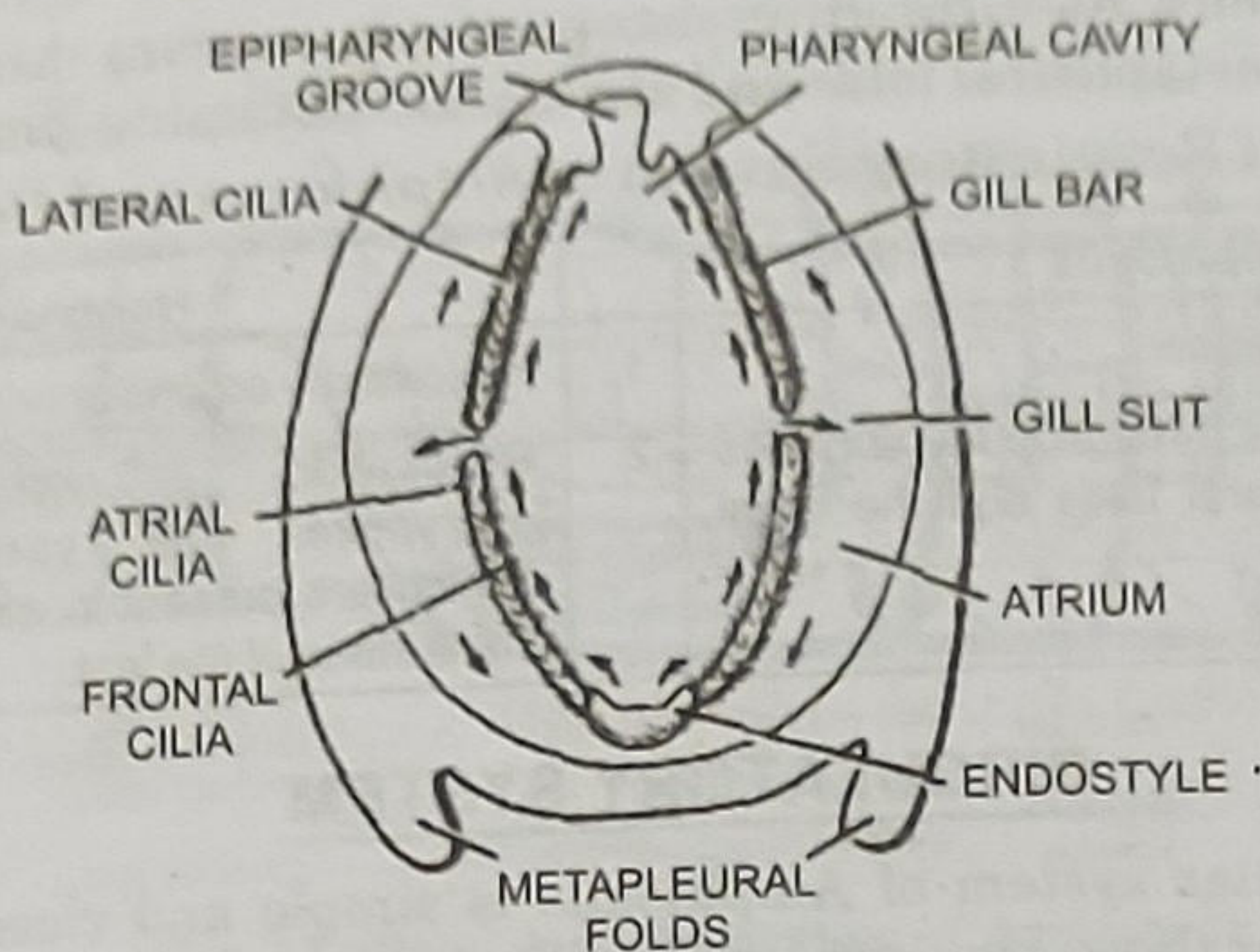


Fig.15 Role of cilia of pharyngeal wall and path of food laden mucus inside the pharynx.

In the stomodaeum, the food particles falling out from the water current are collected in the mucus secreted by the cells of Hatscheks' groove. But inside the pharynx these are picked up by the epipharyngeal bands and are passed on the epipharyngeal groove.

By the time food reaches oesophagus, it becomes rolled up with mucus to form a cord. Its passage down the gut is also affected by the action of cilia which form a tract along the whole length of the gut. The food from the oesophagus moves into midgut, where a lateral tract of cilia directs it into the midgut diverticulum. From here the food returns back to midgut. The ileo-colic ring of cilia causes the rotation of food, which brings about a thorough mixing of digestive enzymes.

The digestive enzymes are secreted by the wall and midgut diverticulum. These get mixed with the food by the rotatory movement of cilia of ileo-colon region. The digestion starts in the midgut and is continued until the gut contents are voided out. In addition to this extracellular digestion, intracellular digestion has also been reported. The small food particles are picked up by the epithelial cells of the hindgut and are digested there. Absorption of digested food starts in the midgut but it is chiefly brought about in hindgut.

ASSOCIATION OF ALIMENTARY CANAL WITH RESPIRATION

The alimentary canal is also associated with the respiration due to the following facts :

1. The wall of the pharynx is vascular and the exchange of gases occurs when blood passes through the afferent branchial vessels and synapticalae.
2. Water current is produced by the cilia of gill bars.
3. Water current is directed towards the pharynx by the rotatory movement of cilia of wheel organ.