Digestive Systems of Branchiostoma:

The digestive system of Branchiostoma consists of an alimentary canal and digestive glands. The alimentary canal is again divided into mouth, oral hood and buccal cavity (vestibule), pharynx or branchial sac, oesophagus, intestine and anus. Hepatic diverticulum is often referred to as digestive gland.

Different parts of the alimentary canal

Mouth

Mouth is a small rounded aperture situated at the base of the vestibule or buccal cavity of the oral hood. It is surrounded by a membrane, called velum, acts as a sphincter which bears 12 slender velar tentacles or languets on its free edge, and help to close or open the mouth.

Oral hood and buccal cavity

A large median aperture is situated just below the pointed tip of the anterior end (rostrum). This aperture is surrounded by a frill-like membrane, called oral hood. The membranous lateral and ventral margins of the oral hood are fringed with buccal cirri.

The buccal cirri are beset with sensory cells some of which are mechanoreceptors. Sensory cells on each cirrus probably provide the animal with information on water quality.

The oral hood and buccal cirri are supported by skeletal rods. During the inflow of water current, the buccal cirri form a sieve to prevent the entry of large particles. The oral hood encloses a cavity, called vestibule or buccal cavity. It is a short part of the foregut that receives water and food particles from the mouth.

Wheel organ

The inner lining of the vestibule produces a complicated ciliated grooves and ridges, called wheel or rotatory organ or ciliated organ of Muller. The wheel organ produces a whirling currents of water to sweep the food matters into the mouth.

Hatschek's groove

There is a ciliated glandular groove running along the roof of the vestibule, called Hatschek's groove. It is lined partly by endocrine cells which are believed to secrete pituitary-like hormones into the blood.

The groove of Hatschek terminates into a small depression, called the pit of Hatschek. The left embryonic coelomic cavity of the region becomes reduced to form the pit of Hatschek of the adult.

Velum

There is a ring of finger-like sensory tentacles around the mouth, called velum which separates vestibule (buccal cavity) from the pharynx.

Pharynx or branchial sac

The pharynx is a large laterally compressed tube which occupies more than half of the total surface area of the body. The lateral wall of the pharynx is perforated by obliquely arranged vertical apertures — the gill-slits or branchial slits.

The number of gill-slits is about 180 pairs. The gill-slits open into an 'U' shaped special cavity, the atrium or peribranchial cavity, which surrounds the pharynx on all sides except the dorsal. The atrium is closed anteriorly but opens to the exterior through an aperture, the atriopore which is situated behind the level-of pharynx. The whole cavity of atrium is lined by epithelium of ectodermal origin.

The gill-slits are separated from one another by the portion of the walls of the body and the pharynx. These portions are called the gill-bars or branchial lamellae, i.e., the gill-bars are actually the vertical portions of the main body wall and the pharyngeal wall. Such a portion of the gill-bar which encloses the coelom is called primary gill-bar.

With the advancement of age, each primary gill-slit is divided into two by the downward growth of the tongue-bar. These resultant gill-bars are named the secondary gill- bars which lack coelom. The gill-bars are provided with cilia. The gill-bars contain supporting gill-rods. The gill-rods are of two types— the primary gill-rods and the secondary gill- rods.

The terminal end of the primary gill-rod is forked and those of the secondary gill-rods are simple, i.e., unforked. Depending on the presence of particular type of gill-rods, the gill-slits are also designated as the primary or secondary ones.

The primary branchial lamellae are connected by transverse skeletal rods, called the synapticulae. The internal wall of the pharynx is ciliated. Several ciliated tracts are present inside the pharynx.

Endostyle

An endostyle is a ciliary and glandular groove present on the floor of the pharynx. The histological structure of endostyle of Branchiostoma similar to that of Ascidia in which the structure of the organ has been discussed in detail.

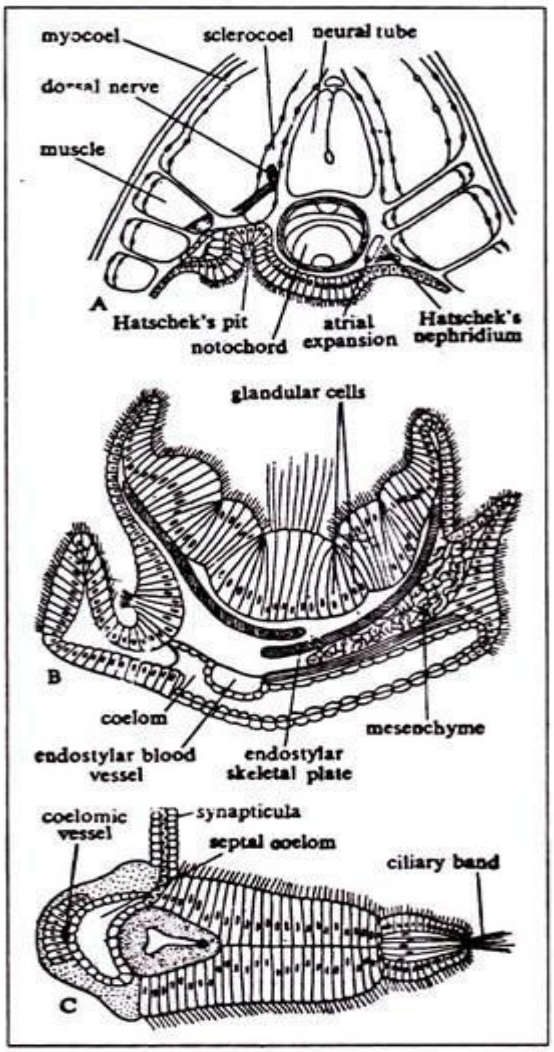

Fig. 3.15 : Sectional views of different portions of *Branchiostoma*. A. Sectional view of the upper half of the oral funnel. Note the position of Hatschek's pit, Hatschek's nephridium, etc. B. Transverse section through the floor of the pharynx showing the relationship of the endostyle with others. C. Transverse section of a single gill-bar (after Jollie, 1962).

The endostyle consists of a few tracts of ciliated cells alternating with mucus-secreting glandular bands. According to Barrington (1968), the endostyle of Branchiostoma produces the hormonal iodothyromines, not well present in tunicates.

He has observed the concentration of radioactive iodine in the glandular columns of the endostyle. The extract contains iodine and, on administration, accelerates the metamorphosis of tadpole larva.

Epipharyngeal or hyper pharyngeal groove
A ciliated median groove is present on the dorsal side of the pharyngeal cavity, called epipharyngeal or hyper pharyngeal groove. The epipharyngeal groove joins with the anterior end of the endostyle by peripharyngeal ciliated tracts.

Oesophagus
The pharynx opens into a short, narrow, ciliated tube, called oesophagus that opens into the midgut. The pharynx and oesophagus constitute the foregut.

Intestine
The intestine (gut) is a straight ciliated tube which can be divided into two regions — midgut and hindgut. The midgut includes hepatic diverticulum and iliocolonic ring.

At the junction of oesophagus and the midgut there is a large single un-branched out-pouching, lying at the right side of the pharynx, called hepatic diverticulum (Fig. 3.16A). The posterior part of the hepatic diverticulum, the midgut narrows into a short, ciliated wider section, called the iliocolonic ring. The tract of the intestine is provided with a weak musculature.

Anus
The intestine proceeds posteriorly as a straight hindgut which opens through the anus.

Digestive gland
Hepatic diverticulum, the so-called liver, referred to as digestive gland in Branchiostoma. It is a large blind out-pouching, develops

at the junction of the oesophagus and the midgut and lies at the right side of the pharynx. The inner walls of the diverticulum, specially the dorsal and ventral walls, are beset with cilia.

It contains zymogen cells which produce digestive enzymes (a lipase and a protease) and are carried into the lumen of the midgut by ciliary activity. It is also a part where fat is deposited.

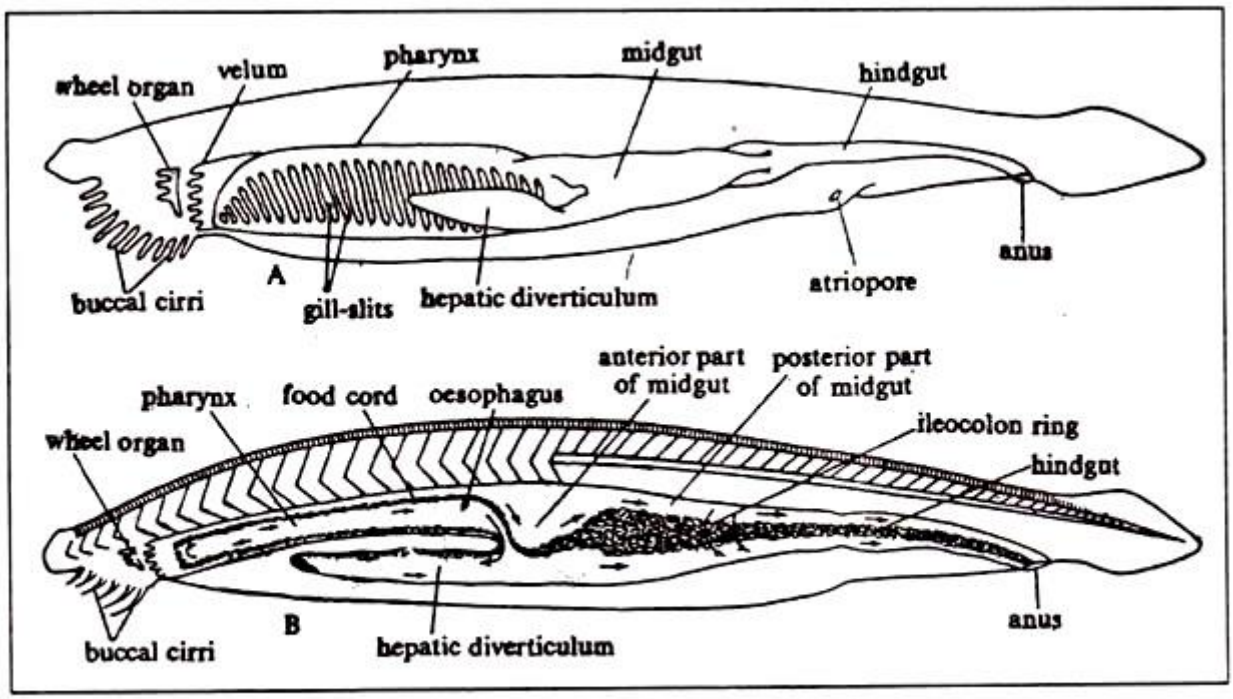

Fig. 3.16 : A. Digestive system of *Branchiostoma*. B. Showing the schematic representation of the feeding current through the gut. The arrows indicate the direction of movement of food cord.

Mechanism of Feeding and Digestion in Branchiostoma

Food

Branchiostoma is a microphagous animal. The food or 'sea soup' consists of protozoans, algae, diatoms and other organic particles.

Feeding

Branchiostoma obtains food by filtering the stream of waters that enters the pharyngeal cavity. The wheel organ produces a vortex. The buccal cirri become curved to form a sieve to prevent the entry of large particles. The sensory papillae in the buccal cirri and velar tentacles act as chemoreceptors and taste the nature of the food particles and also estimate the size of food particles.

If food particles are large in size or liable to cause toxicity, these are expelled by the forceful expulsion of the water from the pharyngeal cavity. The ingress of water into the pharyngeal cavity through the mouth is controlled by the velum.

The pharynx plays the most important role in food collection. The major portion of the water passes out into the atrium through the gill-slits. The cilia present on the gill-bars beat to drive the water out into the atrium and, thus, facilitate the inflow of fresh water current through the mouth.

The food particles, due to their own weight, begin to fall on the floor of the pharyngeal cavity and are entangled by the sticky secretion of the mucus-secreting cells of the endostyle.

The cilia in the endostyle and gill-bars beat to produce an upward current to push the mucus-entangled food particles towards the epipharyngeal groove. The cilia of the endostyle also beat to drive the food along the peripharyngeal-ciliated tracts to the epipharyngeal groove.

The food is pushed backwards by the backward beating of the cilia of the epipharyngeal groove (Fig. 3.16B). The secretion of the glandular cells of the endostyle transforms the boluses of mucus-entangled food particles into a cord-like structure, known as food cord.

The food cord from the pharynx passes through the oesophagus into the hepatic diverticulum and midgut where this food cord is subjected to the action of digestive enzymes secreted by the hepatic diverticulum. The food cord from the hepatic diverticulum is pushed backwards by the cilia present in its cavity. The mucus-entangled food cord is rotated by the ciliary action in the ileocolon ring.

Digestion in Branchiostoma is both intracellular as well as extracellular. The intracellular digestion takes place inside the hepatic diverticulum while the extracellular digestion occurs inside the midgut. The secretory cells of the hepatic diverticulum contain

zymogen granules and they show phagocytosis, i.e., the cells are able to engulf the food particles from the food cord and digest the food as seen in Amoeba and Hydra.

The phenomenon of phagocytosis is attested by the fact that carmine particles, after ingestion into the diverticulum, are taken inside the cells. The digestive enzymes in Branchiostoma are amylase, lipase and protease. The digested food is absorbed in the hindgut and the undigested particles are expelled through the anus.

The controlling mechanism of the ciliary mode of feeding in Branchiostoma is not clearly known. The afferent and efferent nerve fibres in the atrium presumably play the important role in feeding. The rate of water current is largely controlled by the intensity of beating of cilia and also the degree of contraction or dilatation of the inhalant and exhalant apertures.

The different receptors present on the velum and the atrium taste the nature of water current. If the water current contains any toxic substance, the atriopore closes and the water is regurgitated by sudden contraction of the pterygial muscles which form the floor of the atrium. Bone (1979) has shown that after ingestion of sufficient food, the food collection is stopped until the food that has been taken in is digested.