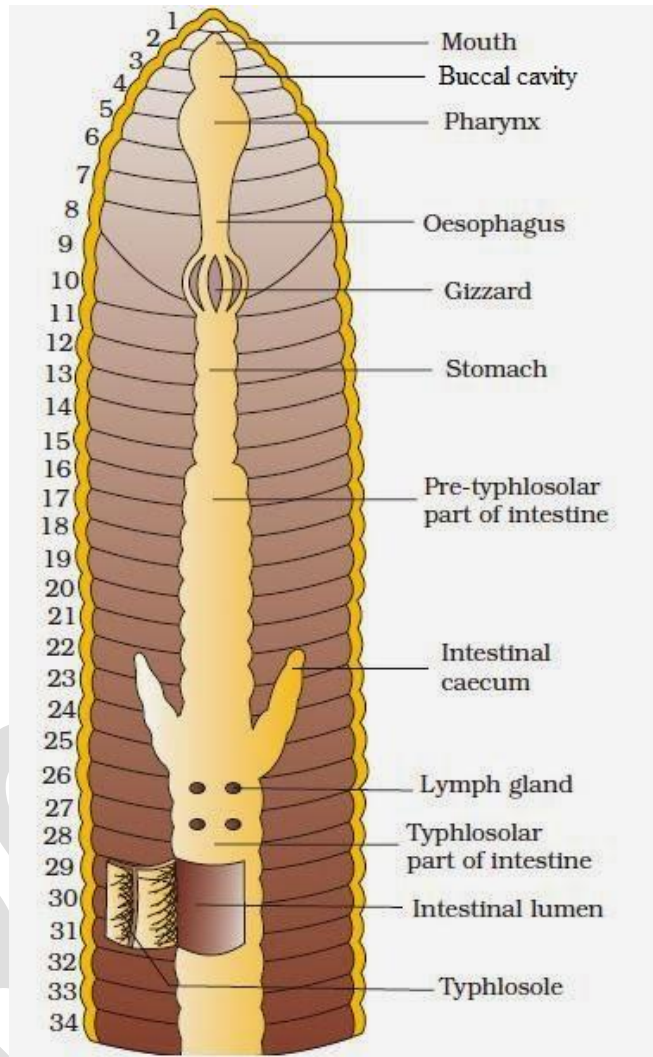


Study of digestive system, septal and pharyngeal nephridia of earthworm



**Fig. Alimentary canal of earthworm**

Digestive system of earthworm mainly contains alimentary canal and digestive glands.

[]Alimentary canal: It runs as a straight tube throughout the length of the body from the mouth to the anus. The parts are as follows:

**1. Mouth and Buccal Chamber:**

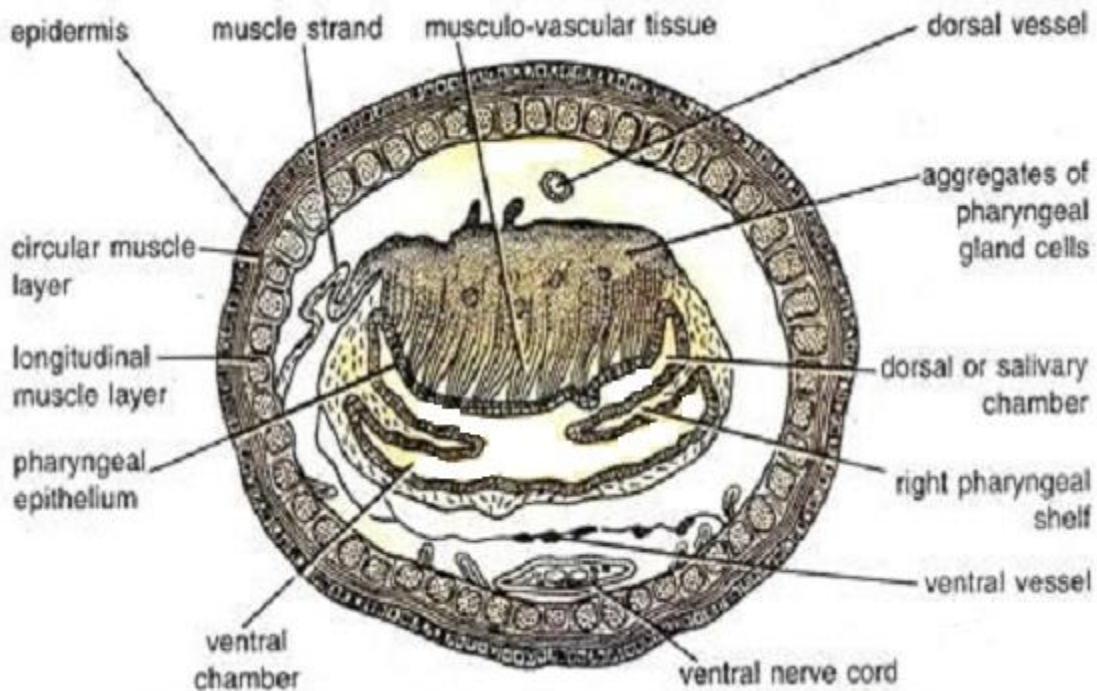
The mouth is a crescentic aperture lying below the prostomium. The mouth leads into a short, thin-walled tube called buccal chamber or buccal cavity running up to the 3rd segment. The

lining of the buccal cavity is folded and it is surrounded by muscular strands. The buccal cavity can be protruded through the mouth with the help of special muscles that run backwards from the buccal chamber to the body wall.

## 2. Pharynx:

The buccal chamber is followed by the pharynx which extends up to the 4th segment. It is a pear-shaped broad and muscular structure separated from the buccal cavity by a groove.

The roof of the pharynx is very thick and projects into the pharyngeal cavity as pharyngeal bulb, its lateral walls internally form two horizontal folds or shelves, one on each side, which divide the lumen of the pharynx into two chambers—the dorsal salivary chamber and the ventral conducting chamber.



[T.S. through pharynx of earthworm]

The roof of the pharynx is lined by ciliated epithelium, above which are many muscles with connective tissues and blood vessels and outside these are the pharyngeal or salivary glands. These are groups of small, whitish unicellular glands of chromophil cells.

These glands open into the salivary chamber of the pharynx through their fine ducts. They secrete mucin for lubrication of food and also a proteolytic enzyme for the digestion of proteins. The ventral conducting chamber of the pharynx serves as the passage for the ingested materials.

The pharyngeal wall remains in connection with the body wall by a thick mass of muscular strands like the buccal chamber. The contraction and relaxation of these muscular strands serve to compress or dilate the pharyngeal lumen. Thus, the pharynx acts as a pump during feeding.

The mouth is pressed against the bits of humus or mud, then the pharynx undergoes a series of contractions resulting into the sucking of the food into the buccal chamber, and then pumping the same backwards into the oesophagus.

### **3. Oesophagus:**

Behind the pharynx is a short, narrow, thin-walled oesophagus running up to the 8th segment. The oesophageal wall is folded internally and devoid of any gland.

### **4. Gizzard:**

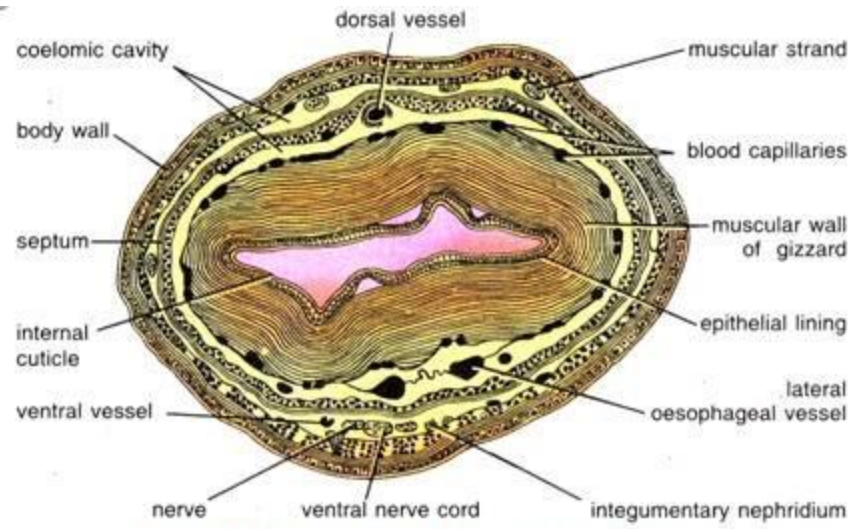
The oesophagus is followed by the gizzard. The gizzard is a prominent oval, hard, thick-walled and highly muscular organ lying in the 8th or 8th and 9th segments. It has a thick wall of circular muscles lined by columnar cells which is further lined by cuticle. The gizzard grinds the food into a fine state.

### **5. Stomach:**

The gizzard is followed by a short, narrow, thin-walled tubular stomach extended up to 14th segment.

The anterior and posterior openings of stomach are sphinctered. Its thin wall is highly glandular and vascularized but less muscular. Its internal wall is folded transversely. The glandular cells situated in the epithelial lining of stomach secrete a proteolytic enzyme. Some calciferous glands are found in the epithelial lining which produce calcium and CO<sub>2</sub>.

The calcium probably neutralizes the contents of the alimentary canal. Calciferous glands are excretory and remove ions of calcium and carbonate from the blood when the level of these ions becomes excessive, they are excreted as calcite into the stomach from where it passes out with mud through the anus.

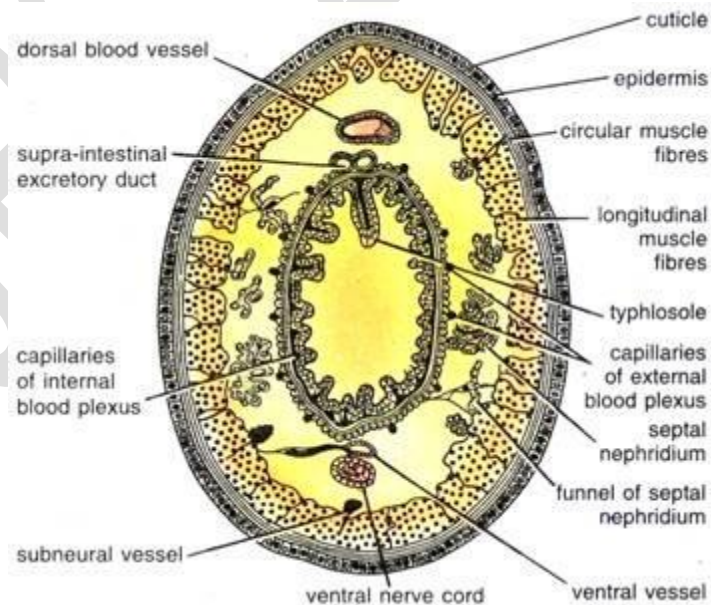


[T.S. through gizzard of earthworm]

### 6. Intestine:

The stomach is extending from 15th segment up to the anus. It has a beaded appearance due to constrictions corresponding to septa but bulging in each segment.

The lining of intestine has ciliated and glandular cells. The intestinal lining is folded to form villi, one of these villi becomes larger and well developed than the others to form the typhlosole. The typhlosole, thus, hangs in the lumen of intestine and runs mid-dorsally from 26th segment up to the last except posterior 24, 25 segments.



[T.S. through typhlosolar nephridia of earthworm]

## **The typhlosole divides the intestine into three regions:**

### **(i) Pre-typhlosolar Region:**

The first part of intestine lying between 15th to 26th segments constitutes the pre-typhlosolar region. In this region the intestinal lining is folded to form villi which are highly vascular, no typhlosole is found in this region. In the 26th segment, two short and conical outgrowths, one on either side, are given off from the intestine. These are called intestinal caeca.

They are extended anteriorly up to 22nd segment and have a special blood supply; internally the caeca have many longitudinal folds which appear as villi in transverse sections, the epithelial cells being highly vascularized and filled with secretory granules.

Chen and Puh (1941) believe that these caeca are digestive glands and secrete an amylolytic enzyme for the digestion of starch. Usually active digestion occurs in this region.

### **(ii) Typhlosolar Region:**

This is the second part of intestine lying between 26th to the last segment except posterior 24, 25 segments.

This region is provided with an internal median fold of the dorsal wall of intestine called the typhlosole, which is in fact, a well developed intestinal villi. The typhlosole increases the absorptive surface of the intestine. The process of digestion is probably completed in this region, hence, it is the major site of absorption.

### **(iii) Post-typhlosolar Region:**

The intestine, in the last 24, 25 segment, has no typhlosole. It is the third region of intestine and is called the rectum. It is thin-walled, vascularised without villi and glandular cells. It contains small pellets of mud which are passed out from the anus as faeces at the opening of burrows. These are actually the castings of Pheretima.

## **7. Anus:**

It is a small circular opening placed at terminal end in the centre of the last or anal segment of the body.

## **II] Digestive Glands of Earth Worm:**

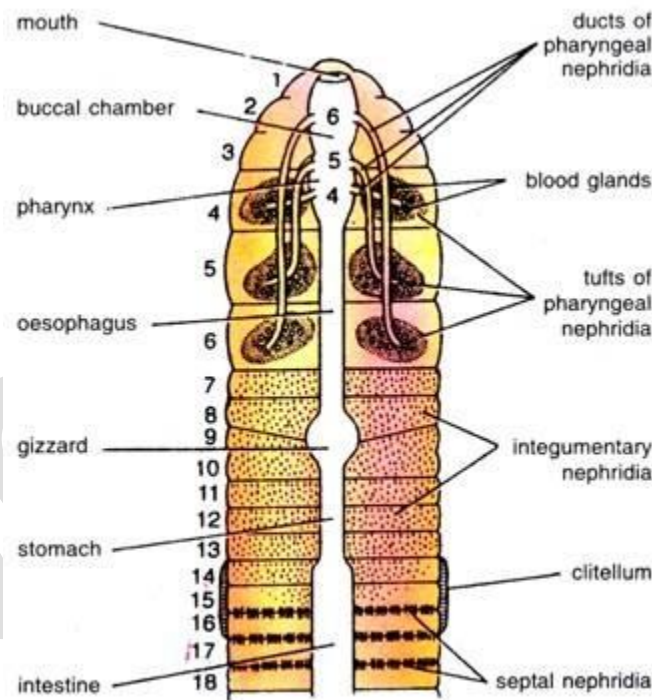
The pharyngeal or salivary gland cells, glandular cells of stomach, intestine and the intestinal caeca are supposed to be the various digestive glands which secrete the digestive enzymes for the digestion of food.

## Septal and Pharyngeal nephridia of earthworm

### **1. Septal Nephridia:**

These are found situated on the inter-segmental septum between 15th and 16th segments to the posterior side of the body.

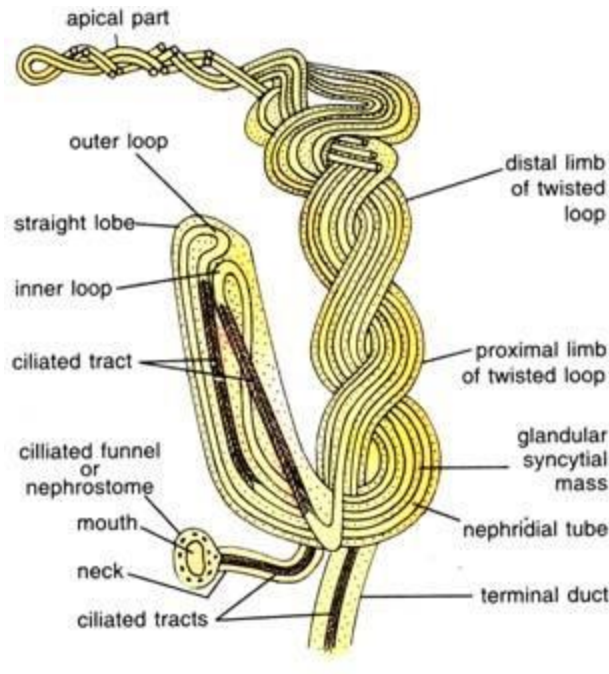
Each septum bears nephridia on both the surfaces arranged in semicircles around the intestine, two rows in front of the septum and two behind it. Each septum has about 40 to 50 nephridia in front and the same number behind, so that each segment possesses 80 to 100 septal nephridia except the 15th segment which has only 40 to 50 nephridia. These are not found in the segments up to 14th.



[Different types of nephridia in earthworm]

### **Structure:**

The septal nephridia may be considered typical of all the nephridia of *Pheretima*. Each septal nephridium (Fig. 66.22) consists of nephrostome, neck, body of nephridium and the terminal duct.



[A septal nephridium]

### (i) Nephrostome:

It is also known as ciliated funnel or nephridiostome. It is the proximal flattened funnel-shaped structure of the nephridium lying in the coelom.

It has an elliptical mouth-like opening leading into an intracellular canal of the large central cell, the margins of the opening are surrounded by a large upper lip and a smaller lower lip. The lips are provided with several rows of small ciliated marginal cells and the central canal is also ciliated.

### (ii) Neck:

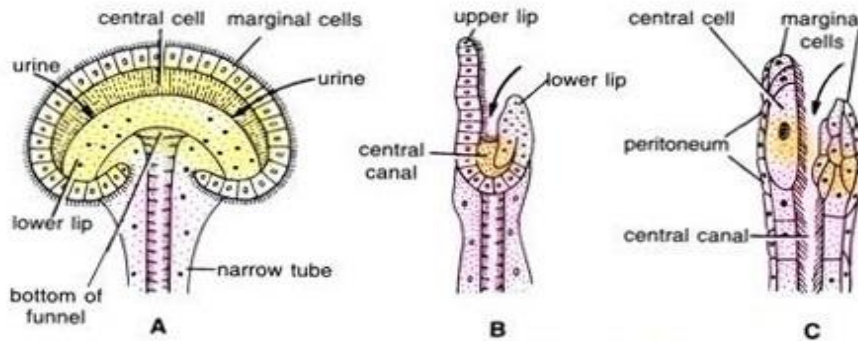
The nephrostome leads into a short and narrow ciliated canal forming the neck. It joins the nephrostome to the body of nephridium.

### (iii) Body of Nephridium:

The body of nephridium has two parts a short straight lobe and a long twisted loop. The loop is formed by two limbs— the proximal limb and the distal limb.

### ADVERTISEMENTS:

Both these limbs are twisted spirally around each other, the number of twists varies from nine to thirteen. The neck of nephridium and the terminal duct join together and remain connected with the proximal limb of the twisted loop, while the distal limb becomes the straight lobe.



[Nephrosome of earth worm : A – whole, B,C – T.S.]

Internally the nephridium is made of a connective tissue matrix having long coiled nephridial duct forming loops. There are four such canals in the straight lobe, three in the lower part and two in the upper part of the limbs of twisted loop. Two canals of the straight lobe out of the four are ciliated like the ciliated canal of the neck.

#### (iv) Terminal Duct:

It is short and narrow with a terminal excretory duct. It joins the nephridium with septal excretory canal.

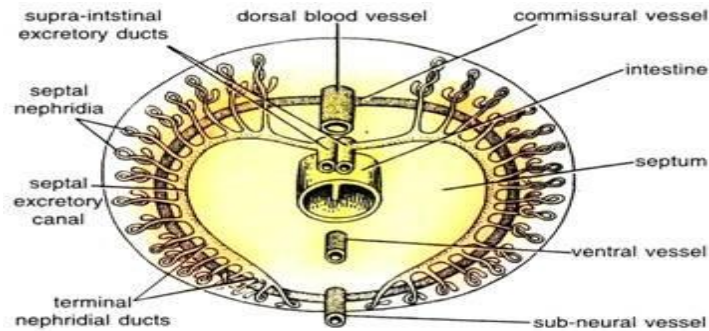
#### Relation of septal nephridia with intestine:

The nephridia hang freely in the coelom and are attached only by their terminal ducts. They open by their terminal ducts into two septal excretory canals lying on the posterior surface of the septum, one on each side of the intestine, each begins ventrally but dorsally it opens in the supra-intestinal excretory duct of its own side.

The supra-intestinal excretory ducts are two parallel longitudinal canals lying above the gut and below the dorsal vessel (Fig. 66.24). These excretory ducts begin from the 15th segment and run to the last segment, they communicate with each other for a short space behind each septum, then either the right or the left duct opens by a ductule into the lumen of the intestine near the septum.

Thus, each segment has one such opening into the intestine of either the left or the right supra-intestinal excretory duct. The waste collected by the nephridia is discharged through the excretory canals and ducts into the lumen of the intestine. Such nephridia opening into the intestine are called enteronephric nephridia.





[Septal nephridia in intestinal region]

### Pharyngeal Nephridia:

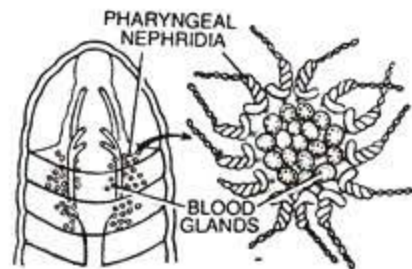
These nephridia lie in three paired tufts, one on either side of the anterior region of the alimentary canal in the segments 4th, 5th and 6th. The tufts of pharyngeal nephridia also contain blood glands.

Each pharyngeal nephridium is about the size of a septal nephridium but it is of the closed type having no funnel or nephrostome. It has a short straight lobe and a spirally twisted loop, its lumen has ciliated canals. Ductules arise from each nephridium and unite to form a single thick-walled duct on each side in each segment.

The two ducts of nephridia of segment 6th open into the buccal cavity in segment 2nd and the paired ducts of nephridia of segments 4th and 5th open into the pharynx in segment 4th.

These nephridia also discharge their wastes into the alimentary canal and are, therefore, enteronephric but such enteronephric nephridia which open into the anterior region of the alimentary canal (buccal cavity and pharynx) are called peptonephridia because they may have taken the function of digestive glands.

Recently it has been reported that the pharyngeal nephridia of *P. posthuma* produce a variety of enzymes like amylase, chimosin, prolinase, prolidase, dipeptidases, aminopeptidase, lipase, etc., which hydrolyse various foodstuffs. Thus, such nephridia work like the salivary glands.



{pharyngeal nephridia of earthworm}