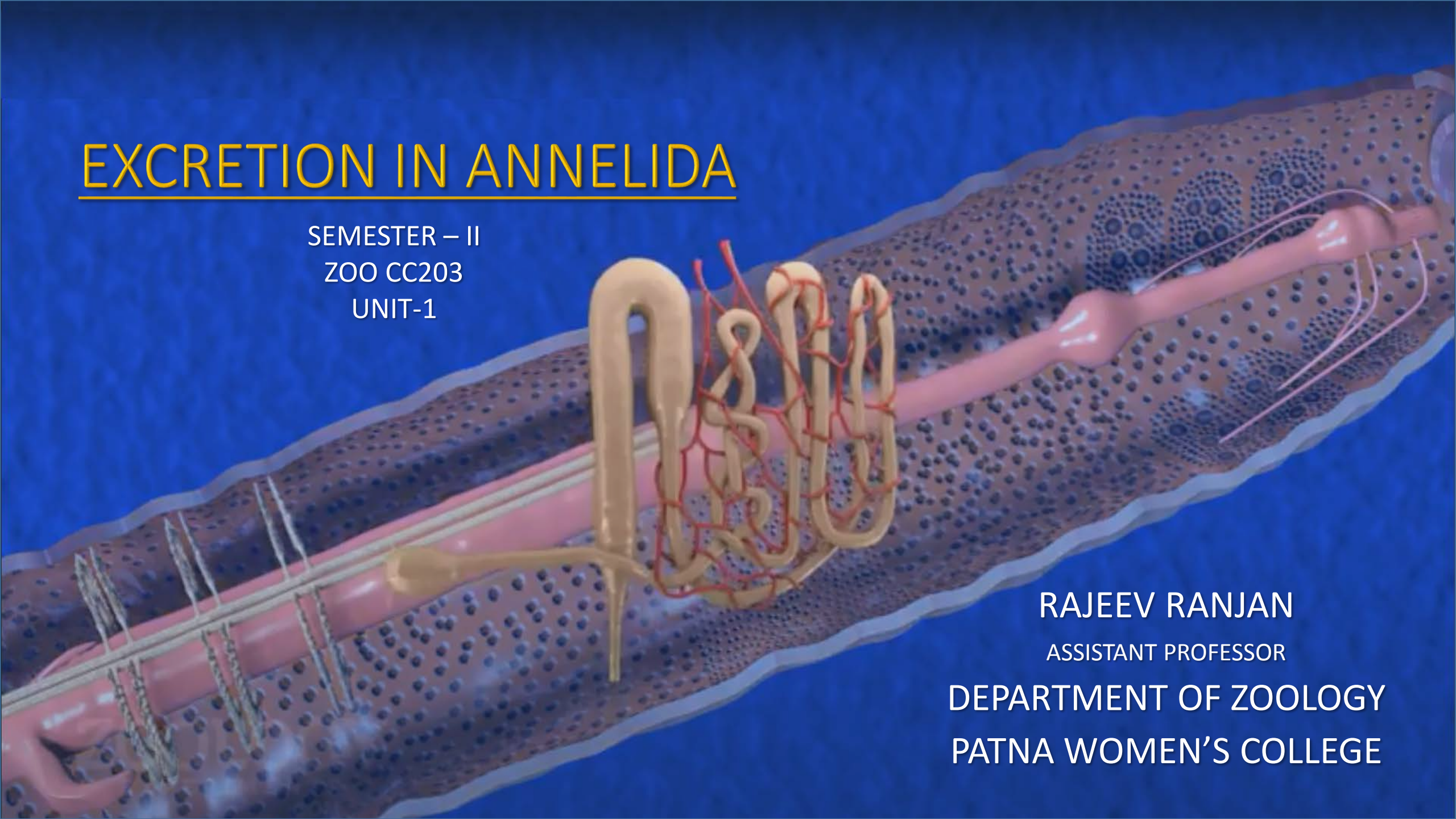
EXCRETION IN ANNELIDA

SEMESTER – II
ZOO CC203
UNIT-1



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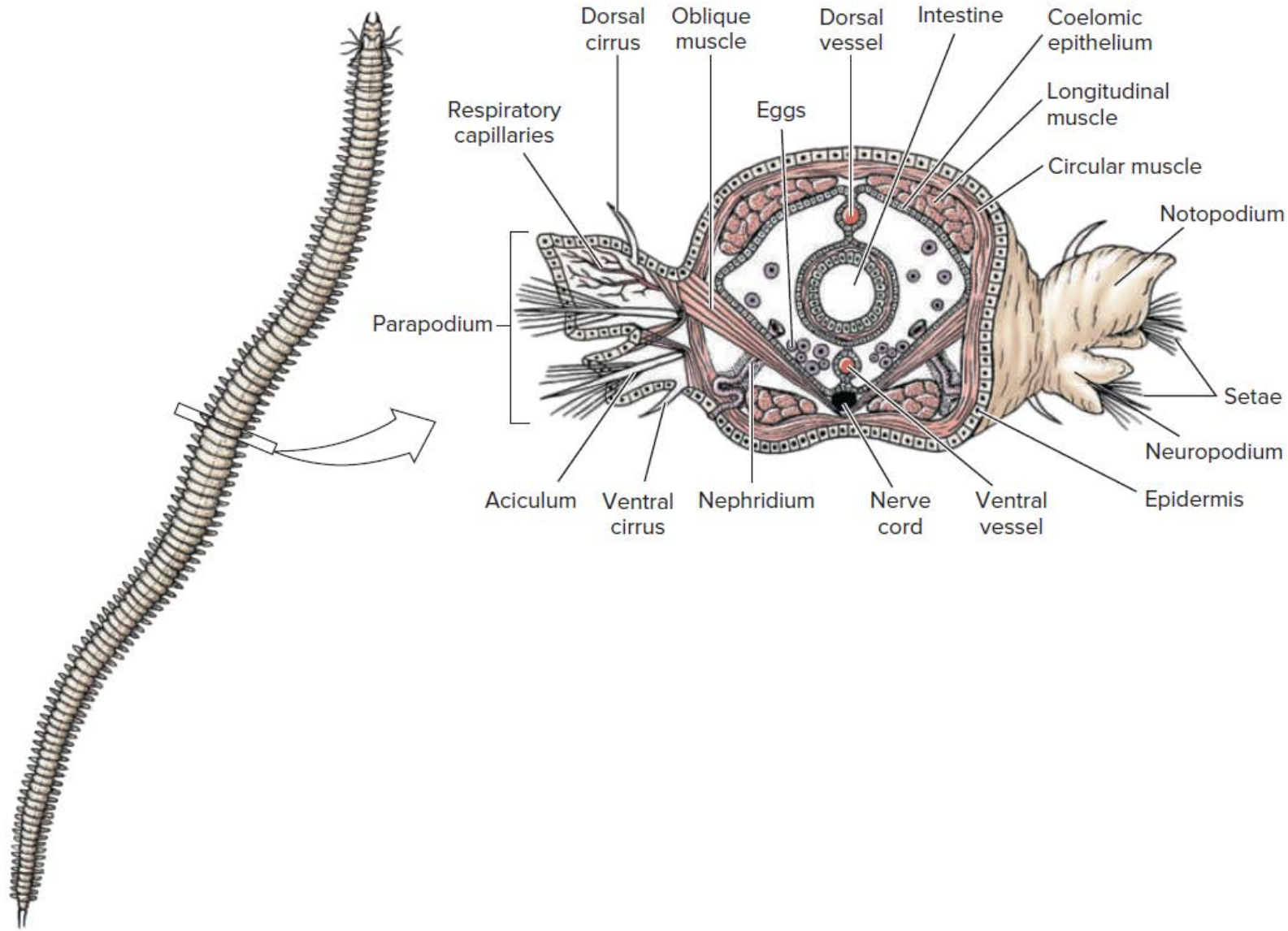
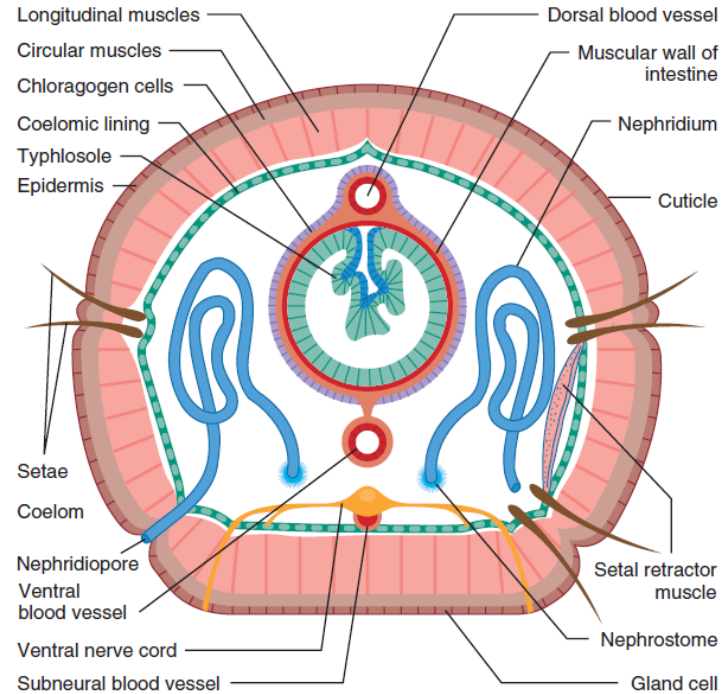
EXCRETION IN ANNELIDA

- Excretion is the process of removal of metabolic waste products from the body.
- In Annelida nitrogenous waste products and carbon dioxide are formed during metabolism and are removed from the body through nephridia.

Definition of nephridium

An excretory tubule which opens to the exterior through the **nephridiopore** and the inner end of the tubule is blind (associated with **terminal cells** or **solenocytes**) in the **protonephridium** or opens in the coelom through the ciliated funnel are called **nephrostome** in **metanephridium**.

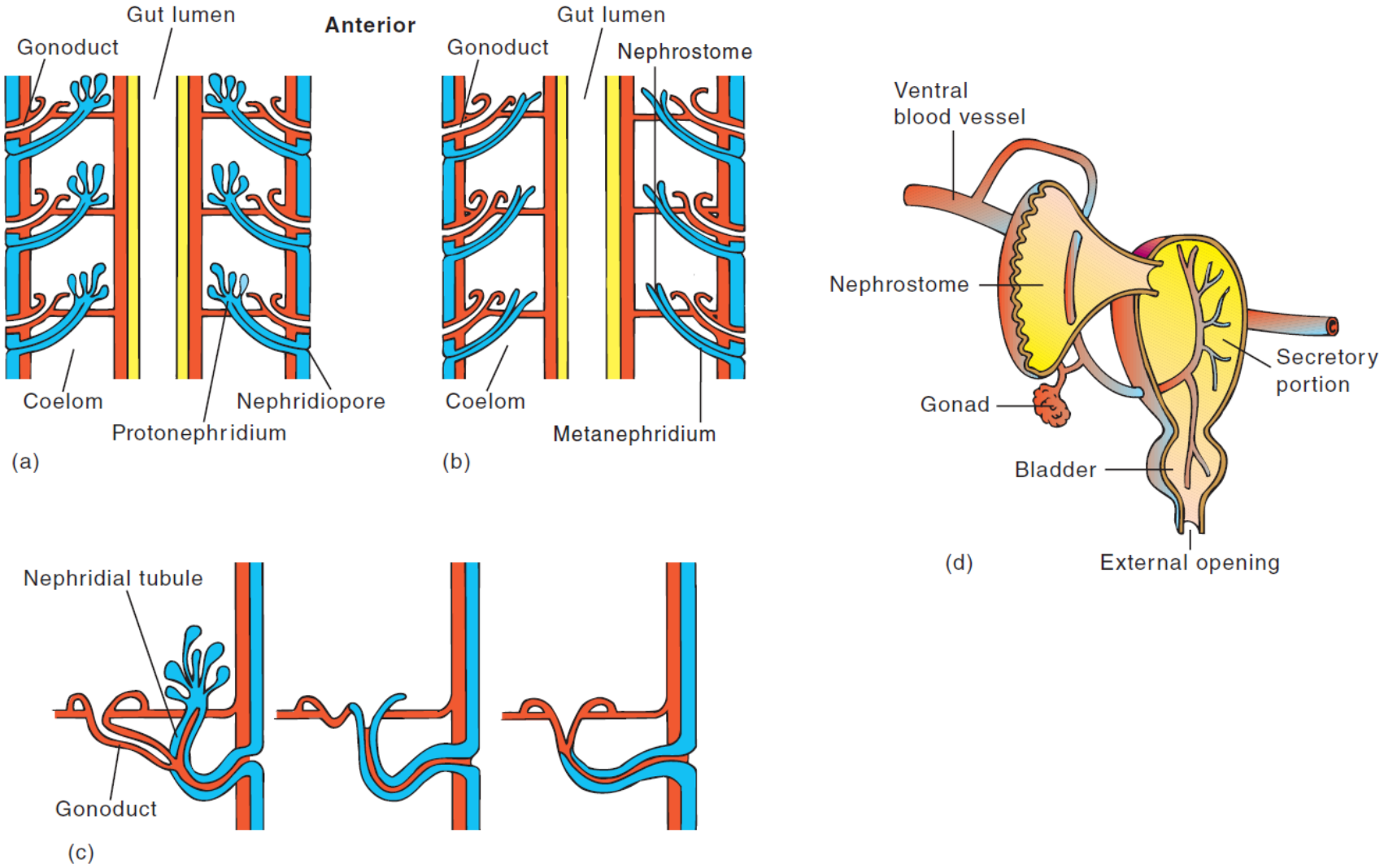




Earthworm Cross Section. The nephrostomes shown here would actually be associated with the next anterior segment. The ventral pair of setae on one side has been omitted to show the nephridiopore opening of a nephridium.

Structure of a typical nephridium

- A typical nephridium consists of a **nephrostome** or a **ciliated funnel** which hangs into the coelom and leads to the **nephridial duct**.
- The nephridial duct or body of the nephridium may be long, short, convoluted or modified otherwise.
- The duct is ciliated internally, situated transversely and is accompanied by blood vessels.
- The nephridial duct opens to the exterior by an opening, called **nephridiopore**.



Annelid Nephridia. (*a*) Protonephridium. The bulbular ends of this nephridium contain a tuft of flagella that drives wastes to the outside of the body. In primitive annelids, a gonoduct (coelomoduct) carries reproductive products to the outside of the body. (*b*) Metanephridium. An open ciliated funnel (the nephrostome) drives wastes to the outside of the body. (*c*) In modern annelids, the gonoduct and the nephridial tubules undergo varying degrees of fusion. (*d*) Nephridia of modern annelids are closely associated with capillary beds for secretion, and nephridial tubules may have an enlarged bladder

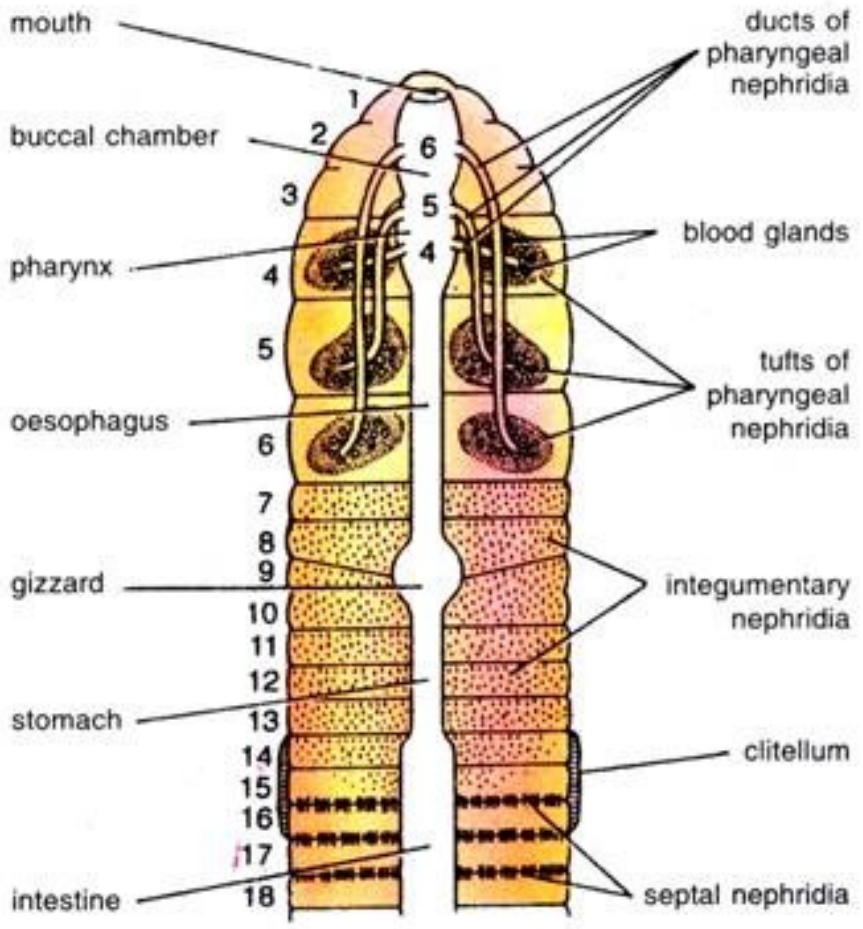
Excretion in Earthworm

- Excretory organs of earthworm is **nephridia.**
- In the body of earthworm three kinds of nephridia occur:

  (a) Septal nephridia

  (b) Integumentary nephridia and

  (c) Pharyngeal nephridia



Pheretima. Different types of nephridia and general plan of their distribution.

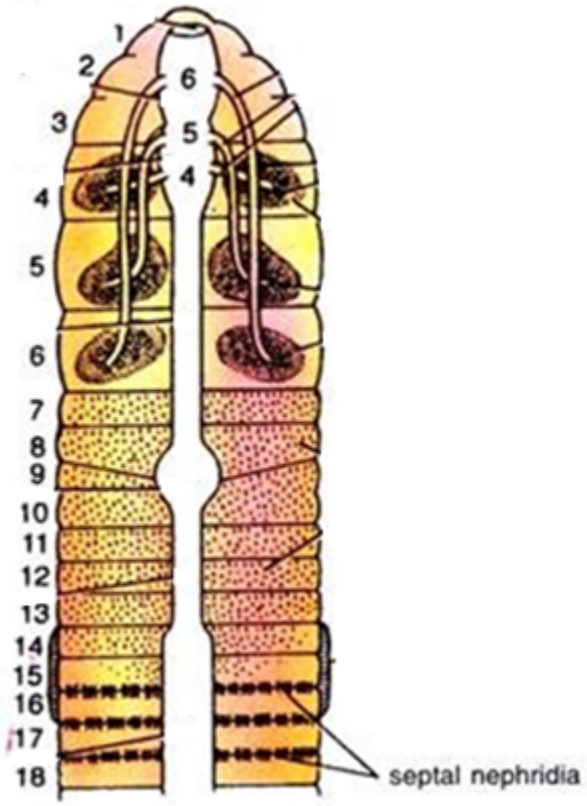
Septal nephridia

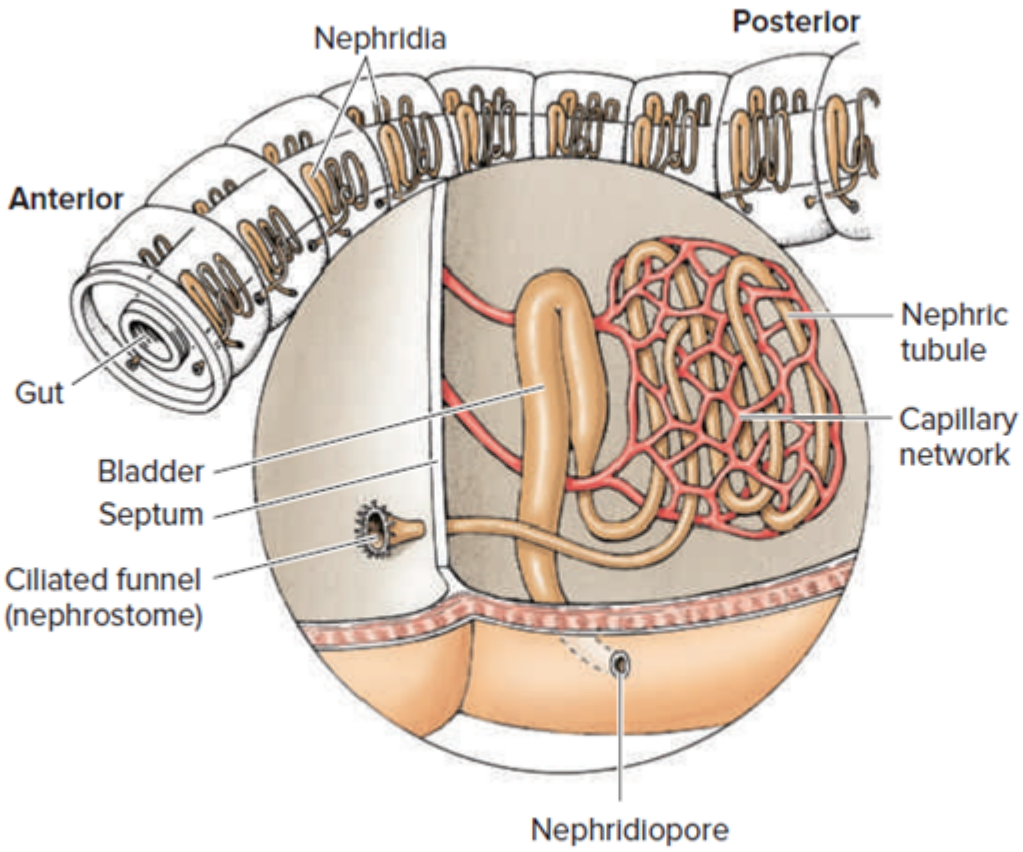
- Septal nephridia remain attached to the two faces of the septum.
- They occur from 15th segment back-ward. That means in the first fourteen segments they are absent.
- Each septum bears 40-50 nephridia in average in its anterior and a similar number on its posterior face.
- Thus in each segment there are about 80-100 nephridia.

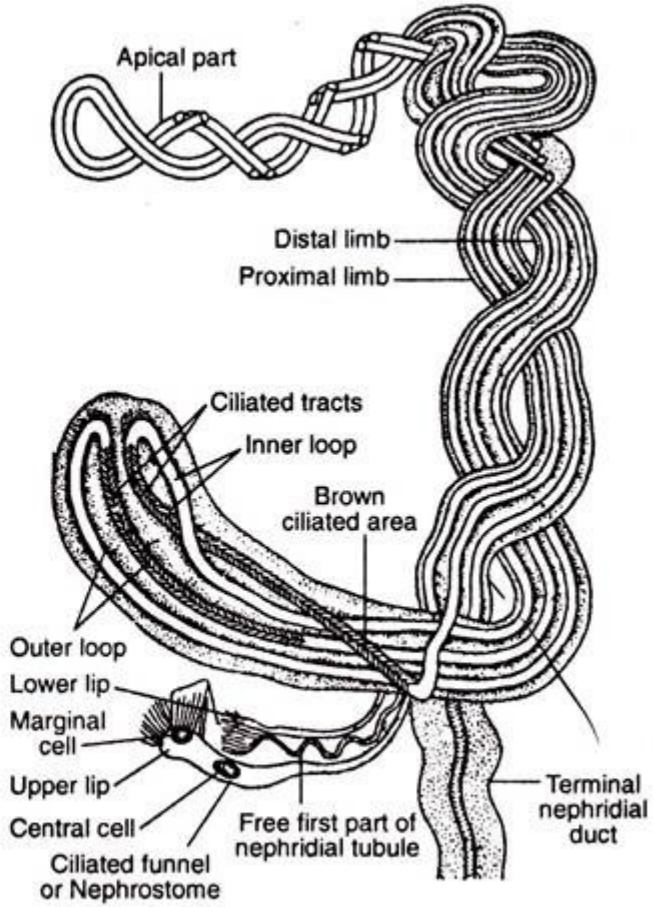
Structure of septal nephridium

- A typical septal nephridium consists of a **main body** formed by a straight lobe and a long narrow, spirally twisted loop, a funnel like **nephrostome** connected to the main body by a short **neck** and a **terminal nephridial duct**.
- The **nephrostome** or **ciliated funnel** is a rounded structure. The mouth of the funnel which communicates with the coelom is provided with a **large upper lip** and a **small lower lip**. The lips are ciliated and are provided with several rows of ciliated **marginal cells**.
- A narrow ciliated tube runs from the funnel into the body of the nephridium, called **neck** and takes several turns inside it.

- The **main body** of the nephridium is made up of a **main lobe** and a spirally **twisted loop**.
- The loop is twice as long as the main lobe and consists of a **proximal limb** and a **distal limb** twisted round each other.
- The straight lobe is continued as the distal limb of the twisted loop and the proximal limb receives the ciliated tubule from the nephrostome and also it gives off the terminal duct which opens at the **nephridiopore**.
- The **straight lobe** bears four parallel tubules, the proximal and distal ones bear three tubules each and in the apical part there are two tubules.
- **Terminal ducts** of the septal nephridium open into a **septal excretory canal** which runs parallel and internal to commissural vessels.
- There are a pair of septal excretory canals one on each side of the septum.
- The two septal excretory canals open into a pair of **supra-intestinal excretory ducts** which run on the mid-dorsal line side by side from 15th segment to the posterior end.
- The supra-intestinal excretory ducts open into the lumen of the intestine by single and small ducts at the level of each inter-segmental septum.



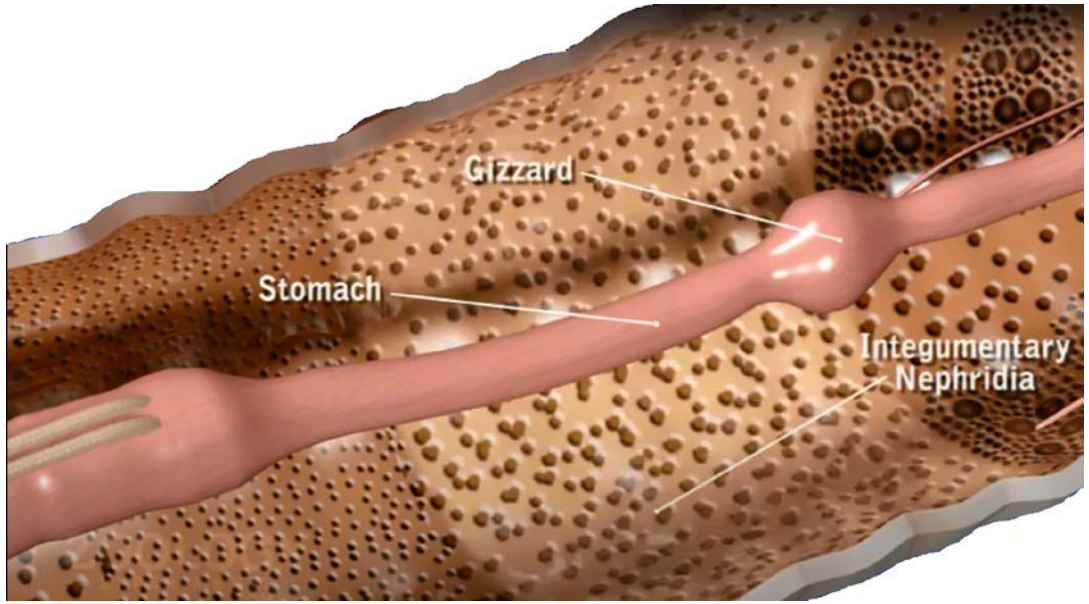




Different structural views of septal nephridia in *Pheretima* (Earthworm)

Integumentary nephridia

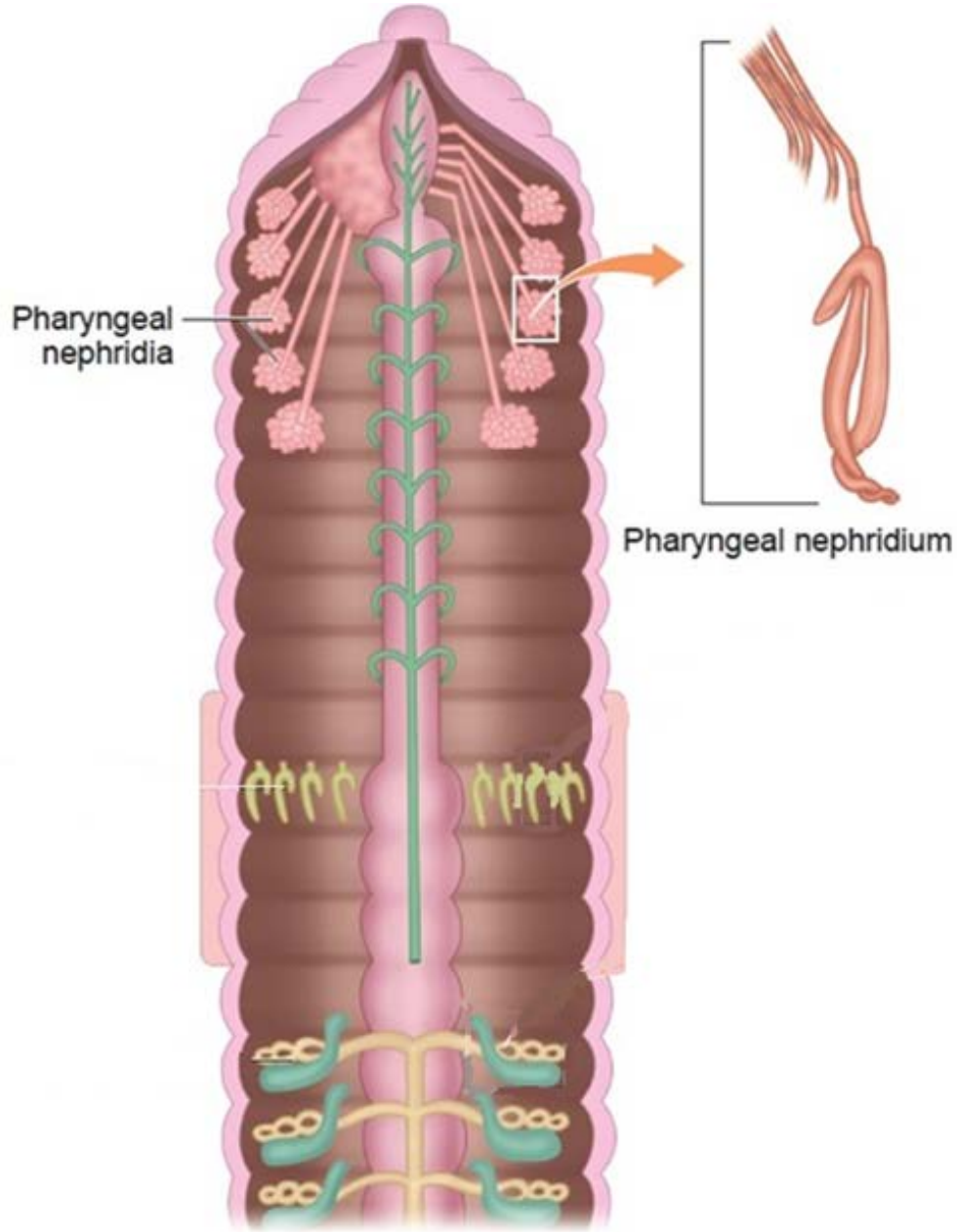
- They are smaller in size than the septal nephridia.
- These 'V'-shaped structures occur on the inner surface of the integument in all segments excepting the first two.
- They number 200-250 in each segment but in the 14th, 15th and 16th segments the number of nephridia is much more.
- Structurally they resemble septal nephridia but lack the **nephrostome**.
- They open independently to the outside by **nephridiopores** on the outer surface of the -body wall.



Integumentary nephridia

Pharyngeal nephridia

- They are as large as the septal nephridia and occur in the form of three pairs of bunches or tufts in the **4th, 5th** and **6th** segments and on either side of pharynx and' oesophagus.
- **Nephrostomes** are also absent in the pharyngeal nephridia.
- In each bunch the terminal ducts of the nephridia join together to form a slender duct.
- The slender ducts again unite in each segment and form a thick-walled duct which opens into the alimentary tube.
- Thus there are three pairs of ducts, one pair each in the 4th, 5th and 6th segments.
- The **pharyngeal nephridia** have digestive function or, in other words, they aid in digestion and hence they are some-times referred to as **'peptic nephridia**'.
- The **septal and pharyngeal nephridia** open into the alimentary canal and are called **enteronephric** while the **integumentary nephridia** open to the outside directly, and are called **exonephric**.
- The enteronephric system helps in the conservation of water in the body because water present in the excretory Product is again reabsorbed in the intestine.
- Some of the nitrogenous excretory substances like **guanin** are extracted from the blood stream by **chloragogen cells**.
- These cells collect and store excretory products and on becoming heavily laden with excretory materials, they pinch off into the coelomic fluid from where they are eliminated through dorsal pores or by nephridiopores.



Pharyngeal nephridium in *Lampito mauritii*

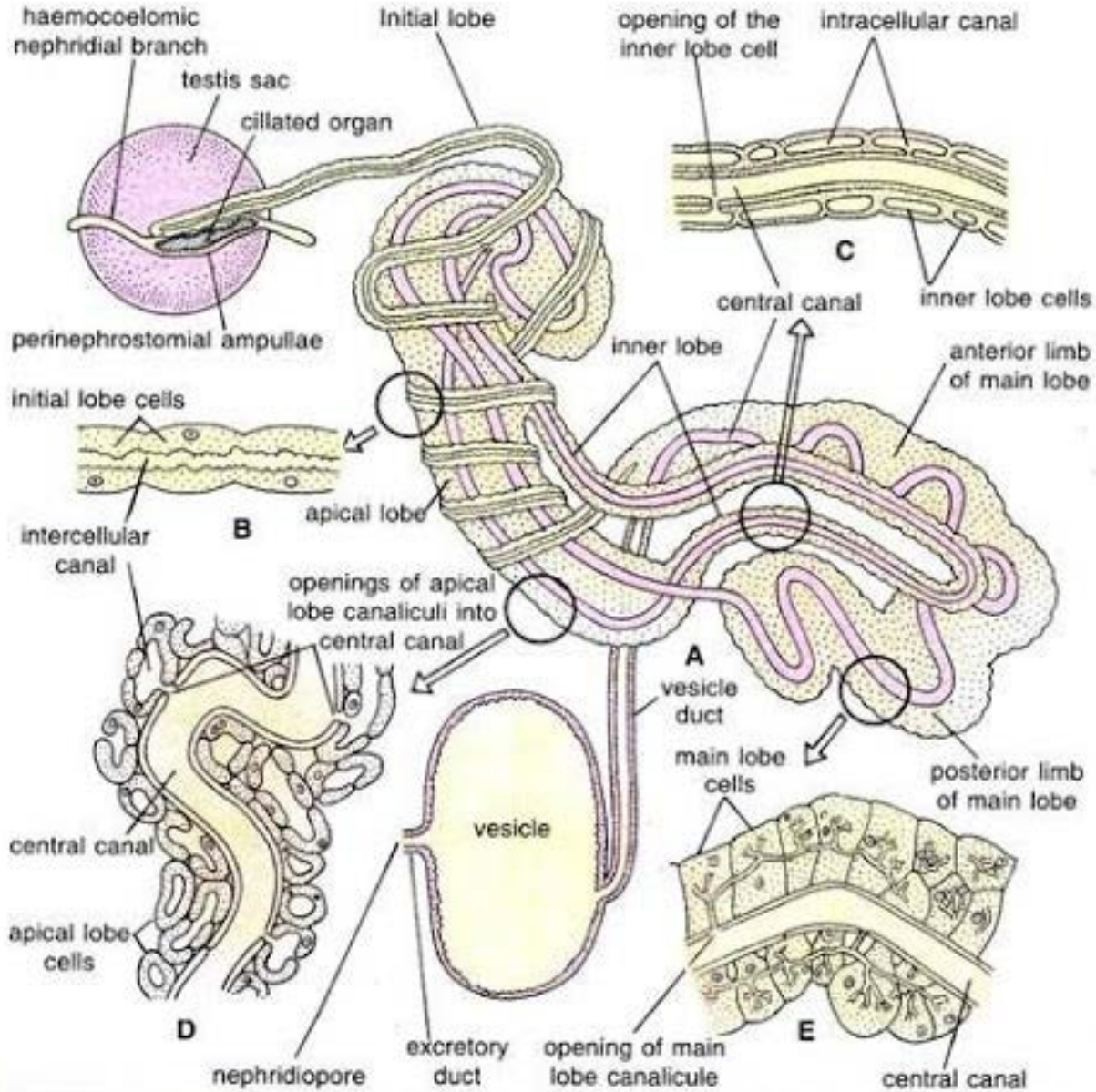
Excretion in Leech

- Excretory system consists of nephridia.
- There are seventeen pairs of nephridia one pair each in 6th and 22nd segments.
- Thus the first five segments and the posterior four segments are devoid of nephridia. Of these seventeen pairs, the anterior six pairs lie in the pre-testicular segments and are called pre-testicular nephridia and the remaining eleven pairs in the testicular segments, are called **testicular nephridia**.

Structure of a testicular nephridium

A typical testicular nephridium consists of:

- Main lobe
- Apical lobe
- Initial lobe
- Ciliated organ
- Inner lobe
- Vesicle duct and vesicle



Hirudinaria. A—A complete testicular nephridium; B—A portion of initial lobe in L.S.; C—A portion of inner lobe in L.S.; D—A portion of apical lobe in L.S.; E—A portion of main lobe in L.S.

(a) Main lobe

- It is a horse-shoe-shaped structure and ventro-lateral in position.
- The main lobe consists of two unequal limbs, anterior and posterior.
- The anterior limb is larger in size than the posterior and the two together at their junction form the bend of the horse-shoe.

(b) Apical lobe

- The posterior limb of the main lobe passes forward to form the stout apical lobe.
- It lies in an antero-posterior position beneath the gut.
- Its anterior end is bent upon itself.

(c) Initial lobe

- It runs as an extremely long and slender lobe twined round the apical lobe.
- At its anterior extremity it runs as a slender thread of cells towards the testis sac and ends abruptly by the side of the **perinephrostomial ampulla**.
- While at its posterior extremity it joins the main lobe near the point of emergence of the vesicle duct.

(d) Ciliated organ

- The ciliated organ lies in the peri-nephrostomial ampulla.
- It is a compound structure made up of a **central reservoir** and **ciliated funnels**.
- The reservoir is spongy in nature.
- The ciliated funnels are present in a large number on the wall of the reservoir.
- Each funnel is like an ear-lobe having a broad distal end and a proximal neck which fits into pores situated on the wall of the reservoir.
- The funnel is made of five to six cells arranged in two tiers and is densely ciliated.
- The **ciliated** organ has no excretory role in adult leeches and is associated with **haemocoelomic** system.

(e) Inner lobe

It lies in the inner concavity of the main lobe and runs forward along the outer border of the apical lobe about half its length.

Route of central canal inside the nephridium

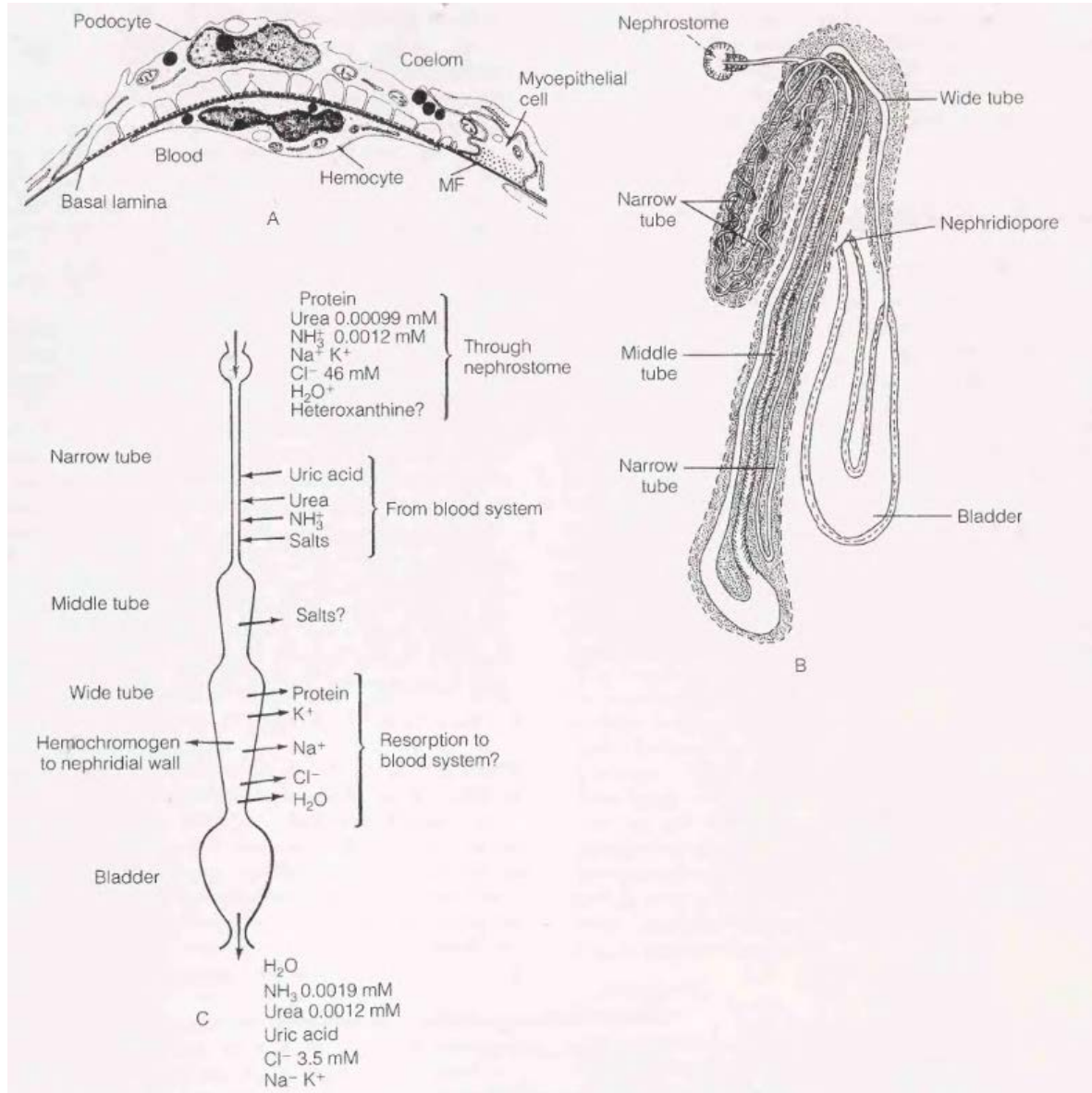
- The central canal follows a long and zigzag course throughout the body of the nephridium.
- It makes one complete and another incomplete round of run inside the body of the nephridium.
- The canal begins as a large intracellular lumen in a single cell at the anterior end of the **apical lobe**.
- Then it comes down the apical lobe to enter the inner lobe from where it goes of the posterior border of the anterior limb of the **main lobe**.
- From the main lobe, it passes along the outer border of the apical lobe and on being embedded in it completes the first 'round'.
- The canal then loops backward and traverses the apical lobe.
- On reaching the posterior limit of the apical lobe it passes onto the **posterior limbs** of the main lobe.
- After traversing the main lobe and forming many loops in it the canal emerges from the posterior lip of the anterior limb and continues into the vesicle as vesicle duct.
- The second part of the canal is incomplete by one-fourth 'round'.

Role of nephridium and ciliated organ

- In the body of leech the **haemocoelomic fluid**, i.e., blood and coelomic fluid, are not present as separate, entities as they are in earthworm.
- The ciliated organ though considered along with excretory structures is totally separated from nephridium in an adult leech.
- The ciliated organ bathes in haemocoelomic fluid and has no excretory role.
- It is subservient to haemocoelomic system and manufactures haemocoelomic corpuscles.
- While the body of the nephridium minus the ciliated organ is richly supplied with lateral channels, it is excretory and osmoregulatory in functions.
- Many workers believe that the **Botryoidal tissues** are excretory in nature.

Physiology of Excretion in annelids

- In most annelids, the blood vascular system and coelom (if present) are involved in the excretion of waste products.
- The polychaetes in which the blood-vascular system is absent or reduced contain **protonephridia**.
- The remaining groups of polychaetes and others possess blood-vascular system and metanephridia.
- In proto-nephridia, the ultra-filtration of the coelomic fluid takes place with the help of terminal cells (e.g. **solenocytes**) and the filtrate fluid passes down through the protonephridial tubule.
- Along the protonephridial tubule some substances such as **salts and amino acids** are reabsorbed and the chief excretory product **ammonia** is excreted through the **nephridiopore**.
- The mouth of **metanephridium** contains open ciliated funnel or nephrostome through which coelomic fluid is drawn by the action of cilia of funnel and the fluid when passing through the metanephridium tubule, some substances like salts, amino acids are resorbed and the nitrogenous waste products like ammonia (20%), amino acids and urea (40%) are excreted and the urea level varies in different groups of annelids in which environment they live.



Oligochaete excretory system and excretion. **A,** Podocyte on the wall of the ventral blood vessel of *Tubifex tubifex* (Tubificidae). **B,** Metanephridium of *Lumbricus terrestris* (Lumbricidae). **C,** Possible functions of various parts of the *Lumbricus* metanephridium. *(A, From Peters, W. 1977. Possible sites of ultrafiltration in* Tubifex tubifex *Mueller (Annelida, Oligochaeta). Cell Tissue Res. 179:367–375; B, After Maziarski from Avel; C, Modified slightly from Laverack, M. S. 1963. The Physiology of Earthworms. Pergamon Press, Oxford, p. 67)*

Functions of nephridia

(i) It eliminates the liquid nitrogenous waste products from the body to the exterior.

(ii) It eliminates the basic and non-volatile acid radicals from the body.

(iii) It maintains the **water balance** of the body.

(iv) It regulates the **osmotic relation** between the blood and tissue.

(v) In some cases they act as **gonoducts (coelomoducts)** by conveying reproductive units.