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NAAC ACCREDITED GRADE—'A'

TOPIC : EXCRETION IN ANNELIDA
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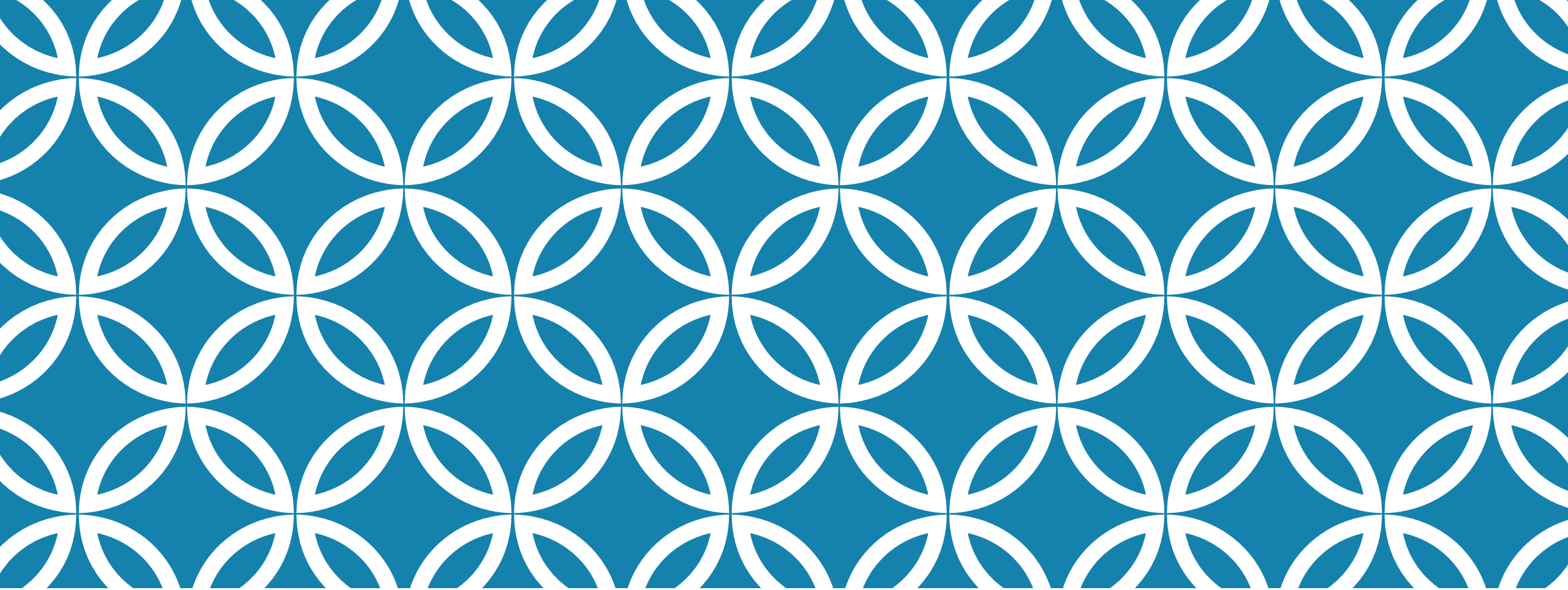


EXCRETION IN ANNELIDS

EXCRETION

- Chemical reactions occur in the cells of living organisms all the time to carry out the life processes. The sum of these reactions is called metabolism.
- Metabolism produces useful products as well as toxic (poisonous) byproducts.
- These toxic substances have to be removed as they are harmful if allowed to accumulate.
- The removal of metabolic waste products from the body of an organism is known as excretion.

MAJOR EXCRETORY PRODUCTS OF ANIMALS

- The major excretory products are carbon dioxide, excess water, and nitrogenous compounds like ammonia, urea, uric acid, etc.
- Carbon dioxide and water are produced in the process of tissue respiration.
- Nitrogenous compounds are formed from the breakdown of proteins and amino acids.
- Water and salts in excess of the body's needs are also excreted.

Excretory Organs in Different Animals

Plasmalemma	Protozoans like *Amoeba*.
General body surface	Porifera (sponges) and coelenterates (*Hydra*).
Flame cells	Platyhelminthes (*Taenia* and *Fasciola*).
Nephridia	Annelida (earthworm).
Malpighian tubules	Arthropods (cockroach).
Coxal gland	Spiders.
Kidney	Main excretory organs in all vertebrates.
Antennae/green gland	Crustaceans (prawn)

EXCRETORY ORGANS IN ANNELIDS

ANNELIDS excrete through the

1. Nephridium

✓Protonephridium

✓Metanephridium

2. Chloragogen cells
3. Botryoidal tissue.

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 or called nephrostome in metanephridium is called a Nephridium.
- Nephridia are basically defined by their function.
- They eliminate wastes from the amino acid and nucleotide degradation as well as sometimes salt and water from the body.
- From the variety of such organs filtration nephridia are assumed to belong to the ground pattern of the Bilateria

NEPHRIDIUM

- In annelids these organs occur as two different structures, protonephridia and metanephridial systems (sensu Ruppert & Smith, 1988).
- Both organs mediate excretion in two steps:

1. An unspecific filtration of body fluid and subsequent modification of the ultrafiltrate.
2. This second step is necessary because during filtration not only metabolic wastes but also all substances with a low molecular weight, like certain anions, amino acids and different sugars, pass the filtration barrier. To utilize them again these substances need to be reabsorbed.

- In both nephridia the ECM acts as filtration barrier, forming a kind of molecular sieve.
- This matrix needs to be stabilized to withstand the filtration pressure by special perforated cells that mediate filtration, i.e., the terminal cell or podocytes. The ultrafiltrate is modified in a simple duct.

GENERAL STRUCTURE OF 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.

NEPHRIDIUM

Typical structure of septal nephridia in earthworm

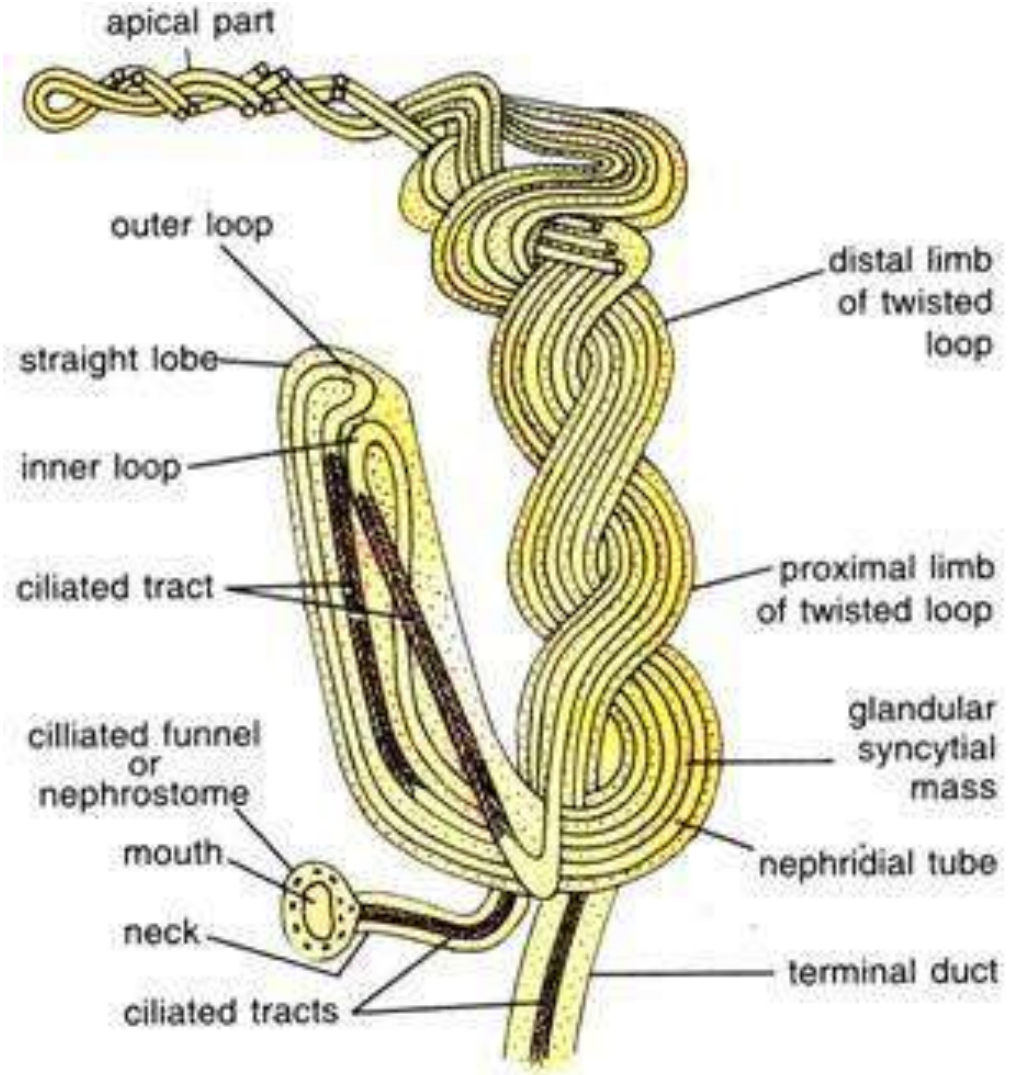
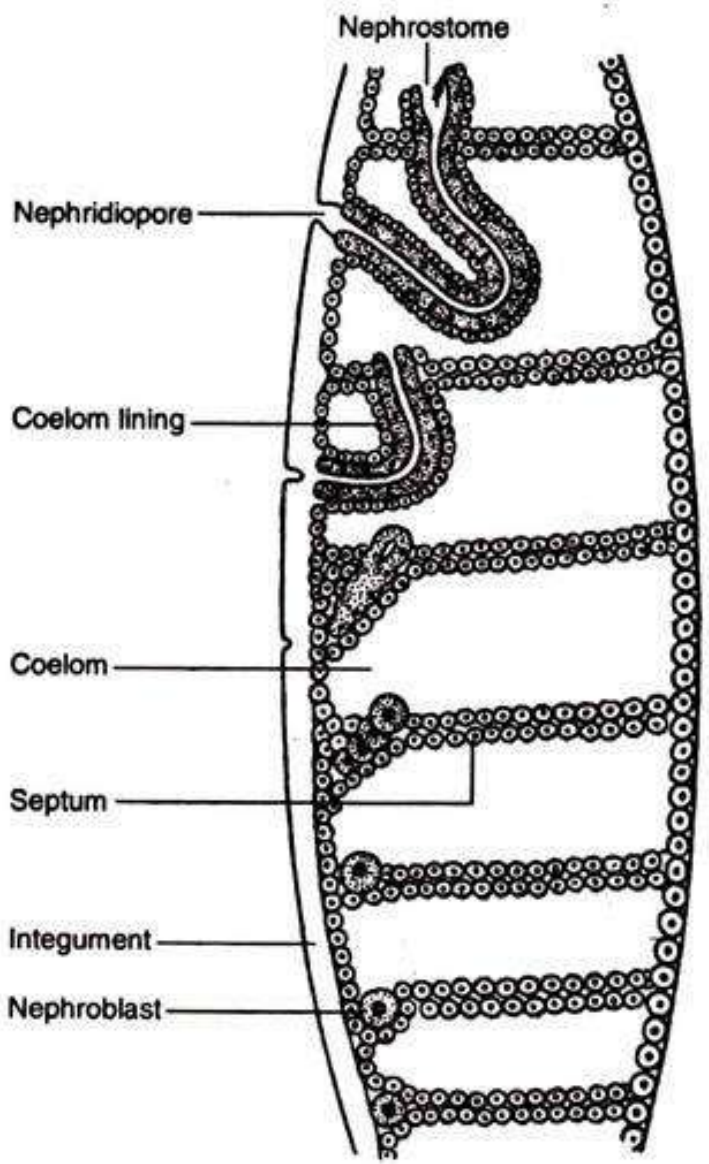


Fig. 66.22. *Pheretima*. A septal nephridium.

Development of nephridia.

- Each nephridium develops from a single cell, called nephroblast.
- They are ectodermal in origin.



NEPHRIDIA IN POLYCHAETES

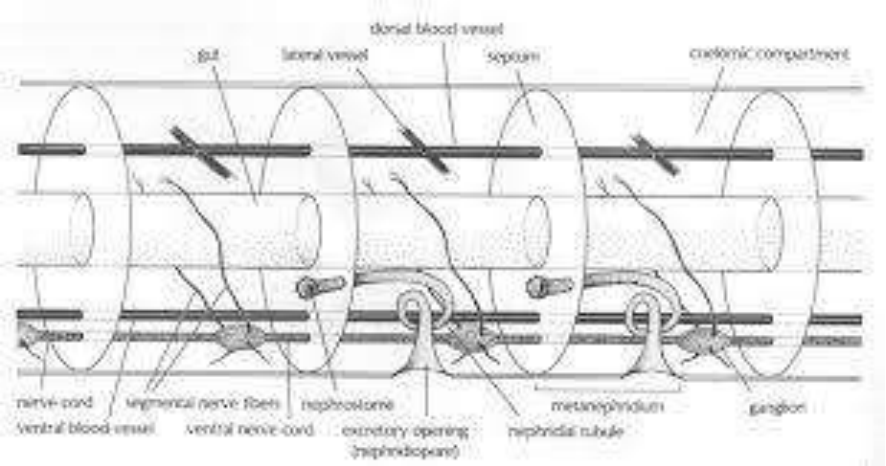
Excretory organ is filtration nephridia.

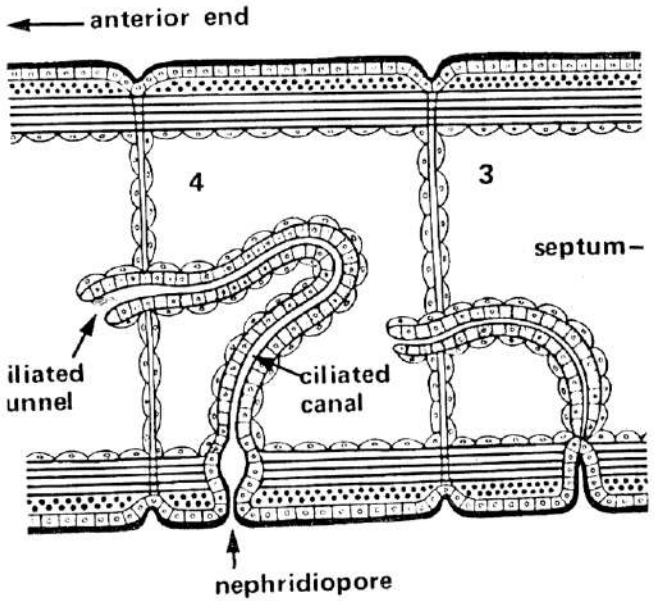
Distribution: A pair per segment .

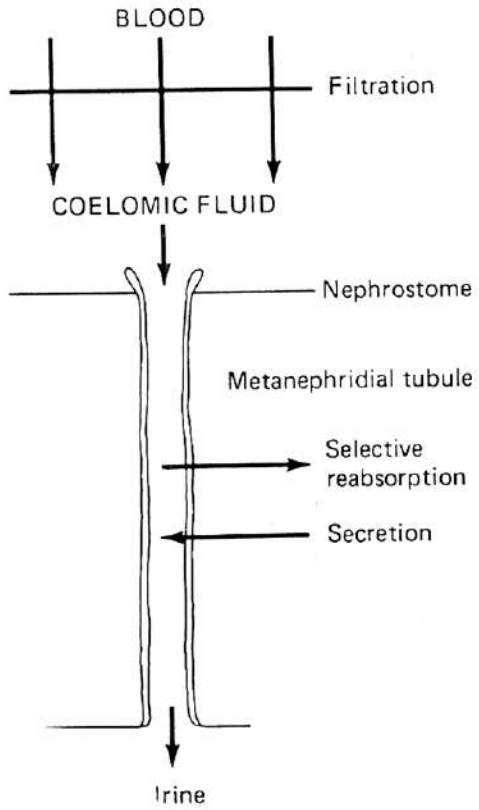
- Reduction to few or even one pair for the entire worm.

Location: The anterior end of the tubule is situated in the coelom of the segment immediately anterior to that from which nephridiopore opens.

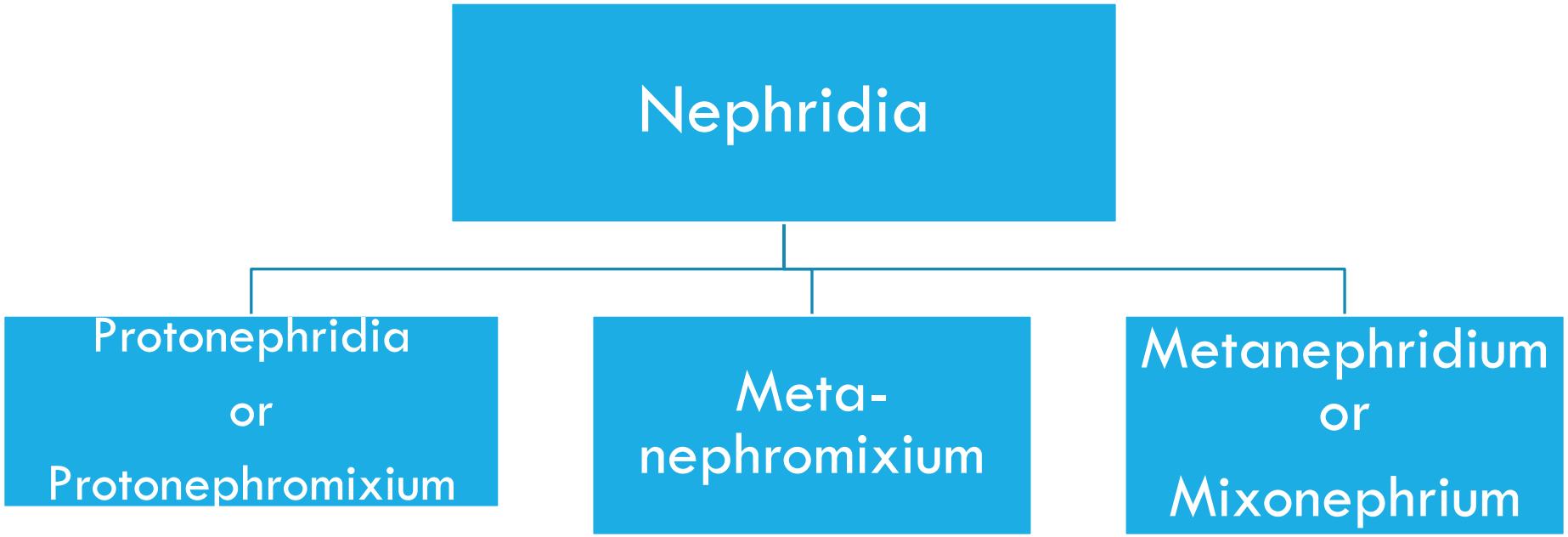
- The tubule penetrates the posterior septum and extends into the next where it may be coiled and then open to the exterior by nephridiopore.
- The structure remains enclosed in a peritoneum.


dorsal blood vessel
gut
lateral vessel
septum
coelomic compartment
nerve cord
Ventral blood vessel
segmental nerve fibers
ventral nerve cord
nephrostome
excretory opening
(nephridiopore)
metanephridium
nephridial tubule
ganglion


anterior end
4
3
septum
iliated
unnel
ciliated
canal
nephridiopore


BLOOD
Filtration
COELOMIC FLUID
Nephrostome
Metanephridial tubule
Selective
reabsorption
Secretion
Irine

Depending on the body design the polychaetes have different types of nephridia.



PROTONEPHRIDIA

Found in: Polychaetes that lack a blood vascular system. (9 families and all larva) or blood system is reduced.

Structure: the coelomoduct and nephrioduct are united .

The terminal cells of protonephridium is called solenocytes having a single flagellum and along tubular filtration collar.

[Metanephromixium: the coelomic and the nephridial duct is united.]

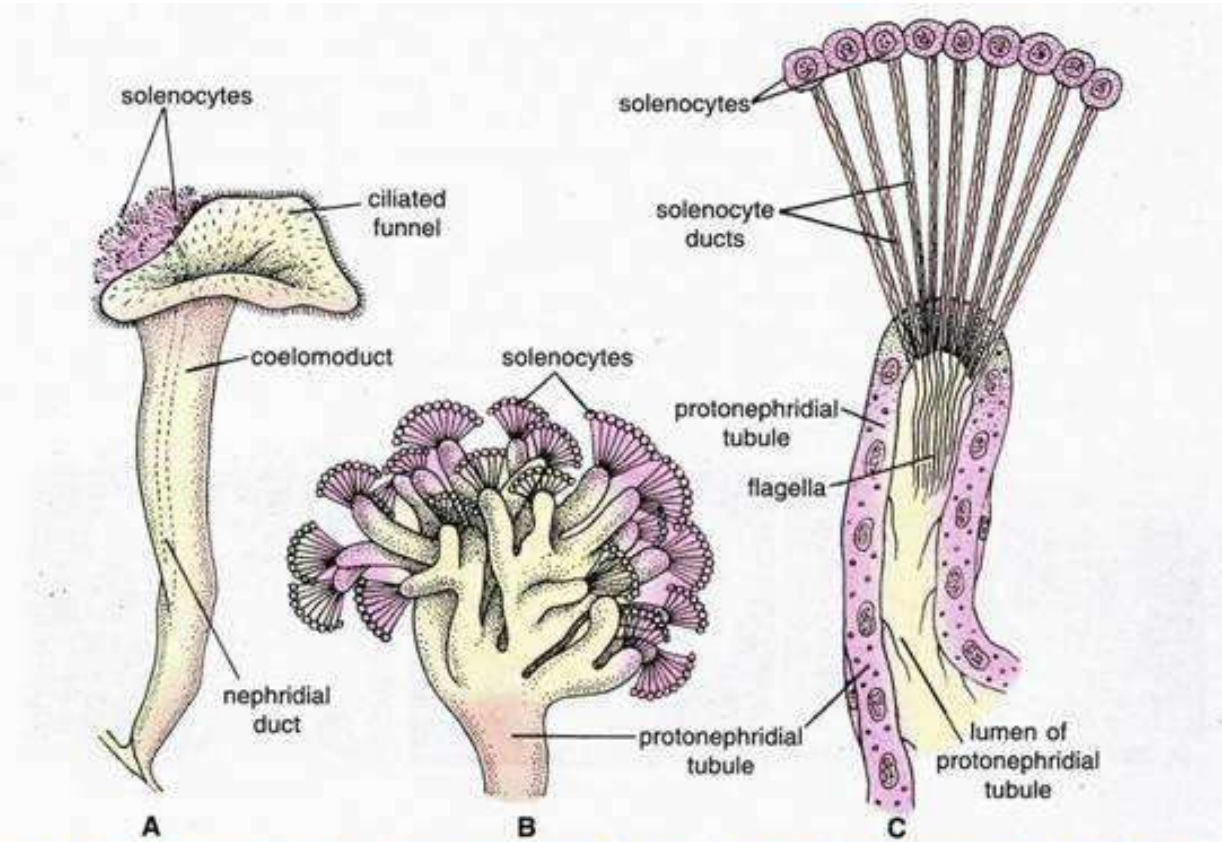
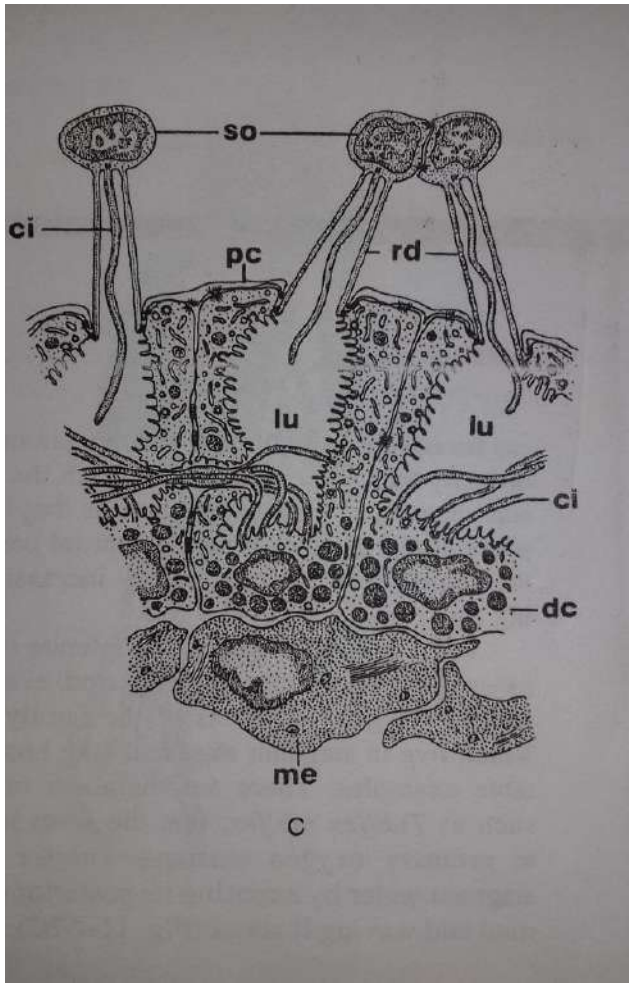


Fig. 69.1. Protonephridium and coelomoduct in *Phyllodoce paretti*. A—Relation of protonephridium and coelomoduct; B—Branched end of protonephridium; C—Solenocytes of one protonephridial branch. (After **Goodrich**).



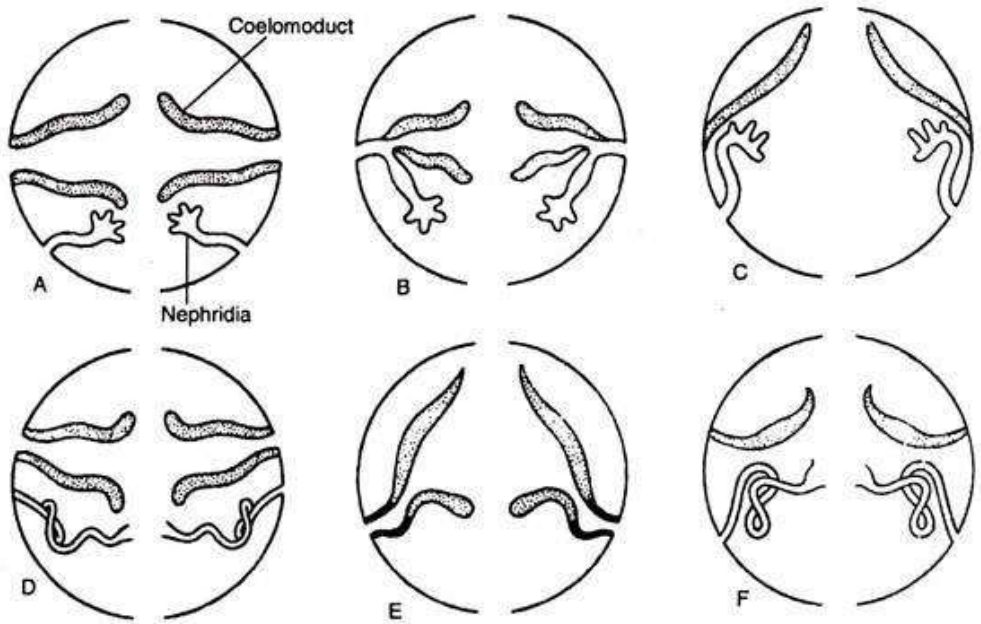


Fig. 17.59: Relationship of nephridia and coelomoducts in polychaeta (after Parker and Haswell). A. Hypothetical stage (Nephridia closed and coelomoducts separate). B. In Phyllodocidae (Nephridia closed but united with coelomoduct). C. In Nephthyidae (Coelomoduct reduced as ciliated organ). D. In *Dasybranchus* (Coelomoduct separate from nephridia with nephrostomes). E. In most annelids (Nephridia with nephrostomes united with coelomoducts to form segmental organ). F. In *Nereis* (Nephridia with nephrostomes and separate coelomoducts reduced as ciliated organ).

METANEPHRIDIA

Found in: Polychaetes having well developed blood vascular system.

Structure: it represents complete incorporation of the coelomoduct and nephridium in a single organ.

Each nephridium is divide into

- ✓Somewhat oval curved body and
- ✓A distinct neck.
- ➢The preseptal end or the neck possesses an open ciliated funnel the nephrostome, which extends a short distance into the adjacent anterior segment.

- The nephrostome has an outer investment of peritoneum and the interior is densely ciliated.
- The post-septal canal or tubule is a highly coiled structure and extends into the next successive segment.
- The tubule forms non-ciliated terminal duct before opening to the exterior through the nephridiopore.
- The mass of coiled tubules remain invested in a sac of peritoneal cells.
- The nephridiopore opens at the base of neuropodium on the ventral side.

METANEPHRIDIUM IN POLYCHAETE ENCLOSED IN PERITONEUM.

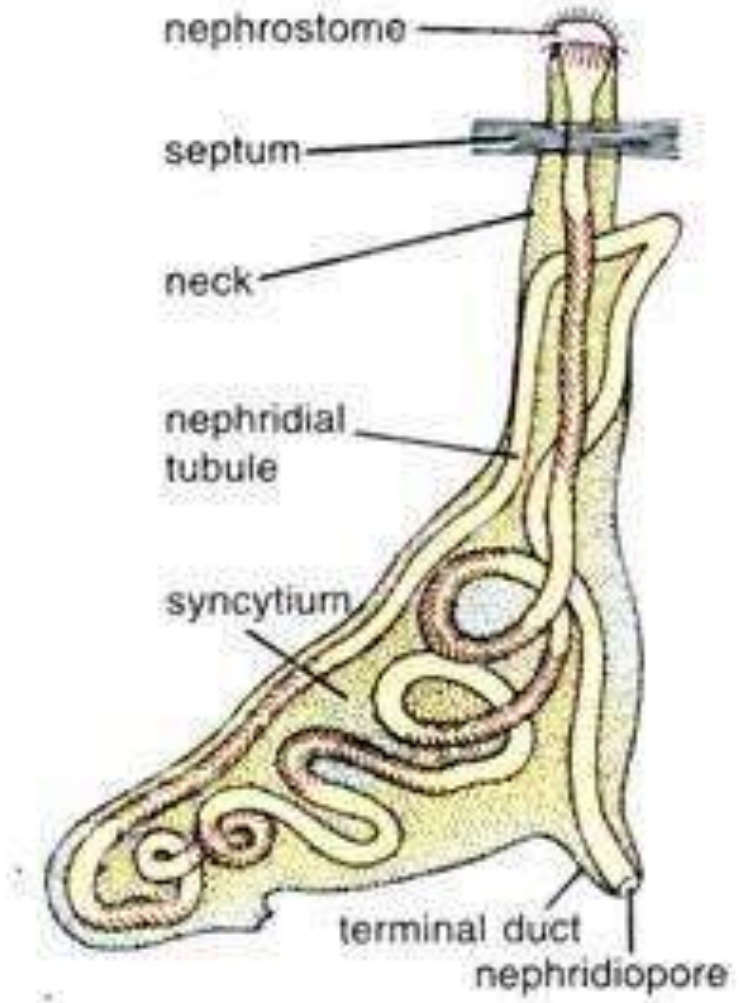


Fig. 65.15. *Neanthes*. A nephridium.

STRUCTURAL VARIATION

In fan worm (Sabella sp)

- One pair of functional nephridia.
- Joins in the midline forms single median canal, which opens through a single median nephridiopore on the head.

NEPHRIDIA IN OLIGOCHAETES (*Pheretima posthuma*)

The excretory organs of earthworm are minute, coiled tube like structures called nephridia.

Nephridia are ectodermal in origin.

They are derivatives of the ectodermal ciliated ducts, several types of nephridia occur in earthworm.

STRUCTURE OF TYPICAL NEPHRIDIA

It consists of

1. **Nephrostome.**

- It is funnel shaped and externally ciliated, opening into the coelomic cavity.
- It consists of mouth like opening, which is surrounded by larger upper lip and smaller lower lip.
- Upper lip is formed by a large central cell and eight or nine marginal cell, whereas the lower lip is formed of four or five compact cells. The lips have several rows of cilia.

2. **Neck:**

- Funnel leads into a short and narrow-ciliated neck, which is continued into the body of the nephridium.
  Due to continuous movement of cilia all the nitrogenous substances of the coelomic fluid are absorbed in the nephridium.

3. Body

- It is the main tubular part of the nephridia which is coiled around at its axis.

It consists of two parts:

1. Short straight lobe- is one half of the twisted loop's length.

It is short, straight tube which remains attached to the twisted loop.

2. Long twisted loop with narrow apical lobe.-

The twisted loop consists of proximal and distal limb, which are spirally twisted upon each other.

Proximal limb is attached to neck

4. **Terminal duct**
   It is the end part of the main body.
   Distal limb of the body of nephridium ends in a short and narrow duct called terminal duct. All the terminal ducts of a segment open into septal excretory duct of their side. Septal excretory duct collect the excretory products and transfer them to a pair of supra-intestinal excretory duct.

Nephridial tube

Nephridium consists of a syncytial glandular mass, inside which coiled tubules run that end up in a narrow terminal duct that opens into excretory duct and eventually lead into the intestine through supra intestinal excretory duct. Coiled tubules have four ciliated tract, one in neck, two in body and one in terminal duct. There are four parallel tubules in the straight lobe, 3 in the basal part and two in the apical part of each limb of the twisted loop and a single tubule in each of the neck and terminal duct.

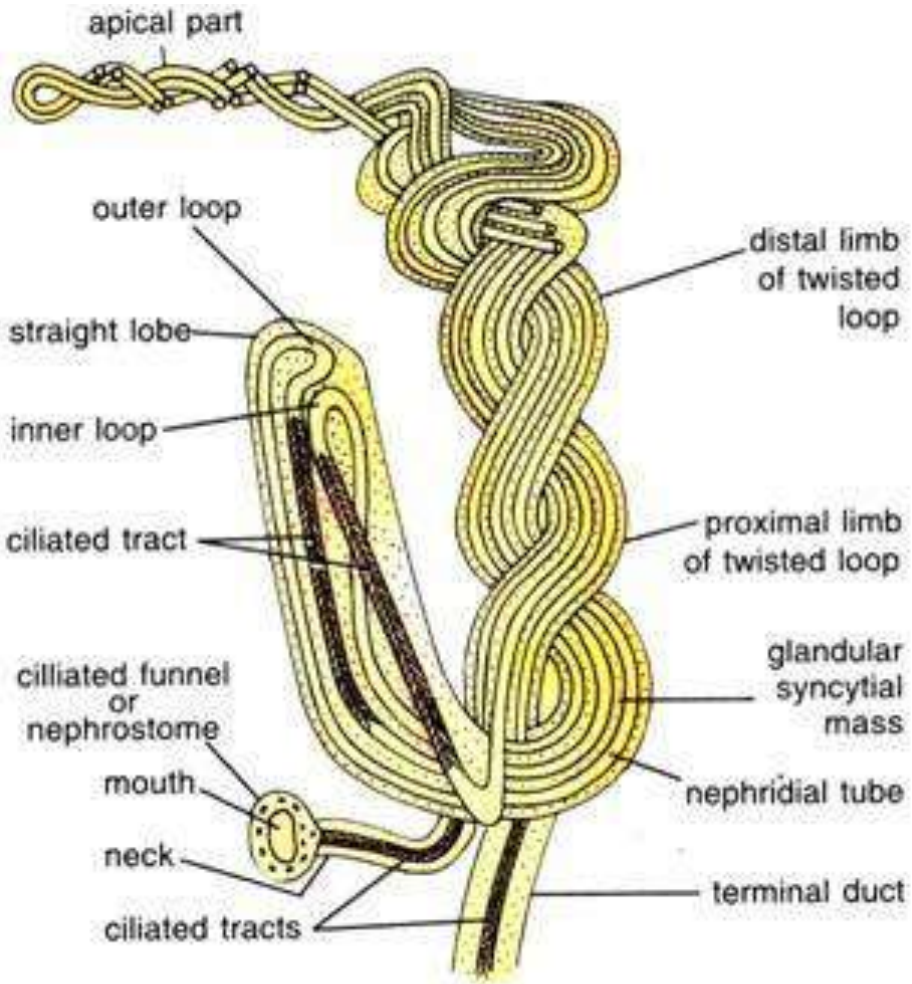
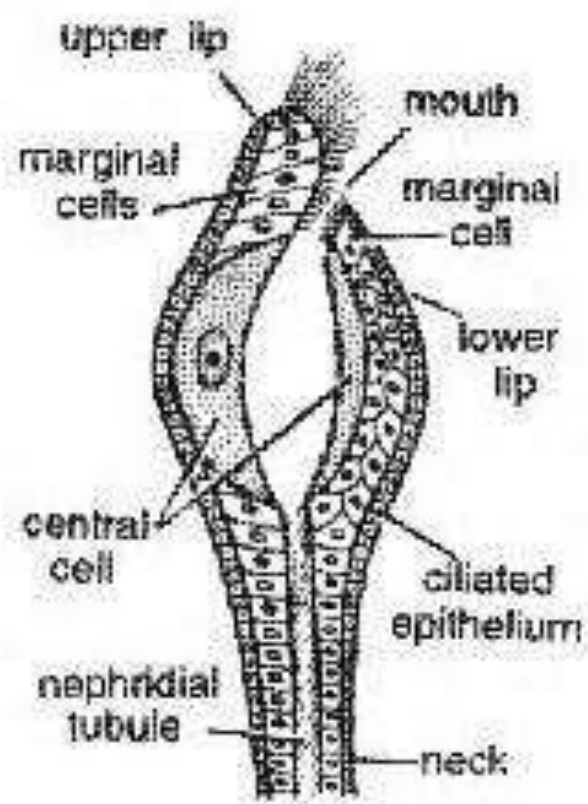


Fig. 66.22. *Pheretima.* A septal nephridium.



CLASSIFICATION OF NEPHRIDIA

❑On the basis of nephrostome :

1. Nephridia with nephrostome are called open-nephridia.
2. Those with no nephrostome are called as closed-nephridia.

❑On the basis of opening of nephridiopore:

1. The nephridia which open out through nephridiopore are called exonephric nephridia and
2. Those which open into the gut are called enteronephric nephridia.

ENTERONEPHRIC AND EXONEPHRIC NEPHRIDIA

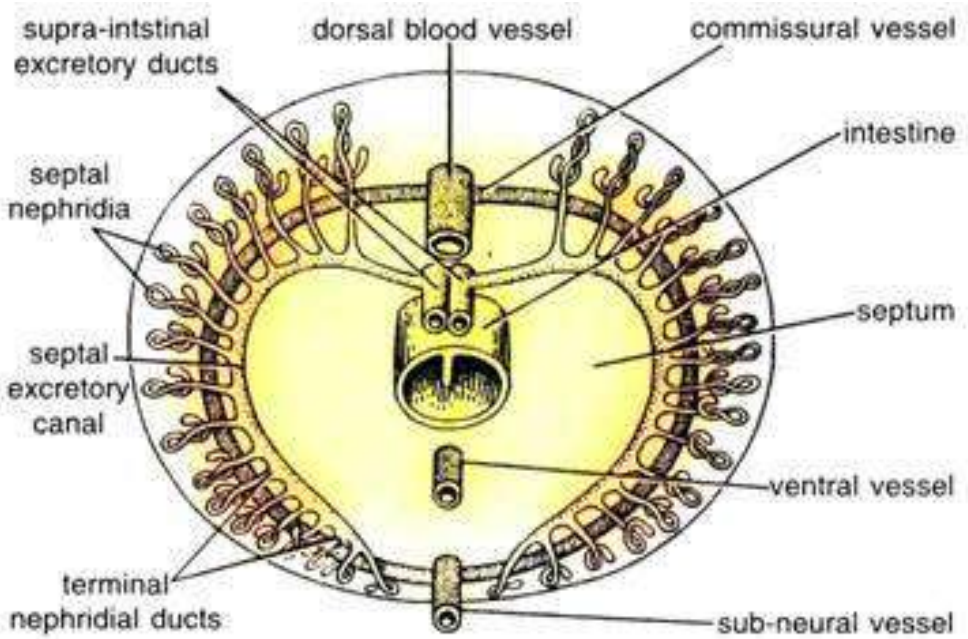
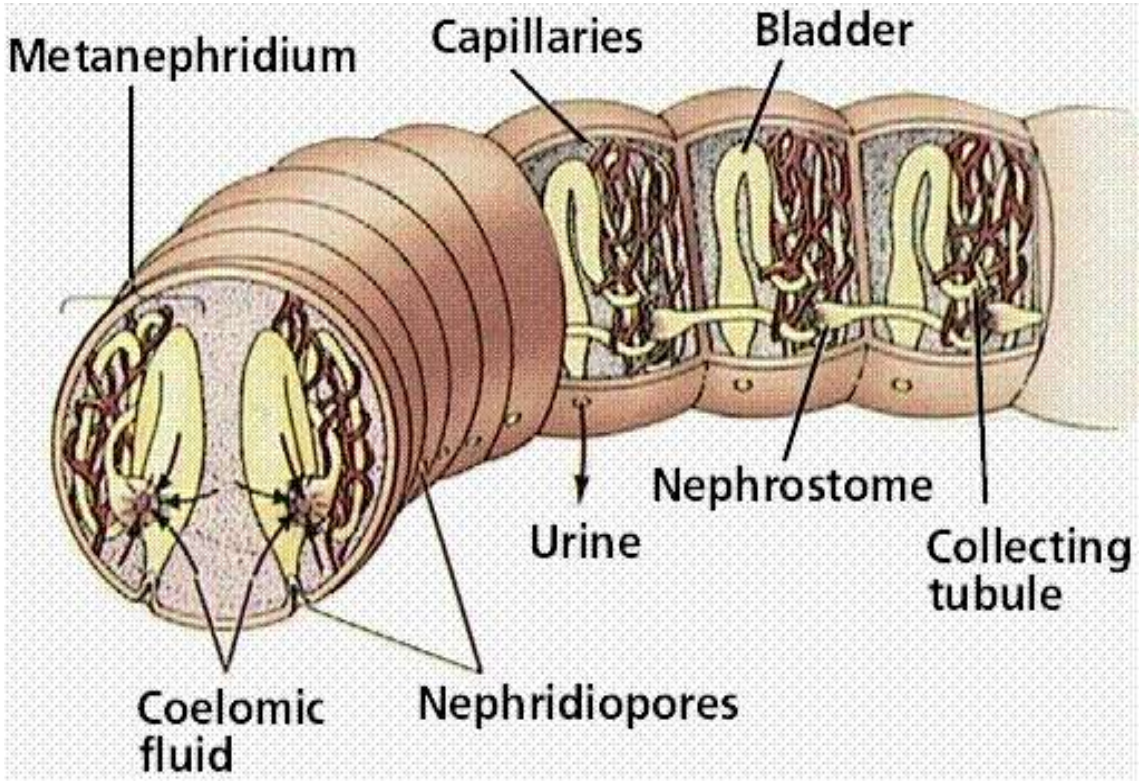


Fig. 66.24. *Pheretima*. The arrangement of septal nephridial system in relation to the intestine.



DIFFERENT TYPES OF NEPHRIDIA

Oligochaetes possesses three types of nephridia:

- Septal nephridia,
- Integumentary nephridia and
- Pharyngeal nephridia.

PHARYNGEAL NEPHRIDIA IN EARTHWORM

- Location: occurs as paired tufts on both the sides of pharynx and oesophagus in the 4^{th}, 5^{th} and 6^{th} segments .
- Structure:

✓ Hundreds of coiled branched tubules without nephrostomes and hence they are closed type.

✓ Each tuft has terminal duct of all tubules that join to form a common thick pharyngeal nephridial ducts.

✓ These ducts run anteriorly to open in the pharynx and oesophagus.

INTEGUMENTARY NEPHRIDIA IN EARTHWORM

- Location: scattered on the entire parietal surface of the body wall in each segment except the first 2.
- ✓ 200 to 250 nephridia in each segment.
- ✓ Segment 14 and 16 has 2000 constituting the ‘ forest of nephridia’

- Structure: V shaped microscopic closed type.
- ✓ Their terminal ducts open outside the body via nephridiopores and are exonephric.

SEPTAL NEPHRIDIA

➢Location:

✓Septal nephridia are present on the intersegmental septum starting from 15th or 16th segment and continue till the last segment.

✓They are present in four rows; two rows on each of the anterior and posterior faces of a septum.

✓They are arranged in a row on each side of the alimentary canal on each face of the septum. Each row contains 20-25 nephridia.

✓Except in 15th segment and in the anal region, all other segments contain 80-100 septal nephridia each.

PHYSIOLOGY OF EXCRETION

- The chief nitrogenous waste products of Pheretima are ammonia, urea and creatinine.
- These nitrogenous waste products are found in the blood, coelomic fluid and excretory fluid of the earthworms.
- All the nephridia have a abundant supply of blood, they collect nitrogenous wastes from the blood. The septal nephridia communicate with the coelom through their nephrostomes and hence they can eliminate excretory wastes both from the blood and coelomic fluid.
- Urine is hypotonic both to blood and the coelomic fluid. Nephridia play an important role in osmoregulation. The enteronephric nephridial system in Pheretima, which discharges excretory fluid into the lumen of the intestine, is an adaptation for conservation of water. Thus these nephridia help also in osmoregulation. Earthworms mostly excrete urea as the excretory products and are describes as ureotelic animals.
- Chloragogen cells: **Chloragogen cells**, also called as y **cells**, are **cells in annelids** that function similarly to the liver in vertebrates. The **cells** store glycogen and neutralize toxins and are present in coelomic fluid of some **annelids**. They are yellowish in colour due to the presence of yellow granules called chloragosomes.

- As a rule there is one pair of nephridia in each segment.
- In *Brachidrilus*, there are two pairs in each segment.
- In *Trinephros*, there are three pairs in each segment.
- There are four pairs in *Acanthoarilus* in each segment.
- In tropical Megascolecidae, the nephridial primordia in each segment splits and as a result numerous nephridia occur in each segment.
- These nephridia are called diffused or plectonephric nephridia.

NEPHRIDIA IN HIRUDINEA

- In Hirudinaria the permanent nephridium is lacking in many anterior and posterior segments.
- The metanephridium consists of a ciliated nephrostome or funnel that leads into an ampulla filled with amoebocytes and closed off against a nephridial duct.

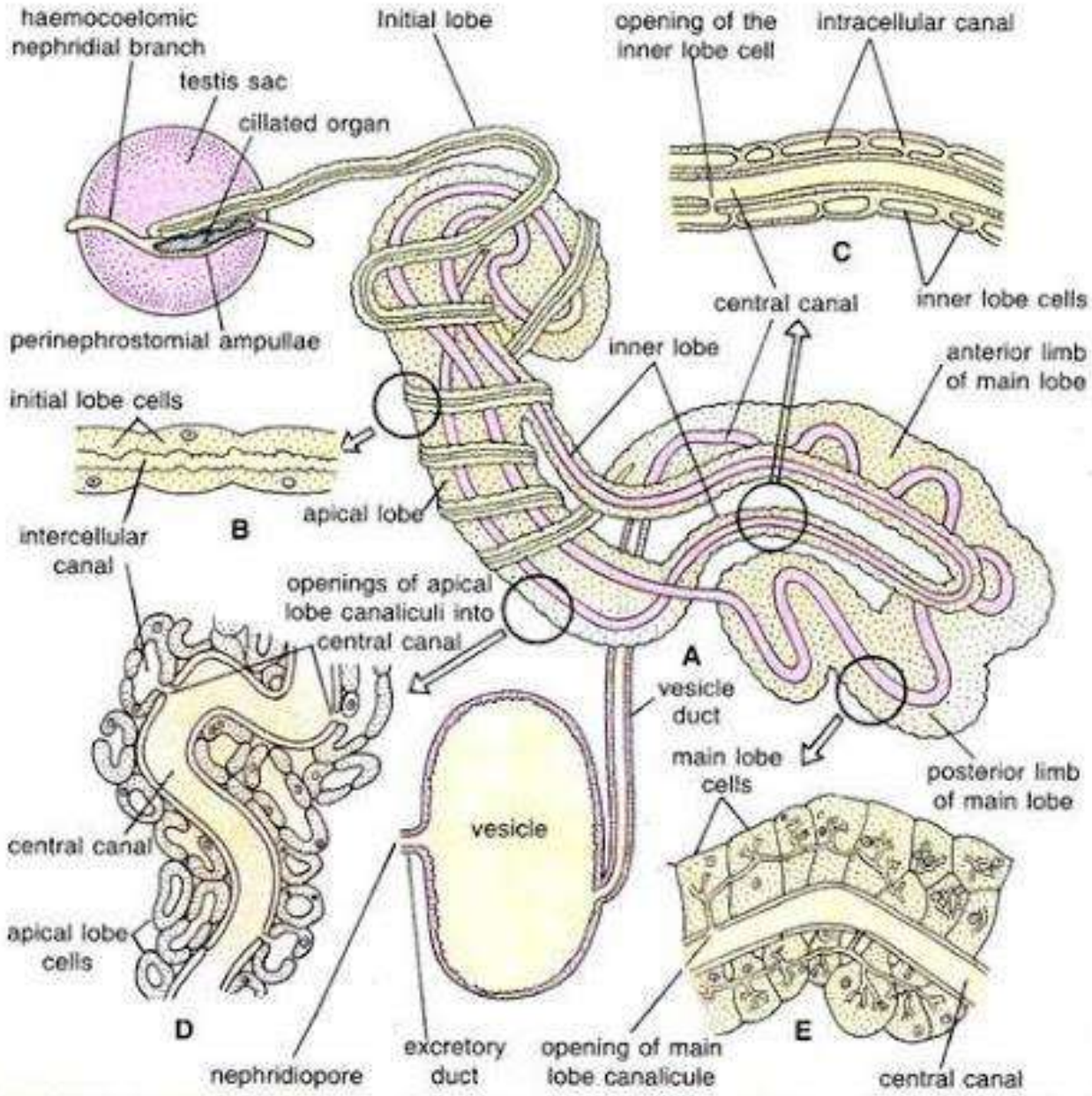


Fig. 67.20. *Hirudinaria*. A—A complete testicular nephridium; B—A portion of initial lobe in L.S.; C—A portion of inner lobe in L.S.; D—A portion of apical lobe in L.S.; E—A portion of

IN *Hirudinaria*

- In ***Hirudinaria*** **the excretory system** includes 17 pairs of **Nephridia**.
- They are arranged in 6th to 22nd segments, one pair in each segment.
- In these 17 pairs the first six pairs will not show contact with testis. They are called **pre-testicular nephridia.**
- The next 11 pairs of nephridia will show contact with testis, hence they are called **testicular nephridia**.
- In leech 17 pairs of nephridiopores are present on the ventral side, from 6uS to 22nd segments, one pair in the last annulus of each segment.

PROCESS OF EXCRETION:

1) A nephridium is supplied with haemocoelomic fluid. The nephridia will remove the nitrogenous wastes of haemocoelomic fluid. It absorbs, more ammonia, small quantity of urea and other substances.

2) Nephridium can also absorb excess of water from the body.

3) These wastes finally reach the vesicle and are sent out through the nephridiopore.

SIGNIFICANCE OF NEPHRIDIUM

- It eliminates the liquid nitrogenous waste products from the body to the exterior.
- It eliminates the basic and non-volatile acid radicals from the body.
- It maintains the water balance of the body.
- It regulates the osmotic relation between the blood and tissue.
- In some cases they act as gonoducts (coelomoducts) by conveying reproductive units.