EARTHWORM

Systematic Position

Phylum: Annelida Class: Oligochaeta

Genus: *Pheretima*

Species: *posthuma*

Common Name: Earthworm

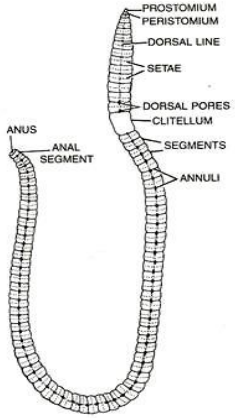


Fig. 7A.1. Earthworm in dorsal view.

Habit and habitat

- These are nocturnal in habit and live in damp, moist, humus-rich soil of lawns, gardens etc.
- In dry weather they burrow deeper into the soil to avoid dryness.
- Their niche is a herbivore and macro-decomposer and is important as a source of food for birds.
- It also helps in soil aeration and increasing soil fertility

EXTERNAL CHARACTERS

- Body is long, narrow and cylindrical.
- Length may reach upto 150 mm.
- Body colour is brown.
- Anterior end is pointed while the posterior end is blunt.
- Body is divided into 100-140 segments called **metameres**.
- The anteriormost segment is called **Prostomium**.
- Mouth is a crescentic aperture, present at anterior end. The segment containing mouth is called **peristomium**.
- Setae are present at all the segments except-1st and last.
  Each seta is embedded in a setal sac.
- A glandular band called **Clitellum** is situated in 14th to 16th segments. It forms coccon during the reproduction.
- **female genital pore** is situated in 14th segment (ventral surface)while male genital pore is present in 18th segment.
- The earthworm feeds on organic matter in the soil.
- The food is sucked by the **pharynx** and the **oesophageal glands** add calcite to neutralise acidity of the soil.

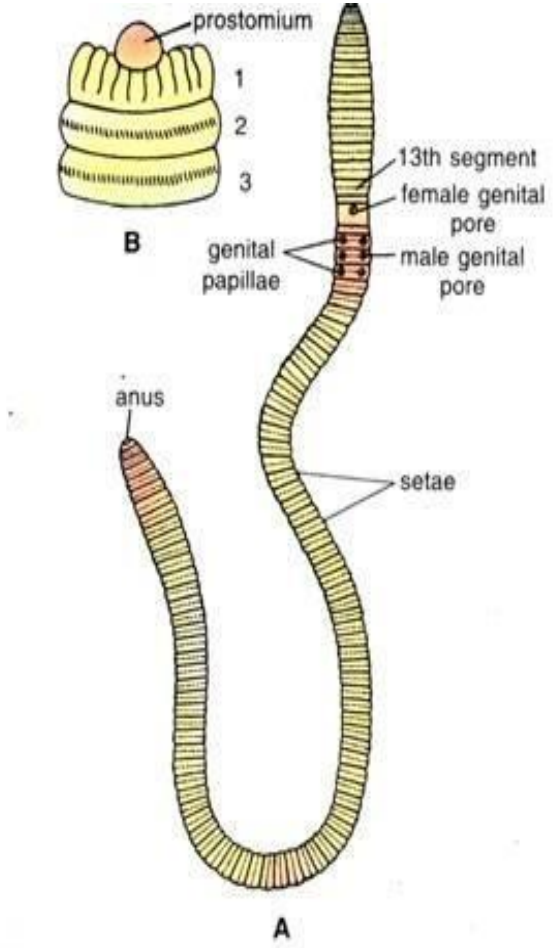


Fig. 66.2. A—*Pheretima posthuma* in ventral view; B—Anterior end in dorsal view.

- The food is then grinded by the horny lining of the **gizzard** and is absorbed in the **intestine**.
- Undigested food material passes out the anus and is deposited as **worm castings**.
- The earthworm 'breathes' by the diffusion of gases through its moist skin.
- The blood contains **haemoglobin** which transports oxygen throughput the body.
- Circulatory system is of **closed type**.
- Earthworms have **no sense organs** but they can sense light intensity by small **light-sensitive cells** found mainly on the uppers skin surface of their body.
- They can also sense vibrations and chemicals by the means of **tactile or chemo-receptors**.
- The earthworms exhibit **undulating movement** which takes place by alternate contration and relaxation of circular and longitudinal muscles of each segment.
- Earthworms are **hermaphrodites** but they reproduce by **cross- fertilization**.

Digestive System ofEarthworm

Digestive system of earthworm consists of alimentary canal and glands along with physiology of digestion.

Alimentary Canal

Alimentary canal is long and straight, extending from mouth to anus. It consists of following parts:

Mouth :

1^{st} segment

Buccal Cavity :
2^{nd}-3^{rd} segment or middle of 3^{rd} segment Pharynx : 3^{rd}-4^{th} segment

Oesophagus :
5^{th} -7^{th} segment

Gizzard :
8^{th} or 8^{th}-9^{th} segment Stomach : 9^{th} or 10^{th}-14^{th} segment

Intestine :
15^{th} up to last segment except anus Anus : last segment

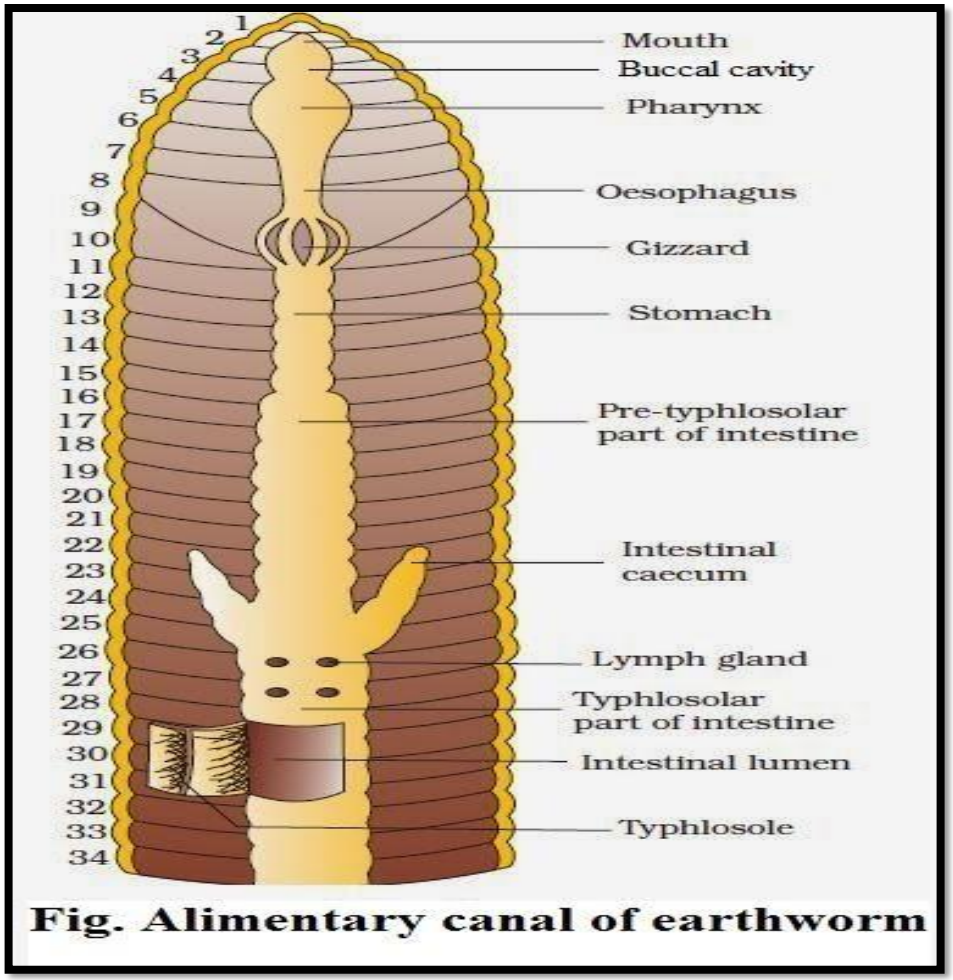


Fig. Alimentary canal of earthworm

- **Mouth**

  It is crescentic aperture situated in the 1^{st} segment below the prostomium.
  Mouth leads into a buccal cavity. Ingestion of food takes place
  through it.

- **Buccal Cavity**

  It is a short, wider, thin-walled tube extending from 2^{nd} up to 3^{rd} or middle of 3^{rd} segment. It consists of two kinds of muscle. They are: protractile muscle and retractile muscle.
  Buccal cavity protrude out through mouth with the help of special muscle for holding the food particles during feeding.
  Buccal cavity leads into spacious organ called pharynx.

- **Pharynx**

  It is small, swollen, wider, thick-walled pear-shaped chamber, which extends up to 4^{th} segment.
  It is wider than buccal cavity.
  It is distinguished from buccal cavity by means of constriction.
  It has pharyngeal gland, located in the dorsal salivary chamber. Pharyngeal gland is composed of many chromaphil cells, which produce saliva containing proteolytic enzyme; protease and mucin. Mucin makes the food soft and protease converts protein into amino acid.

- **Oesophagus**

  It is narrow thin-walled tubular structure extending from 5^{th} to 7^{th} segment.

  It has no gland.
  It passes the food particles from pharynx to gizzard. It leads into gizzard.

- **Gizzard**

  It is oval, thick-walled and highly muscular organ lying in the 8^{th} or 8^{th}-9^{th} segment.
  It is the hardest part of alimentary canal due to the presence of inner lining of cuticle. It also possess chitinuous teeth like projection. It helps in grinding or crushing food so act as grinder during feeding.

- **Stomach**

  Gizzard leads to short, narrow, thin-walled, highly vascular tubular structure called stomach, which extends from 9^{th} or 10^{th} to 14^{th} segment. It is wider than oesophagus.
  It has calciferous gland which helps in neutralization of food by calcification process.

  Stomach leads to intestine.
  The glandular cell of stomach produce proteolytic enzymes for the digestion of protein.

- **Intestine**

It is long, wide and thin-walled tube which extends from 15^{th} to last segment except anus. Its inner lining is ciliated, vascular, folded and glandular. Its intestinal lining is folded to form villi. One of the villi becomes larger and well developed than other called typhlosole which runs mid-dorsally from 27^{th} to last 25^{th} segment.
Typhlosole divides the intestine into 3 regions. They are:

i. **Pre-typhlosolar region**

It extends from 15^{th} segment to 26^{th} segment so it is the first part of the intestine. It consists of villi but no typhlosole.
In 26^{th} segment, there is a pair of short and conical lateral outgrowth called intestinal caeca which extends upward up to 23^{rd} segment. Intestinal caeca produce amylase which helps in starch(carbohydrate) digestion.

ii. **Typhlosolar region**

It is the 2^{nd} or middle part of the intestine which extends from 27^{th} segment tolast
from 25^{th}segment. It has both villi and typhlosole.
The typhlosole is highly vascular and glandular fold that increases the absorptive surface area of the intestine.

- **iii. Post-typhlosolar region**

  It is the last part of the intestine lying in the last 23^{rd}-25^{th} segment in front of anus. It is also called rectum. It lacks villi and typhlosole.
  It contains small pellets of mud which are thrown out through the anus to form casting.

- **Anus**
  It is a circular opening in the last segment called anal segment. Undigested food materials release out through anus in the form of worm casting.

Digestive glands

There are different types of digestive glands associated with alimentary canal of earthworm.

- ❑ Pharyngeal gland
- ❑ Gastric gland
- ❑ Intestinal glands
- ❑ Intestinal caeca

Physiology of digestion

- Digestion is the bio-chemical process in which complex organic food is broken down into simple, soluble and diffusible form in the presence of respective enzymes.

- Earthworms feed upon all kinds of organic humus and debris such as decaying leaves and seeds, protozoan, etc. present in soil. They also feed directly on leaves, grasses and other vegetation.
- During feeding the buccal cavity is protrude out with the help of protractile and retractile muscle. Then the food is drawn into the mouth. The ingested food enters into pharynx through buccal cavity.
- The dorsal chamber of pharynx consists of pharyngeal gland which is composed of chromaphil cell which produce saliva containing mucin and protease.
- Mucin lubricates the food and protease converts protein into amino acids. The foods then pass through oesophagus into gizzard, where grinding or crushing of food material takes place into fine state due to the contraction of circular muscles of gizzard.
- The grinded food material enters into the stomach where the neutralization of food takes place by calcification process. Also there occurs the complete digestion of protein by proteolytic enzymes.
- Now the food material enters into intestine. In intestine, intestinal caeca produce amylase which converts starch into glucose.

- In intestine several enzymes are secreted and acts on the substrate as follo

- Protease: converts protein into amino acid.
- Amylase: converts starch into two molecules of glucose i.e. maltose. Cellulase: converts cellulose into glucose
- Chitinase: digest chitin of exoskeleton of insects. Lipase: converts fats into fatty acids and glycerol.
- Digestion occurs mostly in the intestine and the digested food is absorbed by villi. Then pass into blood stream through capillaries. Undigested food and the soil are released out in the form of casting through anus.

Circulatory System in Earthworm

- Earthworms possess a closed circulatory system in which blood always flows in the vessels and never comes in direct contact with tissues. The system consists of several tubes or vessels, blood glands and blood. The arrangement of different vessels is very complicated and that in the first thirteen segments differs from that of the rest body segments.

- In general, there are few longitudinal vessels acting as collecting or distributing vessels which are connected with one another by some transverse vessels acting as heart. In this text, for the sake of convenience, the circulatory system of earthworm is described according to the segmental arrangement.

Circulatory System in First Thirteen Segments of Earthworm:

In the first thirteen segments following vessels are present:

(a) Dorsal Vessel:

In the first thirteen segments, the dorsal vessel acts as a distributing vessel and extends upto the cerebral ganglion . It gives off branches that supply the blood to the anterior regions of the body.

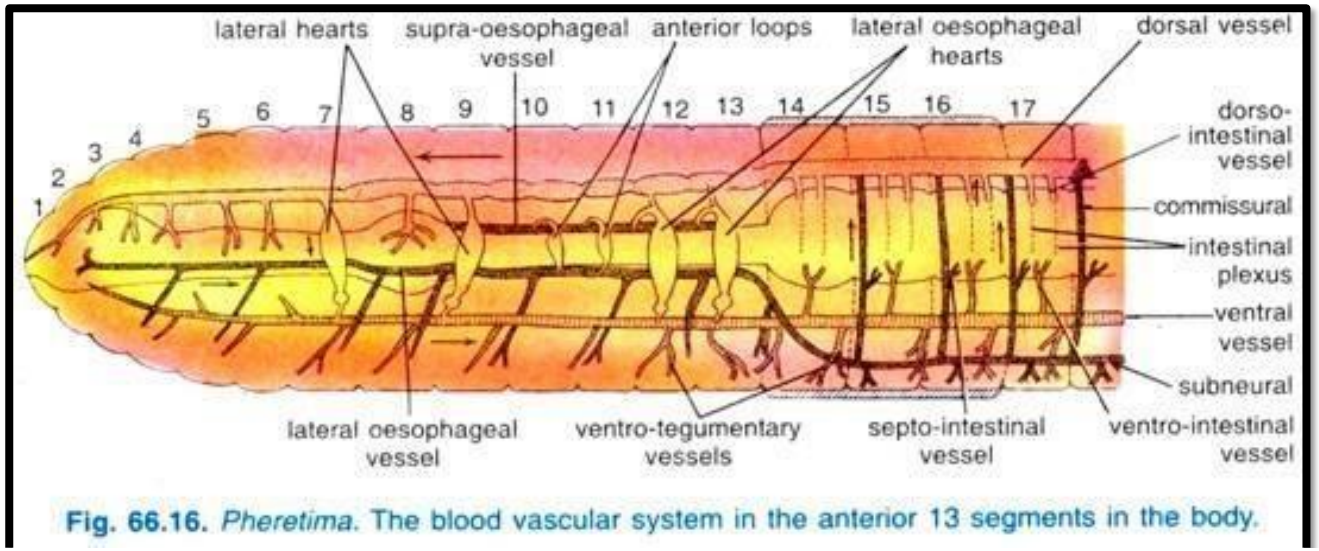


Fig. 66.16. *Pheretima*. The blood vascular system in the anterior 13 segments in the body.

b) Ventral Vessel:

It extends anteriorly up to the 2nd segment (Fig. 2.69). It supplies the blood to ventral body wall, septal nephridia and reproductive organs. It gives a pair of ventro-tegumentary vessel in each segment.

(c) Supra-oesophageal Vessel:

It is a very short vessel extending between segments 9th and 13th. It collects blood from gizzard and stomach.

(d) Lateral-oesophageal Vessel:

These vessels originate from the bifurcation of the sub-neural vessel at the 14th segment. They continue anteriorly along the lateral sides of the oesophagus. They collect blood from lateral regions of gut, body wall, septa and seminal vesicle.

(e) Ring Vessels:

The wall of the stomach between segments 10th and 13th bears dozens of circular vessels in each segment. These vessels carry blood from lateral oesophageals to the supra-oesophageals.

Circulatory System after Thirteenth Segment in Earthworm:

In this region, three large longitudinal vessels run parallel to each other and are as follows:

(a) Dorsal Vessel:

It runs along the mid-dorsal line of the body and just above alimentary canal

It acts as a collecting vessel and in each segment it receives:

(i) A pair of dorsointestinal vessels that bring blood from the intestine and(ii) A commissural vessel running along the posterior border of each septum, collecting blood from skin and nephridia. The wall of dorsal vessel is muscular and its lumen is provided with a pair of valves in each segment which are directed forward and inward to prevent back flow of blood.

(b) Ventral Vessel:

This long vessel runs along the mid-ventral line beneath the intestine

It distributes the blood through the following:

(i) A pair of ventro- tegumentary branches one on each side of each septum. These vessels pierce the septum, run upward and supply the blood to inner body wall and integumentary nephridium. Each vessel also gives a septonephridial branch which runs on the anterior face of the septum supplying blood to septal nephridia.

(ii) A median ventro-intestinal branch that supply the blood to the floor of intestine. In the lumen of ventral vessel valves are absent.

(c) Sub-neural Vessel:

It is a long, slender vessel extending from the posterior end to the 14th segment, and running along the mid-ventral line beneath the nerve cord (Fig. 2.69). It is a collecting vessel and in each segment it collects the blood by a pair of ventral branches from the ventral part of the skin.

The sub-neural vessel is linked to the dorsal vessel by a pair of commissural vessels in each segment. The vessel bifurcates in the 14th segment into two lateral oesophageal vessels

Blood Plexus of the Intestine:

In earthworm, the intestinal wall is traversed by an internal and external network of capillaries. These capillaries are connected with the ventro-intestinal and dorsointestinal vessels.

Heart:

In earthworms, the dorsal and ventral vessels are connected to each other in segments 7th, 9th, 12th and 13th by means of transverse vessels which are commonly known as hearts

However, the anterior pair situated in the 7th and 9th segments are called lateral hearts while the vessels present in the 12th and 13th segments are called laterooesophageal hearts as they communicate dorsally both with dorsal and supra- oesophageal vessels.

The hearts are provided with valves that open in single direction. Under electron microscope, four layers viz. epithelial tissue, connective tissue, circular and longitudinal muscle layers and vascular intima are observed in the wall of heart in earthworm.

Anterior Loop:

In the 10th and 11th segments, a pair of thin-walled, non-pulsatile, non-muscular loop like broad vessels without valves are present. These anterior loops convey blood from the lateral – oesophageals to supra-oesophageals.

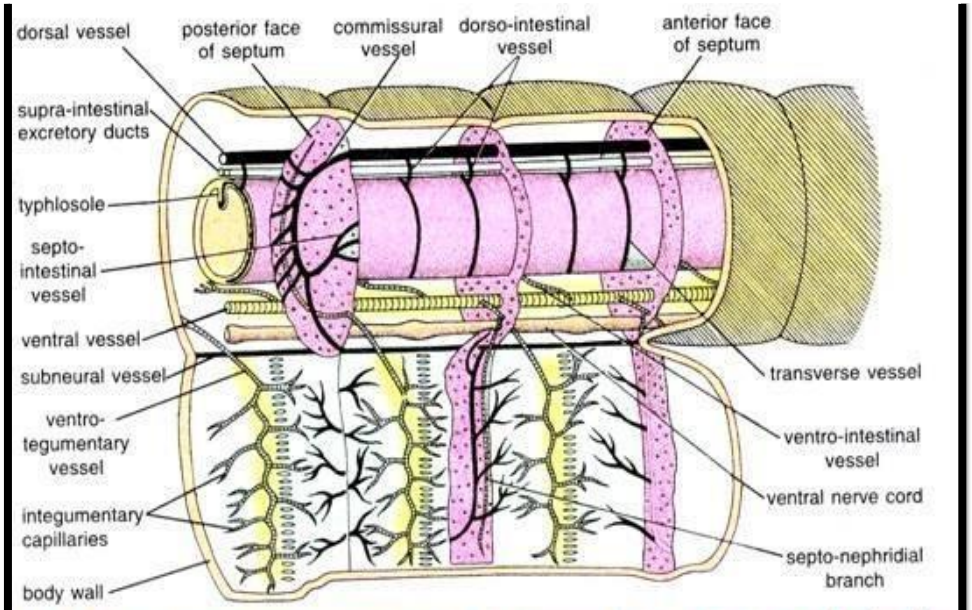


Fig. 66.15. *Pheretima.* Blood vascular system in the segments behind 13th. A part of body wall on the left side has been cut and reflected in order to expose the blood vessels in position.

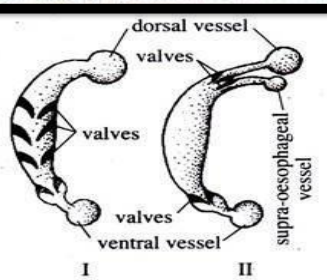


Fig. 2.70 : Heart in earthworm. I—Lateral heart, II—Latero-oesophageal heart.

Circulation of Blood:

The circulation of blood through different vessels is carried out by the peristaltic contraction of heart. In front of each septum, there is a pair of ring valves which direct the blood forward or backward but prevent reverse flow. The route of blood circulation through different vessels is elaborated in Fig.

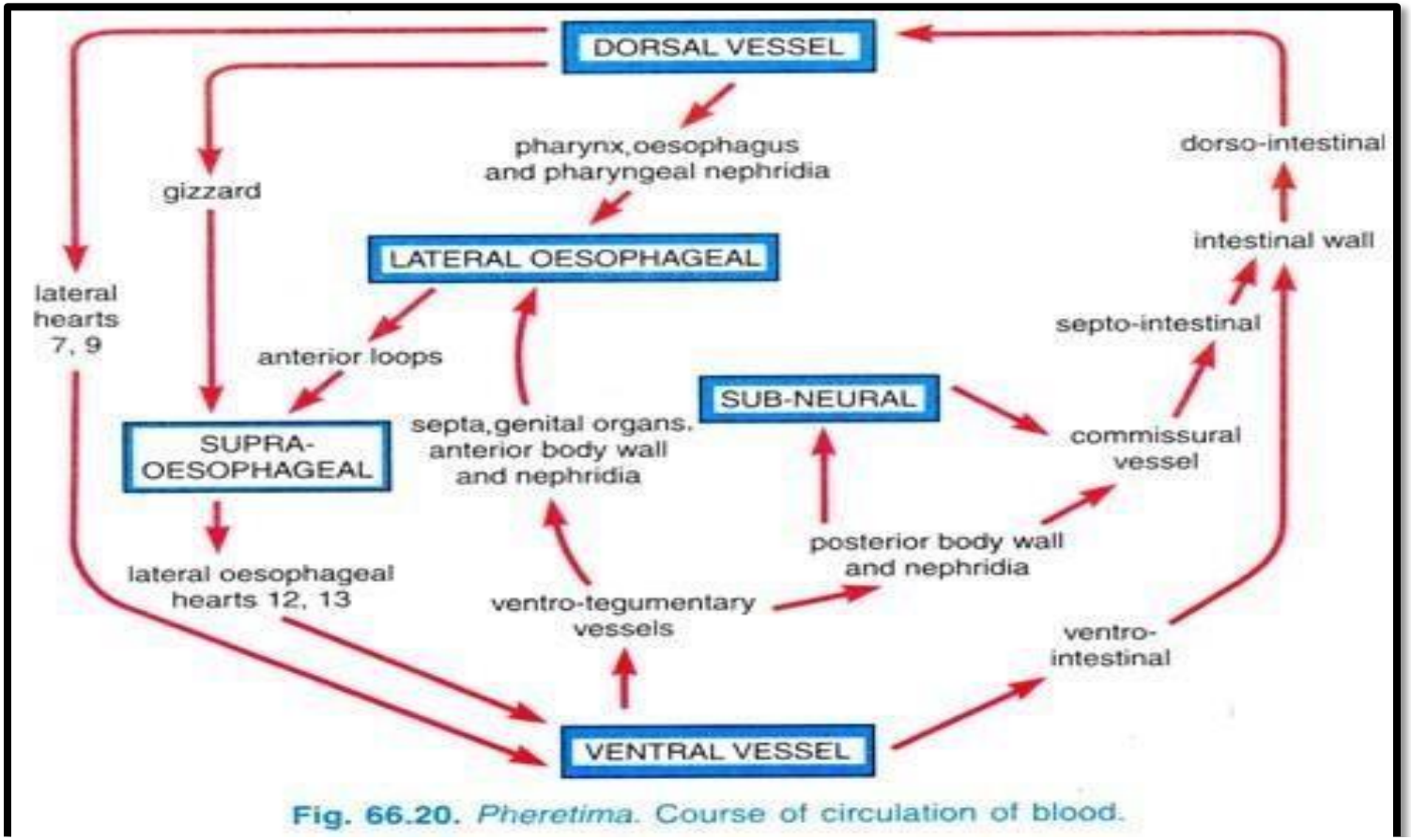
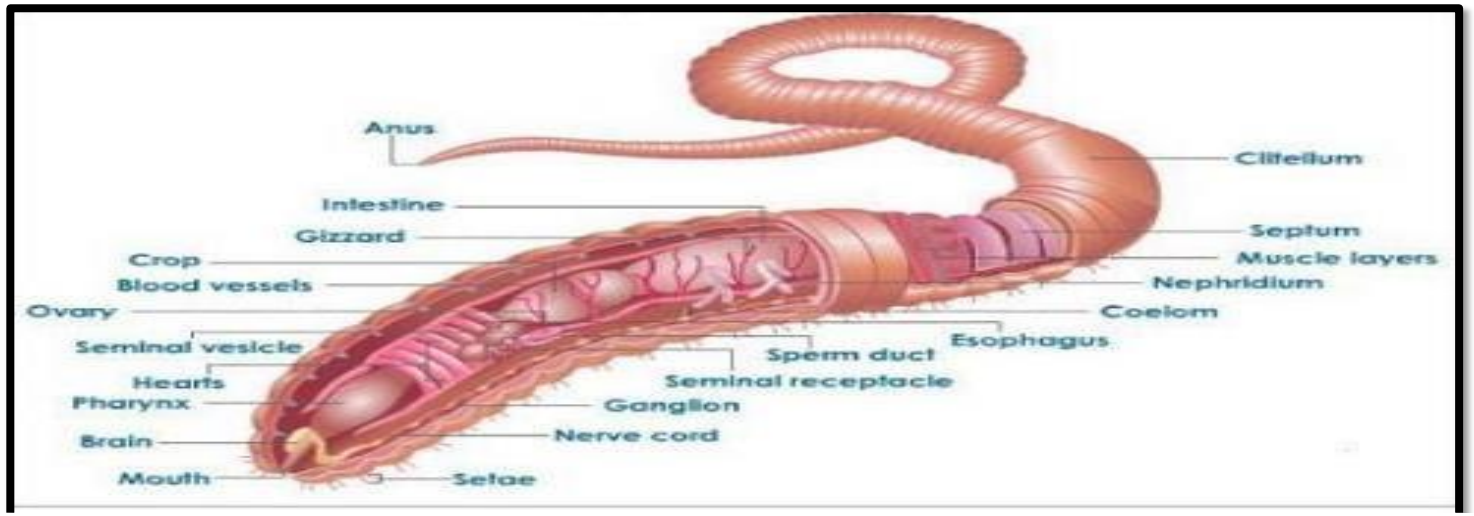


Fig. 66.20. *Pheretima*. Course of circulation of blood.

Excretory system ofEarthworm

- The process of removal of metabolic waste products including nitrogenous material like ammonia, urea, uric acid, amino acid, etc. from the body is called excretion.
  Excretory system consists of nephridia as excretory organ which is analogous to kidney of vertebrates.
  Nephridia are porous, long, thin and coiled tube which are found in all segments except first three.



Types of Nephridia

According to their position in the body, they are of 3 types:

1. Septal Nephridia/ Typical Nephridia
2. Pharyngeal Nephridia
3. Integumentary Nephridia

Septal Nephridia or Typical Nephridia

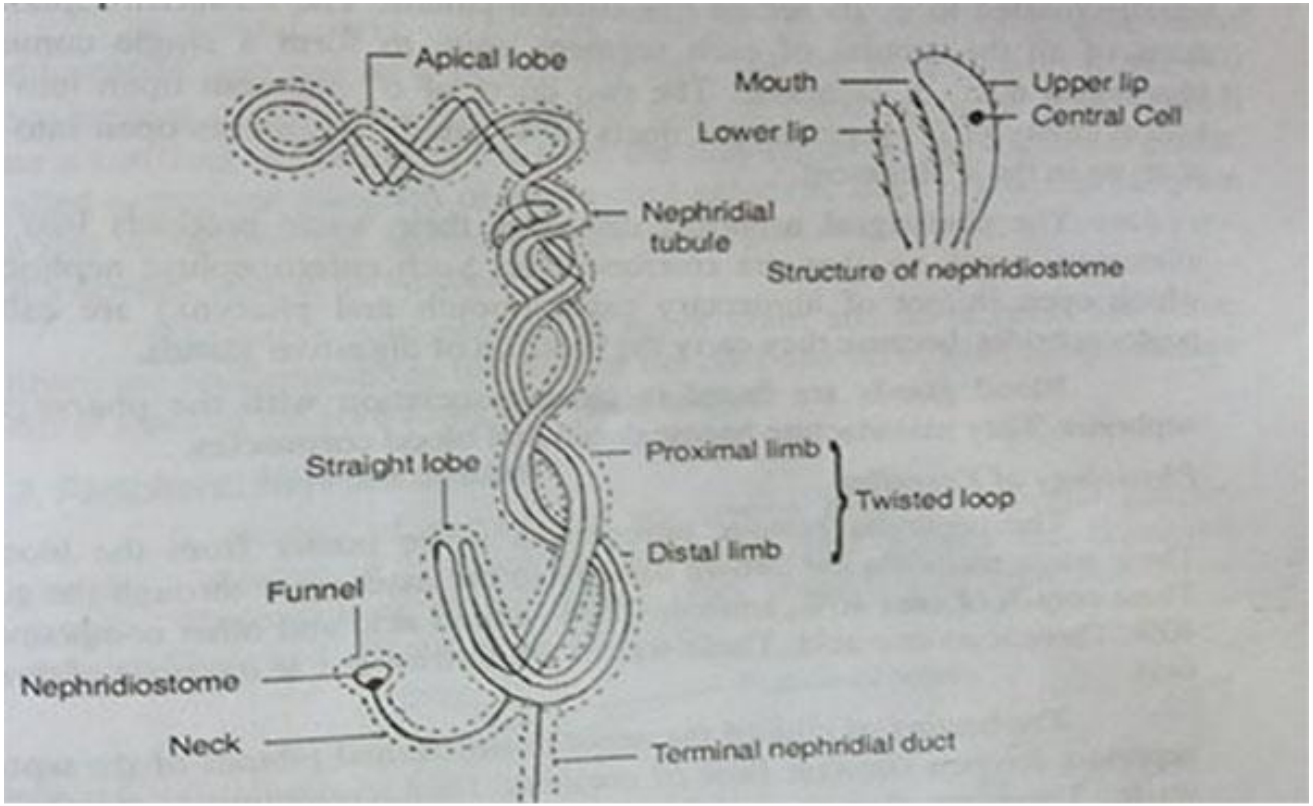


FIGURE: SEPTAL NEPHRIDIA

- They are well developed and the largest nephridia, and found attached to both sides of each intersegmental septum behind the 15th segment.
  Each septum has 40-50 septal nephridia and they are arranged in two rows. So each septum has 80-100 septal nephridia.

  It consists of 3 main parts:

a. Nephridiostome: also called **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.
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.

b. 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.

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 and terminal duct of the twisted loop, while the distal limb to the straight lobe.

The number of twist varies from 9-13.

c. Terminal duct

It is the end part of the main body. Only one intracellular canal.

Proximal 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.

d. 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.
- **Function of septal nephridia**
  Septal nephridia discharge the waste products through canal and ducts into the lumen of the intestine. So they are enteronephric.

2. Pharyngeal nephridia

They are found as paired and lie one pair in each of the 4th, 5th and 6th segment.
They are similar to septal nehridia in structure but they lack nephrostome (contain short straight lobe and spirally twisted loop). Lumen has ciliated canal.

NOTE: The terminal nephridal ducts of all the tubules of each segment unite to form a single common pharyngeal ducts in each side.
They have 3 pair of nephridial canal/duct.

The duct arise from 6^{th} segment which opens into buccal cavity in 2^{nd} segment, the ducts of 4^{th} and 5^{th} segment opens into the pharynx in 4^{th} segment.

- **Function:**
They discharge the waste products directly into the buccal cavity and pharynx from where these are passed outside with undigested food through the anus. So they are called enteronephric nephridia

3. Integumentary Nephridia

They are attached to the inner side of the body wall from 7^{th} to last segment.
They are smaller than septal nephridia.
Each nephridium is V-shaped with short straight lobe and twisted loop without nephridiostome or funnel.

Their lumen has two ciliated canals.

Their terminal nephridial ducts are also very short which open on the
outer surface of the body wall by nephridiopores.
The number of integumentary nephridia ranges from 200-250 in each segment but in clitellar region, their number is about 2000-2500. So clitellum is called forest of nephridia.

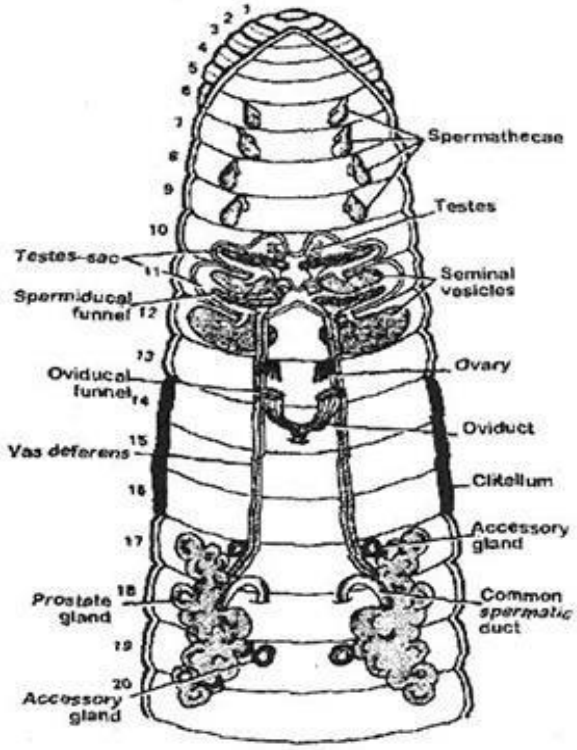
- **Function:**
  They discharge nitrogenous metabolic waste products directly outside from the body through nephridiopores. So they are called exonephric nephridia.

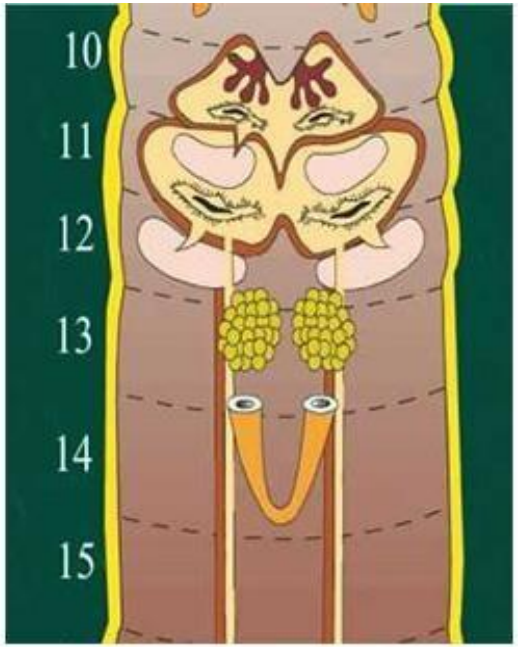
Physiology of Excretion

- Since the nephridia are richly supplied with capillaries, they collect the nitrogenous waste matter and remove from the body.
  NOTE: The nitrogenous wastes are thrown out at the intervals of three days.
- The beating of cilia of the nephridiostome drives a constant flow of coelomic fluid containing metabolic waste along with some other useful substances. The useful substances are absorbed by the body and the metabolic wastes reach the proximal limb of the twisted loop from the nephridiostome. Then they are transferred to the distal limb from where it reaches the straight lobe. When the excretory matters move in the nephridia they are converted into urea and ammonia. These are then passed into the gut through supra-intestinal excretory duct by enteronephric nephridia or outside by the nephridiopores by exonephric nephridia.
- ***NOTE:*** *Earthworm is ureotelic because its nitrogenous waste matter consist of 40% urea, 20% ammonia, 40% amino acid and other nitrogenous compound.*

Reproductive System ofEarthworm

- Earthworms are hermaphrodites but they cannot fertilize their own eggs because of their relative position of male and female genital aperture and they are protrandous (i.e. male sex mature earlier than female gametes). So, cross-fertilization takes place.





Male reproductive organs

They consist of following parts:

- **Testes**

  There are two pairs of small, white and lobed testes, located in 10^{th} and 11^{th} segment.

  They lie ventro-laterally below the alimentary canal, close to mid-ventral line on either side of ventral nervecord.
  Each testis consists of 4-8 finger like projections/ processes, containing round cells called spermatogonia.

  They are enclose within the testis sac.

  Function: They produce sperm.

- **Testis sac**

  Testes are enclosed by wide, thin-walled, whitish structure known as testis sac.

  There are two testis sac present in 10^{th} and 11^{th} segment.
  Testis sac communicates with a pair of seminal vesicles of succeeding segments.

The testis sac of 11th segment become larger as they enclosed the seminal vesicles of that segment.

They develop from the body cavity as small out-growth and lateral become saccular.

- **Seminal vesicles**
  - They are large, white, spherical structure found in two pairs, located in 11th and 12th segments.
  - *They are also called septal pouches as they are formed as outgrowth of*
  - *septa.*
  - Seminal vesicles of 11th segment are smaller and are surrounded by testis sac of the same segment and communicates with the testis sac of 10th segment while those of 12th segment are free and communicate with the testis sac of 11th segment.
  - **Function**
  - Spermatogonia undergo maturation division to form spermatozoa or sperm.
  - Maturation of sperm takes place in seminal vesicles.

- **Spermiducal funnel/ spermatic funnel**

They are cup like curvature found in two pairs.

They are ciliated sperm funnels, lying below each testis in the segment 10^{th} and 11^{th} segment and enclosed within the same testissac.

Function

Mature sperms from seminal vesicles move back to the testes sac and pass through the spermiducal funnel into vasa differentia

- **Vasa deferentia**

They are elongated narrow ciliated thread like tubular structure which extends from 12^{th} to 18^{th}segment.

They are found in two pairs and each pair lie on either side of alimentary canal.

They extends from 12^{th} to 18^{th} segment.

In 18^{th} segment they join together with a thick prostatic duct and forms common prostatic and spermatic duct.

Function

They collect sperm from spermatic funnel and give to prostate gland.

Prostate gland (*A gland in male that surrounds and opens into the urethra where it leaves the bladder*)

There are a pair of large, white, flat, solid, irregular and lobulated gland, extending from 16^{th} to 20^{th} or 17^{th} to 21^{st} segment.

Each gland consists of large glandular part-containing many lobules and small non-glandular part-consisting of several small ductules.

From each prostate gland emerges a short, thick curved prostatic duct in 18^{th} segment.
The prostatic duct joins the two vasa deferentia of its own side unite to form a common prostatic and spermatic duct.

Prostatic duct opens separately through a male genital aperture on the ventral side of 18^{th} segment.
Thus each genital aperture has 3 separate apertures- two of the vasa deferentia and one of the prostatic gland.

Function

It produce prostatic fluid which is alkaline in nature. It activates sperms.

And also it keeps sperm motile.

- Accessory glands

These are two pair of whitish, spherical structures found one pair in each of the 17^{th} and 19^{th} segment.

Found on the ventro-lateral body wall on either side of the ventral nerve cord.

They open to the exterior by a number of ducts on two pair of genital papillae, situated in 17^{th} and 19^{th} segment.

Secretion of these gland helps in holding two worms during copulation. **Function**

They help in pseudocopulation. Male genital pore

It is found in one pair located in 18^{th} segment. Function

It acts as male genital pore.

Female reproductive organ

They includes following:

- **Ovaries**

A pair of small, whitish and lobulated ovaries located in the 13th segment, on either side of ventral nerve cord.
Each ovary consists of several finger like processes in which ova are arranged in a linear series in various stage of development (being mature in the distal part and immature in the proximal part).
Function: They form ova.

- **Oviducal funnel**

Below each ovary, there is a small saucer-shaped ovarian funnel with folded and ciliated margin, which leads into a short oviduct.
Function: Ova enter through oviducal funnel and travel backward along the oviduct.

- **Oviduct**

The two, short conical oviduct lies in 13^{th} and 14^{th} segment.

They run posteriorly and converge to meet below the nerve cord and open by a single median female genital aperture mid ventrally in 14^{th} segment.

Function: They collect ova from ovary and give to female genital pore

- **Spermathecae**

There are 4 pairs in each of 6^{th}, 7^{th}, 8^{th}, 9^{th} segment situated ventro laterally.

Each spermathecae is flask shaped consisting pear-shaped ampulla, short narrow neck and a short narrow elongated diverticulum.

Spermathecae open outside through 4 pairs of spermathecal pores, situated ventrolaterally in the grooves between 5/6, 6/7, 7/8, 8/9 Segment.

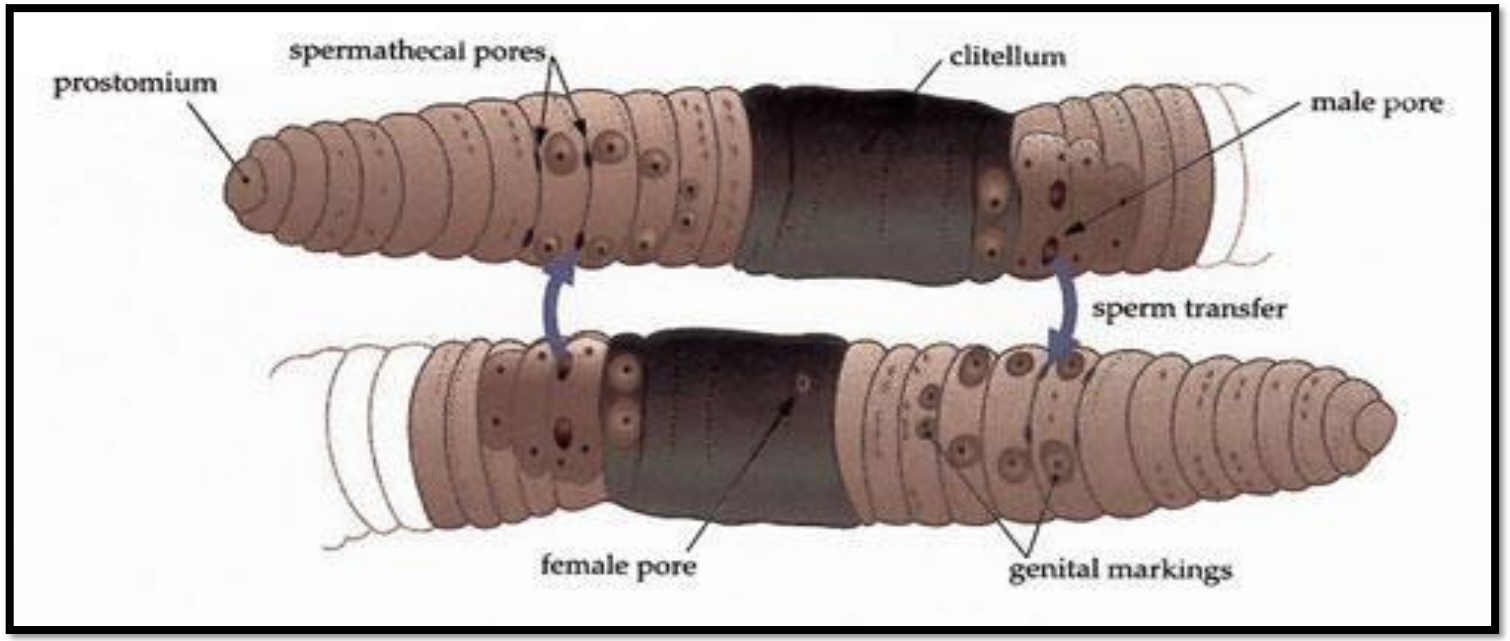
Spermathecaearealsocalledseminalreceptaclesastheystorespermatozoafromanother worm during copulation.

Function: They store sperm in diverticula during copulation and the ampulla provide nourishment for the sperm.

Female genital pore

It is a single unpaired small pore, lies in 14^{th} segment.

Copulation and cocoon formation **Copulation**



The spermatozoa of one worm are transferred to another during a process called copulation.

OR

the process of transformation of sperms of one worm to another worm for the cross-fertilization is called copulation.

Copulation takes place during rainy season (from July to October) at night or early in the morning (dawn in the morning before sunrise).

During copulation two earthworms come closer and are ventrally attached in opposite direction in such a way that the male genital pore of one worm lie opposite to the spermathecal pore of other.

Both worms remain united together by the secretion of accessory glands and also by mutual penetration of setae in each other's body.

Sperm and prostatic fluid of each worm are exchanged and released or
stored in spermathecae through spermathecal pore. Copulation lasts for about an hour.

Then the worm separate and later (after some day) they lay their eggs in cocoon.

Cocoon formation and Fertilization

Cocoon formation takes place after copulation, when ovaries mature. The epidermis of clitellar region (14^{th}, 15^{th} 16^{th}) contain 3 kinds of gland: Unicellular mucous gland- produce mucus for copulation

Cocoon secreting gland- secrete wall of cocoon. Also secrete a gelatinous viscid and sticky substance which form a membrane girdle.

Albumen gland cell- produce albumen; serves for nourishment of the growing embryo, which is deposited between the girdle and body wall. The girdle soon harden on exposure to the air, into a tough but elastic tube which is called cocoon or egg capsule.

Then the worm starts to wriggle behind so that the girdle slipped forward. As the girdle pass over the female genital pore, it receives ova and when it passes over spermathecal, it receives sperm through spermathecal pores.

Finally, the girdle is thrown off from the anterior end and soon the elasticity of its wall closes up two ends to form a cocoon or ootheca. Several cocoon are formed after each copulation because the spermatozoa in spermathecae do not pass out all at one time.

The cocoon are barrel shaped, light yellow in color and measuring about

Fertilization

Fertilization takes place inside the cocoon, where each ovum is fertilized by sperm.

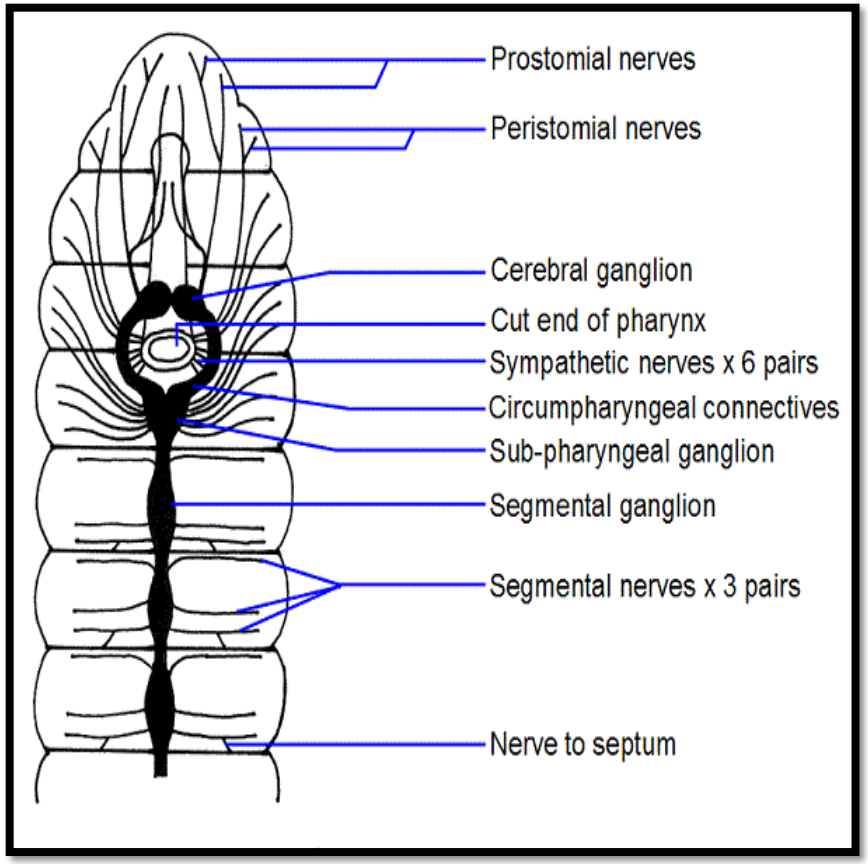
As a rule, there is only one embryo develops (only one fertilized egg proceeds to develop new individual and rest degenerate). So the cocoon contains many fertilized eggs but only one earthworm can release from cocoon.

The development is direct i.e. no larval stage. The young worm when fully grown, crawls out of the cocoon in about 2-3 weeks which resembles the adult except in size and absence of clitellum.

Nervous System ofEarthworm

The nervous system of earthworm is well developed. It consists of 3 parts:

- ❑ Central nervous System
- ❑ Peripheral nervous system
- ❑ Sympathetic nervous system



Central nervous system

This part of nervous system lies along the mid-line of the body. It consists of 2 parts:
Nerve ring and Ventral nerve cord.

a. Nerve ring

It is ring like spherical structure which lies around the pharynx in 3rd and 4th segment.

It has 3 parts:

i. **Supra-pharyngeal ganglia** Also called cerebral ganglia. They are bilobed in structure.

A pair of whitish pear-shaped supra pharyngeal ganglia fused to form brain.

Lies dorsally in the 3rd segment in the depression between the buccal cavity and the pharynx.

ii. **Circum-pharyngeal connectives/ Peri-pharyngeal connectives**

From either side of supra-pharyngeal ganglia, a pair of thick short band circum-pharyngeal connectives arise which enclose the pharynx.

It is outer buldging part which extends from 3rd to 4th segment

.**iii. Sub-pharyngeal ganglia**

Found in lower region of nerve ring which lies in 4th segment.

Ventrally Circum-pharyngeal ganglia meet with a pair of sub-pharyngeal ganglia. Thus a complete nerve ring is formed around the pharynx.

b. Ventral nerve cord

It is long thread like double layered structure, which arises from the posterior part of sub-pharyngeal ganglia and runs the posteriorly up to the last segment of the body. Extends from 5th to last segment.

NOTE: Nerve cord are two in number but they are fused. So they are called double ventral nerve cord.

It has swelling bulb like structure in each segment called segmental ganglion.

Peripheral nervous system

Those nerve which arise from different parts of central nervous system are called peripheral nervous system.

Following pairs of nerve arise from brain:

8 to 10 pairs of nerve arise from brain which communicates or innervate or supply to prostomium, buccal cavity and pharynx.

2 pairs of nerve arise from cirum-pharyngeal connectives which supply to the wall of prostomium and peristomium segment.

3 pairs of nerves arise from sub-pharyngeal ganglia which supply to the 2nd, 3rd and 4th segment.

3 pairs of nerves arise from each segmental ganglion which supply to the various parts of segment, gut wall, body wall and other internal organ.

Sympathetic nervous system

Sensory and motor nerve fuse to form nerve plexuses which moves ventrally through alimentary canal. These plexuses are connected with the peri-pharyngeal connectives.

Economic Importance of Earthworm!

1. The earthworms improve the fertility of soil in different ways and, therefore, they are of utmost importance in agriculture. Actually, the burrowing and soil feeding habits of earthworms make the soil porous which permit both aeration and quick absorption of water. It also permits easy and deep penetration of the plant roots.

They also bring the fresh subsoil to the surface which is still finer and rich in organic matters. The castings of earthworm contain fine soil having mixed with its nitrogenous wastes and faeces of nice manurial value. The faeces of earthworm contain nitrate, calcium, magnesium, potassium and phosphorus which constitute an important component of the humus essential for plant growth.

They also reduce the alkalinity and acidity of the soil to provide better conditions for plant growth. After their death and decomposition, they increase the organic constituents of the soil. Thus, the earthworms make the soil fertile to a great extent. Thus, these worms are also known as natural ploughmen or tillers of the soil.

2. These are used as bait and food. As bait they are used in fishing. The earthworms were used as food by so many uncivilized people of the world and they are still used as food by Macrea people. The earthworms are eaten upon by frogs, toads, moles, hedgehogs and birds which are of many uses to mankind.

3. Many people earn their livelihood by catching these worms and supplying to scientific laboratories.

4. Ayurvedic and Unani system of therapy suggests that these worms were used in making medicines for the cure of diseases like bladder stones, jaundice, pyorrhoea, piles, rheumatism, etc. Even today, these are used in making various medicines of vital importance in India as well as other countries