Pheretima posthuma: The Indian Earthworm

Earthworm: introduction (YOUTUBE)

Class Oligochaeta includes terrestrial earthworms and some other species that live in fresh water. As compared to many setae of polychaetes, they possess few locomotor setae borne directly by body segments which are devoid of parapodia (L., oligos, few + chaete, bristles). There are several genera of earthworms. Common genus of Europe and North America is *Lumbricus.* In India, *Drawida* and *Megascolex* occur in South India and *Eutyphaeus* is found in the Gangetic plain of North India *Pheretima*, which is commonly found South East Asia, Japan, Sri Lanka, and Australia, is represented by 13 species in the Indian soil. Following description applies to *Pheretima posthuma*, whose anatomy has been worked out by late Professor K.N. Bahl (1926) and others. An earthworm is usually studied as a type of Annelida because it is easily available almost everywhere.

Pheretima posthuma

Systematic position

Earthworm: systematic position (YOUTUBE)

Phylum	Annelida
Order	Oligochaeta
Family	Megascolecidae
Genus	*Pheretima*
Type	*posthuma*

HABITS AND HABITAT (ECOLOGY)

Pheretima posthuma is a terrestrial earthworm living in burrows made in moist earth. It prefers to live in the burrow during the day and comes out at night and in damp cloudy weather. It is thus nocturnal in habit. During rainy season, after a heavy fall, earthworms leave their burrows and are seen in large numbers crawling on ground. Earthworm makes its burrow partly by boring with its pointed anterior end and partly by sucking and swallowing the earth. It feeds on dead organic matter present in soil. Food and soil are ingested together and the latter, along with undigested food is finally egested in the form of worm castings Earthworm are hermaphrodite, but they undergo copulation for exchange of their spermatozoa. Fertilization and development occur inside a cocoon Trochophore larva does not occur as young worm hatches out of cocoon. Earthworms possess great power of regeneration.

EXTERNAL MORPHOLOGY

Earthworm: external morphology (YOUTUBE)

1. Shape and size. Earthworm is a bisymmetrical animal. Its body is cylindrically elongated, pointed in front, blunt behind and thickest a little behind the anterior end. It is well-adapted for burrowing A mature worm measures about 150 mm in length and 3 to 5 mm in width

2. Colour. Earthworm is of a glistening deep brown or clay colour Dorsal surface is darker than the ventral surface and carries a dark coloured median line due to dorsal blood vessel which is seen through the integument. Brown colour of worm is due to the pigment porphyrin present in body wall and it protects the body against bright and strong light

3. Segmentation. Soft and naked body of earthworm is divided into 100 to 120 similar segments, called metameres or somites. These are without parapodia. Segments are separated from each other by distinct ring like grooves External segmentation corresponds with the internal segmentation of body.

4. Head. Earthworm lacks a distinct head and sense organs like eyes, cirri and tentacles. First segment at the anterior end of the body is called buccal segment or peristomium bearing the terminal, crescentic mouth. It is prolonged anteriorly into a fleshy lobe, the prostomium, which overhangs the mouth.

5. Clitellum. In mature worms, a conspicuous external feature is a girdle-like thick band of glandular tissue, the clitellum, which completely and permanently surrounds the segments 14 to 16 Due to its presence, the body is distinguished mo peri-clitellar, clitellar and post-clitellar regions. Clitellum is a glandular organ which secretes mucus, albumen and an egg case or cocoon for eggs.

6. Setae. About the middle of each segment there is a ring of tiny curved bristles, called setae or chaetae, formed of a horny nitrogenous organic substance known as chitin. About 80 to 120 setae present on each segment. But they are absent as peristomium, pygidium and the clitellum. Each seta is embedded in a small pit in body wall, called setigerous or setal sac. It is formed by a single formative cell present in the basal part of sac. It has a faint yellow colour and is shaped like an elongated ‘S’ with a swollen middle part, called nodulus. About one-third of its length projects above the surface of skin in a contracted segment

7. Apertures. These include: (i) Mouth, a crescentic anterior aperture, surrounded by peristomium and overhung by prostomium. (ii) Anus, a vertical slit-like aperture at the posterior terminus, (iii) Female genital pore, a single median aperture of oviducts on ventral surface of 14th segment in clitellar region, (iv) Male genital pores, a pair of crescentic openings of common prostatic and spermatic ducts on ventral surface of 18th segment, one on each side, (v) Spermathecal pores, four pairs of apertures of spermathecae in the grooves of 5/6, 6/7, 7/8 and 8/9 segments, one on each side in ventro-lateral position, (vi) Nephridiopores, a large number of very minute openings of integumentary nephridia scattered all over the body except the first two segments, (vii) Dorsal pores minute apertures of coelomic chambers locate mid-dorsally, one in each intersegmental groove behind 12th segment, except the last groove.

8. Genital papillae. These are two pairs conspicuous rounded elevations, one pair each in the 17th and 19th segments, on the ventral surface. Each papilla bears a shallow cup-like depression at its top which acts as sucker during copulation.

BODY WALL

Earthworm: body wall – detail cellular structure (YOUTUBE)

Body wall of earthworm comprises a thin cuticle, an epidermis, a well-developed musculature and a coelomic epithelium or parietal peritoneum.

1. Cuticle. Cuticle is an elastic, non-cellular and finely striated layer which is secreted by the underlying epidermis.

2. Epidermis. It is single-layered and just beneath cuticle. Cells of epidermis are of various types, performing different functions. Supporting cells, forming bulk of epidermis, are of columnar type. Gland cells include numerous mucous cells and a few albumen cells packed with secretory granules. Basal cells, which are small and rounded or conical, lie in spaces between inner ends of supporting cells and gland cells. Receptor cells occur in groups with their outer ends giving out fine hair-like processes. Epidermis rests on a thin basement membrane.

3. Muscles. Musculature lies below epidermis. It consists of an outer thin layer of circular muscle fibres running around the body, and an inner thick layer of longitudinal muscle fibres running along the length of the body. Longitudinal muscle fibres lie in parallel bundles, separated by connective tissue and strengthened by collagen fibres. Setal musculature. Two additional types of muscle also occur inserted at the base of each setal sac bearing a seta. These are a pair of protractor muscles passing outwards to join the circular muscle layer, and a single retractor muscle, passing inwards to join another thin sheet of circular muscles forming a ring (parallel to the ring of setae) below the longitudinal muscles. All the muscle fibres are unstriped, long and spindle-shaped.

4. Coelomic epithelium. Between the body wall musculature and coelom is a thin layer of coelomic epithelium or parietal peritoneum, consisting of flat cells, which are recognizable by their nuclei only.

Coelom

Earthworm: coelom and fluid (YOUTUBE)

Body cavity of an earthworm is a true coelom which lies between the body wall and the alimentary canal. It is lined by coelomic epithelium derived from mesoderm.

[I] Septa

Coelom is partitioned into a series of coelomic chambers by transverse intersegmental septa. Each septum consists of a thin layer of interlacing muscle fibres, covered on both surfaces by coelomic epithelium. Septa are absent in first four segments. First septum, lying between segments 4 and 5, is thin and membranous. Next five septa are thick and muscular. All these six septa are cone-like and run obliquely backwards from body wall to gut wall. There is a single septum between segments 8 and 10, the other being absent.

Contraction of these cone-like septa increases pressure on coelomic fluid, thus making the anterior body segments turgid and elongated during locomotion and burrowing. First nine septa, i.e., up to septum 13/14, are without perforations. Remaining septa beginning from septum 14/15 are perforated by numerous sphinctered oval or circular apertures, through which adjacent coelomic chambers maintain continuity.

[II] Coelomic Fluid

Coelom is filled with an alkaline, colourless or milky coelomic fluid containing water, salts, some proteins and at least four types of coelomic corpuscles as follows:

1. Phagocytes. Largest and more numerous are the nucleated amoeboid corpuscles, or phagocytes. Each has several folds on surface, a deep concavity on one side, and contains many ingested granules such bacteria. as

2. Mucocytes. These are elongate cells, each having a broad, fan-like process, attached to a narrow-nucleated body.

3. Circular nucleated cells. About 10% of follow coelomic corpuscles are rounded, nucleated and blood corpuscle-like cells possessing clear shorter protoplasm and characteristic markings on surface.

4. Chloragogen cells. Also known as yellow cells, these are star-shaped, small-sized cells. They causes become deep yellow when stained with iodine solution. They are supposed to be excretory in function removing excretory products from coelomic fluid.

Functions of coelomic fluid

(1) Helps in locomotion by turgescence.
(2) Its circulation from one chamber to another helps in distribution of digested food.
(3) Exceeding through dorsal pores, it keeps body surface moist thus helping in respiration.
(4) It destroys harmful bacteria and other parasites in soil.
(5) Forms a protective, shock-proof covering around internal organs of body.
(6) Its chloragogen cells help in removing excretory products out of body.
(7) It causes luminescence in some earthworms.

LOCOMOTION

Earthworm: movement (YOU TUBE)

Movement in earthworm involves the musculature of body wall and setae. According to the studies of Gray and Lissman (1938), the worm's body undergoes extension, anchoring and contraction during the course of its progression. A wave of contraction, affecting circular muscles, begins at the anterior end and travels posteriorly. This causes the body to become thinner and longer. This is followed by another wave of contraction affecting longitudinal muscles causing thickening and shortening of body. This is again followed by the wave of thinning and the process is repeated alternately. Each wave of circular contraction causes the segments affected to move forward. But the segments in a state of longitudinal contraction do

not move as they are anchored to the ground by the protruded setae. Setae always protrude during longitudinal contraction and retract during circular contraction. It has been calculated that, by this method, the earthworm travels a distance of about 25 cm in one minute.

When the direction of waves is reversed, the worm crawls backwards.

During locomotion, coelomic fluid serves as a kind of hydraulic skeleton. When compressed due to contraction of circular muscles, it provides stiffness to body and aids in relaxation of longitudinal muscles.

DIGESTIVE SYSTEM

Earthworm: digestive system-dissection (YOUTUBE)

[I] Alimentary Canal

Alimentary canal of *Pheretima* is a complete and straight tube running along the entire length of body. Mouth and anus constitute its anterior and posterior openings, respectively. It is functionally regionated into various parts which are buccal chamber, pharynx, oesophagus, gizzard, stomach, and intestine.

1. Buccal chamber. Crescentic mouth, situated ventral to prostomium at the anterior end of peristomium, leads into a short and narrow protrusible buccal chamber, extending up to middle of third segment. Its lining epithelium is thrown into longitudinal folds.

2. Pharynx. Buccal chamber leads into a spacious pear-shaped muscular pharynx, which extends up to the fourth segment. Its anterior end is marked by a nerve ring placed in a transverse groove between it and buccal chamber. Its cavity is somewhat dorso-ventrally compressed due to the presence on its roof of a large glandular pharyngeal mass producing a salivary secretion, Lateral walls of pharynx are pushed inside forming a narrow horizontal shelf on each side. The two shelves meet anteriorly and posteriorly, thus dividing the pharyngeal cavity into a dorsal or salivary chamber and a ventral or conducting chamber, Salivary secretion contains mucus and proteolytic enzymes which are poured into the salivary chamber.

3. Oesophagus. Behind pharynx lies the oesophagus or gullet. It is a short, narrow, thin- walled tube. It extends up to the seventh segment.

4. Gizzard. Oesophagus is modified into a prominent, oval, hard and thick-walled muscular organ, the gizzard, lying in eighth segment. Its muscular wall consists of circular muscle fibres. It is internally lined by a tough cuticle.

5. Stomach. Gizzard is followed by a short narrow tube, the stomach, which extends from segments 9 to 14, with a sphincter at each end. Its walls are highly vascular and glandular and thrown into internal transverse folds.

6. Intestine. Region next to stomach is the intestine which is a long, wide and thin-walled tube extending from 15th segment to the last. It has beaded appearance due to circular a constrictions corresponding to septa. Its internal lining is ciliated, folded, vascular and glandular. Intestine is divisible into three parts:

(a) Pre-typhlosolar region, First or anterior part lying between segments 15 to 26 is known as pre-typhlosolar region. Its wall is internally folded to form minute processes, the villi, and is highly vascular. From 26th segment are given out externally a pair of forwardly-directed lateral conical outgrowths, the intestinal caeca, which run up to 22nd or 23rd segment. These are richly vascular and internally thrown into villi-like processes.

(b) Typhlosolar region. Second or middle pur lies between 27th segment up to 23-25 segments in front of anus. This is characterised by the presence of a highly glandular and vascular longitudinal ridge, arising as a median in growth of the dorsal aspect of the intestinal cavity. This is called the typhlosole

(c) Post-typhlosolar region. Third or the last part, also known as rectum, is of about 23-25 segments. It is internally marked by the presence of longitudinal folds. It opens to outside through a terminal anus.

[III] Food and Feeding Mechanism

Earthworm feed on dead organic matter, particularly vegetation along with soil. It also feeds directly upon leaves, grasses, seeds, algae, etc. Earthworm ingests food by the pumping action of its pharynx. It presses its mouth against soil and the contractile sucking action of the pharyngeal wall draws fragments of soil into the buccal chamber. Pharyngeal action is augmented by the action of strands of muscle fibres, extending from pharynx to body wall.

[IV] Physiology of Digestion

Ingested food is pressed to move posteriorly. No digestion takes place inside buccal chamber. While passing through the ventral conducting chamber of pharynx, it meets a salivary secretion produced by the glandular cells of pharyngeal mass and poured into the salivary chamber of pharynx. It contains mucin, which lubricates the food and an enzyme protease which digests the proteins. Food then passes back through the oesophagus into the gizzard. The gizzard, acting as a grinding machine, pulverises the food masses. This is facilitated by the contractile movements of its muscular wall which cause the food to roll about, and the internal cuticular lining, striking against which the food particles are ground up fully. In the stomach, a chalky secretion of calciferous glands located in the stomach wall neutralizes the humic acids present in soil. Intestine is the principal site of digestion. Intestinal wall consists of glandular cells which secrete digestive juice containing pepsin, trypsin, amylase, lipase and cellulase, Pepsin hydrolyses proteins into proteases and peptones, and trypsin hydrolyses these products into amino acids. Amylase hydrolyses starch into maltose, lipase brings about hydrolysis of fats into glycerol and fatty acids, while cellulase causes the digestion of cellulose and cellobiose.

Thus digestion is extracellular in earthworm, as in higher animals such as frog and rabbit. Intestine also functions for absorbing the digested nutrients. After being absorbed by the absorptive cells of intestinal

epithelium, nutrients are passed to blood capillaries in the intestinal wall. Presence of typhlosole in greater part of intestine increases the surface both for digestion and absorption.

Undigested food and the soil are eliminated through anus to outside in the form of worm castings. Castings of Pheretima consist of distinct, small and rounded pellets or balls, while those of Eutyphaeus make a large tower-like heap with an open passage in the middle.

CIRCULATORY SYSTEM

Earthworm: circulatory system (YOUTUBE)

Circulatory or blood vascular system of earthworm is a closed system consisting of blood vessels and capillaries which ramify to all parts of the body. Blood is composed of a fluid plasma and colourless corpuscles, physiologically comparable to the leucocytes of the vertebrates. The red respiratory pigment, haemoglobin (or erythrocruorin) occurs dissolved in plasma. It gives a red colour to blood and aids in the transportation of oxygen for respiration.

BLOOD VESSELS

Blood vessels of Pheretima posthuma may be conveniently grouped into three types: (i) longitudinal, (ii) lateral, and (ii) intestinal plexuses.

[I] Longitudinal Blood Vessels

These are five in number. They run lengthwise in the body and are as follows:

1. Dorsal vessel. It is the largest blood vessel of body running mid-dorsally above the alimentary canal, from one end of body to the other. It has thick, muscular and rhythmically contractile wall and is provided with a pair of valves in front of the septum in each segment. Blood flows through it from backward to forward.

Behind 13th segment, dorsal vessel is a collecting vessel, receiving blood through two pairs of dorso-intestinal vessels from intestine and a pair of commissural vessels from sub- neural vessel in each segment. In front of 13th segment (anteriorly), it distributes blood to the anterior regions of alimentary canal and

through the so-called hearts to ventral vessel. Extending up to cerebral ganglia, dorsal vessel trifurcates and the three branches are distributed over the pharyngeal bulb and roof of buccal chamber. In each of the 3rd, 4th, 5th, 6th and 8th segments, a pair of stout pulsating branches send blood to the pharyngeal nephridia, oesophagus and

2. Ventral vessel. It is a large vessel that runs mid-ventrally below alimentary canal and above nerve cord from one end of body to another. Its walls are thin and non-contractile and valves are altogether absent. Blood flows through it posteriorly.

Ventral vessel is principally a distributing a pair of ventro-tegumentary vessels vessel. It supplies blood, in each segment, through integumentary nephridia, body wall, septa and reproductive organs. Behind 13th segment, each ventro-tegumentary vessel sends a small branch, a septo-nephridial branch, supplying the septal nephridia. Besides in each segment behind 13th, ventral vessel gives off a median ventro-intestinal vessel to intestine.

3. Lateral oesophageal vessels. These are two vessels lying one on either ventro-lateral side of gut, running from the anterior end of body up to 13th segment. These receive a pair of ventro- tegumentary vessels in each segment, collecting blood from body wall, septa, nephridia and reproductive organs. Flowing posteriorly, some of its blood passes to the supra-oesophageal vessel through a pair of anterior loops in each of the segments 10 and 11 and through several ring vessels running through the wall of stomach. Rest of blood flows backward into sub-neural vessel.

4. Sub-neural vessel. It is a slender vessel which runs immediately beneath the nerve cord in mid-ventral position. It extends from 14th segment up to the posterior end and is formed by the union of two lateral oesophageal vessels Flow of blood is from in front backwards. It is a collecting vessel and receives blood from ventral nerve cord and ventral body wall in each segment through a pair of small branches. It pours blood via a pair of commissurals, in each segment into
dorsal vessel.

5. Supra-oesophageal blood vessel. It is a short thin-walled collecting vessel lying mid-dorsally above stomach and confined to segments 9 to 13. It is connected to lateral oesophageal vessel through two pairs of anterior loops and to ventral vessel through two pairs of latero-oesophageal hearts. At places it divides into separate vessels which reunite to form a single vessel. It collects blood from stomach, gizzard and (through anterior loops) from lateral oesophageal and pumps it through lateral oesophageal hearts into ventral vessel.

[II] Lateral or Transverse Blood Vessels

All the longitudinal blood vessels are interconnected with one another, directly or indirectly, through numerous segmentally arranged transverse or lateral blood vessels, Lateral blood vessels of anterior region (first 13 segments) and those of posterior or intestinal region (behind 13th segment) of body are described separately as below

[A] Lateral blood vessels of anterior region (first 13 segments)

1. Hearts. In each of the segments 7, 9, 12 and 13 is found a pair of large, thick, muscular, and rhythmically contractile vertical vessels, called hearts. They pump blood from dorsal to ventral vessel, while flow in opposite direction is prevented by internal valves. Hearts of 7th and 9th segments connect dorsal and ventral vessels only and are called lateral hearts. Those of 12th and 13th segments connect both dorsal and supra-oesophageal vessels with ventral vessel, and are designated as latero-oesophageal hearts.

2. Anterior loops. There is a pair of thin-walled, non-pulsatile, non-muscular and loop- like broad vessels, without valves, in each of the 10th and 11th segments. These vessels, known as anterior loops, convey blood from lateral-oesophageal into supra-oesophageal vessel.

3. Ring vessels. These are characters vessels. Ve circular vessels of stomach situated within a muscular coat, about 12 vessels per segment. Through these vessels, blood of lateral-oesophageals reaches the supraoesophageal

4. Ventro-tegumentary vessel gives off a pair of ventro-tegumentary vessels in each segment to body wall, septa, nephridia and reproductive organs of the same segment.

[B] Lateral vessels of intestinal region
(Behind 13th segment)

1. Ventro-tegumentary vessels. Behind 136 segment, ventral vessel gives off a ventro-tegumentary on either side in the posterior region of segment. It sends a delicate septo-nephridal branch to septal nephridia, which runs upwards along the anterior face of septum. Then it pe the septum to enter the segment behind to supply its body wall and integumentary nephridia

2. Commissural vessels. Behind 13 segments, there is a pair of these vessels, a segment. They run upwards along the posterior face of septum, one on either side, convey blood from sub-neural to dorsal vessel Ex commissural gives off a small septo-intestinal branch to the intestinal plexus and receives several branches from septal nephridia and body wall.

3. Dorso-intestinals. In the region of two pairs these vessels each convey blood.

4. Ventro-intestinals. Similarly single ventro-intestinal vessel each segment intestinal region intestinal wall

[III] Intestinal Plexuses

Wall of intestine contains many blood capillaries arranged in two networks, plexuses or plexes. One, the external plexus, lies on the surface of the gut. It receives blood from ventral vessels through ventro-intestinals and septo-intestinals, and passes it on to the internal plexus. The latter is situated between circular muscles and enteric epithelium. Internal plexus passes on blood, along with absorbed nutrients, to the dorsal vessel through dorso-intestinals.

CIRCULATION OF BLOOD

Blood flows from behind to forward in dorsal vessel and from front to backwards in ventral, latero-oesophageal, supra-oesophageal and sub- neural vessels.

Ventral vessel is the main distributing vessel, supplying blood to all parts of body. In the first 13 segments, it supplies blood to body wall, septa, nephridia and reproductive organs through ventro- tegumentaries. Behind the 13th segment, it supplies blood to body wall and nephridia through ventro-tegumentaries and to gut wall through ventro-intestinals.

Sub-neural, lateral oesophageal and supra-oesophageals are the main collecting vessels. Lateral oesophageals collect blood in first 13 segments from alimentary canal, body wall, nephridia, septa and reproductive organs and discharge into supra-oesophageal through anterior loops and ring vessels. Supra-oesophageal also collects blood from gizzard and stomach and pours it into ventral vessel through latero-oesophageal hearts. Sub-neural collects blood in the intestinal region from ventral body wall and nerve cord and sends into dorsal vessel through commissural which also receive blood from body wall, septa and nephridia. Commissural also pours some blood into gut wall through septo-intestinals.

Dorsal vessel functions both as a collecting and a distributing vessel. In the intestinal region, it collects blood through dorso-intestinals from gut wall and through commissurals from sub-neural vessel, septa and nephridia. In first 13 segments, it distributes some blood through branches to alimentary canal and pours the remaining blood through hearts into ventral vessel.

Digested food absorbed through the intestinal wall is distributed to different parts of body by the circulatory system, whereas CO_2 and nitrogenous wastes are carried to nephridia, skin and coelomic fluid for elimination.

BLOOD GLANDS

In segments 4, 5 and 6 lying above pharyngeal mass and connected with pharyngeal or salivary glands, are found small, red-coloured, follicular bodies, the blood glands. Each gland consists of a mass of loose cells surrounded by a capsule with a syncytial wall. Blood glands serve for the manufacture of blood corpuscles and haemoglobin. They are also regarded to be excretory by some workers.

EXCRETORY OR NEPHRIDIAL SYSTEM

Earthworm: excretory system (YOUTUBE)

In Pheretima, excretion is affected by segmentally arranged, microscopic, coiled tubes called nephridia. These are typically unbranched and their inner ends open into coelom by a ciliated funnel, called

nephrostome. Such a nephridium, opening by a ciliated funnel, is termed a metanephridium But, in some cases, nephrostome is secondarily lost and nephridium becomes branched. In Pheretima, nephridia are small sized or micronephridia, as compared to large-sized meganephridia of Nereis and leech. They occur in all segments of body except the first three. According to their location in body, these are distinguished into 3 types: (i) pharyngeal (ii) integumentary, and (iii) septal

[I] Pharyngeal Nephridia

These nephridia occur as paired tufts on either side of pharynx and oesophagus in the 4th, 5th and 6th segments. Each tuft consists of hundreds of coiled branched tubules without nephrostomes. In each tuft, the terminal ducts of all tubules join to form a single thick-walled common duct. Thus, there are 3 pairs of common pharyngeal nephridial ducts, which run anteriorly parallel to the ventral nerve cord. Ducts of 4th and 5th segments open into pharynx, while those of 6th segment open into buccal chamber. Pharyngeal nephridia are thus enteronephric.

[III] Integumentary Nephridia

These nephridia lie scattered on the entire inner or parietal surface of body wall in each segment, except the first two. There are 200-250 nephridia in each segment but in the segments of clitellum (segments 14 to 16), their number increases to more than 2000 constituting the 'forests of nephridia'. Integumentary nephridia are microscopic V-like in shape and lack nephrostomes. Their terminal ducts open on body surface independently through minute openings known as nephridiopores. Integumentary nephridia are thus exonephric.

[III] Septal Nephridia

These are the largest nephridia of Pheretima.

They are attached to both the faces of each excretory intersegmental septum behind 15th segment.

1. Structure. A typical septal nephridium consists of three main parts: (a) nephrostome, (b) body, and (c) terminal duct.

(a) Nephrostome. Nephrostome is a ciliated funnel communicating with the coelom. It consists of an elliptical pore bounded by the so-called upper and lower lips. Upper lip is formed of a large central cell and 8 or 9 marginal cells, whereas lower lip is formed of 4 or 5 compact cells. All the cells are ciliated.

(b) Body of nephridium. Nephrostome leads into the main body of nephridium through a short, narrow and ciliated tube-like neck. Body consists of two parts, a short straight lobe and a long-twisted lobe with a narrow apical part. Straight lobe is one half of the twisted lobe's length. Twisted lobe consists of a proximal limb and a distal limb, which are spirally twisted upon each other. Proximal limb is joined to the neck.

(c) Terminal duct. Distal limb of body of nephridium ends in a short and narrow duct, called terminal duct.

Nephridial tubule. Nephridium consists of a syncytial glandular mass traversed by a coiled tubule, having four ciliated tracts in its course, 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 2 in the apical part of each limb of twisted loop, and a single tubule in each of the neck and terminal duct.

2. Arrangement. Each septum, behind 15th segment bears 4 rows of septal nephridia, 2 on its anterior face and 2 on posterior face. Each row may contain 20 to 25 nephridia, so that there are 80 to 100 nephridia on each septum or in each coelomic compartment Nephridia remain suspended freely in coelom of each segment. While their terminal ducts open into a pair of septal excretory canals, which run inwards along the posterior face of septum one on each side, parallel to the commissural vessel of their own side. These canals discharge their contents dorsally into a pair of supra-intestinal excretory ducts, situated side by side mid-dorsally just above the intestine, but beneath the dorsal blood vessel, and extending from 15th to the last body segment. These ducts open into intestine in each segment through narrow ductules, each having a sphinctered opening. Septal nephridia are thus also enteronephric.

[IV] Physiology of Excretion

Nephnidia are abundantly supplied with blood vessels. Their gland cells extract excess of water and nitrogenous wastes from blood. Septal nephridia also eliminate excretory material from coelomic fluid. Integumentary nephridia, being exonephric, discharge excretory material to the outer body surface through nephridiopores. Pharyngeal and septal nephridia, being endonephric, discharge them into gut lumen from where they are eliminated with faeces.

Aquatic oligochaetes excrete ammonia, and terrestrial species (earthworms) excrete However, earthworms are less ureotelic than other terrestrial animals. Excretory fluid contains 40% urea, 20% ammonia and 40% amino acids and other nitrogenous compounds, but no uric acid or urates.

RESPIRATION

Earthworm: respiration (YOUTUBE)

Respiration takes place by diffusion of gases through general body surface. Gaseous exchange, i.e., intake of O_2 and giving out of CO_2, takes place between blood capillaries of outer epidermis and surface film of

moisture contributed by secreted mucus, excreted wastes and coelomic fluid. Haemoglobin dissolved in plasma of blood acts as a respiratory pigment, transporting O2 to the body tissues.

NERVOUS SYSTEM

Earthworm: Nervous system (YOUTUBE)

Nervous system is well developed and concentrated. It consists of three parts: central, peripheral and sympathetic nervous systems.

[I] Central Nervous System

It comprises an anterior nerve ring and a posterior ventral nerve cord.

1. Nerve ring. It comprises paired cerebral ganglia, circumpharyngeal connectives and subpharyngeal ganglia.

A pair of closely united white, pear-shaped. cerebral or supra-pharyngeal ganglia, forming the so-called brain, lie dorsally in depression between buccal cavity and pharynx in the third segment. A pair of thick stout circum- or peri-pharyngeal connectives arise from them laterally, embracing the pharynx and meeting ventrally in a pair of fused subpharyngeal ganglion lying beneath the pharynx in fourth segment. In this way, a complete nerve ring is formed around the pharynx.

2. Ventral nerve cord. Ventral nerve cord arising from the sub-pharyngeal ganglia, runs backwards in mid-ventral line to the posterior end of body. In each segment, it presents a slight enlargement or a ganglion. Ventral nerve cord appears to be single but it is double, consisting of two compactly united right and left cords, as seen in a transverse section. Each segmental ganglion also represents the fusion of a pair of ganglia, one belonging to each cord of the double ventral nerve cord.

Histologically, the nerve cord consists of nerve fibres and nerve cells. Externally, the nerve cord is covered by a layer of visceral peritoneum, beneath which lies a thin layer of longitudinal

muscle fibres, surrounding a fibrous capsule of epineurium. Fibres form the core of the cord. Two such cores are visible in a section through the cord. This indicates the double nature of the cord. In the regions

of segmental ganglia, two cores of nerve fibres are completely fused along the middle line. On the sides and below cores of nerve fibres lie the nerve cells. These are two types, motor neurons and association neurons. Nerve cells occur more in the ganglia. Nerve cells and nerve fibres lie embedded in a mass of connective tissue, called neuroglia. Dorsally, four giant fibres (one median, one submedian and two lateral) run through the mass of connective tissue along the length of the entire nerve cord. These, like the corresponding fibres of Nereis, are responsible for effecting sudden violent contractions of body in response to alarms. They are filled with a homogeneous plasma-like fluid which helps in their contractions.

[II] Peripheral Nervous System

Each cerebral ganglion gives off laterally 8 to 10 nerves which innervate the prostomium and buccal chamber. Nerves from peripharyngeal connectives supply the peristomium and buccal chamber, while nerves from sub-pharyngeal ganglia supply structures in the 2nd, 3rd and 4th segments. Each segmental ganglion of ventral nerve cord gives off 3 pairs of lateral nerves, one pair in front and two pairs behind the row of setae, which innervate the gut wall, body wall and other internal organs of their segments.

Nerves are of mixed type, consisting of both afferent or sensory fibres and efferent or motor fibres.

[III] Sympathetic Nervous System

It consists of an extensive nerve plexus spread beneath epidermis, within muscles of body wall and on alimentary canal. These plexuses relate to the peri-pharyngeal connectives.

SENSE ORGANS

Earthworm: sense organs (YOUTUBE)

Earthworms have well-developed sense organs or receptor organs which are quite simple in structure, consisting of a single cell or a group of specialized ectodermal cells. Pheretima has three types of sense organs: (i) epidermal receptors, (ii) buccal receptors and (ii) photo-receptors.

1. Epidermal receptors. These distributed all over epidermis but are more abundant on the lateral sides and ventral surface of body. Each receptor has an elevated cuticle covering a group of tall, slender and columnar receptor cells, bearing small hair-like processes at their outer ends and connected with nerve fibres at their inner ends. They are surrounded on all sides by ordinary supporting epidermal cells, are separated from each other by spaces, have nuclei at different levels and possess internally a few basal cells. They are tactile (relating to touch) in function and according to some, they also respond to chemical stimuli and changes in temperature.

2. Buccal receptors. These are confined to the epithelium of buccal chamber. They are similar to epidermal receptors except that they possess broader outer ends, better developed sensory hairs, and more deeply situated nuclei. They are gustatory and olfactory (relating to taste and smell) and probably also respond to chemical stimuli.

3. Photo-receptors. Photo-sensitive organs, restricted only to dorsal surface, are more numerous on prostomium and peristomium and gradually reduce in number towards posterior end of body. They are totally absent in clitellum. Each photoreceptor consists of a single ovoid cell, with a nucleus and clear cytoplasm containing a network of neurofibrillae and a small transparent L-shaped lens or optic organelle or phaosome, made up of a hyaline substance. Lens focusses light rays from all directions on neurofibrils. Neurofibrils converge to an afferent nerve fibre which leaves the cell at its base to join the central nervous system. Photoreceptors enable worms to judge the intensity and duration of light.

REPRODUCTIVE SYSTEM

Earthworm: reproductive system (YOUTUBE)

Earthworms do not reproduce asexually. Reproductive organs are somewhat complicated. The earthworms are monoecious (hermaphroditic) but they cannot fertilize their own eggs because they are protandrous. As a rule, cross- fertilization takes place. It is preceded by copulation and cocoon formation.

[I] Male Reproductive Organs

These include testes, testis sacs, seminal vesicles, vasa deferentia, prostate glands and accessory glands.

1. Testes. There are 2 pairs of very minute, white and lobed testes, one pair in 10th and the other in 1lth segment. They lie ventro-laterally beneath the alimentary canal, close to mid-ventral line, on either side of nerve cord and attached to the anterior wall of their respective testis sacs. Each testis is made of a compact narrow base from which arise 4 to 8 small digitate processes containing rounded cells or spermatogonia, Testes are well formed only in young worms but become degenerated in adults.

2. Testis sacs. Both the testes of each segment are enclosed within a wide, thin-walled testis sac, which is a coelomic space cut off from the general body cavity. Thus, there are two testis sacs situated in segments 10 and 11, ventro- laterally one behind the other below alimentary canal. Each testis sac encloses a pair of testes and a pair of ciliated spermiducal funnels and also communicates behind, by a pair of tubular connections, with two seminal vesicles of succeeding segment. Testis sac of lith segment is large enough so as to enclose also the seminal vesicles of that segment

3. Seminal vesicles. There are two pairs of large, white seminal vesicles lying in segments 11 and 12, respectively. They are also referred to as septal pouches since they grow as outgrowths of the septa. Testis sac of 10th segment communicates with seminal vesicles of 11th segment, and testis sac of 11th segment with seminal vesicles of 12th segment. Seminal vesicles of 11th segment lie enclosed within testis sac of the same segment, while those of 12th segment lie free.

4. Spermiducal funnels. There are two pairs of ciliated spermiducal funnels (or spermrosettes), one of them lying behind each testis in the same segment and enclosed within the same testis sac.

5. Vasa deferentia. Each funnel leads behind into a slender, ciliated, thread-like sperm duct or vas deferens. Two vasa deferentia of same side run close together posteriorly along the ventral body wall up to 18th segment to join the prostatic duct.

6. Prostate glands. Prostate glands are a pair of dirty white, flat, solid, irregular and lobulate masses, lying one on either side of gut and extending from 16th or 17th segment up to 20th or 21st segment. Each gland consists of a big glandular part and a small non-glandular part. Glandular part is a racemose gland consisting of several lobes closely fixed together. Non-glandular portion consists of several small ductules which unite to form a short, thick, muscular and curved prostatic duct in 18th segment. Immediately on its emergence from the inner side of gland, it is enclosed in a common muscular sheath, along with the two vasa deferentia of its own side, forming a common spermatic and prostatic duct, within which the three tubes remain separate. Both common ducts curve inwards to open to the exterior independently by a pair of male genital pores ventrally on 18th segment. Prostate glands manufacture a fluid, the prostatic fluid, of unknown function.

7. Accessory glands. In each of the segments 17th and 19th is found a pair of rounded, white fluffy masses, the accessary glands, on ventro- lateral body wall, one on either side of nerve cordThey open to the exterior by a number of ducts on two pairs of genital papillae, situated externally upon the 17th and 19th segmentsone on either side of mid-ventral line. Their secretion helps probably in uniting the two worms during copulation.

From testes, spermatogonia or sperm-mother cells are shed into testis sacs. From here they enter seminal vesicles to undergo maturation and develop into spermatozoa. Mature sperms move back intoo testis sacs, enter spermiducal funnels, travel along vasa deferentia and finally pass out through the male genital pores during copulation.

[II] Female Reproductive Organs The female reproductive organs consist of ovaries, oviducal funnels, oviducts and spermathecae.

1. Ovaries. A pair of small white, digitate ovaries lies in 13th segment attached to the posterior face of septum 12/13 in front of it, one travel along vasa deferentia and finally pass out on either side of ventral nerve cord. Each ovary is a white compact mass made of finger-like processes in which ova are arranged in a linear series in various stages of development.

2. Oviducal. A large saucer-shaped oviducal funnel, with much folded and ciliated margins, lies immediately behind each ovary in the 13th segment.

3. Oviducts. Each oviducal funnel leads behind into a short conical ciliated tube, the oviduct. The two oviducts run backwards, perforate septum 13/14 and converge to meet in ventral body wall beneath nerve cord, forming a very short common oviduct. It opens to the exterior through the female genital aperture, situated mid-ventrally on 14th segment.

4. Spermatheca. There are 4 pairs of small flask-shaped structures, called spermathecae of receptacula seminales. These are present ventro- laterally, one pair in each of the segments 6, 7, 8 and 9. Each spermatheca has a broad, pear-shaped body, the ampulla, and a short narrow neck, which give off a narrow elongated blind caecum or diverticulum before opening to the

exterior. Thus 4 pairs of spermathecae open to outside by 4 pairs of separate spermathecal pores situated ventro-laterally in the grooves between 5/6, 6/7, 7/8 and 8/9 segments, respectively. Spermathecae receive sperms from another worm during copulation, and store them in their diverticula in Pheretima and in ampullae in other earthworms.

Mature ova shed from ovaries are entangled by oviducal funnels, travel along oviducts, and pass out to the exterior through the female genital aperture, to be laid inside the cocoon.

COPULATION AND FERTILIZATION

Earthworm: Copulation and Fertilization (YOUTUBE)

Earthworms are bisexual, still self-fertilization does not occur because they are protandrous, A reciprocal cross-fertilization occurs between two worms and spermatozoa of one worm are transferred to another during a process, termed copulation. It has not been studied so far in the Indian earthworm Pheretima posthuma, as it probably takes place underground, but has been studied in *Pheretima communissimma*. It generally takes place at night, during rainy season, and lasts for about one hour. There is no penis or vagina for the transfer of sperms. During copulation, two worms apply to each other by their ventral surfaces with head ends pointing in opposite directions, so that the male genital pores of each lie against a pair of spermathecal pores of other Areas surrounding the male genital apertures are raised into papillae, which are inserted successively from behind to forward into the spermathecal pores of the other worm and discharge the
spermatic and prostatic fluid containing spermatozoa, which are stored in spermathecae.
After this mutual interchange of sperms, the two worms separate and later lay their eggs in cocoons. Fertilization is thus external, taking place in the cocoons.

COCOON FORMATION

Earthworm: cocoon formation (YOUTUBE)

Formation of cocoon in Pheretima has not been studied yet. In other worms, such as Eisenia and Rhynchelmis, etc., it is secreted as a viscid and gelatinous substance by clitellar glands, forming a broad membranous band or girdle around clitellum. It hardens gradually on exposure to air into a tough but elastic tube which becomes the cocoon or egg capsule. A slime tube is also secreted by epidermal mucous cells of clitellum over cocoon. As the worm wriggles behind, the slime tube and cocoon are slipped forward over the head. On its way the cocoon receives ova from female genital aperture and sperms of other worm, from spermathecae, that SO cross- fertilization is ensured and zygotes are formed. An albuminous fluid is also deposited inside cocoon by the glands of anterior segments of body. Finally, when cocoon is thrown off the head, its elastic ends close up and a yellowish rounded cocoon is formed.

Fertilization occurs after the cocoon has been deposited in a moist place. Cocoon of Pheretima is a small, spherical body light yellow in colour. Cocoon formation takes place in Pheretima in summer, specially during and after the monsoon. Many cocoons may be formed in succession after each mating, so that all sperms stored in the spermathecae are not passed out at once.

DEVELOPMENT

A cocoon may contain many fertilized eggs but only one embryo develops, growing at the expense of other eggs serving as nurse cells and albumen stored in cocoon. Cleavage is holoblastic and unequal, and development is direct without any free larval stage. A hollow blastula is formed and later a gastrula by invagination. Mesoderm develops from two large cells of blastula, called mesoblasts. They divide to form two mesoblastic bands which later give rise to the coelomic epithelial lining. Young worm, when fully grown, crawls out of cocoon in about two or three weeks. Newly hatched young worm receives no parental care and resembles the adult except for size and absence of clitellum.

ADAPTATIONS OF EARTHWORMS

Earthworms are well-adapted for a subterranean or burrowing mode of life.
(1) Elongated, slender, cylindrical, and streamlined body is well-suited for burrowing in soil.

(2) Setae and musculature serve for locomotion as well as for anchoring body firmly in burrow.

(3) Secretes mucus for plastering the internal walls of burrow.

(4) Coelomic fluid oozing through dorsal pores keeps skin moist for gaseous exchange in the absence of respiratory organs.

(5) Amoebocytes of coelomic fluid kill harmful bacteria and other parasites and protect body.

(6) Nocturnal and burrowing habits provide safety from predators.

(7) Special sensory organs, such as eyes and ears, are absent due to burrowing life.

(8) Hermaphroditism and regeneration ensure continuity of species against many hazards in life.

(9) Copulation followed by formation of cocoons for fertilization and development adaptations for reproduction on dry land.

Important Questions

➤➤Long answer type questions

1. Describe the digestive system of earthworm
2. With the help of proper diagrams describe in brief the blood-vascular system of *Pheretima.*
3. Give an account of the reproductive organs of *Pheretima.*
4. Describe the nephridial system of *Pheretima.*
5. Describe the septal nephridium of *Pheretima*. How do the pharyngeal and integumentary nephridia differ from it?
6. Draw full-page labelled diagrams of the following (i) T.S. *Pheretima* through spermathecae. (ii) T.S. *Pheretima* through seminal vesicles, (iii) VLS *Pheretima* through first 20 segments.
7. Write an essay on the Economic Importance of earthworms.
8. Write short notes on (1) Adaptations of earthworm, (1) Behaviour of earthworm, () Coelom in earthworm, (iv) Cocoon-formation in earthworm, (v) Locomotion in earthworm, (vi) Sense organs of *Pheretima.*

➤➤Short answer type questions

1. Name the animal where the chloragogen cells are present.
2. Where is haemoglobin found in the earth worm blood? How does it compare with the blood of vertebrates?
3. What are lateral warts? Mention their number, location, function Write within four sentences
4. How are setae embedded in the body wall of earth worm. Write in three sentences only
5. 5 With suitable illustration, show all the external apertures seen on the body of earthworm.
6. Give characteristic morphological differences between *Pheretima* and Nereis
7. 7.Give an account of the blood vascular system in the anterior thirteen segments of *Pheretima.*
8. Compare the excretory organs of *Pheretima* with that of Nereis.

9. Sketch the circulatory system in earthworm and name all the parts.

➤➤True and false statements

1. 1.Excretion in earthworm is performed by means of Nephridia.

   True/False/ Do not know

2. Ovary in Pheretima is present in the fourteenth segment.

   True/False/ Do not know

3. Body cavity of earthworm is a haemocoel.

   True/False/ Do not know

4. Syncitium is present in earthworm.

   True/False/ Do not know

5. Typhlosole in earthworm supports the intestine.

   True/False/ Do not know

6. In earthworm blood flows backwards in the dorsal blood vessel.

   True/False/ Do not know

7. In earthworm haemoglobin is dissolved in plasma.

   True/False/ Do not know

➤➤Multiple choice questions

1. In Earthworm, the spermathecae are used for

(a) development of ovum

(b) development of sperm

(c) storing spermatozoa

(d) development of zygote

(e) storing ova

2. In Annelida formation of larva is usually absent. But when present the larva is called

(a) tadpole

(b) Planula

(c) trochophore

(d) Ephyra

3. Metamerism is characteristic of

(a) Platyhelminthes

(b) Nematoda

(c) Annelida

(d) Arthropoda

4.The body cavity found in Annelida is:

(a) enterocoel

(b) schizocoel

(c) pseudocoel

(d) none of these

5.Oxygen is circulated to various tissues of earthworms by

(a) blood corpuscles
(b) plasma

(c) blood corpuscles and plasma

(d) none of the above

6. In Pheretima, spermathecae are found in segments

(a) 4th to 7th

(b) 6th to 9th

(c) 9th to 12th

(d) 17th to 20th

7. Two pairs of hearts in earthworm occur in segments:

(a) 6, 7 and 9, 10

(b) 7, 9 and 12, 13

(c) 9, 10 and 14, 15

(d) none of these

8. In earthworm, blood from seminal vesicle is collected by

(a) ventral vessel

(b) lateral oesophageal vessel

(c) dorsal vessel

(d) supra-oesophageal vessel

9. Earthworm is

(a) ammonotelic

(b) urcotelic

(e) uricotelic

(d) aminotelic

10 Earthworm appears brown due to the presence of:

(a) chloragogen cells

(b) chloragosomes

(c) porphyrin

(d) all of these

11. The urine of earthworm contains

(a) urea

(b) ammonia

(c) creatinine

(d) all of these

12. Exonephric nephridia of earthworm is

(a) septal

(b) pharyngeal

(c) integumentary

(d) all of these

13. The earthworm body is devoid of

(a) cuticle

(b) epidermis

(c) seta

(d) appendages

14. The body cavity of earthworm is

(a) true coelom.

(b) pseudocoelom

(c) acoelom

(d) haemocoel

15. In earthworm the clitellar region helps the process of:

(a) copulation

(b) cocoon formation

(c) digestion

(d) locomotion

16. In earthworm the testes are enclosed in the segments:

(a) 9 & 10

(b) 8 & 9

(c) 12 & 10

(d) 11 & 10

(e) 6 & 9

17. In earthworm the ovary is situated in the

(a) 10th segment (b) 13th segment (c) 11th segment (d) 14th segment

18. Flow of blood in the dorsal blood vessel of *Pheretima* is

(a) from Infront backwards (b) from behind forwards (c) in both direction (d) none of these

19. Lateral and latero-oesophageal hearts in *Pheretima* are situated in the segments

(a) 7, 9, 10, 12

(b) 7, 9, 13, 12

(c) 7, 8, 1312

(d) 7, 9, 11, 12

20. The earthworm moves with the help of

(a) setae alone

(b) setae and muscles

(c) muscles alone

(d) parapodia

21. In earthworm, the typhlosole is a part of the:

(a) reproductive tract (b) intestine (c) circulatory system (d) nephridium

22. Locomotion in earthworm is directly facilitated by:

(a) mucus secreted by the epidermis

(b) segmentation of the body

(c) rhythmic contraction of individual segments

(d) setae

23. The body cavity of earthworm represents a true:

(a) coelenteron (c) coelom

(b) haemocoel (d) blastocoel

24. The nephridia found most in number are:

(a) septal (b) pharyngeal (c) integumentary (d) oesophageal

25. The male genital pore of earthworm is found in:

(a) 14th segment
(b) 18th segment
(c) 16th segment
(d) 17th & 19th segment

26. Which of the following is called natural ploughman:

(a) tapeworm

(b) liver fluke

(c) earthworm

(d) leech

27. Septal nephridia are:

(a) respiratory in function (b) excretory in function (c) circulatory in function (d) nervous in function

28. The blood of earthworm is red because:

(a) haemoglobin is present in blood cells

(b) haemoglobin is dissolved in plasma

(c) both

(d) none

29. Chloragogen cells of earthworm are comparable to vertebrate:

(a) liver

(b) spleen

(d) none

(c) kidney

30. Nephrostome in earthworm is found in:

(a) septal nephridia (b) integumentary nephridia (c) pharyngeal nephridia (d) in all nephridia

30. Nephrostome in earthworm is found in:

(a) septal nephridia (b) integumentary nephridia (c) pharyngeal nephridia (d) in all nephridia

31 Earthworm moves with the help of:

(a) sphincter muscles

(b) muscular contraction

(c) setae only

(d) setae and muscles, supported by hydrostatic pressure of coelomic fluid

32. Excretory product of earthworm is:

(a) ammonia

(b) uric acid

(c) urea

(d) ammonia and urea

33. The lateral hearts of earthworm are present in:

(a) 5th and 8th segment (d) 13th and 14th segment

(b) 7th and 9th segment (c) 10th and 12th segment

34. In earthworm, urea is mainly formed in:

(a) coelomic fluid (b) chloragogen cells

(c) chromophil cells (d) nephridia

35. Chief excretory waste of earthworm is:

(a) water

(b) ammonia

(d) creatinine

(c) urea

36. Earthworm has no special structures for:

(a) locomotion

(b) nutrition

(c) respiration

(d) circulation

37. Segments of earthworm having spermathecae are:

(a) five to eight (b) six to nine

(c) seven to ten (d) four to nine

38. Cocoon of earthworm is secreted:

(a) around clitellum

(b) before fertilization and development

(c) both

(d) after oviposition

39. A larval stage does not occur in:

(a) sponge

(b) Hydra and earthworm

(c) Hydra

(d) cockroach

40. In earthworms the body surface is kept moist with the help of coelomic fluid which oozes out from:

(a) nephridiopores (c) dorsal pores

(b) genital pores (d) ventral pores

41. Testes sacs in earthworm are in which segments:

(a) 13 & 14

(b) 9 & 10

(c) 11 & 12

(4) 10 & 11

42. Intestinal caeca secretes:

(a) proteolytic enzyme

(b) amylase

(c) lipase

(d) all the above

43. Metamorphosis does not occur in:

(a) frog

(b) butterfly

(c) house fly

(d) earthworm

44. In earthworm spermathecae are used for:

(a) development of ovum

(b) storing spermatozoa

(c) development and nourishment of sperms

(d) none of these

45. Skeleton-like function during locomotion of *Pheretima* is performed by:

(a) setae

(b) alimentary canal full of sand

(c) coelomic fluid In *Pheretima*

(d) none of these

45. Skeleton-like function during locomotion of *Pheretima* is performed by:

(a) setae

(b) alimentary canal full of sand

(c) coelomic fluid

(d) none of these

46. In Pheretima, nephrostome is absent in:

(a) septal nephridia

(b) pharyngeal nephridia

(c) integumentary nephridia and pharyngeal nephridia

(d) all these

47. Clitellum in *Pheretima* includes segments:

(a) 12, 13, 14

(b) 13, 14, 15
(d) 15, 16, 17

(c) 14, 15, 16

48. Segment of earthworm in which mouth is found:

(a) peristomium (b) prostomium (c) II segment (d) none of these

49. While burrowing, earthworms do not tear apart the soil, and ingest

(a) grass only

(b) insects only

(c) soil

(d) dead organic particles only

50. Castings of *Pheretima posthuma* are in the form of:

(a) miniature heaps of small pellets or balls of soil

(b) a long-coiled string of soil

(c) a fine powder of soil

(d) none of these

51. Due to burrowing of earthworms the subsoil

(a) is rendered more fertile

(b) brought to the surfare of top soil

(c) is constantly passed through the gut

(d) all of these

52. Natural Ploughman' is said for:

(a) snakes

(b) earthworms and snakes

(c) rabbits

(d) earthworm

53. Male genital aperture of earthworm in :

(a) dorsal surface

(b) ventral surface and single

(c) ventral surface and paired

(d) 14th segment

54. Setae are found all over body in earthworm except:

(a) peristomium (b) clitellum

(c) anal segment (d) all of these

55. Locomotion in earthworm is helped by:

(a) setae

(c) muscles

(b) mucous

(d) all of these

56. In earthworm unicellular salivary glands are found in:

(a) oesophagus

(c) stomach

(b) pharynx

(d) none of these

57. Alimentary canal of *Pheretima* is internally lined by cuticle in:

(a) buccal chamber

(b) gizzard

(c) both

(d) none

58. Typhlosole of *Pheretima* is in:

(a) middle and posterior intestine

(b) middle intestine and for absorption

(c) anterior intestine and for absorption

(d) intestine

59. Chloragogen cells of earthworm are in:

(a) parietal peritoneum and perform excretion

(b) visceral peritoneum and perform digestion

(c) visceral peritoneum and perform excretion

(d) none of these

60. Nephridia of earthworm are:

(a) absent in first three segments

(b) for excretion

(c) for osmoregulation

(d) all of these

61. Which is not enteronephric nephridia of earthworm:

(a) integumentary

(b) pharyngeal

(c) septal

(d) both 1 and 2

62. Pharyngeal nephridia of earthworm are located in segments:

(a) 6, 7, 8

(c) 3, 4, 5

(b) 7, 8, 9

(d) 4, 5, 6

63. Earthworm respires through its:

(a) moist skin

(b) typhlosole

(c) gills

(d) clitellum

64. Blood is red but there are no RBCs in:

(a) leeches

(b) earthworm

(c) earthworm and leeches

(d) rabbit

65. In earthworm, exonephric excretion takes place by:

(a) septal nephridia (b) pharyngeal nephridia (c) integumentary nephridia (d) all of these

66. Segments of earthworm bearing accessory glands

(a) 19, 20

(c) 17, 19

(b) 17, 20

(d) 17, 18

67. Leech is:

(a) unisexual (c) hermaphrodite

(b) dioecious (d) vector

68. Blood from seminal vesicles of earthworm are collected by:

(a) dorsal vessel

(b) subneural vessel

(c) lateral oesophageal vessel

(d) ventral vessel

69. Enteronephric nephridia of earthworm open into:

(a) coelom (b) body surface

(c) intestine (d) stomach

70. Typhlosole of earthworm starts from segment:

(a) 14

(b) 27

(c) 20

(d) 40

71. Organ of earthworm analogous to kidney of rabbit is:

(a) testis

(b) nephridium

(c) lateral heart

(d) salivary gland

72. Earthworm belongs to group:

(a) Oligochaeta (b) Polychaeta (c) Hirudinea (d) Arthropoda

73. Earthworm has:

(a) many eyes

(c) single eye

(b) no eyes

(d) two eyes

74. Neurons in earthworm are:

(a) sensory (b) adjustor

(c) sensory, motor & adjustor (d) adjustor

75. The septal nephridia of *Pheretima* expell their wastes into:

(a) coelom

(b) blood

(c) pharynx

(d) intestine

76. The female genital aperture in *Pheretima* are found in segment:

(a) 18 (c) 13

(b) 14

(d) 16

77. Fertilization in Pheretima occurs in:

(a) soil

(b) cocoon

(c) seminal vesicle

(d) oviduct

78. The clitellum in a mature Pheretima is a thick girdle which is :

(a) glandular in nature and surrounds segments 16-18

(b) non-glandular in nature and surrounds segments 16-18

(c) glandular in nature and surrounds segments 14-16

(d) non-glandular in nature and surrounds segments 14-16

79. The intestinal caeca in Pheretima arise from the intestine in segment:

(a) 24 and extend forward (d) 26 and extend forward

(b) 26 and extend backward (c) 24 and extend backward

80. The flow of blood in the lateral hearts present in segments 7 and 9 of Pheretima is from the:

(a) dorsal to the ventral blood vessel

(b) ventral to the dorsal blood vessel

(c) dorsal to the lateral oesophageal blood vessel

(d) lateral oesophageal to the dorsal blood vessel

81. Which of the following statements is NOT correct with respect to the pharyngeal nephridia of Pheretima?

(a) they are present in 3 paired groups

(b) one paired group of these nephridia lies in each of
the segments 4-6

(c) they are exonephric

(d) they are without nephrostomes

82. There are 4 pairs of spermathecae in *Pheretima*, One pair of these is present in each of the segments:

(a) 4, 5, 6 and 7 (b) 5, 6, 7 and 8

(c) 6, 7, 8 and 9 (d) 7, 8, 9 and 10

83. Lateral oesophageal hearts in earthworm connect:

(a) dorsal and ventral vessels

(b) dorsal and supra-oesophageal vessel with ventral vessel

(c) dorsal and subneural vessel

(d) lateral oesophageal and supra oesophageal vessels

84. Red colour of blood of earthworm is due to:

(a) haemoglobin (b) chlorocruorin

(c) erythrocruorin (d) haemocyanin

85. Typhlosole of Pheretima serves:

(a) to increase the absorptive area of intestinal epithelium

(b) to slow down the rate of passage of food

(c) to secrete digestive juice

(d) no purpose

86. The clitellum of earthworm is concerned with:

(a) copulation

(b) formation of cocoon

(c) storage of sperms

(d) release of sperms from male genital pore

87. Functioning of which one of the following is the nearest comparable with the chloragogen cells of *Pheretima*?

(a) kidney

(b) liver

(c) spleen

(d) sweat glands

88. A ventral nerve cord is found in:

(a) rabbit

(b) snake

(c) earthworm

(d) Amoeba

89. Photoreceptors in *Pheretima* are found in:

(a) dorsal surface (b) ventral surface

(c) lateral sides (d) all over body

90. The generic name *'Pheretima'* was first used by:

(a) Kingberg (c) Lamark

(b) Kimball (d) K.N. Bahl

91. A detailed study about Pheretima made by :

(a) Kingberg

(b) Kimball

(c) K.N. Bahl

(d) Lamark

92. The pigment in skin of Pheretima is:

(a) melanin

(b) porphyrin

(c) carofin

(d) cutinin

93. Male genital papillae are present on segment:

(a) 17

(b) 19

(c) 17 and 19

(d) 18

94. Forests of nephridia' present in the region of:

(a) precliteller

(b) cliteller

(c) post cliteller

95. Coelomic fluid contains:

(a) granulocytes (b) mercocytes (c) leucocyte (d) all

Answers

➤➤True and false statements

1. true 2. false 3. false 4. false 5. true 6. false 7. true.

➤➤Multiple choice questions

1. (c)
2. (c)
3. (c)
4. (b)
5. (c)
6. (c)
7. (b)
8. (b)
9. (b)
10. (c)
11. (a)
12. (a)
13. (d)
14. (a)
15. (b)
16. (d)
17. (b)
18. (b)
19. (b)
20. (b)
21. (b)
22. (d)
23. (c)
24. (c)
25. (b)
26. (c)
27. (b)
28. (b)
29. (a)
30. (a)
31. (d)
32. (a)
33. (d)
34. (b)

35. (c)
36. (c)
37. (b)
38. (b)
39. (d)
40. (c)
41. (d)
42. (b)
43. (d)
44. (b)
45. (a)
46. (c)
47. (c)
48. (a)
49. (c)
50. (a)
51. (d)
52. (d)
53. (d)
54. (d)
55. (a)
56. (a)
57. (b)
58. (b)
59. (d)
60. (b)
61. (a)
62. (d)
63. (a)
64. (c)
65. (c)
66. (c)
67. (c)
68. (c)
69. (a)
70. (b)
71. (b)
72. (a)
73. (b)
74. (c)
75. (d)
76. (b)
77. (b)
78. (c)

79. (d)
80. (a)
81. (c)
82. (c)
83. (b)
84. (a)
85. (c)
86. (b)
87. (a)
88. (c)
89. (c)
90. (a)
91. (c)
92. (b)
93. (c)
94. (b)
95. (d)