Classification of Phylum Annelida

Latin word: Annulus means ring

They are the animals with at least one pair of chitinous setae and vermiform (segmented) worms.

General Characteristics

- **Symmetry and Size:**

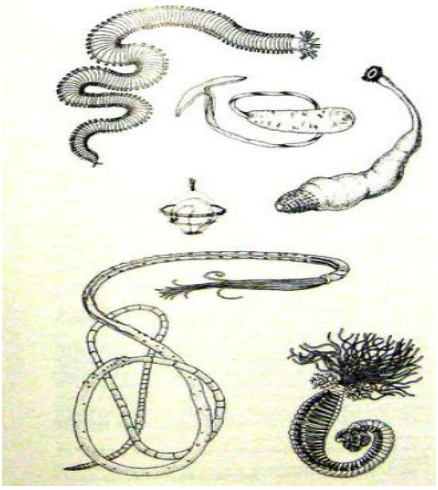
I. Bilaterally symmetrical.

II. Size ranges from few tenth of a mm to about metres.

III. Largest annelid Giant Earthworm named *Microchaetus rappi/ Microchaetus microchaetus* (Length 1.36m).

IV. Smallest annelid: *Chaetogaster annandalai* (Length 0.5mm)

Neotenotrocha sp (only a few micron in length).



- **Metamerism:**

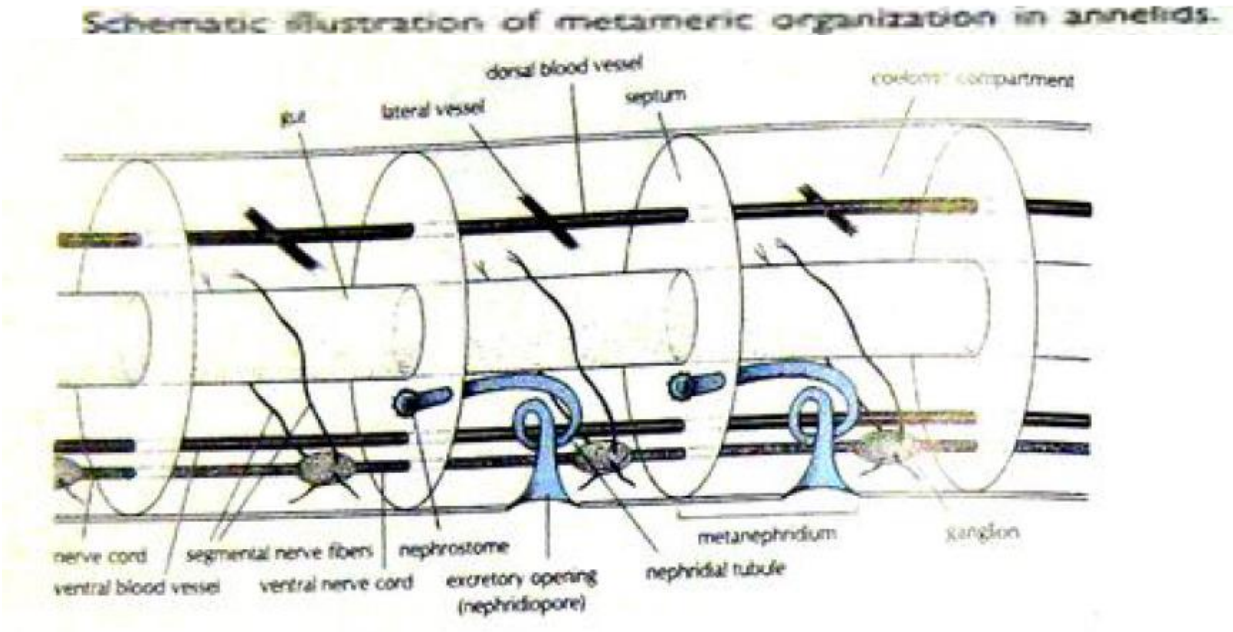
I. The body is divisible into similar segments (metameres) which are arranged in linear series and the segmented part of the body is limited to the trunk only.

II. The head or the acron is represented by **prostomium** and contains the brain and the terminal part of the body is known as **pygidium** which bears the anus.

III. The formation of a new segment in a segmented animal takes place just in front of the pygidium. The oldest body segments are therefore anterior and the youngest are at the posterior most position.

IV. Metameres are coelomic compartments created by partitioning of the coelom with transverse septa and each septum is composed of two layers of peritoneum, one derived from the segment in front and one from the segment behind and in between is a layer of connective tissue.

V. Metameres are also provided with lateral nerves, blood vessels and excretory organs.



- **Coelom:**

I. Fluid filled cavity present between the gut and the outer body wall is the coelom.

II. Coelomic fluid functions as hydraulic skeleton against which the muscles act to change the body shape.

III. Contraction of the longitudinal muscles causes the coelomic fluid to exert pressure at the lateral sides thus the body widens.

IV. Contraction of the circular muscles causes the coelomic fluid to exert pressure in an anterio-posterior direction and the body elongates.

V. This generates a powerful force enabling the animal to thrust the anterior part of the body through substratum to move forward rapidly

- **Body wall:**

I. Body covering consisting of a fibrous collagenous cuticle that is never shed or moulted.

II. Beneath the cuticle is a glandular epidermis in which the nerve fibres are present and a connective tissue of varying thickness.

III. Cuticular fibres are arranged in a cross helical pattern which strengthens the body wall and often gives a sheen to the body.

IV. Dermal layer consists of both circular and longitudinal muscles which lie beneath the circular ones. The circular muscles form a continuous sheath. Except in some polychaetes.

V. Body wall serves for a surface of gaseous exchange.

- **Digestive system:**

I. More or less straight digestive tract starting from anterior mouth to the posterior anus.

II. The gut remains suspended within the coelom by longitudinal mesenteries and by the septa, through which the gut penetrates.

III. Extracellular digestion.

- **Blood Circulatory System:**

I. Well developed blood vascular system (exception leeches where coelomic canals are found).

II. Blood circulated through small vessels, but large sinuses may be present.

- **Excretory system:**

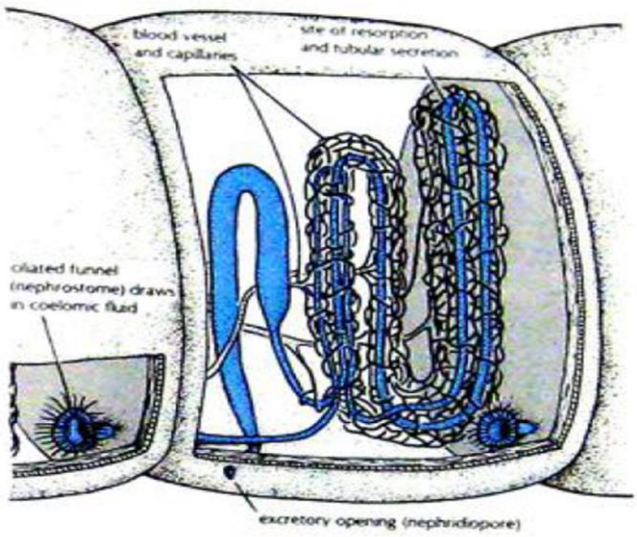
I. Main excretory organs are nephridia, although a small part excretion can take place through general body surface.

II. Most annelid segments contain a pair of nephridia which open from its both ends. This type of nephridia are called metanephridia.

III. Coelomic fluid is drawn into the nephridium at nephrostome by the action of the cilia.

IV. As the fluid passes through the convoluted tubule, some substances like salt, aminoacids and water are reabsorbed and other metabolic wastes are secreted into the lumen of the tubule.

V. The urine formed finally emerges out through the nephridiopore.



Diagrammatic representation of a typical metanephridium

- **Nervous System:**

I. It consists of an anterior dorsal ganglionic mass or brain, a pair of circumoesophageal connectives surrounding the gut and a long double or single ventral nerve cord with ganglionic swelling and lateral nerves.

II. Brains vary in size and structure, mobile forms have complex brains and the sessile or burrowing forms have simpler one.

III. Ventral nerve cord runs along the body length, varies in thickness and dilates into a ganglion of each segment from which segmental nerves pass out to the body walls, muscles and guts.

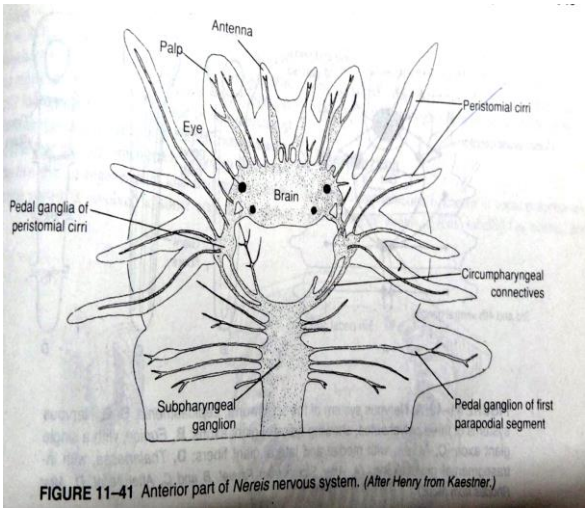


FIGURE 11–41 Anterior part of *Nereis* nervous system. *(After Henry from Kaestner.)*

- **Sense organs:**

I. 6 major kinds of sensory structures found. They are palps, antennae, eyes, statocysts, nuchal organs and lateral organs.

II. Palps and antennae are located on the head.

III. Nuchal organs are ciliated, paired chemosensory structure innervated from the posterior part of the brain.

IV. Annelids also have a variety of epidermal sensory cells that may be responsive to light or touch. These are the lateral organs.

- **Locomotory Organs:**

I. Mainly parapodia, setae. Setae provided with hooks are called uncini.

II. Besides, neuropodia and notopodia are also found in some variety.

III. Locomotion may be of swimming and crawling type.

Classificatory scheme (Pechenik, ….)

Phylum Annelida
- Class Polychaeta
  - Family Siboglinidae
    - Subfamily Frenulata
    - Subfamily Vestimentifera (or Obturata)—the vestimentiferans
  - The Echiurans
  - The Sipunculans
  - Class Clitellata
    - Subclass Oligochaeta
    - Subclass Hirudinea—the leeches

Class Polychaeta

- **Polychaeta**= Poly.chaeta
- Poly means many; and chaeta means seta
- **Defining Characteristics** : paired lateral outfoldings of the body wall (parapodia).
- Approximately 70% of all annelid species are placed in the class Polychaeta. Nearly all polychaetes are marine.
- **Size:** Majority are less than 10cm long with a diameter ranging from 2-10mm, but some interstitial forms are less than 1mm. Body length may be upto 70cm or more is a common phenomenon and *Eunice* and *Nereis* may attain a length of 1m.
- **Outlook/Morphology:** Polychaetes generally possess at least one pair of eyes and at least one pair of sensory appendages (tentacles) on the anteriormost part of the body (the prostomium) generally, the body wall is extended laterally into a series of thin, flattened outgrowths called parapodia.
- **Habit and habitat:** Polychaetes may be errant (free moving) or sedentary (sessile). Among the errant species some are pelagic species, some may crawl beneath rocks and shells, some may be active burrowers and others may be tubicolous. The obligate tubicolous species cannot leave the tubes and can only project their heads from the opening of the tubes.
- **Metamerism:**

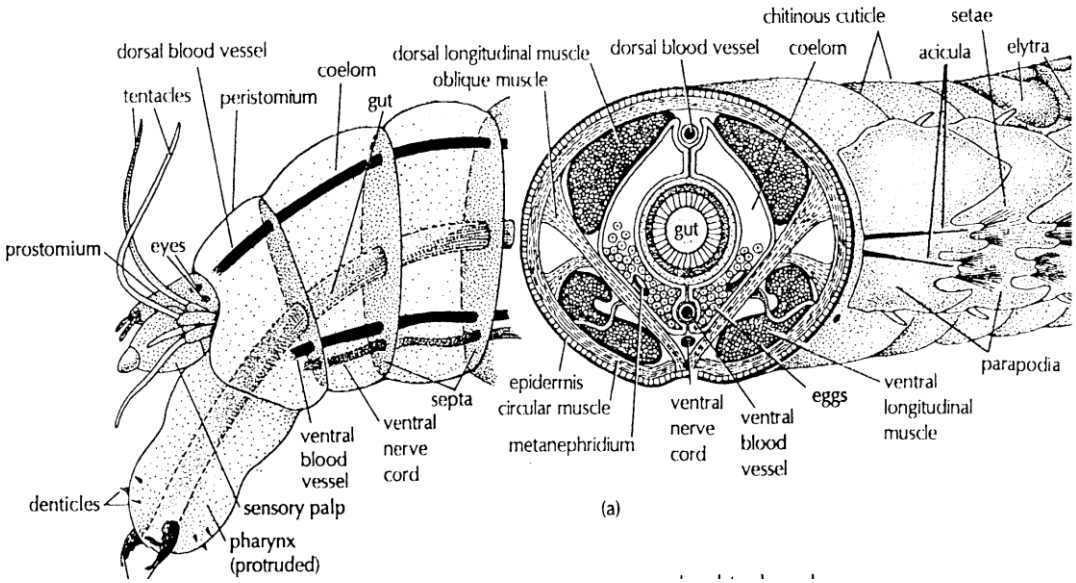
I. Perfectly segmented with identical cylindrical body segments, each bearing a pair of lateral fleshy paddle like appendages called parapodia.

II. Prostomium bears sense organs including a pair of eyes, antennae, and ventrolateral palps.

III. Mouth situated ventrally between prostomium and peristomium which forms the lateral and ventral margins of the mouth.

IV. Pygidium carries the anus.

Figure: Hypothetical polychaete worm, composite of several species, showing typical major features.



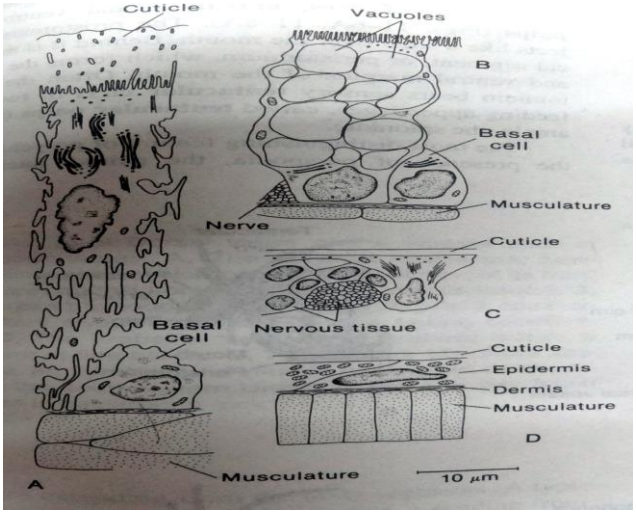
- **Bodywall:**

I. Outer cuticular body covering external to the epidermal layer which is consists of cuboidal or columnar epithelium. It also contains mucous secreting gland cells.

II. Beneath the epithelial layer lies a layer of circular muscles below which lies a much thicker layer of longitudinal muscle fibres and thin layer of peritoneum.

III. The longitudinal muscle fibres are divided into 4 bundles- two dorsolateral and two ventrolateral in position.

IV. Oblique muscles are often found as well, serving to maintain body turgor and to operate the parapodia.



- **Digestive System:**

I. The alimentary canal of polychaetes when present is a straight tube extending from the mouth at the anterior end of the worm to the anus at pygidium and is differentiated into a pharynx (or buccal cavity if the pharynx is absent), short oesophagus, stomach (in sedentary species), intestine and rectum.

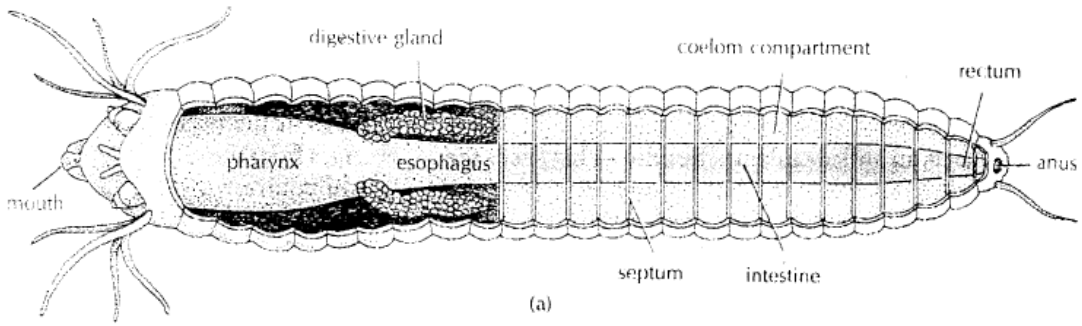
Siboglinid species are devoid of an alimentary canal.

I. In some species, evaginations of the gut form blind ending digestive glands or digestive caeca increasing the amount of surface area available for digestion and absorption.

II. The stomach or anterior intestine elaborates enzymes for extracellular digestion and the intestine is the site of absorption.

- **Feeding habit:**

Feeding habits are highly diverse among polychaetes and include predation, scavenging, suspension feeding, and deposit feeding.



Digestive system of an errant polychaete *Nereis*

- **Excretory System:**

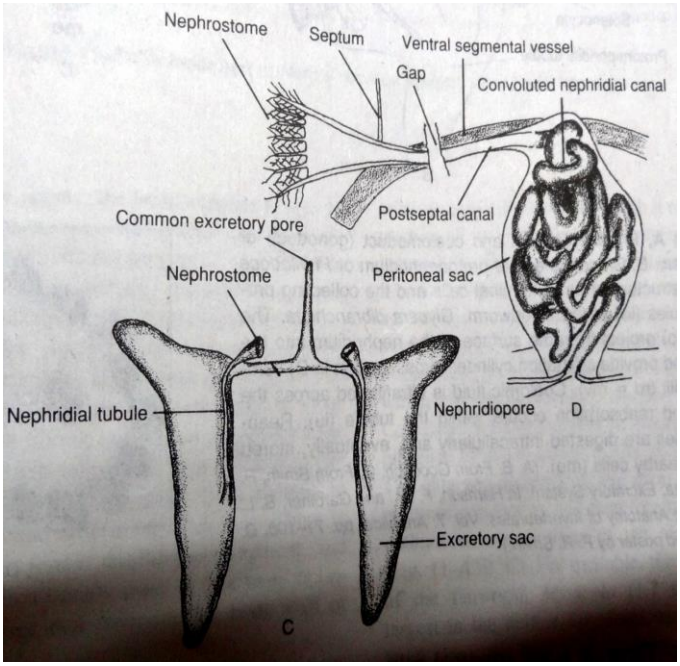
I. A number of polychaete families have protonephridia whereas all other polychaetes except for some siboglinid species -have metanephridia. Intriguingly, polychaetes of most species have protonephridia in their larval stages, even when the adults have metanephridia.

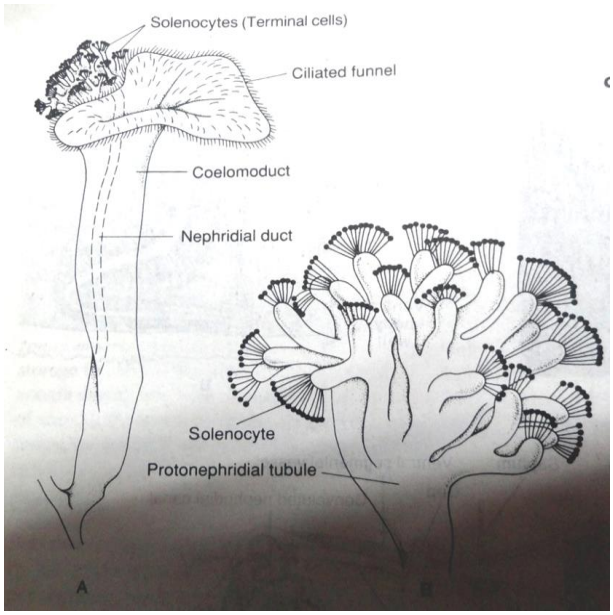
II. The nephridia (either protonephridia/metanephridia), in general are distributed as one pair per segment but reduction to a few or one pair in the whole worm has been reported in some families.

III. In polychaetes with protonephridia, coelomic fluid is ultrafiltered as it is drawn across the terminal meshwork into the nephridial tubule by ciliary beating.

IV. In polychaetes with metanephridium, both the preseptal portion of the nephridium and the post septal tubule are covered by a reflected layer of peritoneum from the septum.

V. The preseseptal end of polychaete metanephridia possess an open ciliated funnel the nephrostome and the postseptal canal becomes greatly coiled to form a mass of tubules which are enclosed in a thin a sac like covering of peritoneal cells. The nephridiopore opens at the base of the neuropodium at the ventral side. The entire lining of the nephridial tubule is ciliated.





- **Blood vascular System:**

I. Polychaetes generally have a closed circulatory system consisting of a dorsal vessel (carrying blood anteriorly), a ventral vessel (carrying blood posteriorly), and capillaries connecting the two.

II. Siboglinid polychaetes have a specialized heart, whereas in other polychaetes, circulation is maintained by contractions of the blood vessels specially of the dorsal vessel. Valves assure unidirectional flow of the blood throughout the body.

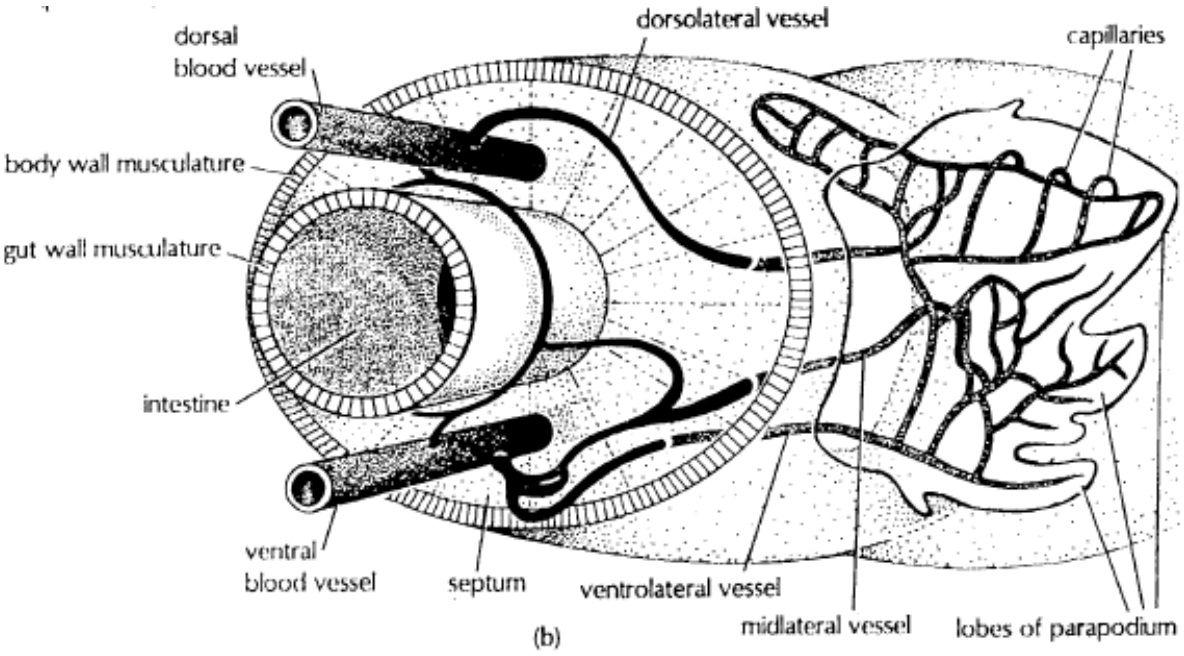
III. In each segment, the ventral vessels give rise to one pair of ventral parapodial vessels, which supply parapodia, bodywall and the nephridia and to several ventral intestinal vessels supplying the gut.

IV. Oxygen-carrying blood pigments are present in the circulatory fluid of most polychaetes.

V. Haemoglobin is present specially in Siboglinid polychaetes as well as in some other polychaetes.

VI. Chlorocruorin, another iron-containing pigment, is found in the blood of several polychaete species. This pigment is chemically quite similar to hemoglobin, but it has a greenish coloration.

VII. A third iron-containing pigment, hemerythrin, is found in at least one acknowledged polychaete species. Hemerythrin is structurally dissimilar to the other 2 pigments, and it is always contained within cells.



- **Nervous System and sense organs:**

I. Polychaetes have a mass of ganglia (aggregation of nerve tissue) forming a brain.

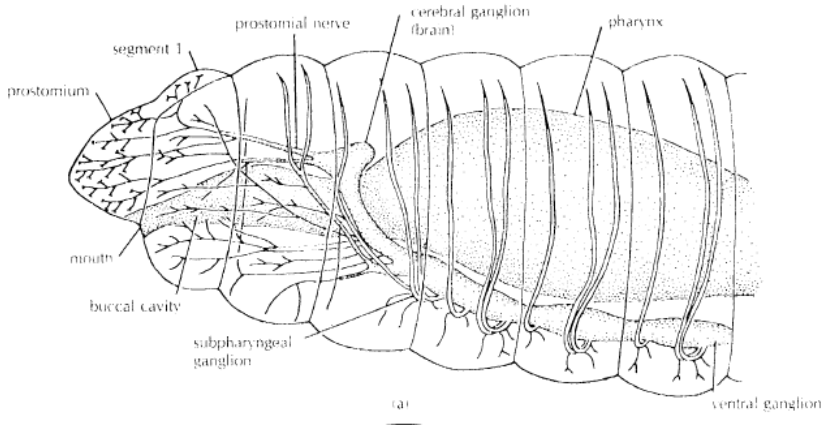
II. A solid ventral nerve cord passes from the anterior to the posterior end of each individual. For segmented species swelling of the cord in each segment form segmental ganglia.

III. A variety of sense organs, including touch receptors, statocysts, light receptors, vibration receptors and chemoreceptors are distributed along the length of the body.

IV. In most polychaete species, the head bears a pair of ciliated depressions or slits, called nuchal organs, chemosensory in nature.

V. Among polychaetes, the various receptors are either connected to the ventral nerve cord by means of segmental nerves (in the case of the eyes and nuchal organs) connected directly to the brain by other nerves.

VI. Lateral nerves extending from the ventral nerve cord also innervate: the digestive tract and the parapodia and body wall musculature of each segment.



- **Reproduction:**

I. Mostly by sexual method (as most of them are gonochoristic), but asexual method is also observed in some of them.

II. Gametes arc produced by peritoneal tissue, rather than any distinct gonads and are then released into the associated coelomic compartments, where they mature. In hermaphroditic species anterior abdominal segments produce eggs and posterior abdominal segments produce sperms.

III. In many tube dwelling polychaetes, epitoky is observed which means a marked morphological transformation in preparation for reproductive activity. An epitoke is formed which is a sexually mature male or female highly specialized for swimming and sexual reproduction.

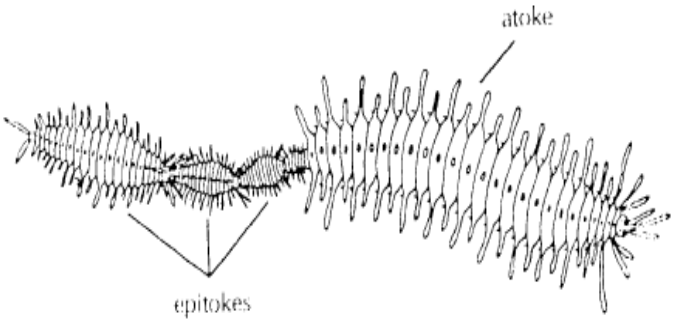
IV. Epitokal modifications include changes in the formation of head, structure of setae and parapodia, the size of the segments and segment musculature.

V. Epitokes arise from atoke (nonreproductive individual) either by direct transformation of the entire individual (Nereis) or by transformation and separation of the posterior segments from atoke (Eunicids and Syllids)

VI. ***Swarming:*** Epitokous polychaete swim to the surface during shedding of the eggs and sperms. This synchronous behavior congregates sexually mature individuals in a relatively short time and increases the likelihood of fertilization.

VII. Fertilization external.

VIII. Some species reproduce asexually by fragmenting and subsequently regenerating the missing parts



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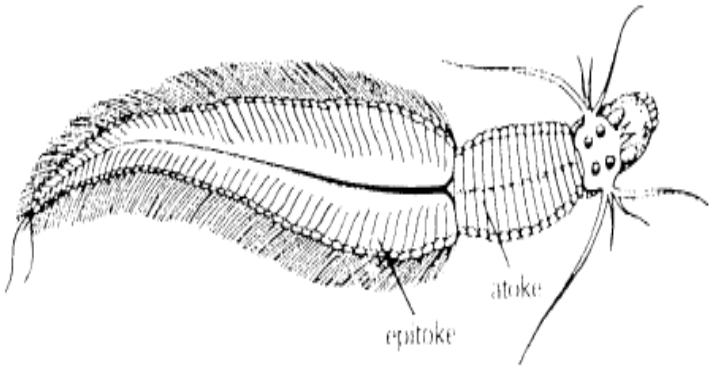


(c)

- **Development (Trochophore larva):**

I. Free living embryo develops an alimentary canal and two rings of cilia.

II. These rings are the prototroch (the first wheel), located around the equator of the animal, anterior to the mouth, and the telotroch (the tail wheel), located posteriorly on what will become the terminal portion ,of the adult, the pygidium.

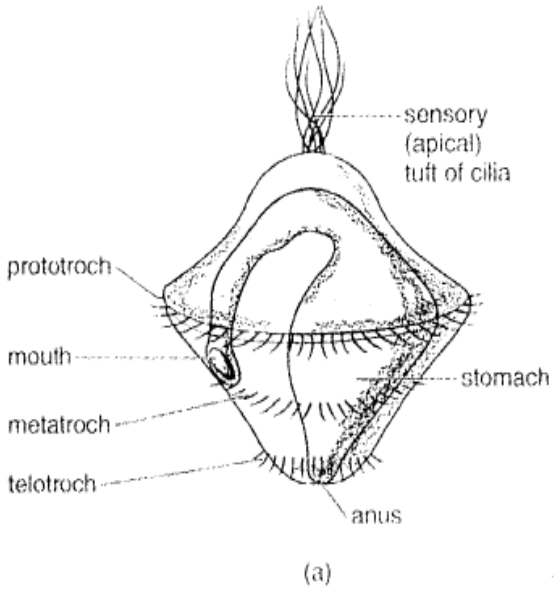
III. “The prototroch is the major locomotory organ. Because of the ciliated rings, the larva is called a trochophore, meaning "wheel bearer”.

IV. A third band of cilia' the metatroch ("between wheel"), later forms between the prototroch and the telotroch.

V. Some polychaetes produce a nonfeeding short lived trochophore stage that subsists on stored yolk reserve and metamorphoses after swimming for some time.

VI. Some species lack any free-living larval stage through its life history. Instead, the embryos develop within a gelatinous egg mass anchored to the sediment or to the inside surface of female’s tube.

VII. Polychaete metamorphosis transforms the trochophore into the juvenile body form by gradual lengthening of the growth zone.



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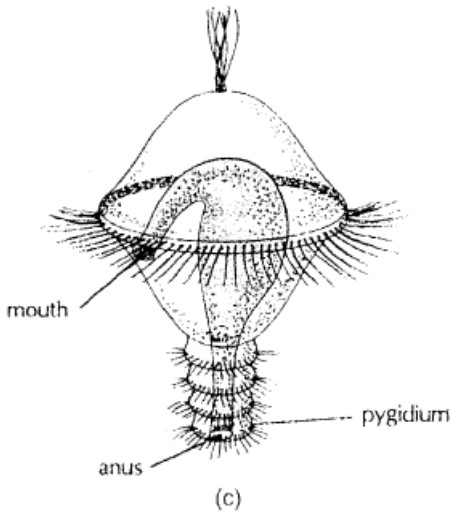

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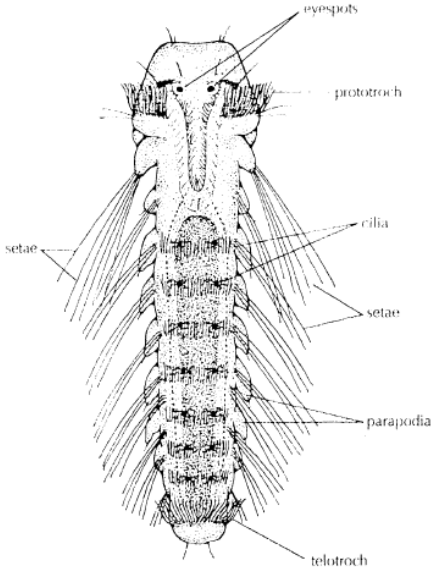


(d)

Class Clitellata

- **General Characteristics:**

I. Pronounced cylindrical glandular structure named clitellum present that plays major role in reproduction.

II. Clitellum secretes mucous for copulation, nutritious albumen for eggs and a cocoon in which eggs and albumen are deposited.

III. Gonads are permanent in nature and are restricted to genital segments.

IV. Development direct i.e. no larval stage.

V. Lack parapodia, head and pygidial appendages.

Detailed Charateristics:

- **HABIT AND HABITAT:**

Subclass Oligochaeta

I. Among the described 3500 species of oligochaetes the aquatic species are mostly fresh water forms. A few are marine.

II. Remaining are terrestrial.

Subclass Hirudinea

The subclass Hirudinea, which includes the leeches, has approximately 500 to 630 described species, which are believed to have evolved from oligochaete stock. Mainly freshwater form but some are marine.

- **EXTERNAL ANATOMY:**

Subclass Oligochaeta:

I. Streamlined body.

II. Prostomium lacks conspicuous sensory structures like eyes and tentacles.

III. Parapodia absent but setae present less densely distributed along the body.

IV. Clitellum present.

Certain adjacent body segments in the anterior half of the body are thickened and swollen by glands, that secrete mucous for copulation and also secrete the cocoon. The glandular area of these segments collectively called the clitellum that partially or completely covers he segments and often forms a conspicuous girdle around the body.

Subclass Hirudinea

I. Bilaterally symmetrical dorsoventrally flattened body frequently tapered at the anterior end.

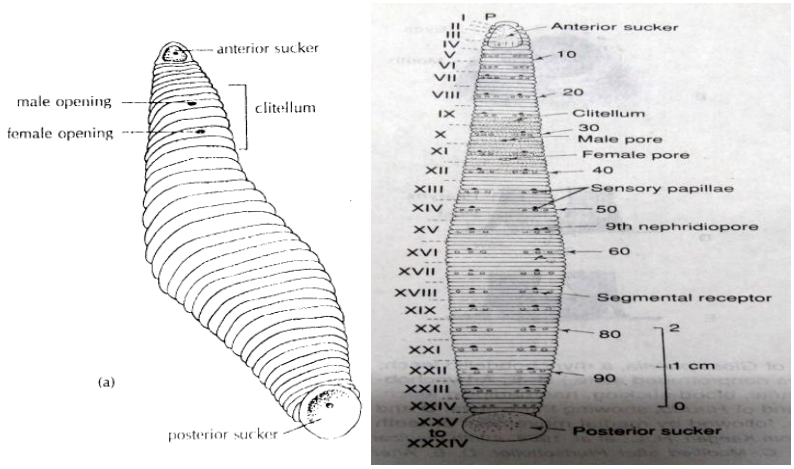
II. The segments at the both extremities have been modified to suckers; the anterior sucker being smaller than the posterior one. Anterior sucker surrounds the mouth.

III. Body divisible into head and trunk region.

IV. Dorsally the head bears a number of eyes, ventrally it bears the anterior suckers and the trunk consists of pre-clitellar, clitellar and post clitellar region.

V. The anus opens dorsally on or near the last trunk segment.

VI. Setae and parapodia absent.



- **METAMERISM:**

Subclass Oligochaeta:

Septa divide the body coelomic cavity into a series of semi isolated compartments.

Subclass Hirudinea:

I. The body is generally not separated into compartments by septa, and the continuous coelomic space is largely filled with connective tissue, or mesenchyme.

II. Number of segments fixed.

III. Secondary external annulations obscure original segmentation.

BODY WALL:

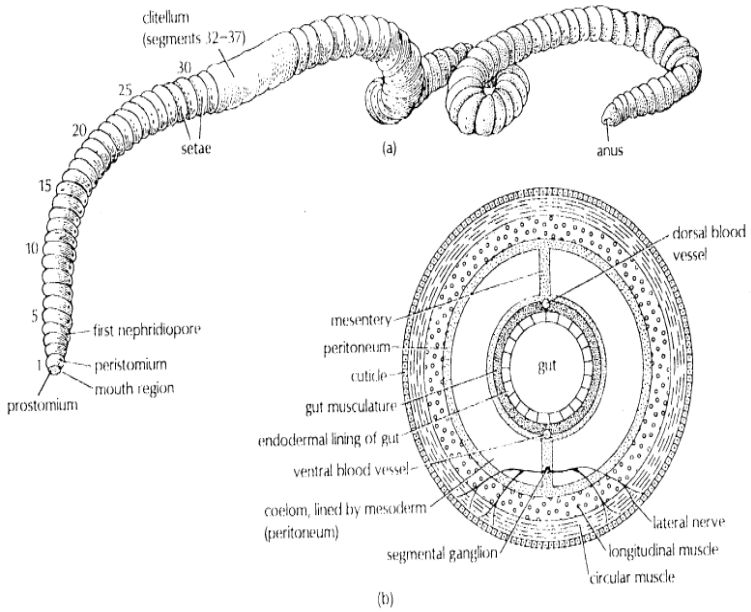
Subclass Oligochaeta:

I. A thin cuticle overlies an epidermal layer which contains mucous secreting glands.

II. Body wall is composed of inner layer of longitudinal muscles overlaid by a layer of circular muscles.

III. Continuous series of localized contraction and relaxation of the longitudinal as well as circular muscles help in the movement of the oligochaetes.

(a)External morphology of the terrestrial oligochaete



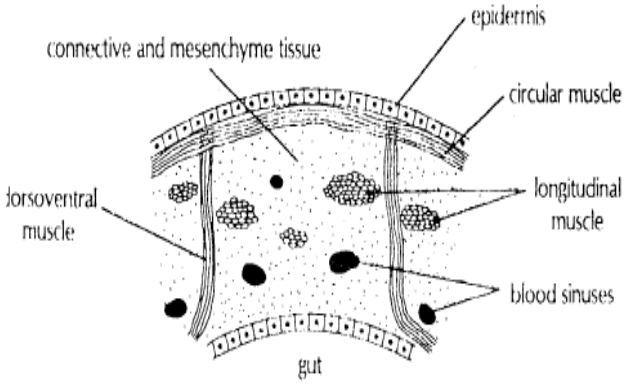
(b) Oligochaete in diagrammatic cross section showing the arrangement of muscle layers of the

Subclass Hirudinea:

I. It consists of typical annelidan cuticle and epidermis but the fibrous connective tissue beneath the epidermis is very thick and occupies much of the interior of the body.

II. Cell bodies of the epidermal glands may extend upto the peripheral connective tissue layer (dermis).

III. Below dermis is aler of circular muscles followed by diagonal muscles and a powerful longitudinal musculature. Dorsoventral muscles are also present.



ALIMENTARY CANAL:

Subclass Oligochaeta:

I. The digestive tract is straight and relatively simple.

II. Mouth situated beneath prostomium and opens into a small buccal cavity.

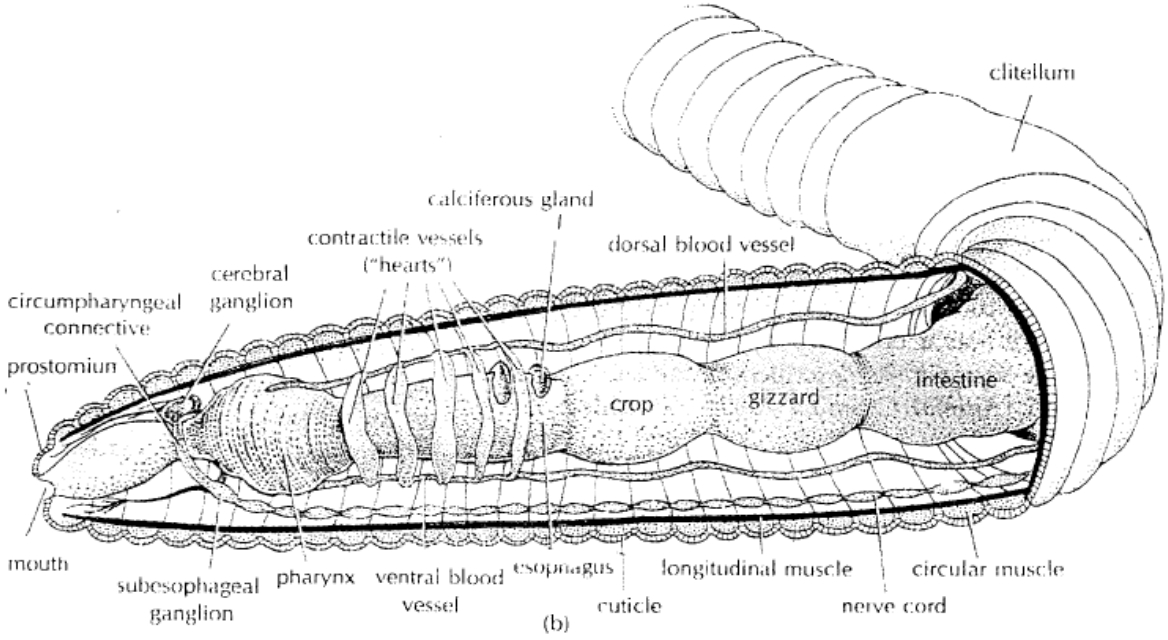
III. In oligochaetes there may be some modifications in the basic arrangement of the digestive tract.

a. The oesophagus may be modified to form a crop, for food storage and/or a gizzard, a highly muscular structure lined with hard cuticle, for grinding food.

b. Calciferous glands are associated with the esophagus; these may function in regulating blood pH by controlling the concentration of carbonate ions.

c. The intestine of many terrestrial oligochaete species is thrown into a ridge or fold (typhlosole), which increases the gut's effective surface area.

d. Associated with the intestine (and dorsal blood vessel) of oligochaetes is a characteristic yellow tissue called chloragogen. (Chloragogen cells play major roles in protein, carbohydrate, and lipid metabolism of oligochaetes.



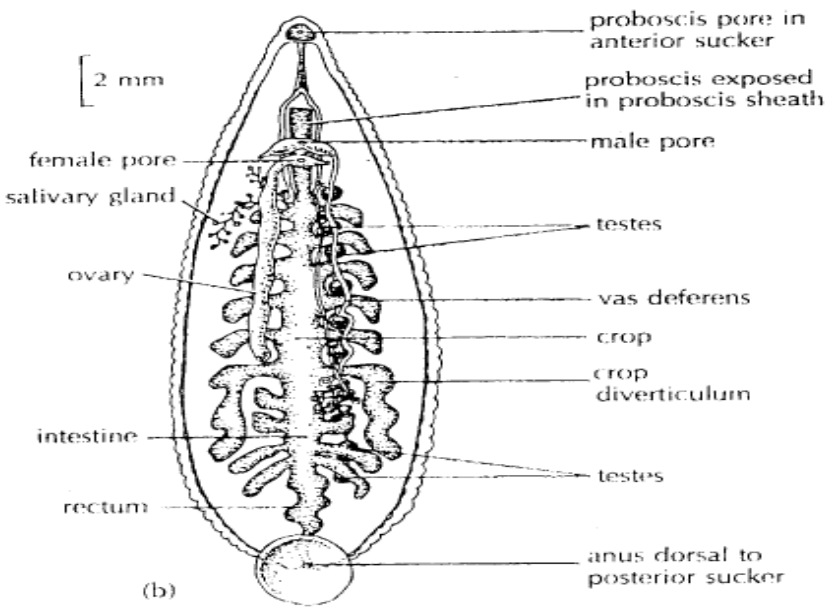
Digestive and Circulatory system of a common oligochaete

Subclass Hirudinea:

I. The mouth of a leech opens into a muscular, pumping pharynx.

II. Salivary glands associated with the pharunx secrete hirudin, an anticoagulant.

III. A crop and digestive glands are found in some species.



RESPIRATION AND GAS EXCHANGE:

Subclass Oligochaeta:

I. There are usually no specialized respiratory organs, true gills occur only in a few oligochaetes.

II. Gas exchange in almost all oligochaetes take place by diffusion of gases through general body segment.

Subclass Hirudinea:

I. The general body surface helps in gaseous exchange in most of the leeches.

II. Only fish leeches have gills which are basically lateral leaf like branching outgrowths of the body wall.

CIRCULATORY SYSTEM:

Subclass oligochaete:

I. Same as in polychaetes. Branches from the segmental vessels send blood into capillaries in the integument and supply various segmental organs

II. Vessels lack endothelial lining, but are lined only by the basal lamina of the overlying peritoneum.

III. Dorsal vessel is contractile.

IV. The vessels in the oligochaetes are commonly referred to as heart and the number of such hearts may vary in different oligochaetes.

V. Oxygen carrying blood pigments are found in the circulatory fluid of most oligochaetes. Haemoglobin containing blood is specially characteristic of oligochaetes**.**

Subclass Hirudinea

I. Blood circulatory System is often reduced or absent.

II. Among the leeches, coelomic fluid assumes all or part of the circulatory role, reaching the tissues via contractile coelomic sinuses and channels.

III. All of the vessels and channels are lined up by an endothelium, the peritoneum.

IV. The haemocoelomic fluid is propelled by the muscular contraction of the lateral longitudinal channels.

V. Blood contains haemoglobin.

NERVOUS SYSTEM AND SENSE ORGANS:

Subclass Oligochaeta:

I. A mass of ganglia forms the brain.

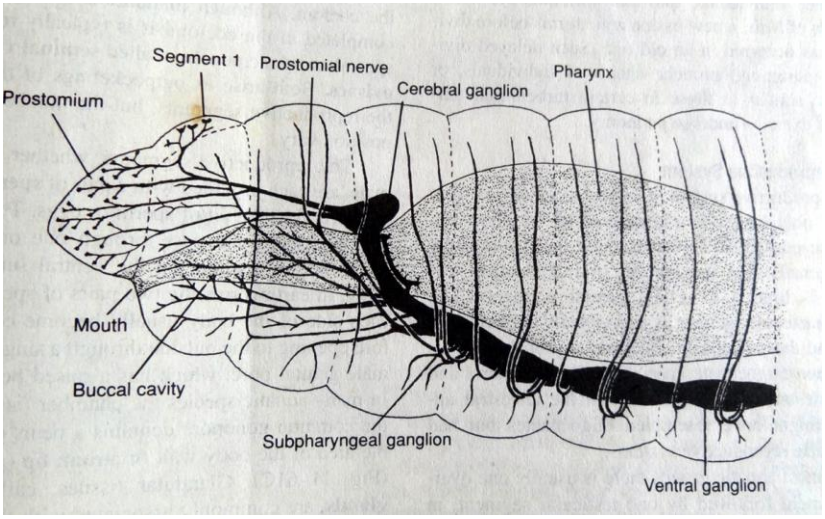
II. A solid ventral nerve cord or a pair of nerve cord in primitive condition runs from anterior to posterior direction of the body.

III. Swelling of the cord in each segment forms segmental ganglion.

IV. Oligochaetes lack eyes except for a few aquatic forms.

V. The integument is supplied with dispersed photoreceptors situated in the inner part of the epidermis specially at the anterior end.

VI. Chemoreceptors are present in the form of projecting tubercle made up of clusters of sensory cells with sensory processes.



Subclass Hirudinea:

I. The general plan of the nervous system is similar as in other annelids but the anterior and posterior ganglia are concentrated into masses because of the segmental modification forming the suckers.

II. The brain consists of paired subpharyngeal ganglia.

III. Behind the subpharyngeal ganglia the ventral nerve cord consists of segmental ganglia.

IV. 7 additional pairs of ganglia fuse to form the caudal ganglion associated with posterior sucker.

V. Pigment cup ocelli and sensory papillae are the sense organs.

EXCRETORY SYSTEM:

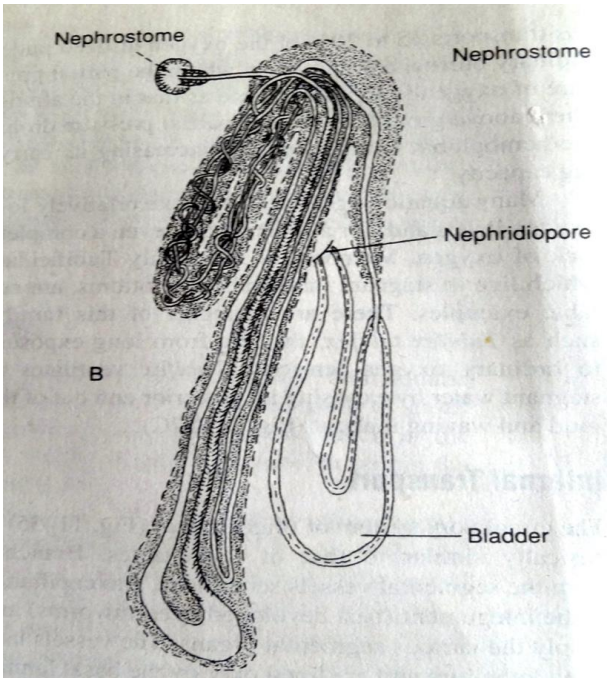
Subclass Oligochaeta:

I. Adult oligochaetes have a metanephridial system and there is one pair of metanephridial tubules per segment except the extreme anterior and posterior segments.

II. In each nephridium following the nephrostome, the nephridial tubule is greatly coiled and before opening to the exterior the nephridial tubule is dilated to form a bladder. Nephridiopores are usually situated at the ventrolateral surface of the body.

III. Majority of the oligochaetes possess a single typical pair of nephridia per segment and is thus known as holonephridia.

IV. Both urea and ammonia are important excretory products.



Subclass Hirudinea:

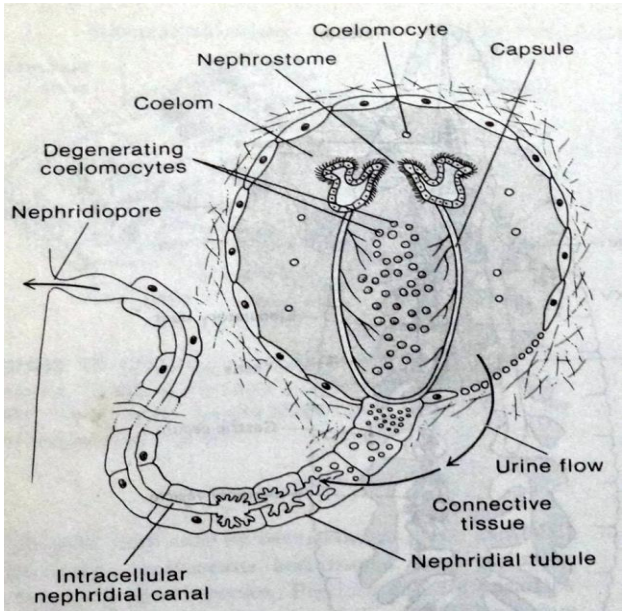
I. Leeches contain 10-17 pairs of metanephridia, 1 pair per body segment situated in the middle third of the body.

II. Due to loss of septa and reduction in coelomic size, the nephridial tubules are embedded in the connective tissue and the nephrostome project into the coelomic channels.

III. Each ciliated nephrostome opens downsteam into a nonciliated capsule which joins the nephridial tubule.

IV. The nephridial tubules consists of a main duct that receives numerous branched ductules called canaliculi.

V. The main duct typically expands into a urinary bladder before opening to the exterior at a ventral nephridiopore.



REPRODUCTION:

Subclass Oligochaeta:

Sexual :

I. All oligochaete species are hermaphroditic, and generally only a few segments of each individual produce gametes. Moreover, gametes are produced within distinct testes and ovaries.

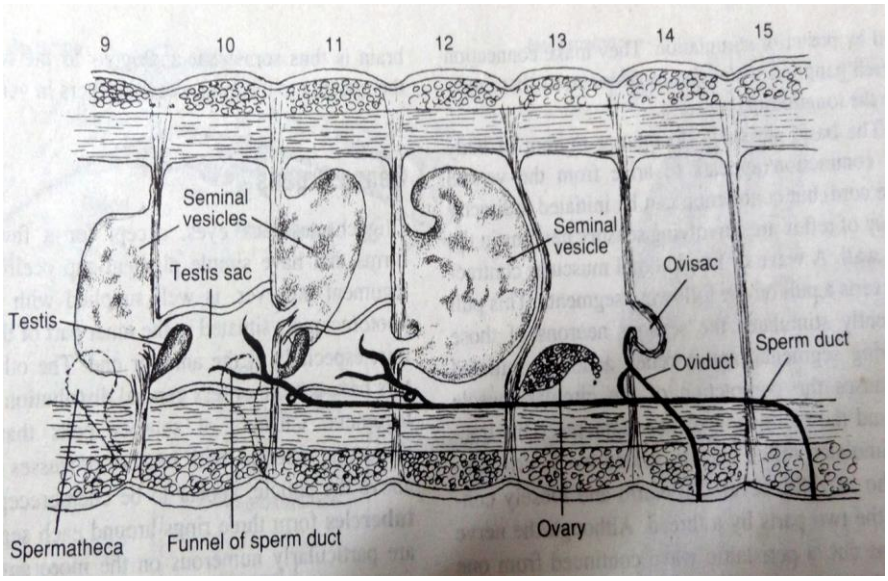
II. The sperm are stored for later use in specialized organs called spermathecae and are exchanged simultaneously between two mating individuals.

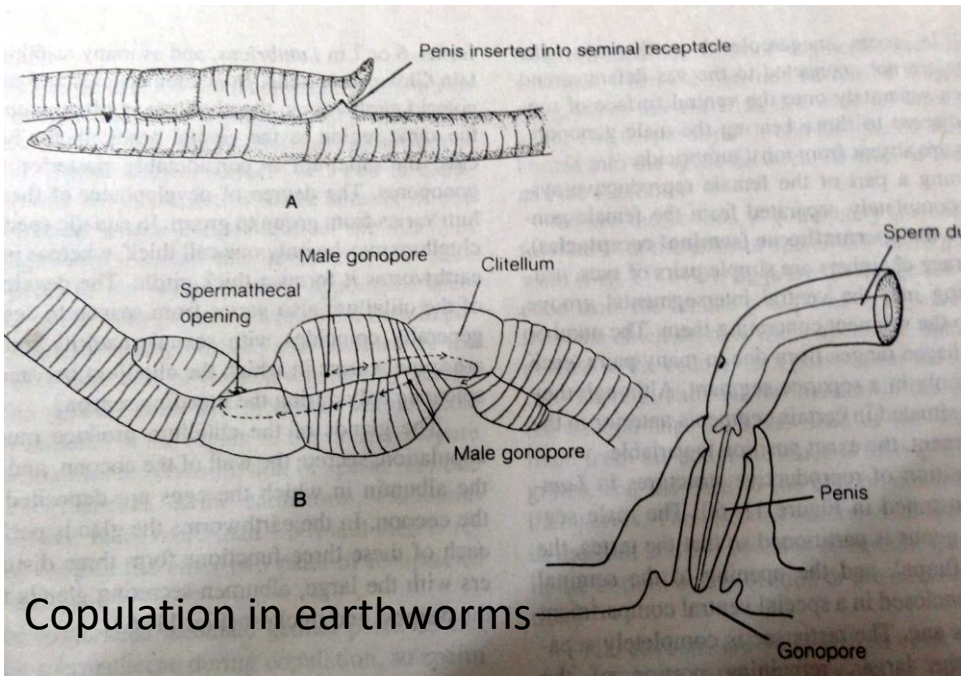
III. Eventually, eggs and sperms are extruded from separate openings into a complex cocoon secreted by the clitellum, and thus fertilization occurs externally.

IV. The embryos develop in and feed upon a nutritive fluid found within the cocoon.

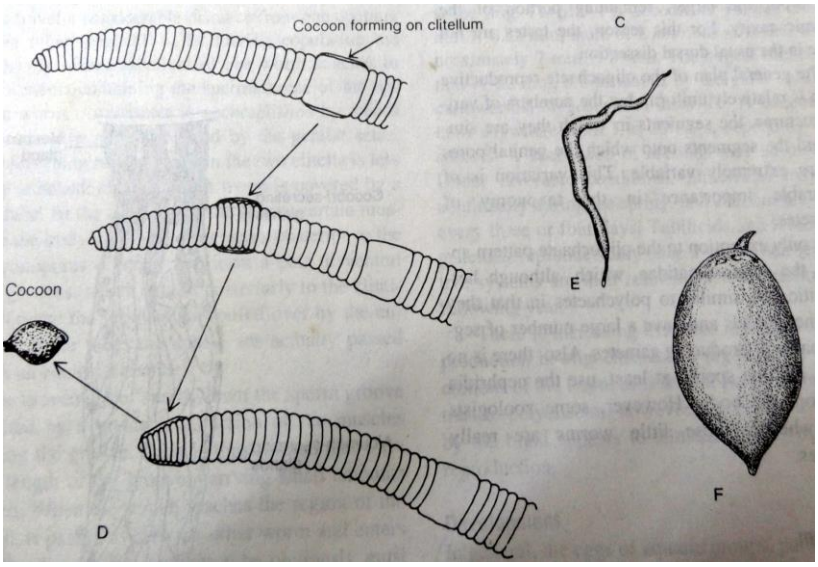
V. Miniature worms emerge from the cocoons after completion of development.

VI. Oligochaetes lack free living larval stages, even in marine environment.





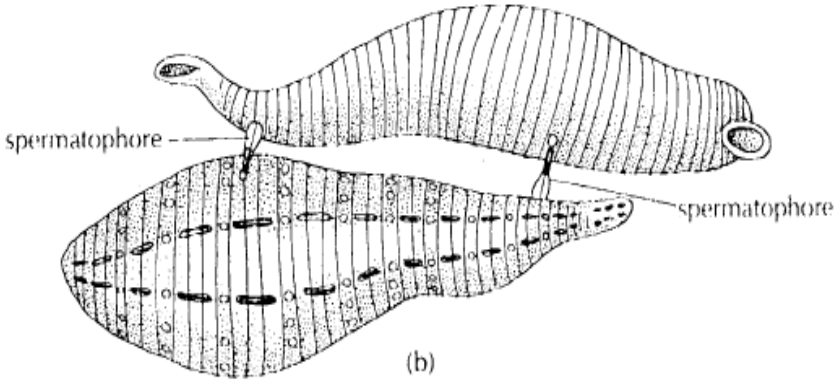
Copulation in earthworms



Cocoon in oligochaetes

Subclass Hirudinea:

- Adult leeches are hermaphrodites and a free-living larval stage is absent from the life cycle.
- Only a few segments of each individual are directly involved in gametogenesis.
- Fertilization internal, either through copulation or, in species lacking a penis, by jabbing packets of sperm (spermatophores) into the partner's body or through penetration of the body wall by the spermatophores themselves.
- Sperm exchange is mutual between two mating individuals, and the fertilized eggs of each individual generally develop within external cocoons.
- The clitellum generally functions in producing the cocoon and a nutritive fluid



Asexual:

I. It is more common among oligochaetes, particularly in freshwater species.

II. This process of asexual reproduction involves the transverse (i.e., crosswise) division of the “adult" into a number of separate sections and the subsequent regeneration of each section into a complete individual.

III. In addition, quite a few oligochaete species specially those living in terrestrial environment are parthenogenetic; that is, eggs may develop normally in the absence of fertilization.

Echiurans:

- ***Echiura***

  Echis : serpent like

- Echiurans were long placed in a separate Phylum. Echiurans are not segmented as adults. Their placement as Annelids are supported by molecular data where it has been said that segmented coelomic pouches appear briefly during embryogenesis, and by a report of distinct segmentation the nervous system during larval development. This evidence suggests that the present adult condition represents a secondary loss of segmentation from a segmented ancestor.

- **Habit and habitat:**

  Mostly live in shallow water.

- **External Anatomy:**

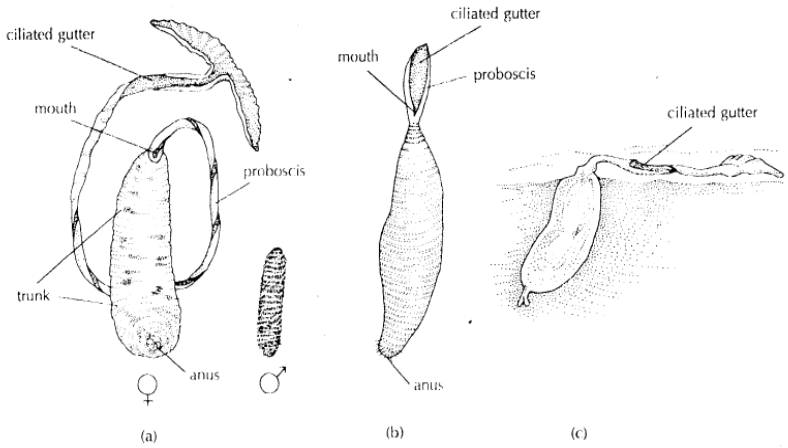
I. Cylindrical sausage shaped body, length varying from several millimeter to more than 8 cm.

II. Body has an anterior cephalic projection commonly called the proboscis, which contains the brain.

III. The proboscis is muscular and quite mobile-in some species, it can be extended more than 25 times the length of the body proper.

IV. The proboscis is ciliated on the ventral surface and serves as the organ of food collection in all echiurans.

V. A single pair of large, chitinous, annelid-like setae located just posterior to the proboscis. Some echiurans bear additional setae in the form of a ring just anterior to the anus. Setae probably help in burrowing.



- **Digestive system and feeding habit:**

I. The mouth, is located at the base of the proboscis near the junction of the proboscis and the body proper (the trunk).

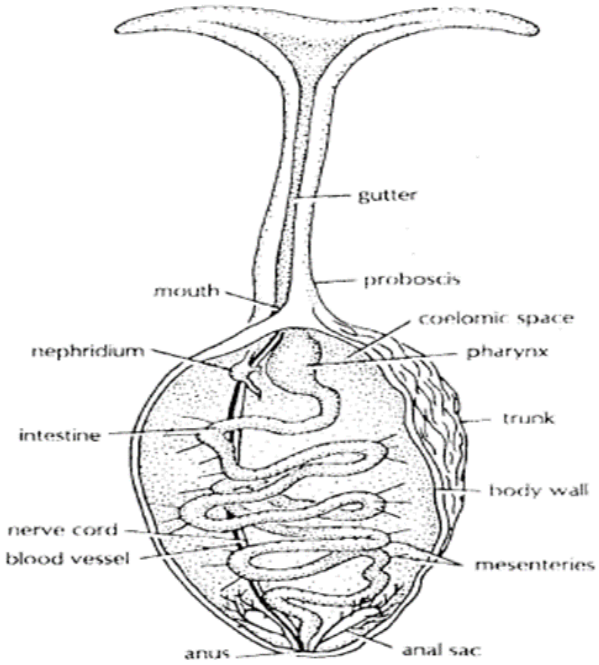
II. The digestive tract is contained within the trunk and is very long and convoluted, with the anus opening posteriorly.

III. Most echiurans are deposit feeders except for the genus *Urechis* who are suspension feeders.

- **Internal Anatomy:**

I. The trunk contains a single, uninterrupted, large coelomic space that extends into the proboscis.

II. There is no metameric segmentation of the coelomic space, nor of the ventral nerve cord that runs through it. Metamerism present only during development.



- **Excretory System:**

I. The members of most species possess I to 5 pairs of nephridia.

II. Coelomic fluid is presumably drawn into each nephrostome by ciliary action, and a final urine is excreted through the nephridiopores opening to the surrounding seawater.

III. The one additional organ, one pair of anal sac within the echiuran coelom is also believed to serve an excretory role. They are the outpockets of the rectum.

IV. The sacs are muscular, and their surface is dotted with many thousands of ciliated funnels resembling nephrostomes Iike metanephridia and these funnels collect coelomic fluid.

V. There is no indication that the collected fluid is then modified by either secretion or resorption.

VI. Discharge is accomplished by periodic muscular contractions of the sacs; one way valves at the base of the funnels prevent fluid from moving back into the coelom.

- **Respiratory system:**

Echiurans lack specialized respiratory organs; diffusion across the general body surface apparently satisfies the requirements for gas exchange in most species.

- **Nervous system and sense organs:**

I. A ventral nerve cord passes uninterrupted throughout the body. Brain present.

II. The nervous system includes a nerve ring around the oesophagus and a conspicuous ventral nerve cord.

III. Echiurans have no specialized sensory system, other than sensory cells studding the proboscis.

- **Circulatory system:**

I. Dorsal and ventral blood vessels are present.

II. Coelomic fluid contains blood pigments like haemoglobin.

- **Reproductive System:**

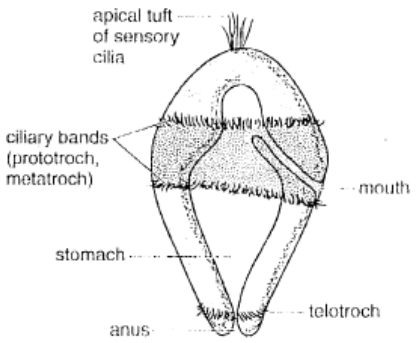
I. Echiurans are gonochoristic (dioeceous).

II. Echiurans lack distinct gonads. Instead, gametes are produced by the peritoneal Iining of the coelom and are released into the coelomic cavity.

III. The gametes of Echiurans leave the body by passing through the metanephridia, exiting at the nephridiopore.

IV. Fertilization external.

Trochophore larva observed during development.



Sipunculuns:

- ***Sipuncula***

  Sipunculus : tube like

- Previously they were considered under separate minor phylum. Some developmental details suggests a close relationship with molluscs, but recent gene sequence studies suggest clear annelid affinities. Some molecular studies suggest that sipunculans are in fact polychaetes.
- lf sipunculans really are polychaete annelids, then they have apparently lost all traces of segmentation and parapodia from an ancestor that possessed those features. There is still uncertainty here, and it may that the sipunculans are not annelids but rather the sister group of annelids.
- One morphological evidence supporting its linkage with the polychaetes is presence of nuchal organs- chemoreceptors as in polychaetes.
- **Habit and habitat:**

I. All are marine, but mostly found in shallow water. Some are also found at higher depths of water.

II. They are burrowers but cannot form any tube and generally reside in muddy or sandy sediments and empty tubes of polychaetes and empty shell of molluscs.

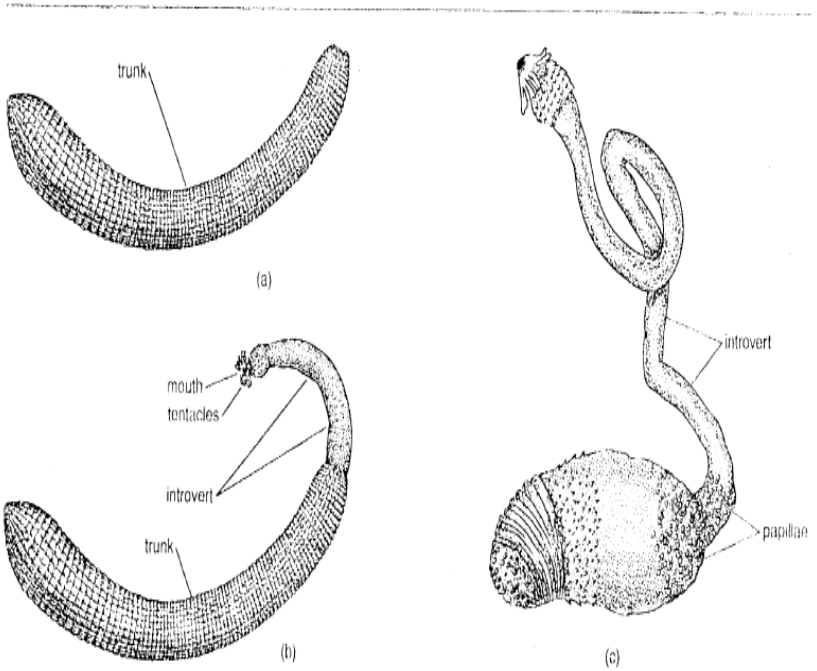
- **External Anatomy:**

I. Length vary from few millimeters to 1m.

II. Body consists of a plump, unsegmented trunk and an anterior reversible and fully retractable introvert.

III. Mouth opens at the end of the introvert.

IV. Introvert contains mucous containing tentacles surrounding the mouth.



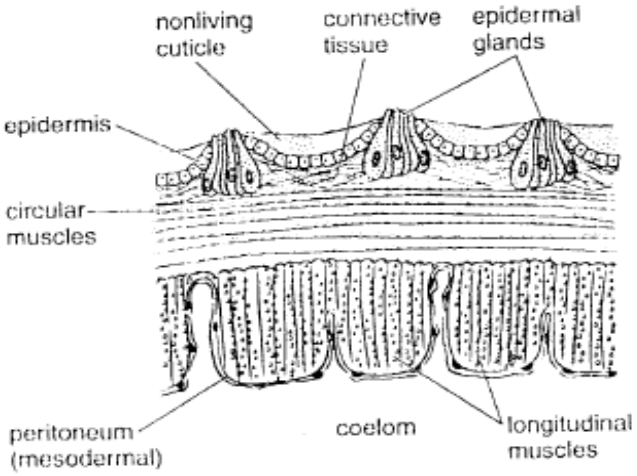
a.

a. Introvert within b. introvert extended c. with conspicuous papillae

- **Body wall:**

I. Sipunculans have a body wall composed in sequence of an outer cuticle, an epidermis, and a laver of circular muscles, a layer of longitudinal muscles, and a peritoneum lining the coelom.

II. Contracting the body wall musculature causes the introvert to be thrust out of the body, while contraction of the introvert retractor muscles draws the anterior end of the animal inside back the trunk



- **Internal Anatomy:**

I. Body consists of an enormous coelomic cavity without any segmentation.

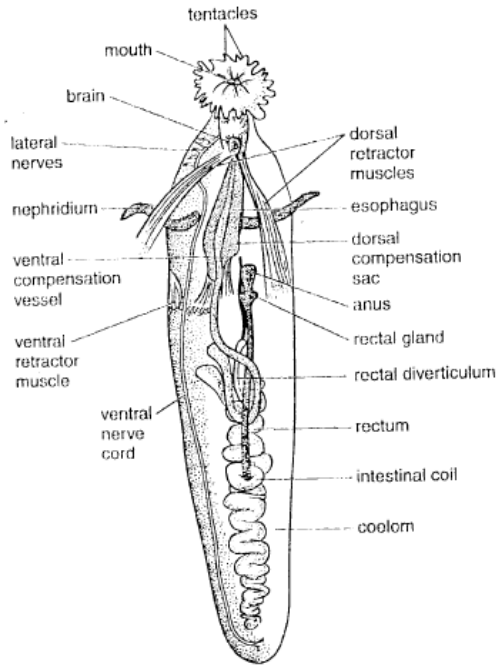
II. The hollow tentacles of the introvert are not in continuation with the coelom. Instead the tentacles are connected to a series of sacs called the contractile vessels or compensatory sacs attached to the sites of the oesophagus.

- **Alimentary Canal and feeding habit:**

I. U shaped digestive tract with the anus opening at about the midpoint of the trunk.

II. This might be linked to the adaptation for staying at burrows.

III. Deposit feeders.



- **Circulatory System:**

I. In contrast to other annelids, sipunculans lack blood circulatory system with heart and blood vessels.

II. However, cells in the coelomic fluid contain oxvgen-binding pigment- hemerythrin.

III. Gas exchange takes place via the tentacles, introvert, body wall, with coelomic fluid serving as a circulatory medium.

- **Nervous system and sense organs:**

I. Brain with normal ventral nerve cord.

II. Nuchal organ act as sense organ.

- **Excretory System:**

I. Main excretory organ metanephridia.

II. Most Sipunculans have only one pair of these organs.

III. The nephridial svstem is supplemented by a peculiar system of urns. These urns are clusters of cells that arise and detach from the peritoneal lining of the coelom. Floating freely in the coelomic fluid, urns collect solid wastes and eventually deposit these wastes in the body wall of the animal or exit the animal through the nephridial system.

- **Reproduction and development:**

I. Gametes arise from peritoneum, mature in the coelom and finally exit through nephridiopores.

II. Trochophore larva is present during development. In some sipunculans, the trochophore develops further to form a pelagosphera larva.