NERVOUS AND SENSORY FUNCTIONS

- Nervous systems are similar in all three classes of annelids.
- A pair of suprapharyngeal ganglia, connect to a pair of subpharyngeal ganglia by circumpharyngeal connectives.
- A double ventral nerve cord runs the length of the worm and a paired segmental ganglion is in each segment.
- Segmental ganglia coordinate swimming and crawling movements.
- The subpharyngeal ganglia help mediate locomotor functions.
- The suprapharyngeal ganglia probably control motor and sensory functions involved with feeding, and sensory functions associated with forward locomotion.

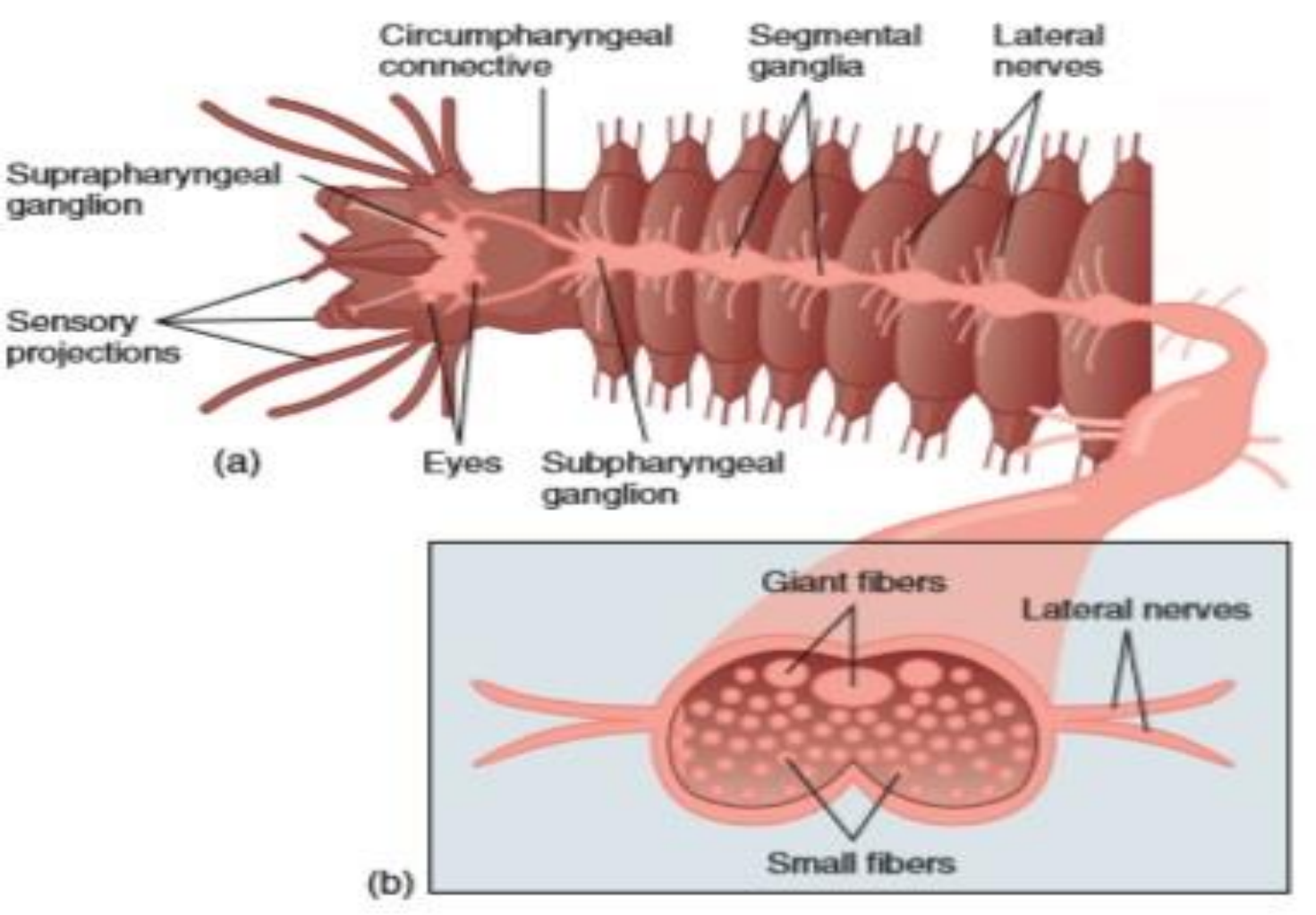

Fig: Nervous System of a Polychaete. (a) Connectives link suprapharyngeal and subpharyngeal ganglia. Segmental ganglia and lateral nerves occur along the length of the worm. (b) Cross section of the ventral nerve cord, showing giant fibers.

SENSORY STRUCTURES

- Two to four pairs of eyes are on the surface of the prostomium.
- Vary in complexity from a simple cup of receptor cells to structures made up of a cornea, lens, and vitreous body.
- Most polychaetes react negatively to increased light intensities except fanworms.
- Nuchal organs are pairs of ciliated sensory pits or slits in the head region thought to be chemoreceptors for food detection
- Statocysts, ciliated tubercles, ridges, and bands, contain receptors for tactile senses, cover the body wall.

EXCRETION

- Annelids excrete ammonia.
- The excretory organs of annelids are called nephridia.
- Annelids have two types of nephridia. 1) Protonephridium 2) metanephridium

1) Protonephridium

- It consists of a tubule with a closed bulb at one end and a connection to the outside of the body at the other end.
- Protonephridia have a tuft of flagella in their bulbular end that drives fluids through the tubule.
- Some primitive polychaetes possess paired, segmentally arranged protonephridia that have their bulbular end projecting through the anterior septum into an adjacent segment and the opposite end opening through the body wall at a nephridiopore.

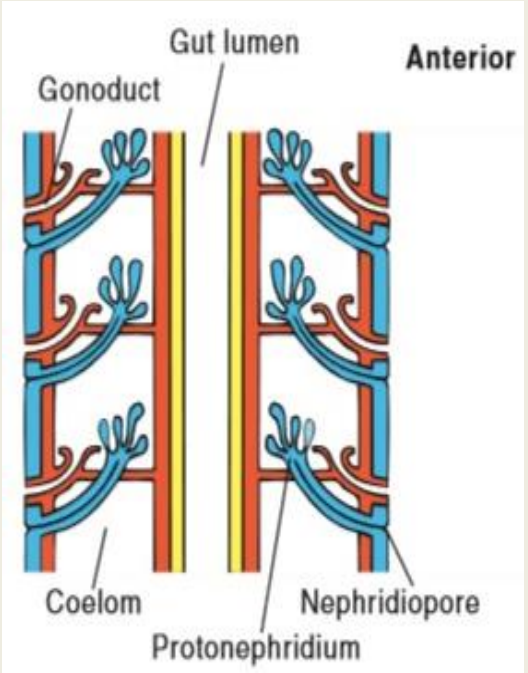

Fig: Annelid Nephridia. Protonephridium.

2) Metanephridium

- A metanephridium consists of an open, ciliated funnel, called a nephrostome, that projects through an anterior septum into the coelom of an adjacent segment.
- At the opposite end, a tubule opens through the body wall at a nephridiopore or, occasionally, through the intestine.
- There is usually one pair of metanephridia per segment, and tubules may be extensively coiled, with one portion dilated into a bladder.
- A capillary bed is usually associated with the tubule of a metanephridium for active transport of ions between the blood and the nephridium

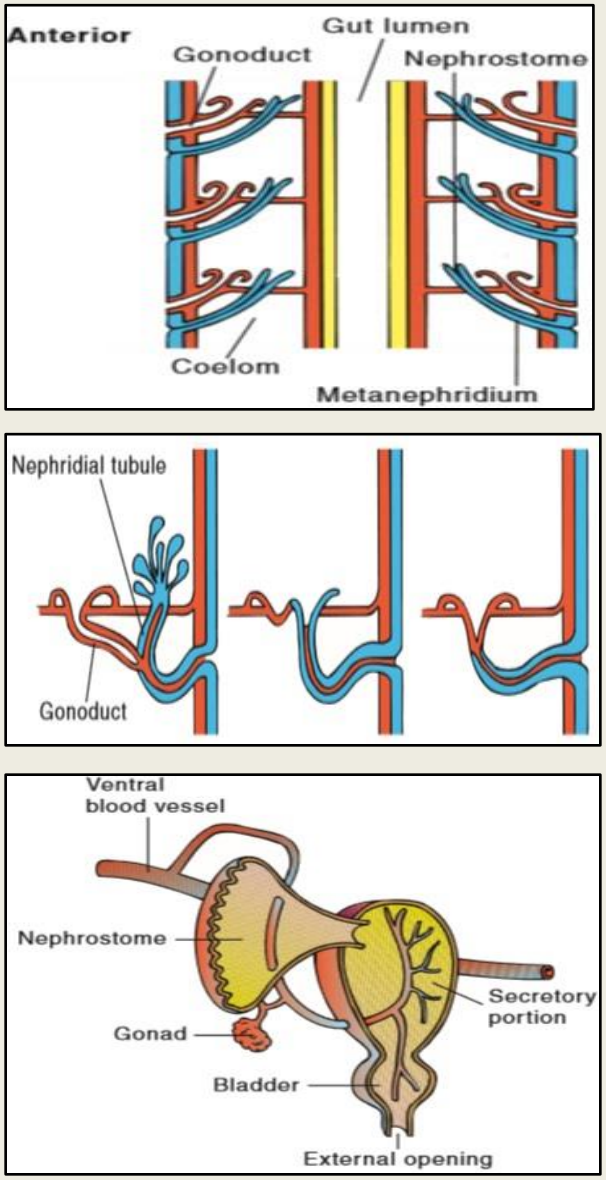

Fig: Annelid Nephridia

REGENERATION AND REPRODUCTION

- All polychaetes have remarkable powers of regeneration
- Some polychaetes reproduce asexually by budding or by transverse fission;
- Sexual reproduction is much more common.
- Most polychaetes are dioecious.
- Gonads develop as masses of gametes and project from the coelomic peritoneum.
- Fertilization is external in most polychaetes

Epitoky

- Epitoky is the formation of a reproductive individual.
- Body is modified into two body regions.
- Anterior segments carry on normal maintenance functions.
- Posterior segments are enlarged and filled with gametes.
- Modified parapodia for more efficient swimming.
- swarming of epitokes

DEVELOPMENT

- Spiral cleavage
- Planktonic trochophore larvae.
- Larvae eventually settle to the substrate.
- As growth proceeds, newer segments continue to be added posteriorly.
- Many other polychaetes lack a trochophore and display direct development or metamorphosis from another larval stage.

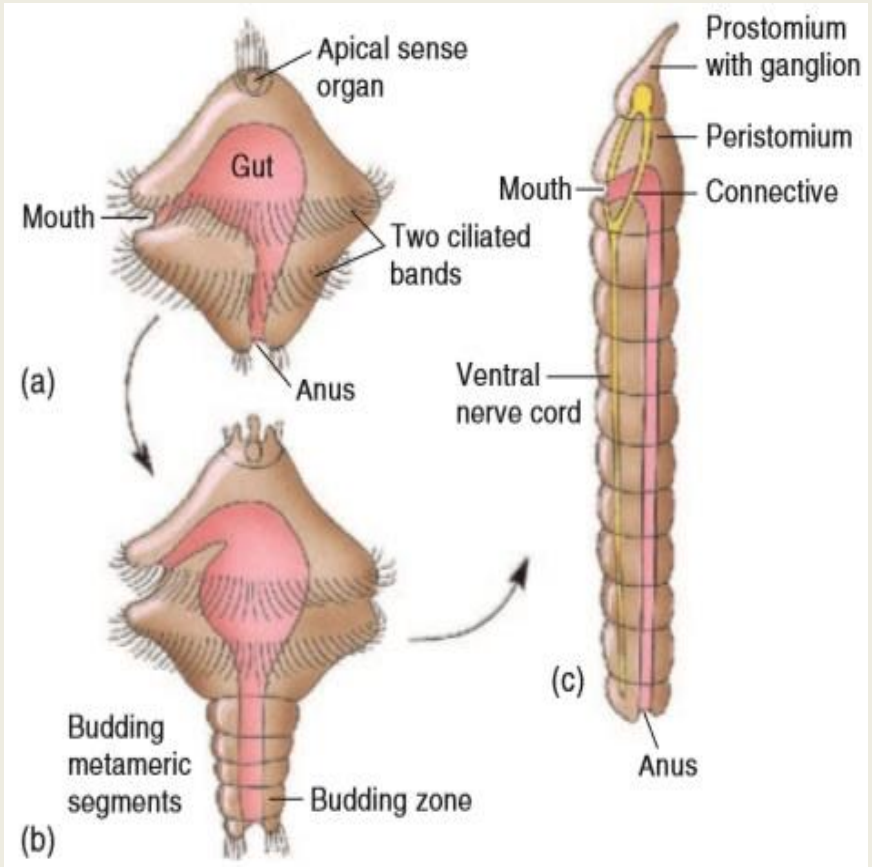

Fig: Polychaete Development. (a) Trochophore. (b) A later planktonic larva, showing the development of body segments. As more segments develop, the larva settles to the substrate. (c) Juvenile worm.

CLASS OLIGOCHAETA

GENERAL CHARACTERISTICS:

- **Over three thousand species**
- **found throughout the world in freshwater and terrestrial habitats.**
- **A few oligochaetes are estuarine, and some are marine.**
- **Aquatic species live in shallow water, where they burrow in mud and debris.**
- **Terrestrial species live in soils with high organic content and rarely leave their burrows.**
- **In hot, dry weather, they may retreat to depths of 3 m below the surface.**
- **Soil conditioning habits of earthworms are well known.**
- ***Lumbricus terrestris* is commonly used in zoology laboratories because of its large size.**
- **Common native species like *Eisenia foetida* and various species of *Allolobophora* are smaller.**

EXTERNAL STRUCTURE AND LOCOMOTION

- Oligochaetes have setae, but fewer than are found in polychaetes
- lack parapodia.
- The prostomium consists of a small lobe or cone
- lacks sensory appendages.
- A series of segments in the anterior half of an oligochaete is usually swollen into a girdlelike structure called the clitellum
- Clitellum secretes mucus during copulation and forms a cocoon.
- a nonliving, secreted cuticle covers the body.

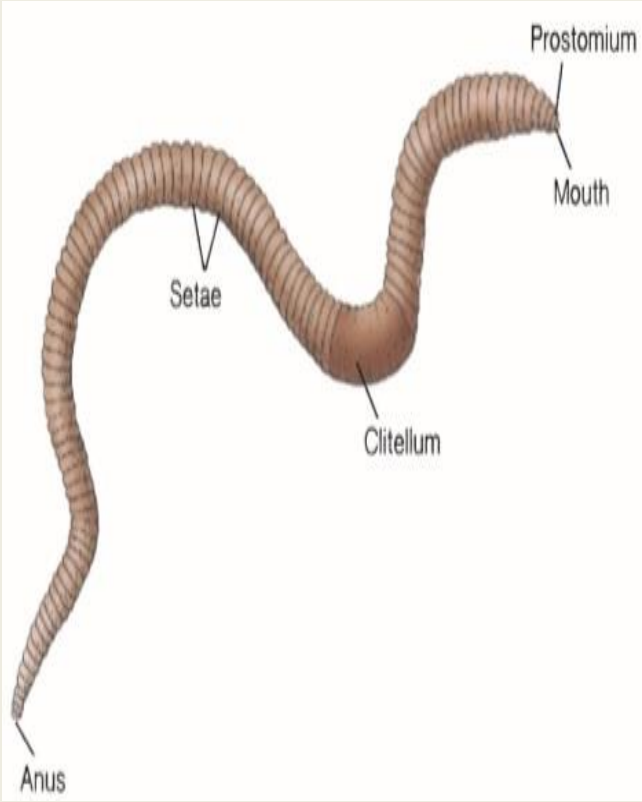

Fig: Class Annelida. External structures of the earthworm, *Lumbricus terrestris*.

EXTERNAL STRUCTURE AND LOCOMOTION

- locomotion involves the antagonism of circular and longitudinal muscles in groups of segments.
- Neurally controlled waves of contraction move from rear to front.
- Segments bulge and setae protrude when longitudinal muscles contract, providing points of contact with the burrow wall.
- Burrowing is the result of coelomic hydrostatic pressure being transmitted toward the prostomium.
- Contraction of body-wall muscles generates coelomic pressure that forces the prostomium through the soil.

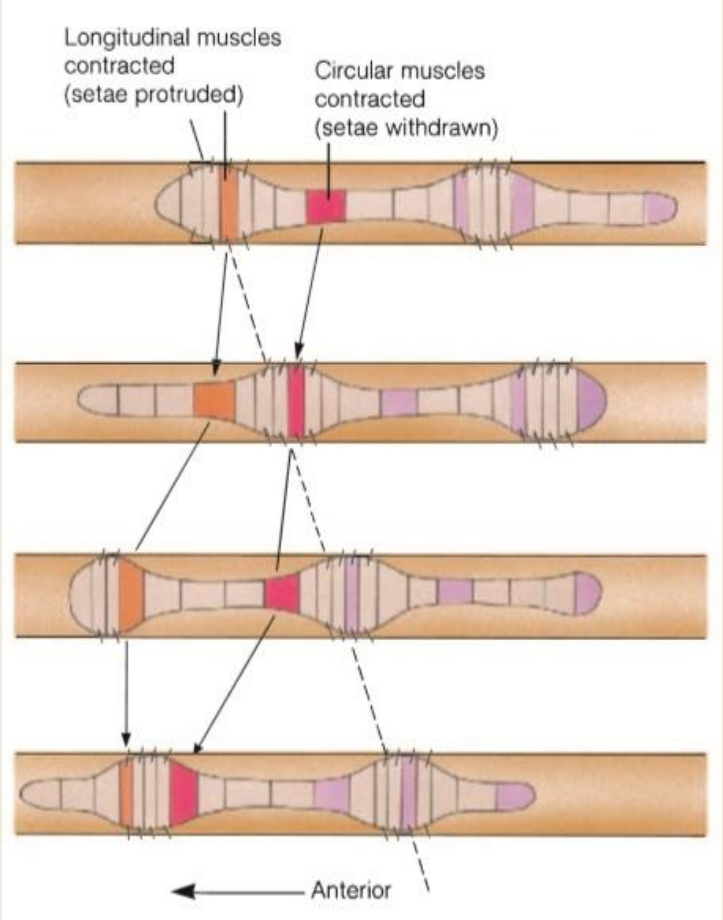

Fig: Earthworm Locomotion. Arrows designate activity in specific segments of the body, and broken lines indicate regions of contact with the substrate.

FEEDING AND THE DIGESTIVE SYSTEM

- Oligochaetes are **scavengers**.
- Digestive tract is tubular and straight.
- Mouth leads to a muscular pharynx.
- In the earthworm, pharyngeal muscles attach to the body wall.
- **Pharynx** acts as a pump for ingesting food and pumps the food into the esophagus.
- The **esophagus** is narrow and tubular, and frequently expands to form a stomach, crop, or gizzard.
- **Crop** is a thin-walled storage structure.
- **Gizzard** is a muscular, cuticle-lined grinding structure.

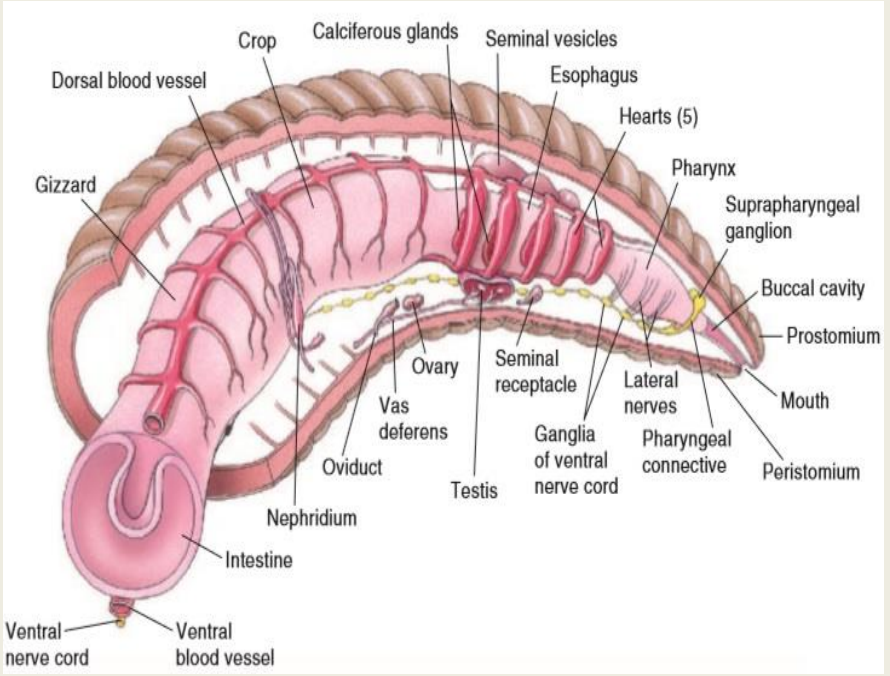

Fig: Earthworm Structure. Lateral view of the internal structures in the anterior third of an earthworm.

FEEDING AND THE DIGESTIVE SYSTEM

- **Calciferous glands** rid the body of excess calcium absorbed from food.
- They also help regulate the pH of body fluids.
- **Intestine** is a straight tube and is the principal site of digestion and absorption.
- A dorsal fold of the lumenal epithelium called the **typhlosole** substantially increases the surface area of the intestine.
- The intestine ends at the anus.

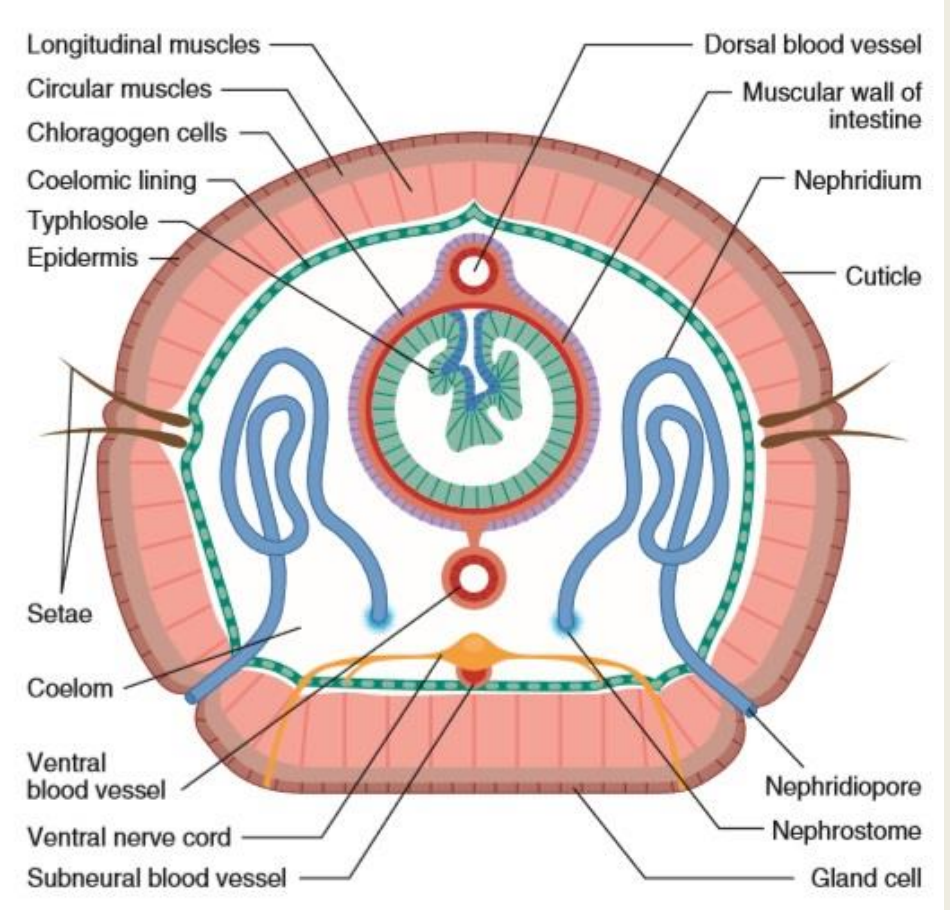

Fig: Earthworm Cross Section. The nephrostomes shown here would actually be associated with the next anterior segment.

GAS EXCHANGE AND CIRCULATION

- **Segmental vessels** expand and may be contractile.
- In the earthworm, for example, **expanded segmental vessels** surrounding the esophagus propel blood between dorsal and ventral blood vessels and anteriorly in the ventral vessel toward the mouth.
- These segmental vessels are sometimes called **“hearts,”** however the main propulsive structures are the dorsal and ventral vessels.
- Branches from the ventral vessel supply the intestine and body wall.

NERVOUS AND SENSORY FUNCTIONS

- The ventral nerve cords and all ganglia have undergone a high degree of fusion.
- Giant fibers mediate escape responses.
- Oligochaetes lack well-developed eyes, given their subterranean lifestyle.
- Other oligochaetes have simple pigment-cup ocelli, and all have a “dermal light sense”.
- Scattered photoreceptor cells mediate a negative phototaxis in strong light and a positive phototaxis in weak light.
- Oligochaetes are sensitive to a wide variety of chemical and mechanical stimuli.
- Receptors for these stimuli are scattered over the body surface, especially around the prostomium.

EXCRETION

- metanephridia for excretion and for ion and water regulation.
- Nitrogenous wastes include ammonia and urea.
- Oligochaetes excrete copious amounts of very dilute urine, although they retain vital ions.

Chloragogen tissue

- Chloragogen tissue surrounds the dorsal blood vessel and lies over the dorsal surface of the intestine.
- It acts similarly to the vertebrate liver.
- It is a site of amino acid metabolism.
- Deaminates amino acids and converts ammonia to urea.
- Converts excess carbohydrates into energy-storage molecules of glycogen and fat.

REPRODUCTION AND DEVELOPMENT

- All oligochaetes are monoecious and exchange sperm during copulation.
- One or two pairs of testes and one pair of ovaries are located on the anterior septum of certain anterior segments.
- Both the sperm ducts and the oviducts have ciliated funnels.
- seminal vesicles are sites for maturation and storage of sperm prior to their release.
- Seminal receptacles receive sperm during copulation.

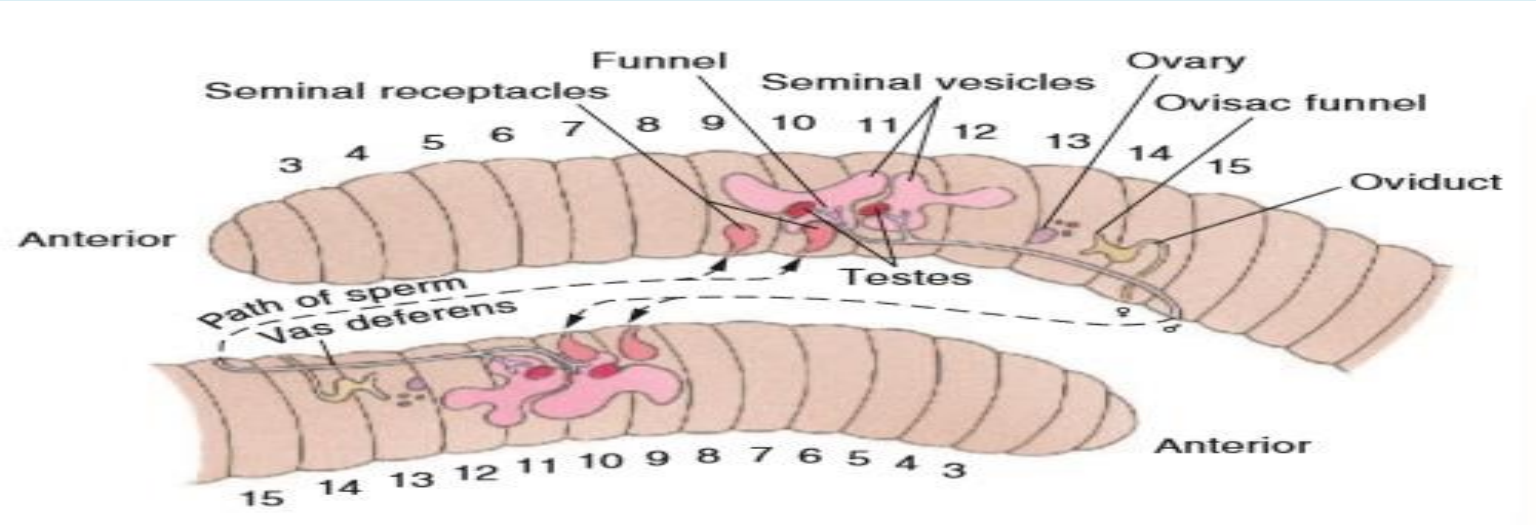

Fig: Earthworm Reproduction. Mating earthworms, showing arrangements of reproductive structures and the path sperm take during sperm exchange (shown by arrows).

REPRODUCTION AND DEVELOPMENT

- A pair of very small ovisacs, associated with oviducts, are sites for the maturation and storage of eggs prior to egg release.
- During copulation orientation lines up the clitellum of one worm with the genital segments of the other worm.
- Some species also have penile structures and genital setae.
- In *Lumbricus*, muscular contractions along sperm groove help propel sperm toward the openings of the seminal receptacles.
- Copulation lasts two to three hours.
- The clitellum forms a cocoon for the deposition of eggs and sperm.
- The cocoon consists of mucoid and chitinous materials that encircle the clitellum.

REPRODUCTION AND DEVELOPMENT

- The cocoon consists of mucoid and chitinous materials that encircle the clitellum.
- The clitellum secretes a food reserve, albumen, into the cocoon, and the worm begins to back out of the cocoon.
- Fertilization occurs in the cocoon.
- Ends of the cocoon are sealed, and the cocoon is deposited in moist soil.
- Spiral cleavage is modified.
- No larva forms.
- Hatching occurs in one to a few weeks, depending on the species.
- Freshwater oligochaetes also reproduce asexually.
- Asexual reproduction involves transverse division.

CLASS HIRUDINEA

GENERAL CHARACTERISTICS

- Contains approximately five hundred species of leeches.
- Most leeches are freshwater; others are marine or completely terrestrial.
- Leeches prey on small invertebrates or feed on the body fluids of vertebrates.

EXTERNAL STRUCTURE AND LOCOMOTION

- Leeches lack parapodia and head appendages.
- Setae are absent in most leeches.
- Leeches are dorsoventrally flattened and taper anteriorly.
- They have 34 segments.
- Several secondary divisions, called annuli, are in each true segment.
- Anterior and posterior segments are usually modified into suckers

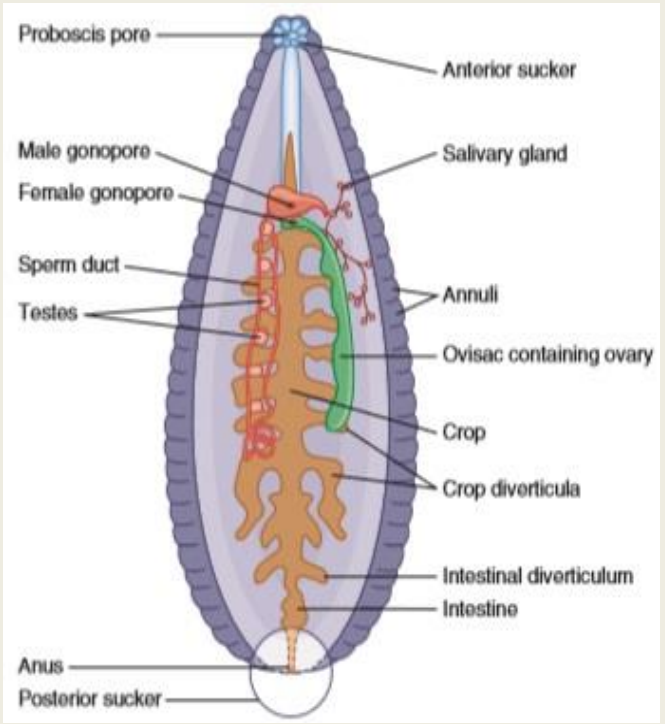

Fig: Internal Structure of a Leech.

EXTERNAL STRUCTURE AND LOCOMOTION

- A layer of oblique muscles is between the circular and longitudinal muscle layers.
- In addition dorsoventral muscles are responsible for leech flattening.
- The leech coelom has lost its metameric partitioning.
- Septa are lost
- connective tissue has invaded the coelom.
- Series of interconnecting sinuses.
- Leech has a single hydrostatic cavity and uses it in a looping type of locomotion.
- Leeches also swim using undulations of the body.

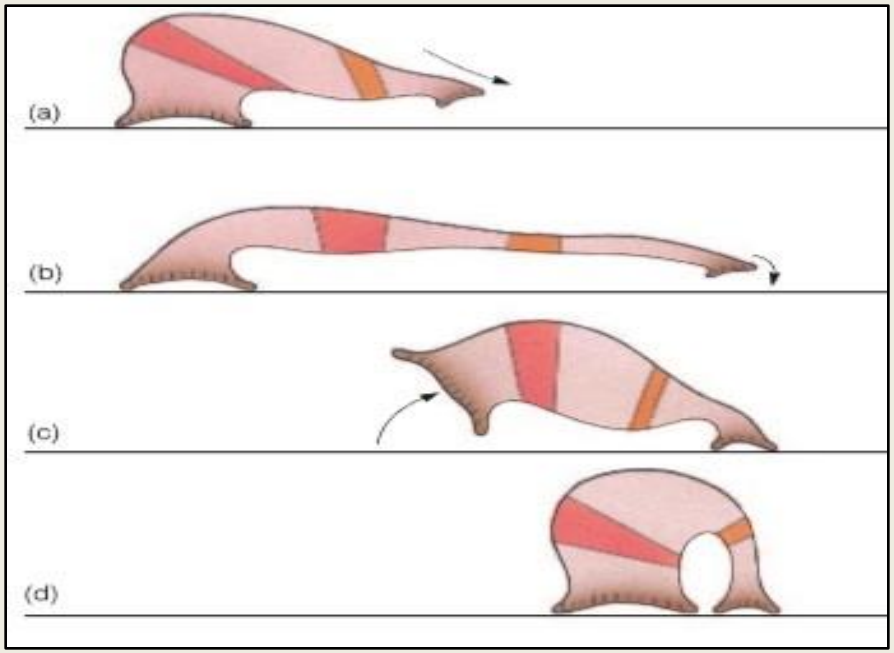

Fig: Leech Locomotion. (a,b) Attachment of the posterior sucker causes reflexive release of the anterior sucker, contraction of circular muscles, and relaxation of longitudinal muscles. This muscular activity compresses fluids in the single hydrostatic compartment, and the leech extends. (c,d) Attachment of the anterior sucker causes reflexive release of the posterior sucker, the relaxation of circular muscles, and the contraction of longitudinal muscles, causing body fluids to expand the diameter of the leech. The leech shortens, and the posterior sucker again attaches

FEEDING AND THE DIGESTIVE SYSTEM

- Many leeches feed on body fluids or the entire bodies of other invertebrates.
- Some feed on the blood of vertebrates, including human blood.
- Leeches are sometimes called parasites.
- The mouth of a leech opens in the middle of the anterior sucker.
- In some leeches, the anterior digestive tract is modified into a protrusible proboscis, lined inside and outside by a cuticle.
- In others, the mouth is armed with three chitinous jaws.
- While feeding, a leech attaches to its prey by the anterior sucker and either extends its proboscis into the prey or uses its jaws to slice through host tissues.

FEEDING AND THE DIGESTIVE SYSTEM

- **Salivary glands** secrete an anticoagulant called **hirudin** that prevents blood from clotting.
- a **muscular pharynx** pumps body fluids of the prey into the leech.
- The **esophagus** leads to a large stomach with **lateral cecae**.
- Most leeches ingest large quantities of blood or other body fluids and gorge their stomachs and lateral cecae, increasing their body mass **2 to 10 times.**
- After engorgement, a leech can tolerate periods of fasting that may **last for months**.
- The digestive tract ends in a **short intestine** and **anus**.

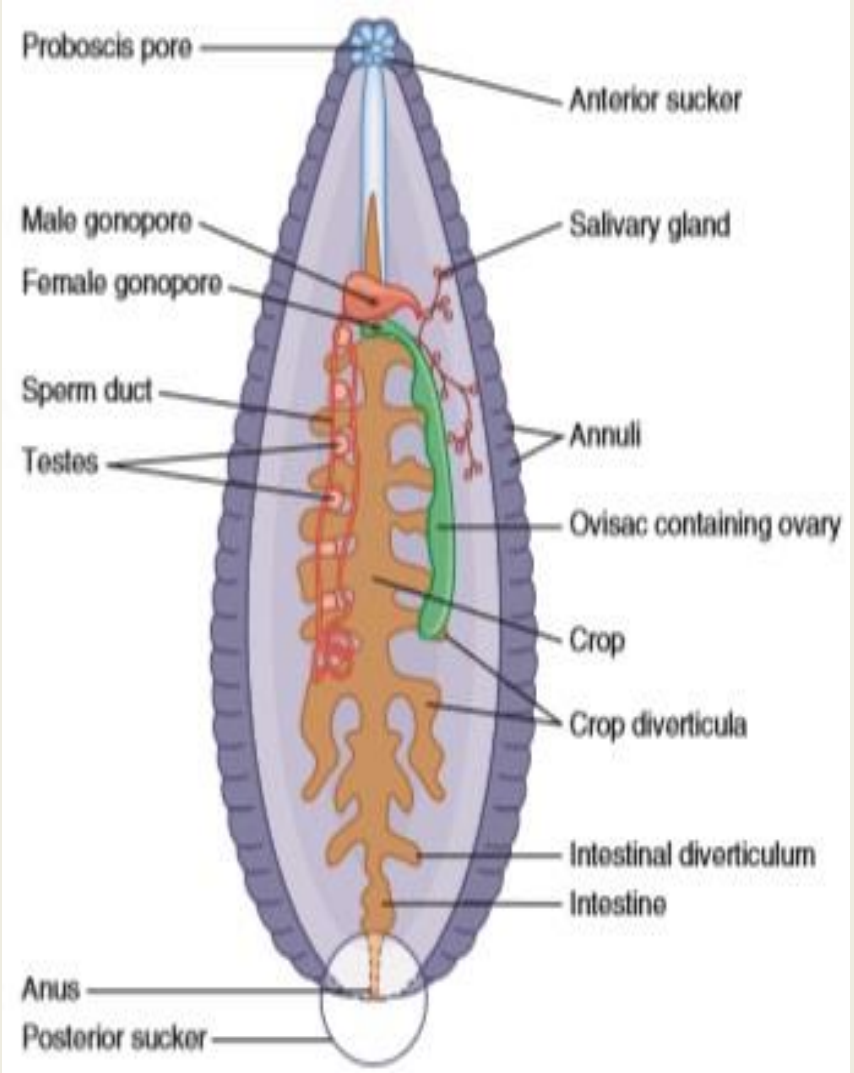

Fig: Internal Structure of a Leech. Annuli subdivide each true segment. Septa do not subdivide the coelom.

GAS EXCHANGE AND CIRCULATION

- Leeches exchange gases across the body wall.
- In most leeches, circulatory pattern is highly modified.
- Coelomic sinuses replace vessels.
- Coelomic fluid has taken over the function of blood and, except in two orders, respiratory pigments are lacking.

NERVOUS AND SENSORY FUNCTIONS

- The leech nervous system is similar to that of other annelids.
- Ventral nerve cords are unfused, except at the ganglia.
- The suprapharyngeal and subpharyngeal ganglia and the pharyngeal connectives all fuse into a nerve ring that surrounds the pharynx.
- Ganglia at the posterior end of the animal fuse in a similar way.

NERVOUS AND SENSORY FUNCTIONS

- Most leeches have photoreceptor cells in pigment cups (2 to 10) along the dorsal surface of the anterior segments.
- Normally, leeches are negatively phototactic
- When they are searching for food, they become positively phototactic.
- *Hirudo medicinalis*,the medicinal leech, has a well-developed temperature sense.
- All leeches have sensory cells with terminal bristles in a row along the middle annulus of each segment.
- Sensory cells, called sensory papillae, are of uncertain function but are taxonomically important

EXCRETION

- Leeches have 10 to 17 pairs of metanephridia, one per segment in the middle segments of the body.
- Their metanephridia are highly modified.
- In addition to the nephrostome and tubule, a capsule believed to be involved with the production of coelomic fluid.
- Chloragogen tissue proliferates through the body cavity of most leeches

REPRODUCTION AND DEVELOPMENT

- All leeches reproduce sexually and are monoecious.
- They have a single pair of ovaries and from four to many testes.
- Leeches have a clitellum that includes three body segments and present only in the spring, when most leeches breed.
- A penis assists sperm transfer between individuals.
- A few leeches transfer sperm by expelling a spermatophore from one leech into the integument of another, a form of hypodermic impregnation.
- Cocoons are deposited in the soil or are attached to underwater objects.
- There are no larval stages.
- the offspring are mature by the following spring.