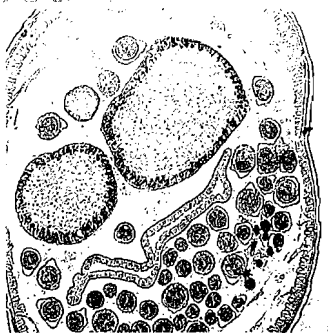
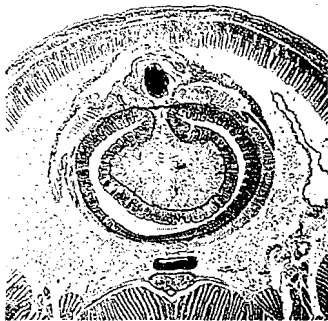
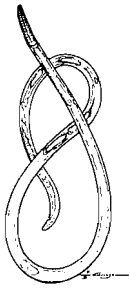


Kingdom Animalia: Platyhelminthes, Nematoda, Rotifera, and Annelida Phyla

OBJECTIVES *After completing this exercise, the student should be able to:*



- List the advantages of the members of the phylum Platyhelminthes over the members of phylum Porifera and phylum Cnidaria.
- Identify the anatomical structures of planarians, flukes, and tapeworms.
- List, cite an example of, and identify the major characteristics of each of the three classes of the phylum Platyhelminthes.
- Name the phylum and class of each of the animals in the jars on display.
- Describe two evolutionary advantages possessed by members of both the phylum Nematoda and the phylum Rotifera.
- Examine the cross-section slide of the roundworm *Ascaris* and identify its component parts.
- Distinguish between a male and a female nematode.
- Examine the rotifer slide and identify the “wheels” and the “forked foot.”
- List, cite an example of, and identify the major characteristics of each of the three major classes of the phylum Annelida.
- Distinguish between a pseudocoelom and a true coelom, and explain the advantage of possessing a true coelom.
- Dissect an earthworm and identify the anatomical parts boldfaced in the directions.
- On the earthworm cross-section, identify the structures described in the text.
- Explain the reproductive system of the earthworm.

Phylum Platyhelminthes

Members of the phylum Platyhelminthes are commonly referred to as the flatworms. As the name implies, they are flattened dorsoventrally. The flatworms have many advantages over the Porifera and Cnidaria (the topics of Chapter 22), such as:

1. Bilateral symmetry.
2. A complex organ-system level of organization.
3. A mesodermal germ layer, which results in their being referred to as **triploblastic** in general structure.
4. A central nervous system showing **cephalization**.
5. A distinct head with sense organs.

Other characteristics of this phylum include

- the absence of a body cavity, referred to as **acoelomate**
- the absence of an anus
- the combining of sexes within single animals, called **hermaphroditism**.

Platyhelminthes have both parasitic and free-living forms and is subdivided into three classes: Class Turbellaria, Class Trematoda, and Class Cestoda.

CLASS TURBELLARIA

Class Turbellaria encompasses the free-living flatworms, an example of which is *Dugesia*, the common planaria. Members of this class are found under rocks or attached to submerged objects in the clear water of lakes, springs, and streams.

Obtain and examine a prepared slide of the freshwater planaria (see Figure 23.1). In your examination, note the general body shape, with special attention to the head, eyespots, and auricles (lateral projections on the head that function as tactile and chemosensory organs in the anterior region). On this slide the digestive system is stained by feeding the worms India ink before preserving them, which clearly demonstrates the branching of the **gastrovascular cavity**. Identify the muscular **pharynx**, or **proboscis**, which is withdrawn into the pharyngeal pouch in the middle area of the body. This pharynx may be extended out of the body while feeding.

Using a concave depression slide, prepare a wet mount of living planaria. *Cover with a coverslip*. Notice the general shape and the mode of locomotion of the flatworm. Feeding the planaria with bits of liver is optional. After viewing the planaria, return them to the container marked "Fed Planaria." Also examine the preserved specimens on display in jars.

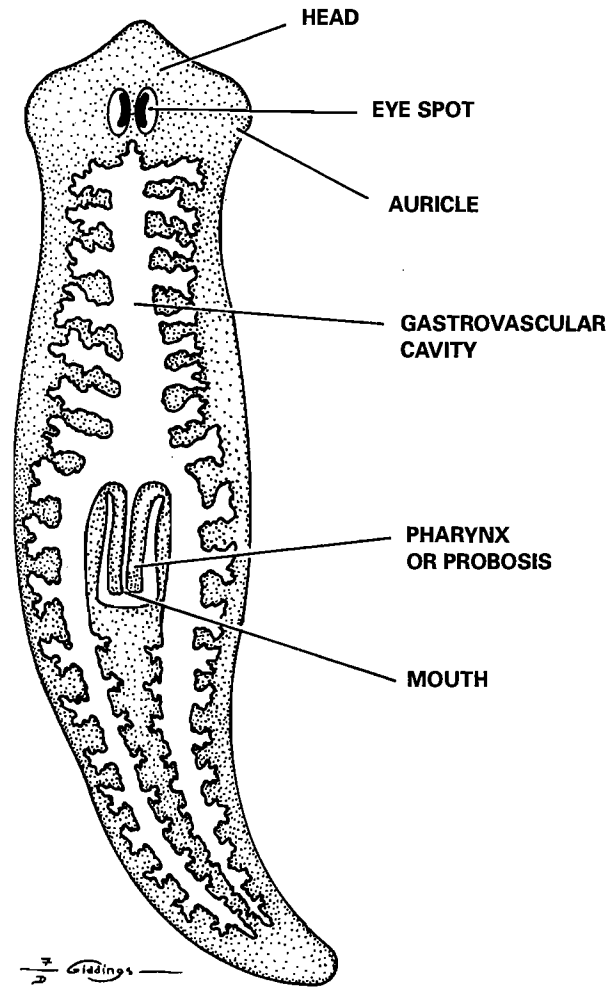


Figure 23.1 Planaria: Digestive System

CLASS TREMATODA

Class Trematoda is composed of parasitic flatworms known as the flukes. They have evolved a thick, protective outer layer of non-living substance known as the **cuticle**, which is secreted by the epidermis and protects the organism from being digested by the host's digestive enzymes.

Examine the slide of *Clonorchis sinensis* (whole mount) under low power. *Clonorchis*, the Chinese liver fluke, possesses an anterior **oral sucker** and a large **ventral sucker**. Beginning anteriorly at the oral sucker, trace the digestive tract to the short muscular **pharynx**, and then to the forked **gastrovascular cavity**. The reproductive system includes a mass of **testes** at the posterior end. Sperm that is produced here move through a duct to the **genital pore** just anterior to the ventral sucker. Eggs are produced in an **ovary**, anterior to the testes. In front of the ovary is a large convoluted duct called the **uterus**, which serves as a storage area for fertilized eggs.

On Figure 23.2, label the anatomical structures of the Chinese liver fluke that are identified in boldface type in the preceding paragraph. Also examine the preserved specimens of trematodes in jars.

CLASS CESTODA

Class Cestoda includes the tapeworms, all of which are parasitic. Examine the preserved specimens on display and obtain a prepared slide of *Taenia pisiformis*, the dog and cat tapeworm. This organism is transmitted by ingesting infected fleas and also may infect humans in this way.

Examine the stained slide and, with the help of Figure 23.3, identify the following areas and their associated structures.

1. **Scolex**, or head with **rostellum**: attaches to the intestinal wall of the host, has rows of **hooks** and four **suckers**.
2. **Neck**: has no segmentation and represents a growing area.
3. The body, or **strobila**: consists of units called **proglottids**.

The **proglottids** behind the neck are young, or immature, and contain only the male sex organs, whereas **proglottids** in the middle region are mature and contain both male and female sex organs. At the posterior end, the **proglottids** lack male reproductive organs as they have disintegrated and the **proglottids** in this region are **gravid**, or “ripe” sections filled with fertilized eggs, which will become detached and pass out of the host via the feces, to be picked up by another successive host.

Phylum Nematoda

Phylum Nematoda consists of the unsegmented roundworms. Although some are parasitic, most are free-living. This phylum is advanced over the ones previously studied in that animals in this phylum possess a *complete digestive tract*, which has two openings—a mouth and an anus, allowing for one-way passage of ingested food.

A second advancement is the presence of a body cavity. This cavity is not a true **coelom** because it does not lie between layers of **mesoderm**. The cavity, called a **pseudocoelom** (pseudo = false; coelom = body cavity) is found between the outer body wall and the digestive tube. A unique characteristic of this group is that each animal has a limited number of cells in its body. This specific number of cells is characteristic of its species. Animal growth in this phylum beyond the embryo stage is attributable to cell growth rather than cell multiplication as in other phyla. The musculature consists mainly of longitudinal muscles, which cause the animals to move in a whiplike fashion.

1. Examine the display jars containing specimens of *Ascaris*, a common roundworm found as a parasite in humans and pigs. These worms feed on the contents of the intestinal tract. Some damage may be done to their host by their thrashing motion or by clogging the intestinal tract if present in large numbers. The male is smaller than the female and is curved at the posterior end. Also, at the posterior end of the male are **spicules**, tiny bristles that aid in copulation. The **cuticle**, or outermost covering of the worm, is important in protecting the animal from the digestive enzymes of its host and in acting as an exoskeleton to which muscles

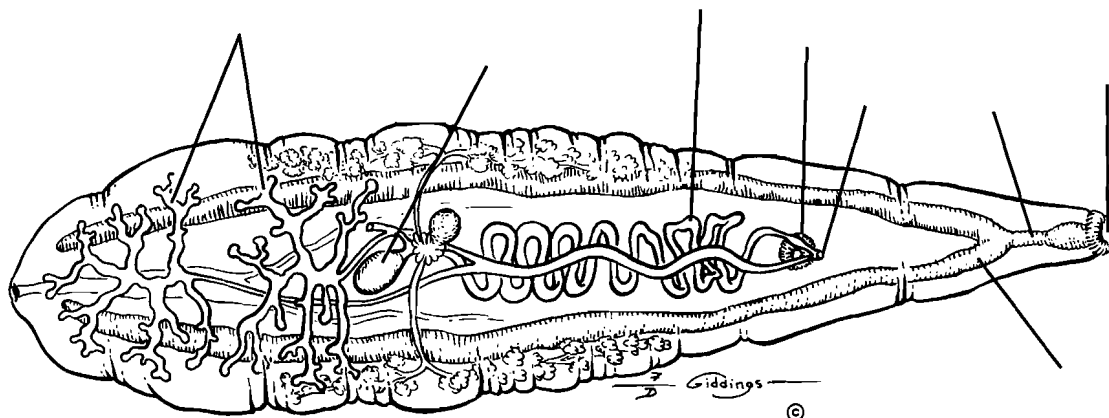


Figure 23.2 Chinese Liver Fluke, *Clonorchis sinensis*

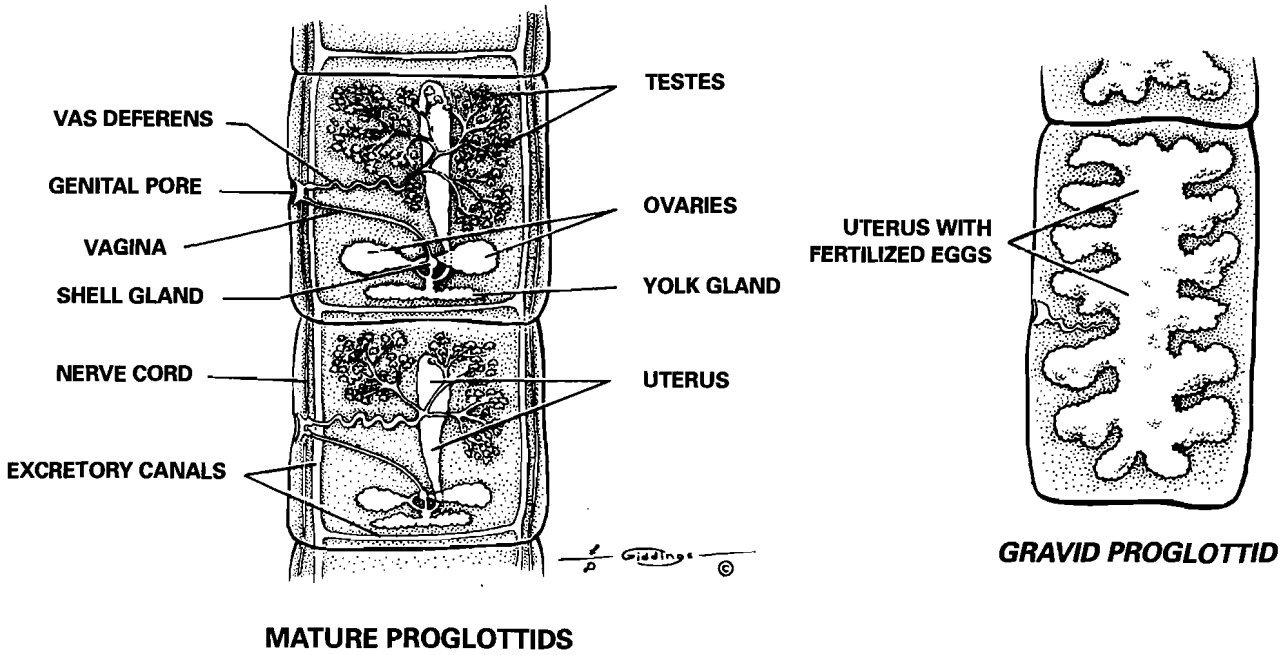
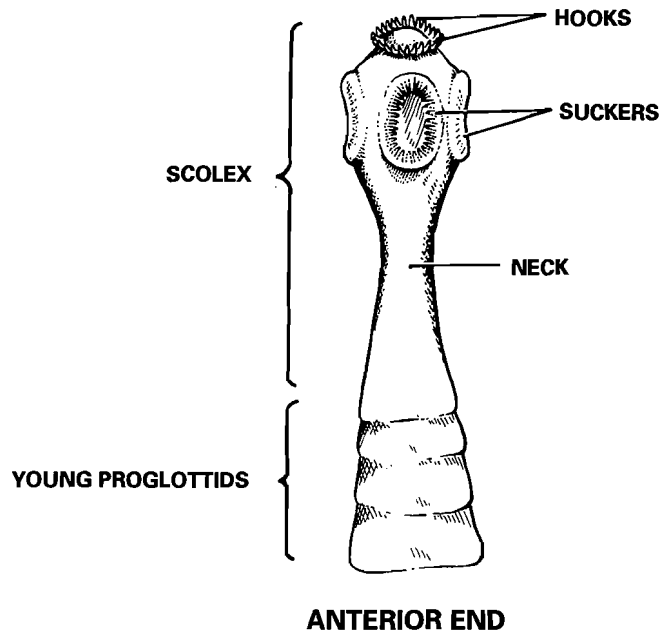


Figure 23.3 Tapeworm, *Taenia pisiformis*

are attached. Sketch the male and female *Ascaris* below.

- Examine an *Ascaris* male cross-section slide and a female cross-section slide. Referring to Figure 23.4, identify the following parts: pseudocoel, testis, ventral and dorsal nerve cords, cuticle, intestine, ovary, eggs, and uterus.
- Examine slides of *Ancylostoma*, a human hookworm. The anterior end has hooks with which it attaches to the intestinal wall of the host. Unlike *Ascaris*, the hookworm feeds on its host's blood. You can distinguish the male from the female by looking at the posterior end of the worm, which in the male is modified for copulation by way of a fanlike structure called a bursa. Sketch the male and female hookworms, indicating the anterior and posterior ends.

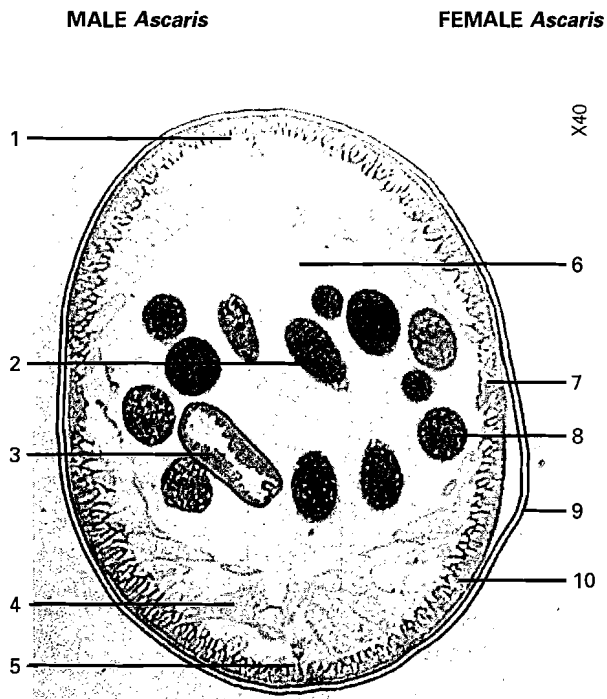


Figure 23.4A Roundworm, *Ascaris*, Male, Cross-Section

- | | |
|----------------------------------|---------------------------------------|
| 1. Dorsal nerve cord | 7. Lateral line |
| 2. Vas deferens | 8. Testis |
| 3. Intestine | 9. Cuticle |
| 4. Longitudinal muscle cell body | 10. Contractile sheath of muscle cell |
| 5. Ventral nerve cord | |
| 6. Pseudocoel | |

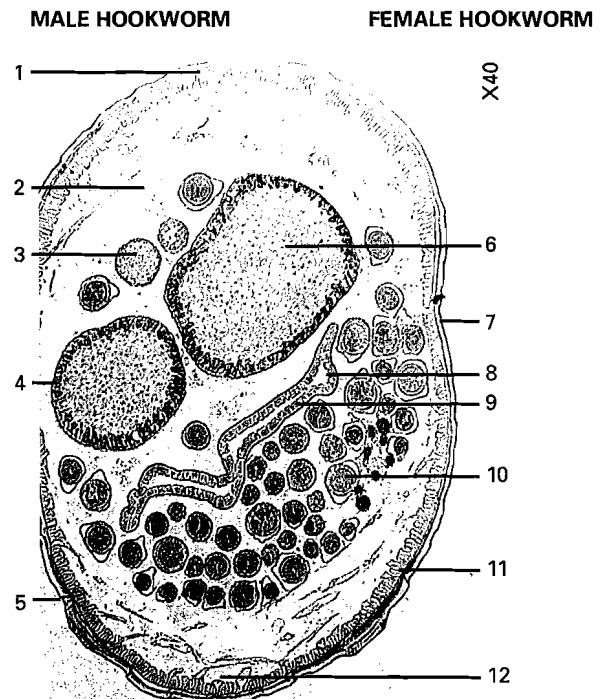


Figure 23.4B Roundworm, *Ascaris*, Female, Cross-Section

- | | |
|----------------------|--------------------------|
| 1. Dorsal nerve cord | 7. Lateral line |
| 2. Pseudocoel | 8. Lumen |
| 3. Oviduct | 9. Intestine |
| 4. Uterus | 10. Ovary |
| 5. Cuticle | 11. Longitudinal muscles |
| 6. Eggs | 12. Ventral nerve cord |

4. Examine a slide of the voluntary muscle fibers of rat or man containing specimens of encysted *Trichinella spiralis*. This roundworm forms cysts in the muscle of hogs and may infect humans who eat insufficiently cooked pork. The cyst causing trichinosis, which you observe on the slide, is only one stage in the life cycle of this animal. Try to locate the muscle tissue of host, cyst wall, and worm.

Other representatives of this phylum, such as pinworms, filarial worms, the human whipworm, vinegar "eels," and heartworm in dogs, to mention only a few, may be discussed in class.

5. Examine pond water for free-living nematodes. You should be able to identify them by their whip-like thrashing motion. Figure 23.5 illustrates these nematodes. Attempt to isolate one on a slide and examine it more closely. Write a brief description of the nematode below.

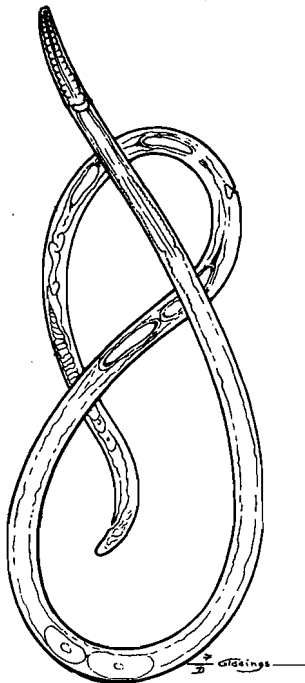


Figure 23.5 Free-Living Nematode

Phylum Rotifera

The rotifers, or "wheel-bearing animalcules," usually are less than 1 mm. in length and usually are found in freshwater. Most of the 1,500 species of Rotifers are free-living, a few are parasites, and a few inhabit saltwater. Members of this phylum possess both a complete digestive tract and a pseudocoelom. The distinguishing characteristics of the animals included in this phylum are:

1. "Wheels" of beating cilia on the anterior end of the body.
2. Absence of external cilia elsewhere.
3. A chewing pharynx or **mastax**, which is used for grinding the ingested food particles.
4. A "forked foot" on the posterior end of the body.
5. Growth beyond the embryo stage by cell growth rather than by cell multiplication.

Examine a slide of a Rotifer whole-mount. Identify the wheels and the forked foot. Use Figure 23.6 to help you.

Examine pondwater for aquatic rotifers. If they are moving quickly, add a drop of Protoslo to the slide under the coverslip. Write a brief description of a rotifer here.

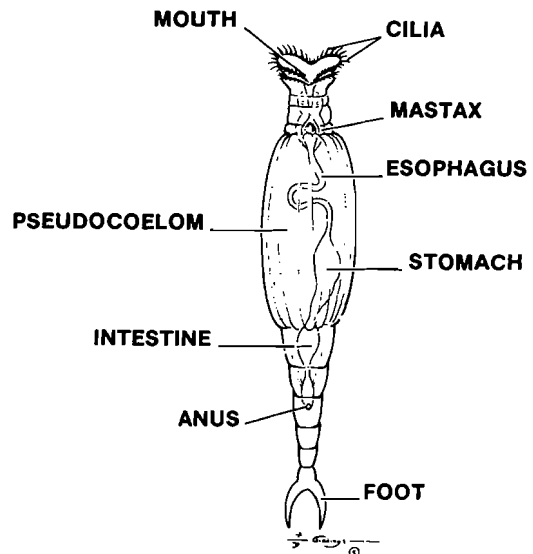


Figure 23.6 Rotifer

Phylum Annelida

The phylum Annelida consists of approximately 7,000 species of segmented worms, divided into four classes:

1. *Polychaeta*, the marine bristleworms and sand-worms
2. *Hirudinea*, the leeches
3. *Oligochaeta*, the earthworms
4. *Archannelida*, a small, primitive group of tiny marine worms.

Study the specimen jars on display for the first three classes.

A unique feature of the phylum Annelida not seen previously in the organisms studied is the presence of a true body cavity, the coelom, which is completely lined by mesodermal tissue. With a true body cavity the digestive tract is independent from the muscles of the body wall. Therefore, rhythmic contraction of these muscles, called **peristalsis**, allows food to be moved through the digestive tract without movement of the entire animal.

CLASS POLYCHAETA (MANY BRISTLES)

The polychaetes represent the largest class of annelids. They possess fleshy tentacles on the head, and two fleshy appendages, **parapodia**, on each segment except the first and last. Many setae, or chitinous bristles, are found on the parapodia, which are used for swimming, burrowing, crawling, and gas exchange. Figure 23.7 depicts the clamworm. Examine the polychaetes on display.

CLASS HIRUDINEA

The leeches lack tentacles, parapodia, and setae. Many of the members of this class are parasitic and inhabit freshwater. An interesting feature of the leeches is that they have two muscular suckers—small anterior suckers that surround their mouth, and large posterior suckers used in locomotion and attachment.

Examine the slide of a leech and locate the structures indicated in Figure 23.8. Examine the leeches on display.

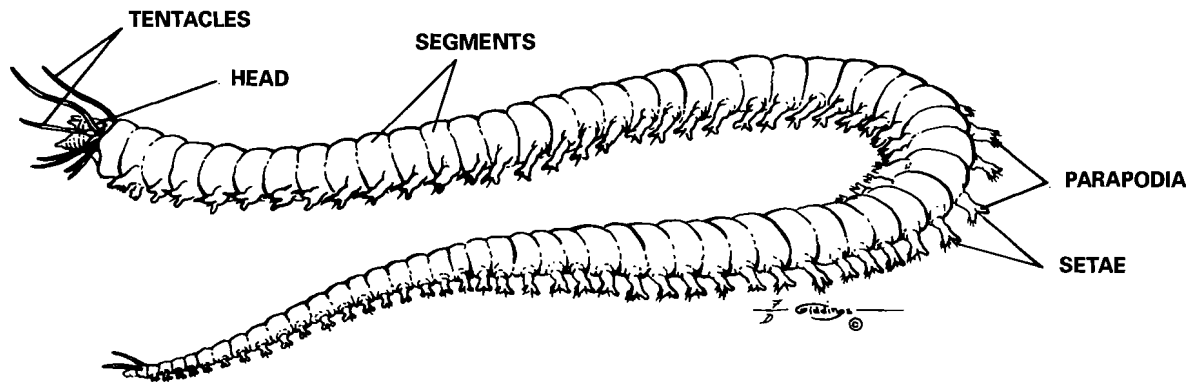


Figure 23.7 Clamworm

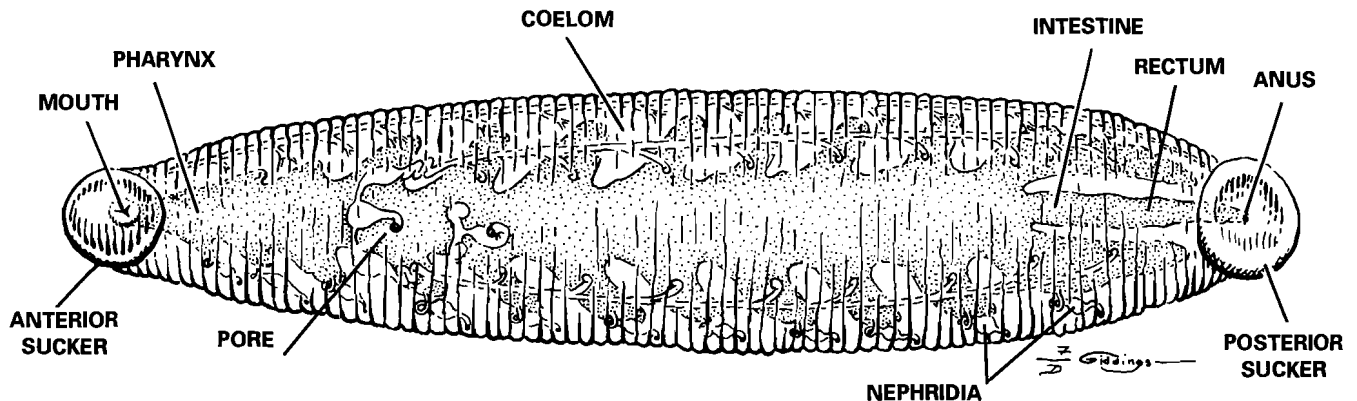


Figure 23.8 Leech

CLASS OLIGOCHAETA (FEW BRISTLES)

Members of the class Oligochaeta inhabit damp soil and freshwater. They are somewhat degenerate annelid types with the head and locomotor structures greatly reduced. They lack parapodia, having only setae.

The earthworm will be studied extensively in lab. Before you start dissecting, read the directions carefully. The diagrams are intended to help you find the anatomical parts, and you may ask your instructor for assistance, too. You must be able to identify the parts in the dissected animal and not just memorize the labels on the figures.

External Anatomy of the Earthworm

Obtain a specimen of *Lumbricus* (the "night-crawler" earthworm) and run your fingers over the surface of its body. Do you note any differences between the resistance to the motions of your fingers in different directions? This is caused by the presence of the setae on the ventral and ventrolateral surfaces. Place the worm on moist paper toweling in a dissecting pan. Refer to Figures 23.9, 23.10, and 23.11 as you perform the dissection.

The most obvious feature of the earthworm is its segmentation. The very small first segment overhangs the mouth and is known as the **prostomium** (meaning in front of the mouth). Note that it does not have a corresponding ventral portion. Beginning with the next segment (the first complete one) in Figure 23.9, we will assign numbers to the segments for convenience. Several segments, beginning with number 32 or 33, are swollen because of large hypodermal glands responsible for the formation of the **cocoon**. These swollen segments comprise the **clitellum**, which is located anteriorly. This structure is not as obvious from the ventral surface as it is from the dorsal surface. The anus is located at the end of the last segment.

With the aid of a stereomicroscope, determine the number and location of the setae and their orientation on a segment. Locate the openings of the sperm ducts or vasa deferentia which lie ventrolaterally on segment 15 (See Figure 23.10); they are a pair of transverse slits lying between two swollen lips. The oviduct openings are similarly located on segment 14 but are less conspicuous.

Place the worm, *ventral side down*, in a dissecting pan. Carefully pin your specimen through the prostomium and the posterior segment. Make a short, longitudinal incision in the dorsal midline, forward through the body wall from a short distance back of the clitellum to the anterior end. Be very careful not to cut through more than just the body wall, noting the septa (thin membranes). Pin the body flat by placing the pins in every fifth segment, and lean each pin toward the outer edges of the pan so your view will be unobstructed.

Internal Anatomy

CIRCULATORY SYSTEM

The earthworm has a circulatory system consisting of five pairs of hearts surrounding the esophagus, one pair each in segments 7 through 11 (see Figure 23.10). The hearts usually are black. The dorsal blood vessel, located along the middorsal line above the digestive tract, carries blood anteriorly. If you cannot see it at this stage, do not cut away to find it; search later. You will see smaller blood vessels on the outer surface of the gut and the inner surface of the body wall.

DIGESTIVE SYSTEM

Identify the mouth and the **buccal cavity**, which extend through the first three segments. More conspicuous is the **pharynx**, a thick muscular organ with accessory lubricating glands inside, occupying segments 3 to 5. From this segment to segment 14 is the relatively slim **esophagus**. In segments 15 through 17,

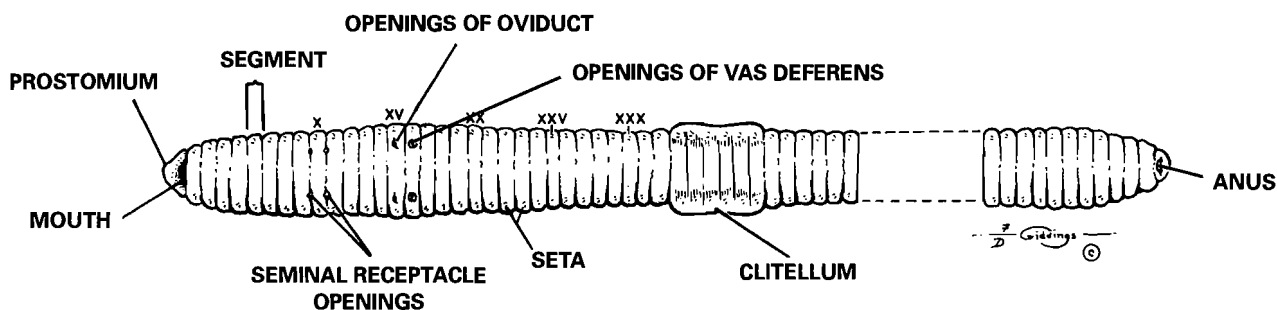


Figure 23.9 Earthworm: Ventral View

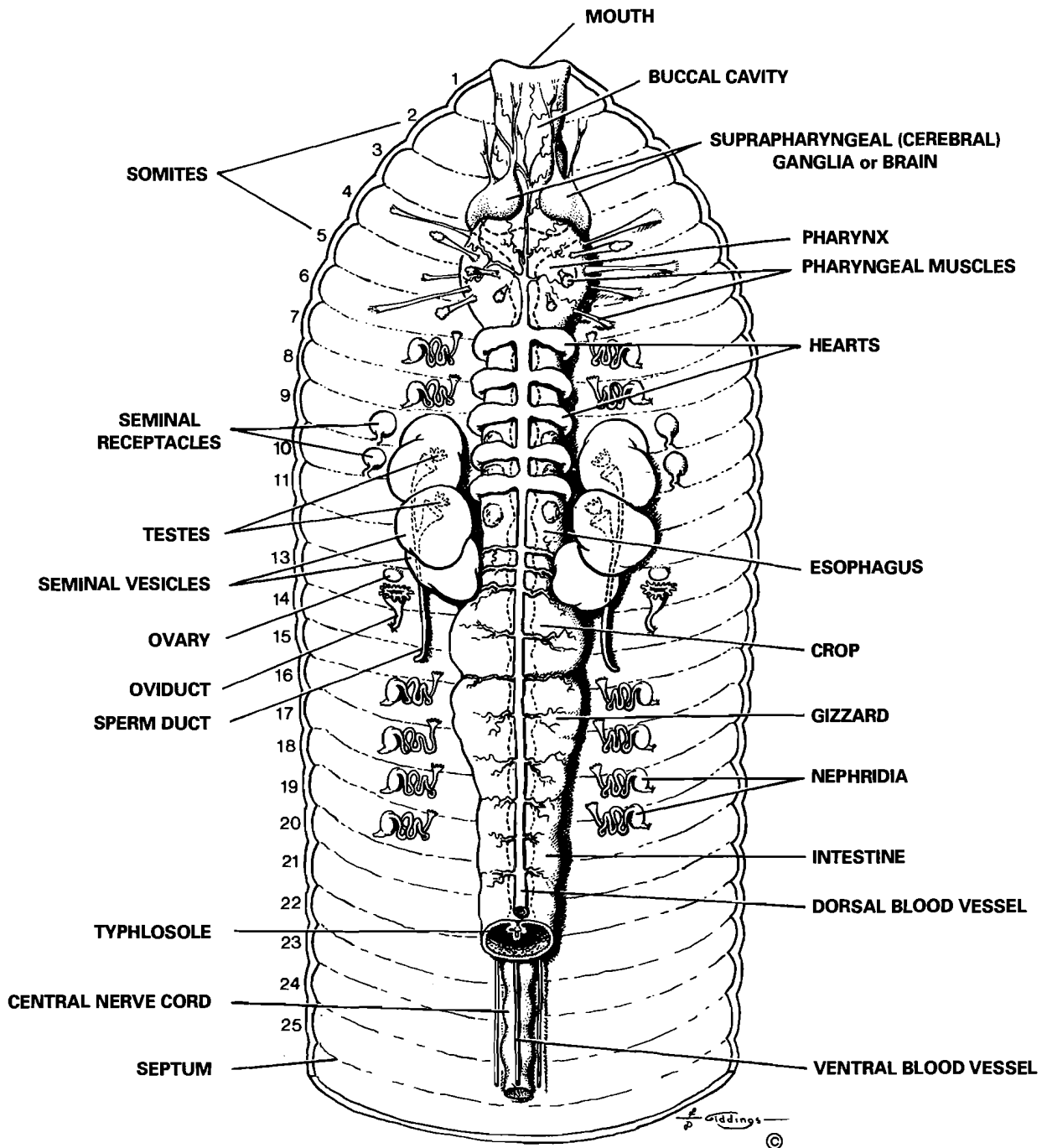


Figure 23.10 Earthworm: Dorsal Dissection

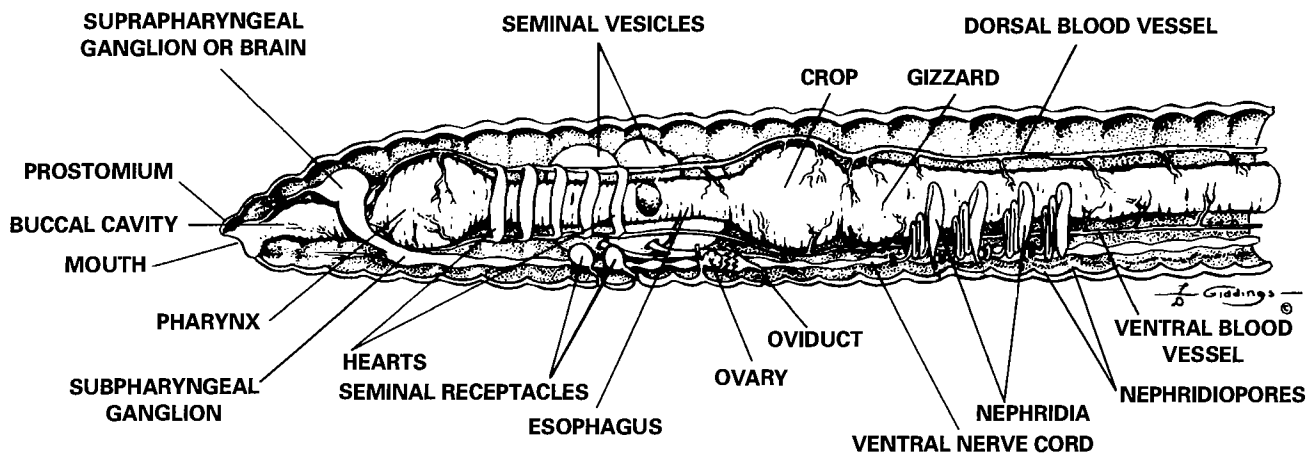


Figure 23.11 Earthworm: Lateral Dissection

the digestive tract expands into the **crop**, where food is stored. Posterior to the crop is a thick-walled **gizzard**, a mastication organ. Using your probe, feel the difference in the walls of the crop and gizzard. How are they different? _____

The intestine is located beyond the gizzard and leads to the **anus**. Most digestion and absorption takes place in the intestine. It is well supplied with secretory cells. The inner surface area of the intestine through which absorption can take place is greatly increased by two devices—segmental constrictions and the **typhlosole**, which is an internal longitudinal ridge of the intestinal wall. Refer to Figure 23.10 to help you find the typhlosole.

EXCRETORY SYSTEM

Each segment, except for the first three and the last, has a pair of white tubular excretory organs, the **nephridia**, which lie lateral to the gut. Each organ opens to the outside through its own duct and pore. These pores are difficult to see. The nephridia act like tubules in a human kidney. By filtration, reabsorption, and tubular secretion, they yield protein-free urine and maintain the steady state of the body.

NERVOUS SYSTEM

Extend the middorsal incision from the clitellum toward the anus. Remove the intestine carefully to expose the ventral nerve cord located beneath the ventral blood vessel. **Ganglia** (singular: ganglion) are present along the cord in each segment and handle much of the coordination of these animals without intervention of the main brain. The nerve cord and the ganglia are difficult to see in worms. You should

see (unless you accidentally cut it away) the brain, composed of a pair of white ganglia above the pharynx in segment 3. These communicate with the ventral nerve cord through a pair of circumpharyngeal connectives.

REPRODUCTIVE SYSTEM

The most obvious portions of the *male reproductive tract* are the two three-lobed **seminal vesicles**, or sperm reservoirs (see Figure 23.11), usually cream-white in color. Fastened ventrally and extending dorsally around each side of the esophagus, they include the two small testes within them. Sperm are freed from the testes and complete their development in the seminal vesicles. They are passed out through funnel-shaped mouths of the vas deferens or sperm ducts, also well hidden by the vesicles.

The *female reproductive tract* is composed of ovaries, egg sac, and oviduct, all difficult to distinguish. Despite the fact that these worms do not have separate sexes, they cannot fertilize themselves. Copulation must occur. But with both sexes in a single animal, any two worms that meet can copulate (obviously a convenient situation). A sperm transfer then occurs in both directions. After transfer, sperm are stored in seminal receptacles, located in segments 9 and 10, until needed to fertilize eggs in cocoons.

Each earthworm produces a cocoon containing eggs. For each cocoon, a slime tube is secreted around the clitellum and anterior somites, and within the cocoon forms as a separate secretion over the clitellum. The tube and cocoon then slip forward, and sperm to fertilize the eggs enter when the cocoon passes over the seminal receptacles. As the worm withdraws from the tube, the cocoon closes into a lemon-shaped case that is deposited in the damp soil. Each cocoon has several fertilized eggs of which one or two develop.

CROSS-SECTION OF AN EARTHWORM

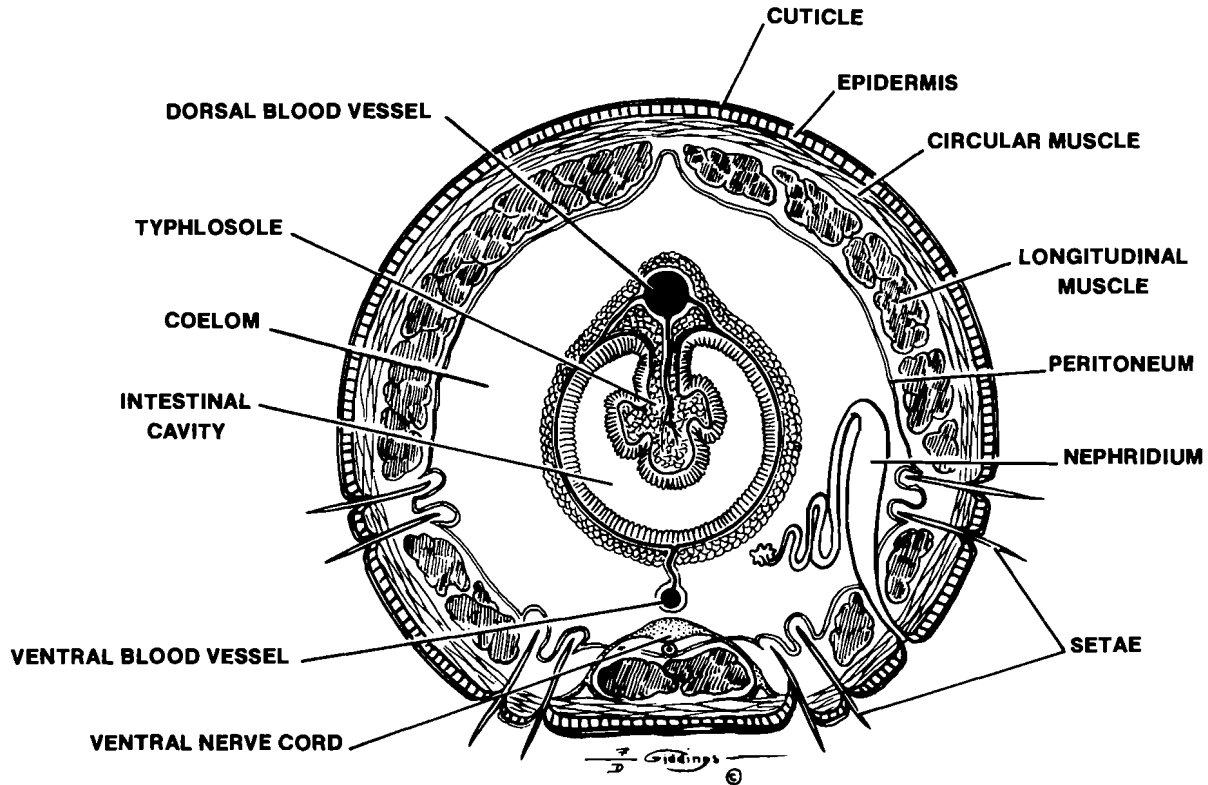
On a prepared slide, note the following structures, referring to Figure 23.12:

1. *Body wall* (beginning with the outermost layer)

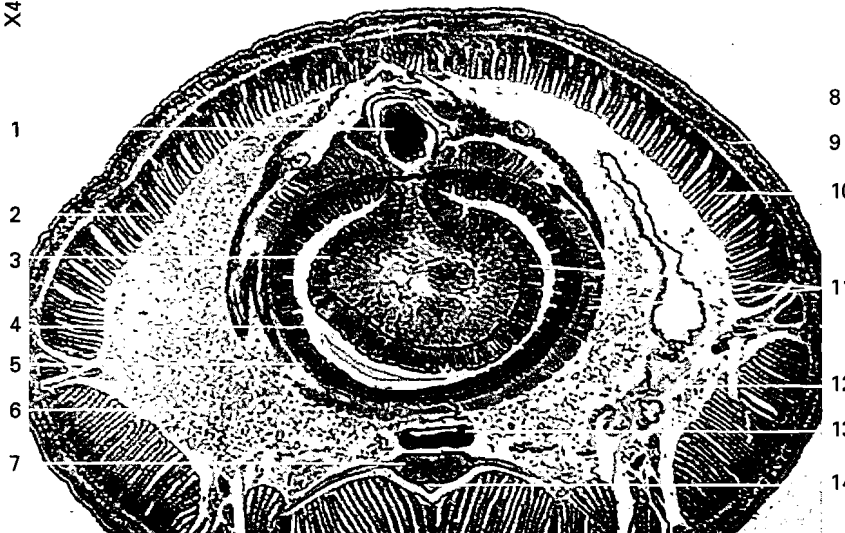
- a. Cuticle: thin external chitinous layer
- b. Epidermis: outer cellular layer, which contains epithelial cells

c. Circular muscle layer: located just beneath the epidermis, with the fibers cut longitudinally in the section

d. Longitudinal muscle layer: these fibers are arranged in blocks of feather-like bundles extending toward the center; they are cut transversely



X40



- 1. Dorsal blood vessel
- 2. Peritoneum
- 3. Typhlosole
- 4. Lumen of intestine
- 5. Intestine
- 6. Coelom
- 7. Ventral nerve cord
- 8. Epidermis
- 9. Circular muscles
- 10. Longitudinal muscles
- 11. Chloragogenous cells
- 12. Nephridium
- 13. Ventral blood vessel
- 14. Subneural blood vessel

FIGURE 23.12 Earthworm, *Lumbricus*, Cross-Section, Posterior to Clitellum

- e. Peritoneum: a thin epithelial lining, separating the body cavity from the body wall.
 - f. Coelom: the body cavity
2. *Intestine*
- a. Typhlosole: dorsal invagination of the intestine
3. *Blood vessels:*
- a. Dorsal vessel: just above the intestine
 - b. Ventral vessel: just below the intestine
4. *Other structures:*
- a. Ventral nerve cord: positioned ventrally between the body wall and the ventral blood vessel
 - b. Nephridia: segmental excretory organs, within the coelom, between the intestine and the body wall; in these sections, only incomplete portions of nephridia can be seen, usually appearing as wavy lines.
 - c. Setae: two pairs ventrally and two pairs ventrolaterally projecting from the body wall.

Review Questions

1. List the three major classes of flatworms, and give an example of each.
- a. _____
 - b. _____
 - c. _____
2. Why do tapeworms not need a digestive system? _____
- _____
3. Identify each of the following terms:
- Immature proglottid _____
- Mature proglottid _____
- Gravid proglottid _____
- Scolex _____
- Strobila _____
4. Distinguish between an incomplete and a complete digestive system, and give an example of an animal having each. _____
- _____
- _____
- _____

5. Distinguish between a pseudocoelom and a true coelom, and give an example of an animal that possesses each. _____

6. List three examples of parasitic nematodes.
 - a. _____
 - b. _____
 - c. _____
7. List four distinguishing characteristics of the Phylum Rotifera.
 - a. _____
 - b. _____
 - c. _____
 - d. _____
8. What is the function of the typhlosole in an earthworm? _____
9. What is the function of the seminal vesicles in an earthworm? _____
10. How many setae per segment are found in an earthworm? _____
11. What is the function of the earthworm's clitellum? _____
12. Diagram the digestive system of an earthworm, label all of its specialized structures, and give the function of each.

13. Describe four external features by which the ventral surface of an earthworm can be distinguished from the dorsal surface.

- a. _____
- b. _____
- c. _____
- d. _____

14. Describe three external features by which one can distinguish the anterior end of from the posterior end of an earthworm.

- a. _____
- b. _____
- c. _____

15. Complete the following chart:

	Porifera	Cnidaria	Platyhelminthes	Nematoda	Annelida
Level of organization	cellular	tissue			
Symmetry	radial	radial			
Tissue layer	none	epidermis gastrodermis			
Nervous system	none	none			
Body cavity	no	no			
Complete digestive tract	no	no			
Unique characteristic					