

Earthworms (*Lumbricus terrestris*) are representative animals of the phylum Annelida. Examining external and internal structures of an earthworm will reveal some major annelid characteristics. *Lumbricus* is an excellent animal for study because of its body organization. An earthworm is a segmented animal. Its body plan consists of many rings (annellus means "ring" in Latin). Each segment, or

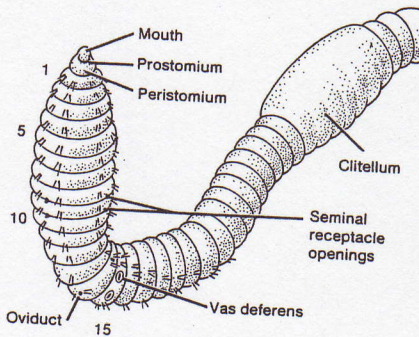
ring, of an earthworm is numbered in sequence from anterior to posterior end. Organs can be located by finding the particular segments they are known to be in. An earthworm "map" lists the location of each organ or structure by segment number.

Give the scientific name for the earthworm:

Name the phylum to which the earthworms belong: _____ Describe the origin of the phylum name: _____

Tell how the organs are located in the earthworm: _____

Members of the phylum Annelida are the most complex of the worms. The bodies of annelids consist of many segments, or sections. In annelids, the mouth is located between the first and second segments that form the prostomium. Covering each segment is a thin cuticle that is secreted by the epidermis. Each segment has a ring of circular muscle that enables the segment to elongate. Beneath this muscle are several bands of longitudinal muscles that shorten and thicken. These muscles and bristlelike structures on the surface of the annelid aid in movement. Between the body wall and the digestive tract is a cavity called the coelom. The annelid circulatory system is well developed. Aortic arches above the esophagus pump blood within the blood vessels to all parts of the body. Paired nephridia remove wastes from the annelid. The nervous



system consists of a pair of ganglia extending ventrally from the bilobed brain below the esophagus and joining to become the ventral nerve cord. In the earthworm, a typical annelid, the reproductive system is more complex than other annelids. Although the earthworm contains male and female reproductive organs, it cannot fertilize its own eggs. Instead, the earthworm must exchange sperm cells with another earthworm.

Tell where the prostomium is located: _____

Tell where the cuticle is found: _____

Tell where the coelom is located: _____

Tell what it means if an organism has a coelom: _____

Name the "hearts" the earthworm uses to pump blood through its closed circulatory system: _____

Tell what nephridia do: _____

External Anatomy

Line a waxed dissecting pan with a single sheet of folded newsprint.

Obtain a preserved earthworm specimen, rinse it thoroughly with water to remove excess preservative, and place it in the pan.

Locate the clitellum, a thick band located about one-third the length of the body. The anterior end is the end closest to the clitellum, the other end is the posterior end. Locate the anterior and posterior end of your specimen. Also locate the dorsal (back) and ventral (belly) surfaces of the earthworm. The dorsal surface is darker and more rounded than the ventral surface.

How many segments are located between the anterior end and the clitellum? _____

How does the dorsal surface of the earthworm differ from the ventral surface? _____

Tag the following structures using dissecting pins and paper tags. (Call your instructor when you have the tags in place so the location of each part can be verified. While waiting, you can read ahead, but tag only ONE section at a time.):

Clitellum, anterior end, posterior end, dorsal surface, ventral surface. Verified _____

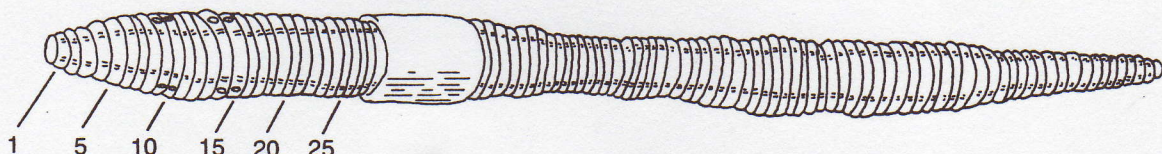
Gently rub your finger over the ventral surface and along the sides of the earthworm. Rub from the posterior end to the anterior end. Repeat the same procedure from the anterior end to the posterior end. The "sandpaper" you feel are sharp bristles are called setae. Each segment of the earthworm has four pairs of setae that are used for traction in locomotion. If you have ever seen a bird try to pull an earthworm out of the ground, you have witnessed the effectiveness of the setae—they lock the earthworm in the soil.

How many setae are located on each segment? _____

Find the prostomium, or lip, which covers the mouth at the anterior end. The earthworm uses this lip as a bettering-ram as it makes a tunnel through the soil. At the posterior end of the earthworm, locate the anus. The earthworm is unusual in that the "food" (soil) that goes in the mouth is actually cleaner than it comes out of the anus. "Dirty soil" goes in, "clean soil" comes out—the earthworm digests usable material in the process.

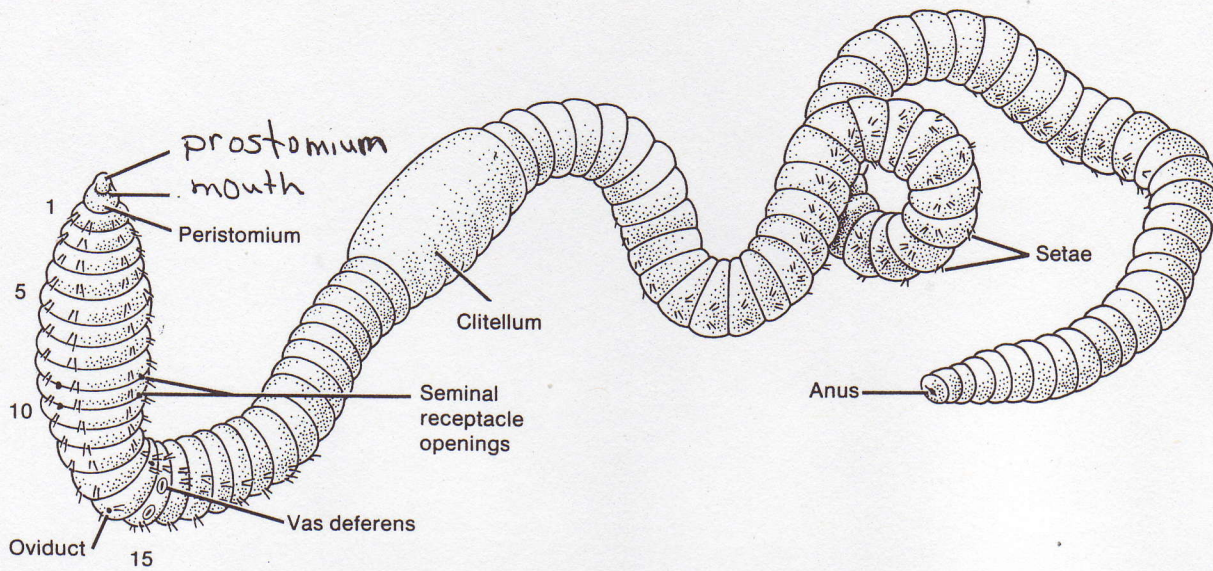
Many structures in the earthworm can be located by counting segments. Counting starts at the anterior end with segment 1. (See the diagram below.) Use a hand lens to locate the following structures: the openings to the seminal receptacles in segments 9 and 10; the openings to the oviducts in segment 14; and the openings to the sperm ducts in segment 15.

On the figure below, label the following structures: anterior end, posterior end, segments, setae, clitellum, prostomium, mouth, anus and openings to the seminal receptacles, oviducts, and sperm ducts.



Tag each of these structures on your earthworm: prostomium, anus, location of the setae, location of the external reproductive structures

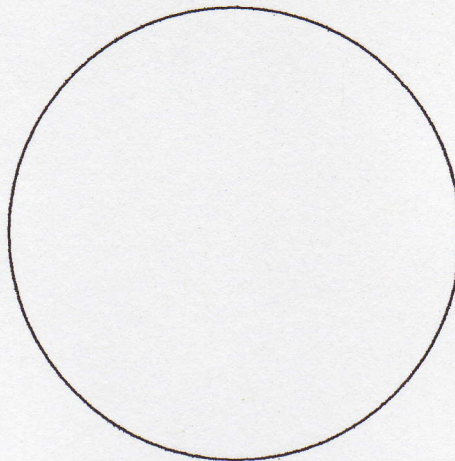
Verified _____



Good artists are good observers! Try your hand at being a good observer by drawing your earthworm in the space below. Put as much detail into your drawing as you can. The diagram above might be of some help if this is new to you.

Once you have completed your drawing, label the prostomium, clitellum, and anus.

Place your earthworm on the stage of a stereoscope. Locate some segments with some observable setae. Use the circle below as a field of view and draw several of the segments showing the setae. Don't forget to add your magnification.



_____ X

Internal Anatomy

Place the earthworm in the dissecting pan with its dorsal surface up.

Stretch out the earthworm and, with dissecting pins, pin both ends to the bottom of the pan.

(A help diagram is found on the next page of this guide. It will help you through the steps below. Study the diagram before you begin the dissection!)

Insert a blade of the scissors at the posterior end of the earthworm and slightly to the right of the dorsal blood vessel. This blood vessel runs under the skin from one end of the earthworm to the other. Cut along the dorsal surface from the posterior end to the anterior end of the earthworm. **Note: Only a shallow cut is necessary because the skin and muscles of the earthworm are very thin. Keep the scissors under the skin and parallel to the bottom of the pan.**

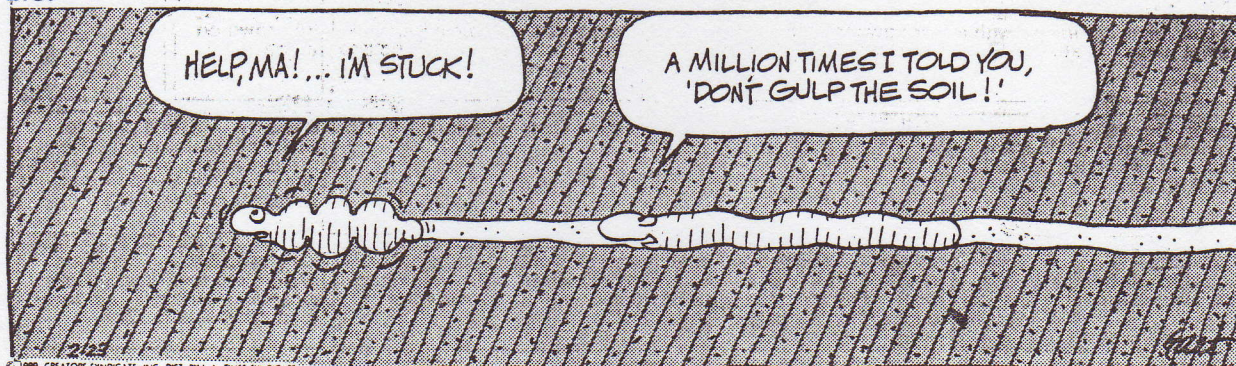
After every 10 to 15 segments, gently fold back the body wall on either side and pin it to the pan. Place the pins at 15° angles so they will not interfere with your observations. **Note: As you continue this investigation, periodically bathe the earthworm with a few drops of water from a dropper to prevent the earthworm from drying out.**

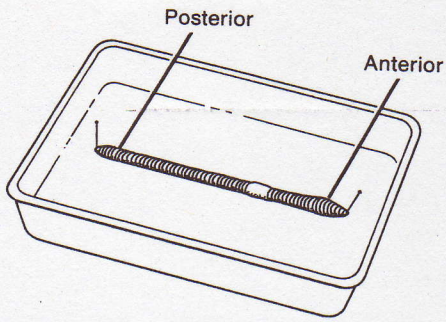
As you cut, notice the septa, or thin membranes, that separate each segment. Carefully cut through the septa to separate the internal organs from the body wall. The internal organs of the earthworm (and you, for that fact) are located in a large body cavity called the coelom.

The earthworm has a true coelom. What does that mean? _____

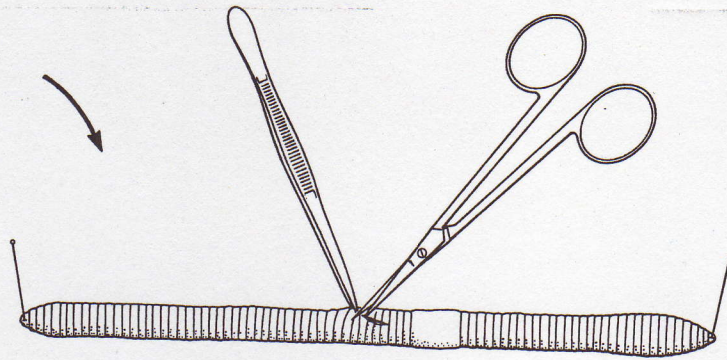
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B.C.

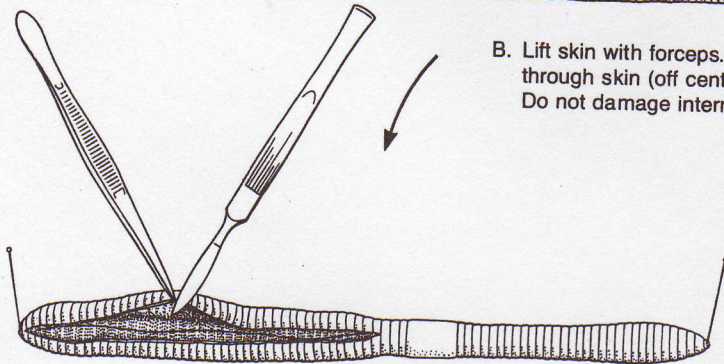




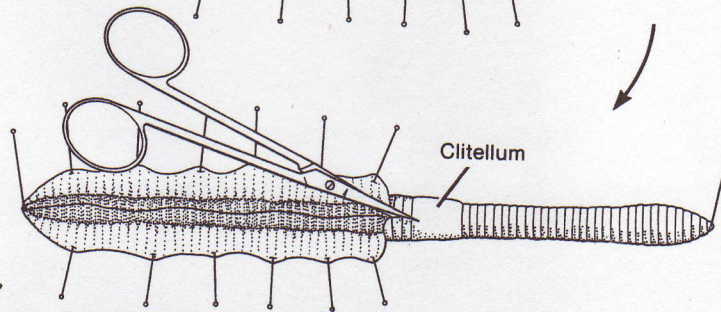
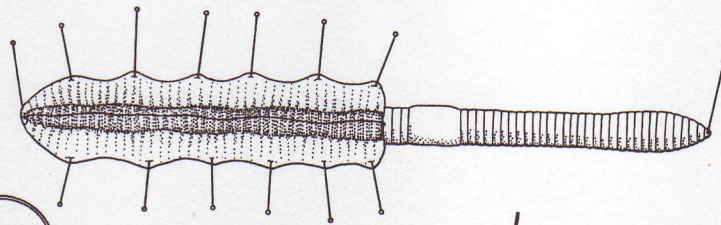
A. Place worm in tray, dorsal side up. Pin through anterior and posterior segment.



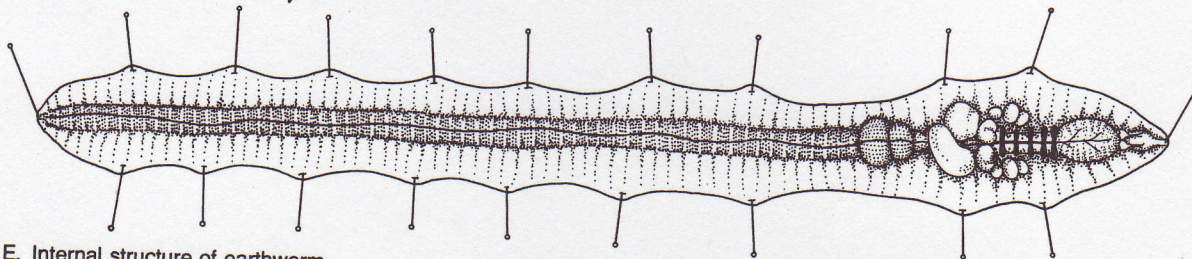
B. Lift skin with forceps. With scissors cut through skin (off center) to the anus. Do not damage internal organs.



C. With scalpel or razor, cut through septa on both sides of intestine. Pin body wall to tray as shown.

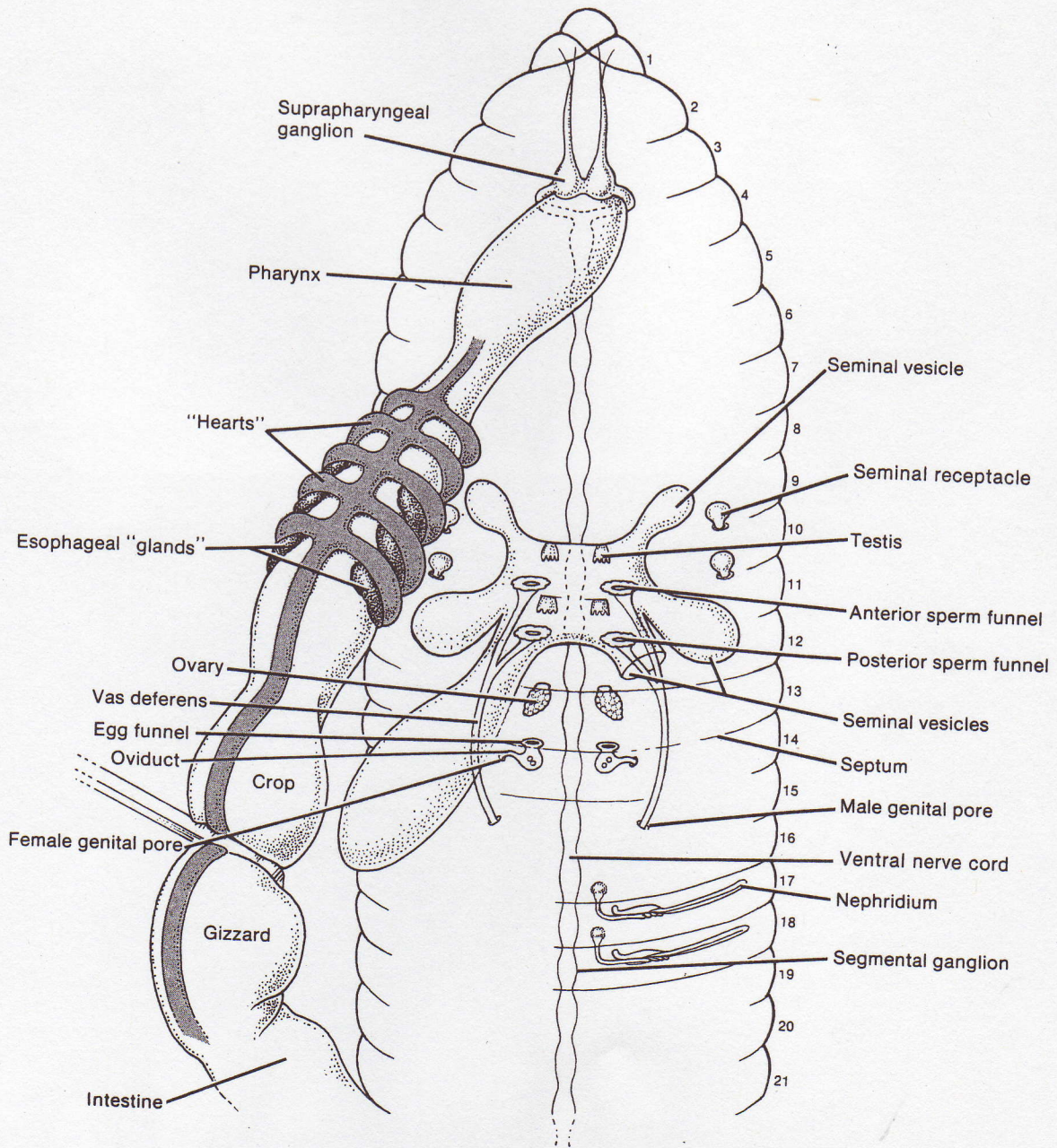
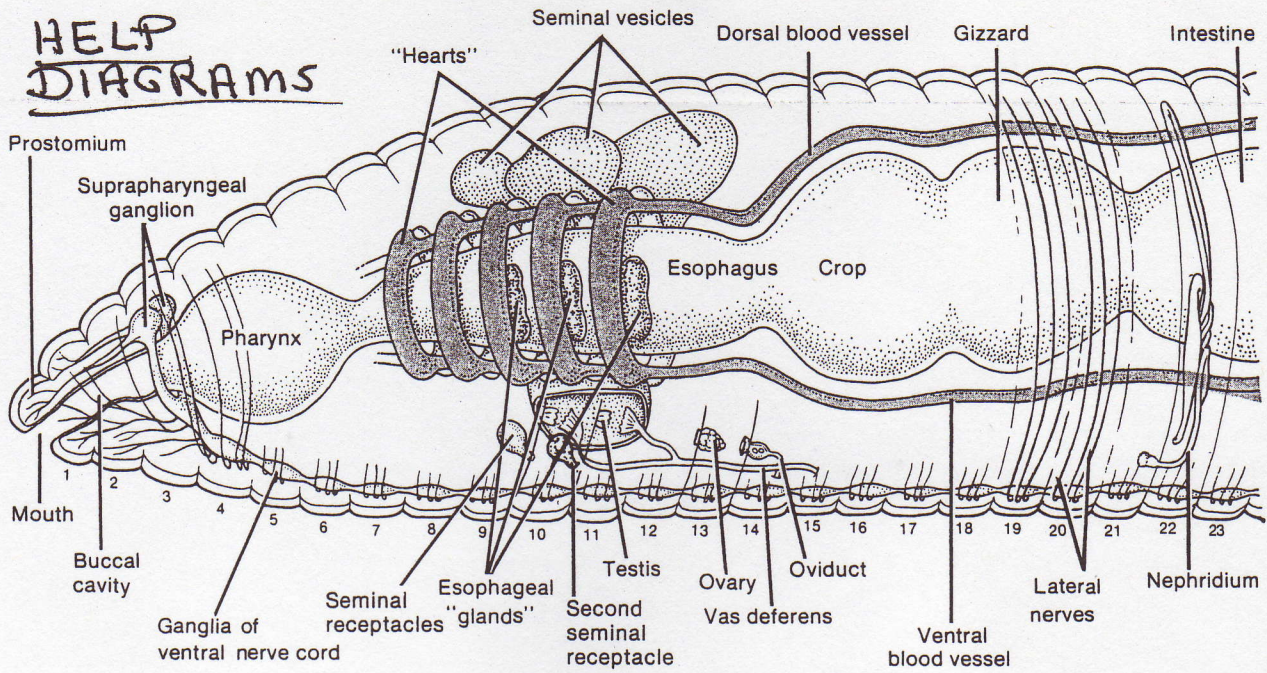


D. Cut through clitellum toward anterior end. Sever septa and pin as shown in E.



E. Internal structure of earthworm.

HELP DIAGRAMS



Digestive System

Locate the mouth (also called the buccal cavity) on the ventral side of segment 1.

Follow the path of the digestive system by locating the pharynx in segments 2 through 6, the esophagus in segments 7 through 14, the crop in segments 15 and 16, the gizzard in segments 18 and 19, and the intestine in segments 20 to the anus.

The earthworm has a tube-within-a-tube body structure. The inner tube is the digestive tract.

Food, in this case “dirty dirt” (soil with lots of organic matter), is taken in by the mouth. The prostomium (the lip on the anterior end that is used like a battering ram as the earthworm moves through the soil) moves to the side to allow the soil to enter the mouth.

The food passes into the pharynx, the widened tube behind the mouth. You also have a pharynx.....When you stand at a mirror and open your mouth wide (go ah-h-h-h) the pharynx is the area you see at the back of your throat.

From there, food travels down the narrow esophagus to the crop. (In humans, the food also travels down the esophagus but it lands in the stomach.) The crop is a large, thin-walled storage bag—chickens also have a crop.

Just below the crop is the gizzard, a muscular structure that grinds the food. Chickens also have gizzards that are used for grinding food. If you have ever eaten a chicken gizzard you know how thick, tough, and muscular it is. Earthworms and chickens use the gizzard to grind their food since they don't have teeth. (Now you know why your mom wants you to chew your food—you don't have a gizzard.)

The food is then digested in the narrow intestine, which continues to the posterior end of the earthworm. Any undigested food is removed through the anus. An interesting aside on earthworm digestion.... Earthworms eat “dirty dirt” and digest the organic material for their use. Because of that, the material that leaves the anus is technically cleaner than what goes in the mouth. The leftover material shouldn't be called “clean dirt” because there is still undigested organic material in it but it is interesting to note that what goes in the earthworm's mouth is dirtier than what comes out the anus.

Give an alternate name for the mouth. _____

What does a “tube-within-a-tube” mean when referring to the earthworm's body structure? _____

Why is the food that enters the earthworm's mouth called “dirty dirt”? _____

Tell what the prostomium does. _____

What is the function of the esophagus? _____

What is the function of the crop? _____

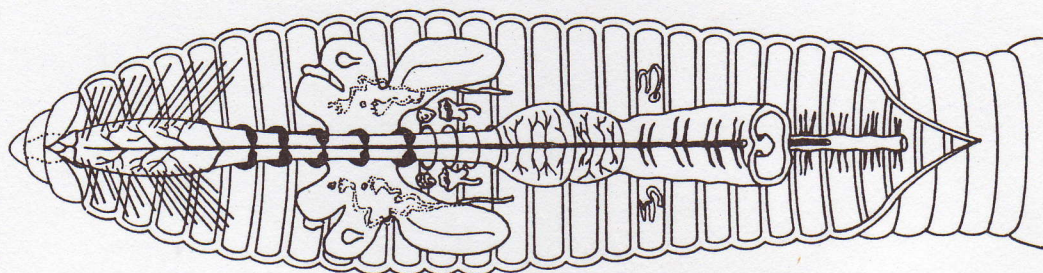
What is the function of the gizzard? _____

How do the crop and gizzard work with each other? _____

What is the purpose of the intestine? _____

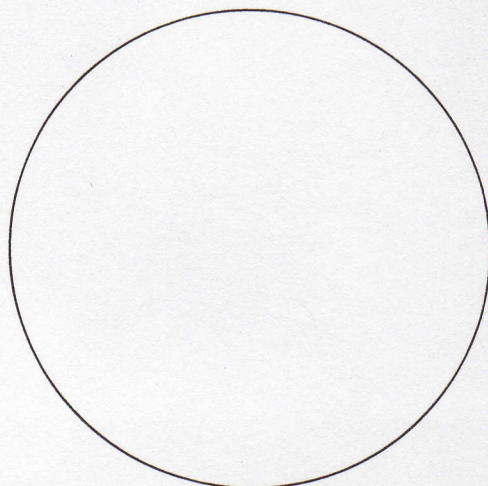
Tell why (technically) the material entering the mouth of an earthworm is dirtier than what leaves the anus. _____

On the figure below, label the following structures: mouth pharynx, esophagus, crop, gizzard, and intestine. (Hint: Use the segment numbers as a guide for locating the organs.)



Tag the following: pharynx, esophagus, crop, gizzard, intestine. Completed _____

Cut into the intestines. Use a probe to remove a sample of the digested food and place it in a drop of water on a microscope slide. Add a cover slip and view under the compound microscope. Draw a sample of what you observe in the space below. Leave your slide in place and let your instructor verify what you have seen.



_____ x magnification

Verified _____

Respiratory System

The earthworm has no specialized organs such as lungs or gills to take in oxygen. Instead, oxygen diffuses through its skin into its blood. The skin must be moist for oxygen to move across the cell membranes—if the skin dries, the earthworm will suffocate. Since the skin is the organ of respiration in the earthworm there are no other organs to locate for this system.

Explain how respiration takes place through the skin. _____

What happens to an earthworm if its skin dries out? _____

What happens to an earthworm, after a big rain, when the soil is flooded? _____

Muscular System

The skin also contains muscles. Just inside the body wall are the circular muscles, which go around each segment. Under these are the longitudinal muscles. When the circular muscles contract, they squeeze the longitudinal muscles, much like a hand squeezing toothpaste out of a tube. The squeezing elongates the longitudinal muscles, which then contract to shorten the worm. The action of these two sets of muscles, together with the setae, makes the earthworm's locomotion far more efficient than other worms.

How does an earthworm move through the soil? 1. With the body shortened, the earthworm locks his posterior body setae into the wall of the burrow. The anterior setae are pulled into the body. This locks the back end so it can't move and frees the front end. 2. The earthworm uses his muscles to elongate the body. The prostomium acts as a battering ram making a new burrow through the soil. 3. The earthworm then locks his anterior setae into place and retracts the posterior setae—this locks the front end and frees the back end. 4. He once again shortens his body bringing the posterior end forward.

Though the description above sounds simple, it is actually much more complicated—just as with walking in you. In reality, the function of the muscles and setae ripple through the body in a highly organized manner. This is all coordinated by the nervous system.

Outline the four stages used by an earthworm to move through the soil:

1. _____
2. _____
3. _____
4. _____

Circulatory System

The earthworm has a closed circulatory system, as does the human. Blood is pumped around the body in blood vessels. The blood absorbs digested food from the intestine and oxygen from the skin and delivers them to body tissues.

The blood vessels extend the entire length of the worm. The dorsal vessel is the major pump, moving the blood from the posterior end to the anterior end of the worm. You may find this vessel in the skin flap of the worm on the dorsal surface. The easiest place to locate the vessel is where it crosses the crop and gizzard.

The ventral vessel lies beneath the organs. The two vessels are connected by five aortic arches (sometimes called "hearts"), which surround the esophagus. The "hearts" may be difficult to see as they are located behind the esophagus.

Name the type of circulatory system found in both the earthworm and the human: _____

Give the major characteristic of this system: _____

Give the official name for earthworm "hearts" _____

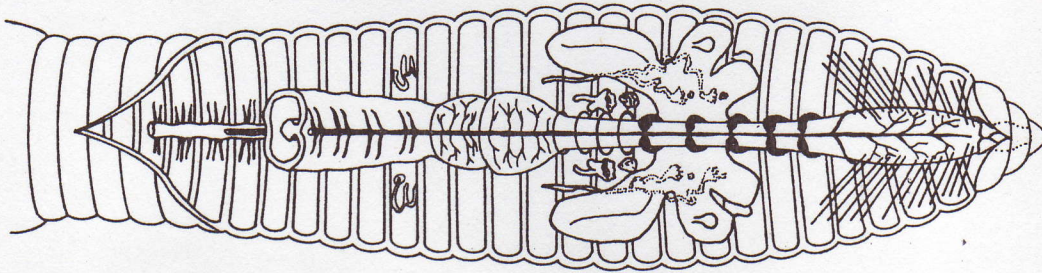
The earthworm has a circulatory system superior to that of the lower animals that you have studied. Explain why this is necessary. _____

Locate the thin dorsal blood vessel that extends the length of the earthworm.

Find the five pairs of aortic arches that surround the esophagus in segments 7 through 11. When the muscular walls of the arches contract, they act as "hearts" that pump blood through the earthworm.

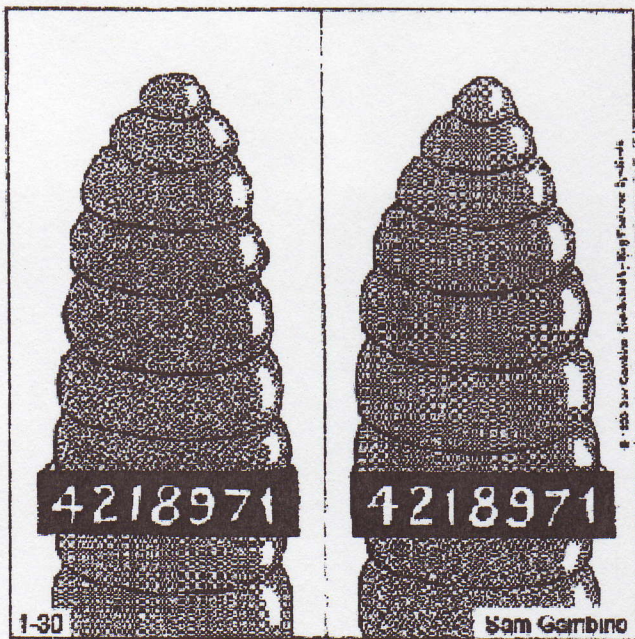
Using a straight teasing needle, lift up a section of the intestine near the posterior end of the earthworm. Locate the ventral blood vessel and the aortic arches that connect the dorsal and ventral blood vessels.

In the figure below, label the following parts: dorsal blood vessel, aortic arches, and ventral blood vessel.

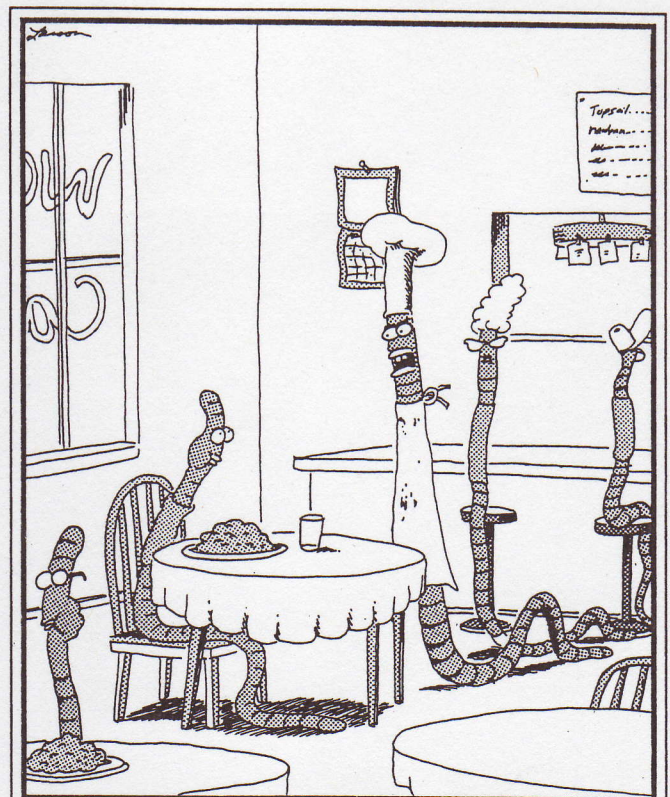


Tag the following: blood vessel (your choice, dorsal or ventral), aortic arches

Verified _____



Front and side mug shots of an earthworm.



"I've been told you don't like my dirt!"

Nervous System

The earthworm has a ganglion mass that serves as its brain. It appears as a small white mass of tissue just above the pharynx. The brain is connected to the ventral nerve cord, which extends the length of the worm. To see the ventral nerve cord, dissect out a piece of intestine about 4 cm long. The nerve cord appears as a white thread along the ventral body wall. You might see the ventral blood vessel above the nerve cord.

Locate the two-lobed "brain" that appears as a small mass of white tissue in segment 3.

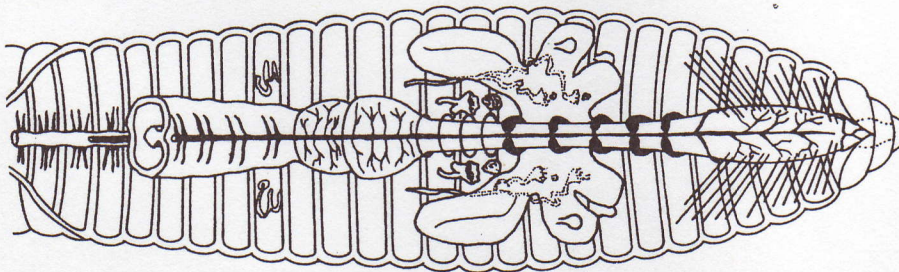
Using a straight teasing needle, lift up the pharynx and part of the esophagus. Locate the white ventral nerve cord that extends along the ventral surface of the earthworm from segment 3 to the last segment. Two nerves pass around the esophagus and connect the brain to the ventral nerve cord.

Locate a small ganglion, or mass of nerve cells, that is attached to the ventral nerve cord in each segment. The brain is actually two slightly larger ganglia.

Give the official name for the earthworm's brain. _____

Name the major nerve that extends the length of the worm. _____

On the diagram below, label the ganglion and ventral nerve cord....



Tag the following: ganglion, ventral nerve cord

Verified _____

Excretory System

Each segment of the earthworm has its own organs of excretion—the nephridia. The nephridia serve as small kidneys, removing waste products from the blood and body fluids. The nephridia appear as small white coiled tubes on each side of the digestive tract, near the body walls. You may need to use a hand lens to locate them.

What is the function of the nephridia? _____

Using a straight teasing needle, lift up the digestive system near the center of the earthworm. Locate the nephridia, or small white coiled tubes, lying against the lateral walls of the earthworm. Use a hand lens to examine these structures. The nephridium opens into the coelom, runs through the body wall, and ends in an excretory pore. Each segment has a pair of nephridia except for the first three segments and the last segment.

Reproductive System

The earthworm is hermaphroditic--it has both male and female reproductive organs. The seminal vesicles, which store sperm, are three pairs of white sac-shaped structures on each side of the esophagus. The seminal receptacles, which receive sperm during mating, are two pairs of small white round structures near the vesicles. Testes, which produce sperm, and ovaries, which produce eggs, lie under the seminal vesicles and will probably be difficult to see.

What is the major characteristic of a hermaphrodite? _____

What is the function of the seminal vesicles? _____

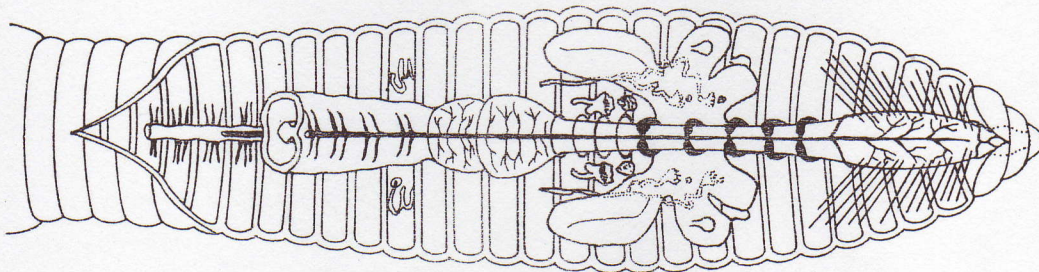
What is the function of the seminal receptacles? _____

Locate the seminal vesicles in segments 9 through 13 of the earthworm. The seminal vesicles consist of three lobes on either side of the esophagus. The sperm cells are stored in these lobes until they are transferred to another earthworm during mating.

In segments 9 and 10, locate the two pairs of small seminal receptacles. These organs receive and store sperm cells from another earthworm during mating.

Using a hand lens, attempt to locate the two pairs of small testes in segments 10 and 11 and the small pair of ovaries in segment 13.

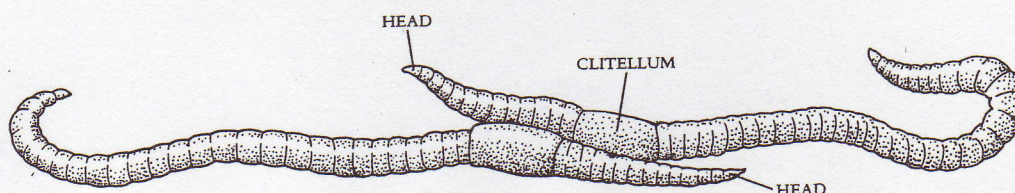
In the diagram below, label the nephridium, seminal vesicles, seminal receptacle, testes, and ovaries.



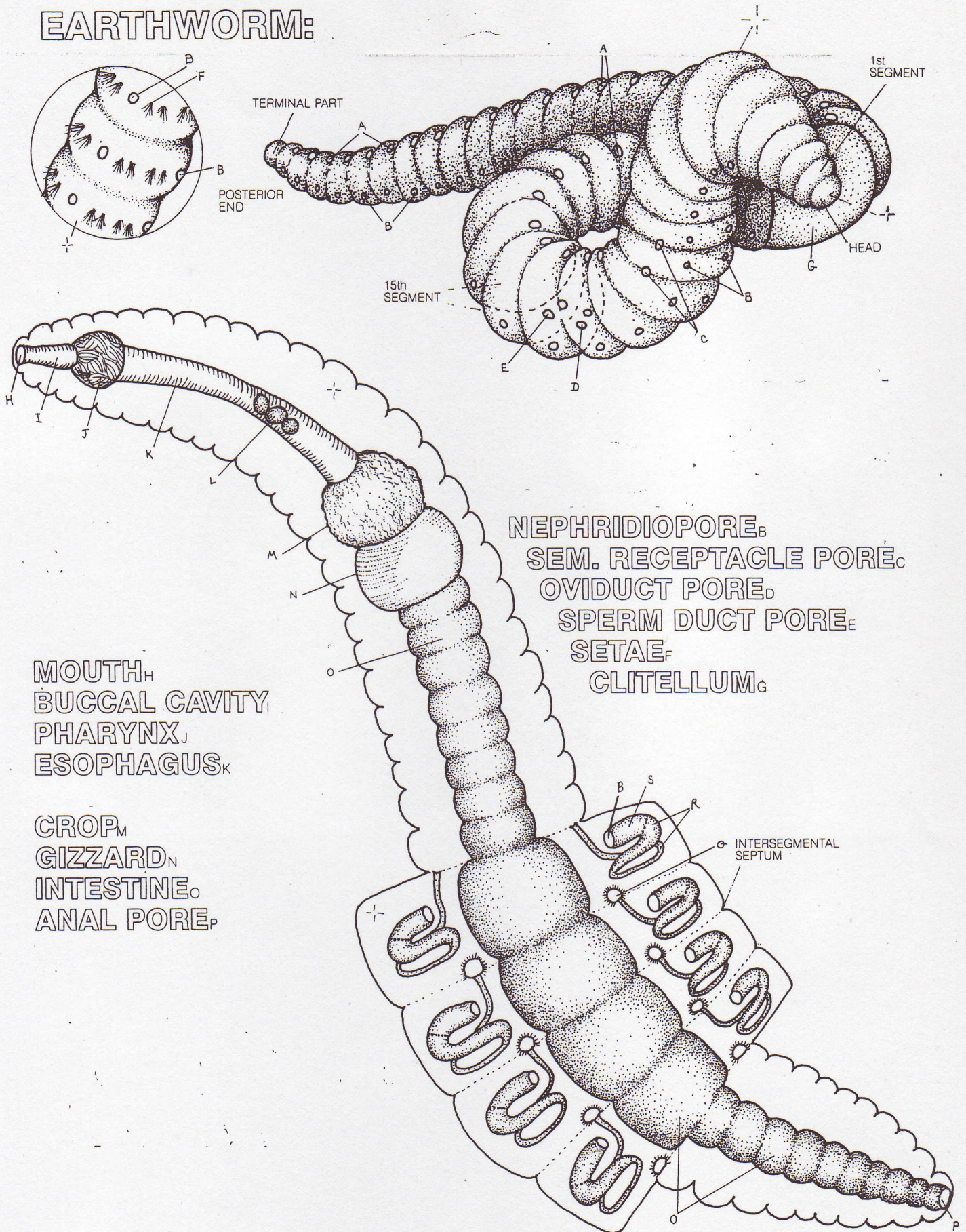
Tag the location of any reproductive gland.

Verified _____

Earthworms during mating:



EARTHWORM:



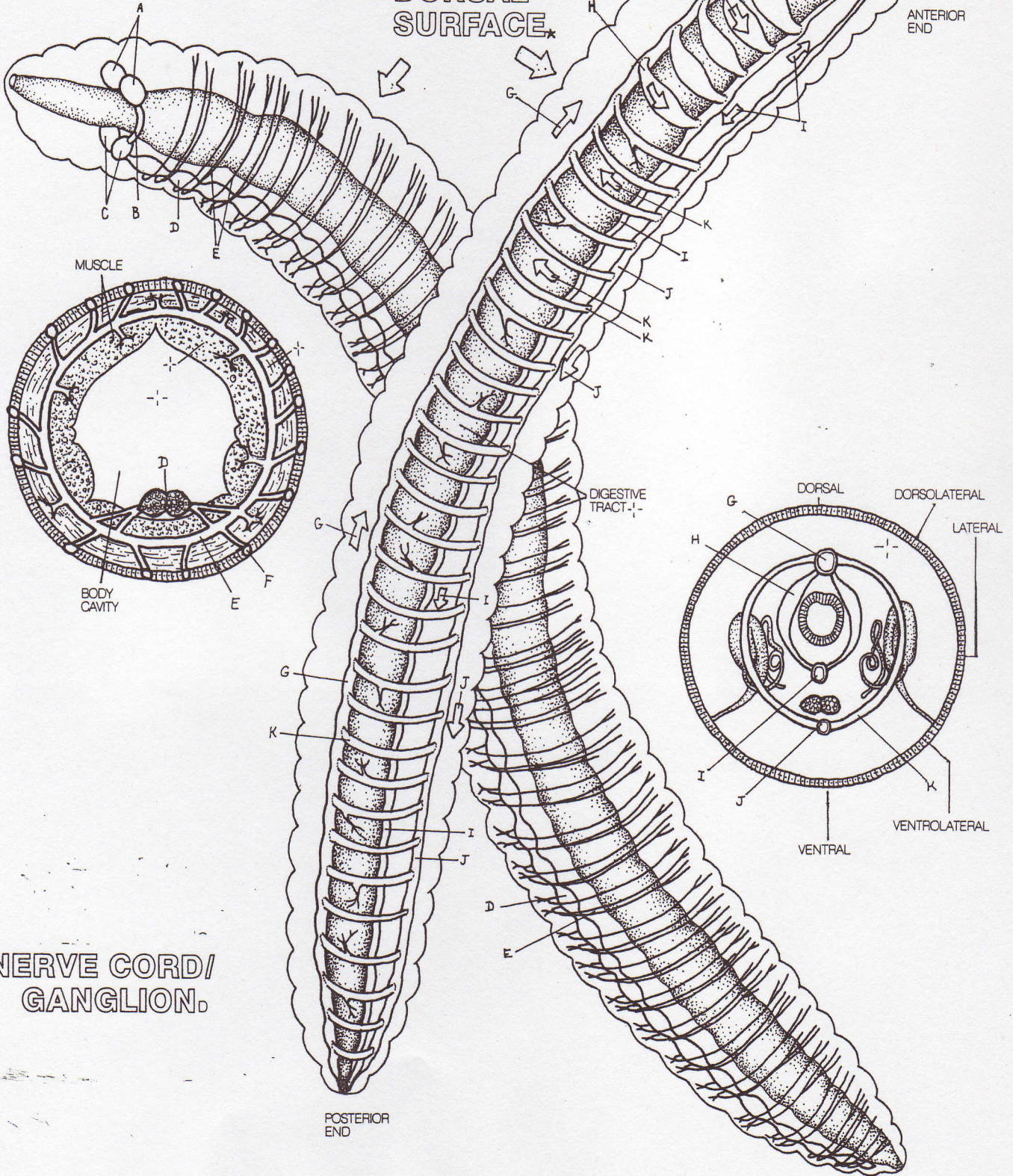
EARTHWORM:

DORSAL VESSEL,
HEART

CEREBRAL GANGLION

DORSAL
SURFACE

ANTERIOR
END



NERVE CORD/
GANGLION.

EARTHWORM:

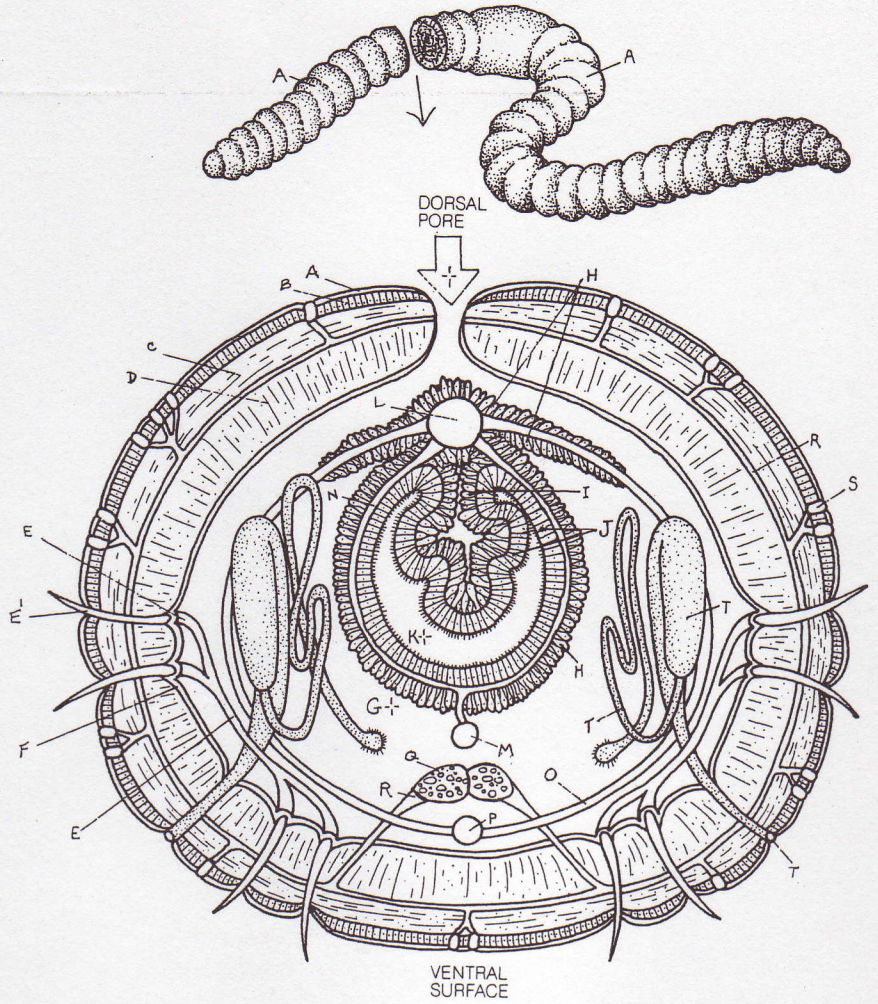
CUTICLE_A
 EPIDERMIS_B
 MUSCLE.
 CIRCULAR_C
 LONGITUDINAL_D
 SETA RETRACTOR_E
 SETA_F

COELOM_{G+}

LUMEN_{K+}

VESSELS.
 DORSAL_L

NERVE CORD.
 NERVE_R
 SENSE ORGAN_S



LOCOMOTION

