

Phylum Annelida

The phylum Annelida is constructed on a tube within a tube body plan. The digestive tract with terminal mouth and anus runs more or less through the center of the body. Annelids are characterized by external and internal segmentation. Thin septa separate one segment from another internally while transverse furrows delineate segments externally. Diagrams on earthworm anatomy abound on the Internet.

1. *Lumbricus* (the earthworm)

Earthworm anatomy (*Lumbricus terrestris*) in general, is somewhat similar to the more complex marine forms such as *Glycera spp.* and *Nereis spp.* Because of this and the ready availability of the earthworm, especially at bait shops, we decided to include it here. The freshwater black worm (*Lumbriculus variegates*) is included for the same reasons.

<<Activity>>

A. Movement:

The earthworm moves by coordinated waves of muscle contraction (peristalsis) from anterior to posterior. Each wave consists first of an elongation and thinning followed by a shortening and thickening of the body. The earthworm body is divided into about 100 segments, each of which is filled with incompressible coelomic fluid. Each segment, for the most part, is isolated from adjoining segments so that, in theory, it could expand or contract independently of the others. This, however, does not happen. The nervous system coordinates movement so that segment expansion or contraction occurs in peristaltic waves along the length of the body. Circular muscles, under the epidermis, run around the animal while longitudinal muscles run the length of the worm.

>>Examine a diagram of an earthworm cross-section and locate each of the muscle groups. What happens to each segment when the circular muscles contract and the longitudinal muscles relax against the incompressible coelomic fluid?

>>Locate the following structures on a diagram of an earthworm cross section: Cuticle; Smooth Muscles; Longitudinal Muscles; Intestine; Typhlosole; Dorsal Blood Vessel; Ventral Blood vessel; Setae; Coelom (body cavity); Ventral Nerve Cord; Nephridium. Describe the general function of each. The cross section shows the relationship between the coelom or body cavity and the internal organs.

>>Place a live earthworm on a piece of wet paper towel. Note the swollen segments (clitellum) about 1/3 from the anterior end. The clitellum functions in various aspects of reproduction: it secretes mucus to aid in copulation, and it produces egg albumin and the cocoon wall into which the eggs are placed.

>>Based on the anatomical information above, describe movement of your specimen in detail. Can you see the peristaltic waves of contraction? How does the animal obtain traction as it moves forward? Note that the setae, seen in the earthworm cross-section, allow the anterior segments to grip the substratum thereby facilitating forward movement. Run your finger along the ventral surface of the animal from anterior to posterior and then from posterior to anterior. Can you feel the setae? You may need to moisten the animal with spring water from time to time. What happens to earthworms trapped on a concrete or blacktopped surface on a sunny day?

<<Activity cont. >>

>>Now place the same earthworm on a wet, slick surface such as your tabletop. Can the earthworm move as well as it did on the paper towel? Explain.

>>During “normal” movement touch the head with a soft paintbrush. Does this sensory stimulus have an effect on the peristaltic waves? Does the original wave continue or does a new one start? Record your observations.

>>Now, gently touch the head with a blunt probe. Is peristalsis reversed? If so, what happens when two waves meet? Record your observations.

B. Photosensitivity

The earthworm has light sensitive cells over most of the body. For example if light is directed at the worm laterally, it responds by turning its head in the opposite direction.

>>Place several worms on wet paper towels on the desktop. Cover with an opaque box to adapt them to darkness. The box will need to have a hole in the top that can be both covered and uncovered during this particular activity. Small holes meant for a pen light work best in order to keep out unnecessary light. Uncover the hole in the box and using a fine beam of light from a penlight, map the worm’s response to light at several points along the body. Record your observations. Worms should be dark adapted for five minutes in-between measurements. What is the significance of the worm’s response?

C. External Anatomy

>>Using your live specimen and a diagram of earthworm external anatomy, identify the following structures: prostomium; mouth, setae; spermathecal openings; sperm groove; and clitellum

D. Internal Anatomy

>>Place a worm (either preserved or anesthetized in 10% ethanol) ventral side (flat side) down in a dissecting pan. On the curved dorsal surface carefully make an incision with a dissecting scalpel or razor blade from just anterior to the clitellum to the prostomium. Starting near the clitellum, pin down the body wall laterally so the internal organs are visible. Based on information from an illustration of earthworm internal anatomy and your live specimen identify the following structures: prostomium, buccal cavity; cerebral ganglion, pharynx; esophagus; septum; dorsal blood vessel; seminal vesicle; crop; gizzard; and intestine.

2. *Lumbriculus variegatus* (Blackworm)

Blackworms, members of the family Lumbriculidae, are aquatic annelids that feed on detritus along the edges of marshes, ponds and streams in North America. **They can be purchased at many tropical fish stores.** In addition they can be kept in the classroom at room temperature for long periods of time. The 25-50 mm long worms have about 175 clearly visible segments as adults.

<<Activity>>

A. General Anatomy

Transfer one blackworm to the well of a depression slide filled half full of spring water and cover with a cover slip. Examine under a dissecting microscope and under 100x of your compound microscope. This usually holds the animal in position so that you can see internal anatomy and blood circulation in more detail. The head, identified by several black bands of pigment, is the most active part of the worm and “leads the way”. The dorsal surface is usually uppermost when the animal is undisturbed. The blackworm exhibits several distinct types of movement that we will explore in more detail later in the exercise. The pre-segmental prostomium is the anterior most structure and the mouth is situated ventrally just behind it. Most segments have two pairs of setae (2 dorso-laterals and 2 ventro-laterals). The setae can as in the earthworm be extended and pulled inward and are important in movement.

The worm can also be viewed ventrally by turning over the covered depression slide.

B. Digestive System

The mouth leads into a muscular pharynx, visible through the transparent epidermis, in the first 6-8 segments. The pharynx joins the intestine (difficult to distinguish the pharynx from the intestine) that extends internally along the entire length of the animal and opens to the outside through an anus. The intestine appears beaded since it is constricted by the internal septae that separate each segment.

>>Can you observe movement of food along the digestive tract? Describe.

The digestive gland or liver covers the surface of the intestine in the anterior half of the animal. Blackworms are hermaphroditic. The reproductive organs are difficult to observe.

C. Circulatory System

The wide contractile dorsal vessel runs mid-dorsally along the entire length of the worm. Describe how blood is pumped along the dorsal vessel.

>>Is it pumped in one direction?

There are lateral vessels that branch from the dorsal vessel at each septal boundary.

<<Activity cont. >>

>>Can you observe blood moving into these contractile vessels? These vessels, which eventually bring blood to the ventral vessel, have blind ending branches. Describe these branches. What function(s) do you suppose they have?

The non-contractile ventral vessel carries blood from anterior to the posterior end.

>>Are you able to observe blood flow in the ventral vessel? The dorsal vessel extends into the anterior segments and sends branches to the brain. Can you see these branches?

>>Make a diagram of the general features of the circulatory system.

D. Movement

After: Drewes, C. and K. Cain. 1999. *As the worm turns. Locomotion in a freshwater oligochaete worm*. The American Biology Teacher, Vol. 61 (6): 438-442.

Forward and Rearward Movement

>>Insert a 12.5-cm piece of filter paper in the bottom of an 150 mm Petri dish. Wet it completely with spring water and remove any excess water. Invert the bottom half of a 60 mm Petri dish (upside down) on top of the filter paper, in the middle of the dish. Tape two washers on top of the smaller dish and secure them with two rubber bands crossed at ninety-degree angles. The crossed bands over the washers are meant to hold the small dish securely in place. Add 4 ml of spring water to the paper. What you have created is a miniature "racetrack". You can create the "racetrack" using other types of glassware.

>>Place one worm on the edge of the inner dish and gently touch the posterior end with a soft paintbrush to initiate forward movement. It may take several tries to get the animal to move. If the worm floats away from the inner dish edge, tilt the entire dish, remove the worm with a pipette and reposition it. It may be necessary to flush the worm from the filter paper with a squirt of spring water and then pipette it into position. Remove any excess water. Do not use forceps to handle the animals.

>>Describe forward movement. It may be necessary to gently stroke the posterior end with the brush several times.

- Do the peristaltic waves move anteriorly or posteriorly as the animal moves forward?
- How many segments are used in one wave of longitudinal muscle contraction?
- How many segments are used in one wave of circular muscle contraction?
- Is movement similar to that observed in the earthworm?

>>Determine how fast (use a stopwatch) your worm can crawl over a distance of 10 cm. (The inner dish must be marked). You are only allowed to touch the worm four times. Offer a prize for the owner of the fastest worm.

>>Describe backward movement. This can be initiated by gently stroking the anterior end. Answer the same questions as above.

<< *Activity cont.*>>

Swimming

>>Fill a glass dish with 1-2 cm of spring water and place a new worm in the center. Slide a piece of white paper under the preparation so that movement can be clearly observed. Tape a narrow rubber band (#19) to an applicator stick (probe) so that it forms a small loop. Holding the probe at about a 45-degree angle, gently stimulate the tail with the rubber loop. This should evoke a swimming response.

>>Describe the escape response. Which muscles are responsible for this unusual method of locomotion?

>>Gently stimulate segments near the head with your rubber probe. Do the same for the near the tail? What would be the adaptive value of such a response?