| wrong | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| right | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | |
| score | 100 | 98.2 | 96.4 | 94.6 | 92.9 | 91.1 | 89.3 | 87.5 | 85.7 | 83.9 | 82.1 | 80.4 | 78.6 | 76.8 | 75 | 73.2 | 71.4 | 69.6 | 67.9 | |

# **Animalia:** Annelid Worms You: ____________ Partner: ______________

Have you ever gone fishing? When most people think of fishing, a first thought is to gather some earthworms for fish bait. Not too many people consider that when fishing for a vertebrate they use an invertebrate animal as the bait. Further, most people have not really examined an earthworm very closely before threading it onto a fishhook. Today we shall remedy that.

Earthworms are members of the phylum **Annelida**, the segmented worms, and belong to the class Oligochaeta (few hairs). They can be found in most moist and reasonably warm soil types in all terrestrial biomes of the world. Today we will examine two relatives, *Lumbriculus* (the aquatic mudworm) and *Lumbricus* (the earthworm).

Earthworms need to be moist to exchange gas through their skin and to replace the water they lose through excretion. So earthworms live in soil containing 35 to 75% water. Earthworms have no eyes or ears, but can distinguish light versus dark and are sensitive to vibrations. Earthworms process organic matter for their food, so larger populations will be found in organic soils. At the mouth, earthworms take in soil with decomposing plants and animals, animal feces, and other soil microorganisms. The organic material is digested out of the soil as it passes through the tubular body and is released from the anus.

Earthworms may penetrate soil to a depth of two meters but are abundantly found in the top half-meter of warm, moist soil. They drag litter materials deeper into the soil, adding and recycling nutrients. The passages earthworms dig as they pass through the soil aerate and drain excess water. Small seeds of plants can enter the passages assisting germination and establishment. Earthworm excretion adds simpler nutrients to the soil for plant uptake into the food web. So these organisms are part of the decomposer class of organisms.

## *Lumbriculus variegatus*

The body of *Lumbriculus* is very small. Use a pipette (snipped at the tip to be wide-bore) to move your worm from the stock culture and into a Petri dish bottom. Be sure to put some water from the culture into the dish to allow swimming space for your worm. While trying to capture your worm, observe the **swimming motion** of the worms.

The worm swims most like a: [ snake inchworm ].

After your worm has rested a few moments, you might notice that its posture is to keep the anterior end on the bottom of the Petri dish and the posterior end floating at the surface. The posterior end of the vascular system is more highly branched and closer to the epidermis. For what function is this the end of the animal floating to the surface of the water?

[ feeding gas exchange ]

Does your worm respond to light? Now of course, floating one's tail near the surface of some water and burying the anterior end in sediments for feeding, presents some interesting questions. Keep your Petri dish wrapped on top and bottom with the black paper and place it on the stage of your dissection microscope (with the light OFF). Pull the dish part-way out of the paper, so that about half of the dish is exposed. Locate the worm and rotate the dish so that the tail is the only part of the worm exposed (the rest of the worm is shielded by the paper). Turn on the microscope lamp (to the T position). Observe any behavior. Rotate the dish as needed to again expose the tail only. Repeat this a few times until you are convinced of the response. Then repeat this project by exposing just the last few segments of the head. It is important that the head is NOT plunged more than a few millimeters into the bright light. This is an eyeless animal, so the photoreceptors need to be very close to the light-dark interface. Again repeat until you are convinced that you know the response.

Which part of the body responds by avoiding the light? [ head tail ]

Which part of the body appears to respond very little to the light? [ head tail ]

[ 4- ]



Koning, Ross E. 1994. Plantae: Reproductive. *Plant Information Website*.
http://plantphys.info/organismal/labdoc/worm.doc

Now try to test how your worm postures itself in a shaded or a lighted environment. Rotate the dish so that the worm is laying with its length along the light-dark interface. Observe its behavior for a few moments. Repeat until you are sure of the behavioral response.

The worm spends most of its time with its anterior end in the [ lighted darkened ] end of the Petri dish and its posterior end in the the [ lighted darkened ] end of the Petri dish.

Now you may expose your worm to light as needed for the rest of the exercise.

Compared to its width, the worm body is [ long short ].

Compared to its middle, the ends of the worm body are [ wide narrow ].

This kind of shape is known as fusiform. Fusiform body shapes improve penetration through soil and reduce drag when swimming. Once you have your worm in a Petri dish, move the dish onto the stage of a dissection microscope and observe.

The body is [ uniform segmented ].

This characteristic distinguishes the nematode from the annelid worms. If you focus your dissection microscope closely on the body you might be able to see whether hair-like setae extend from the surface of the body.

*Lumbriculus* worms [ do do not ] possess setae.

This characteristic would make them oligochaete worms. The bristly projections provide frictional resistance for an otherwise slippery worm to achieve locomotion and soil penetration.

At the anterior end of the worm, the first segment will include the mouth and a nose-like projection called a prostomium. The mouth is ventral and the prostomium dorsal in that first segment. At the posterior end of the worm the last segment includes the anus. Along the middle of the body you will find segments with at least some specialization. Earthworms have a thick zone nearer to the anterior end than to the posterior end called the clitellum.

Does *Lumbriculus* have a clitellum? [ yes no ]

Now that you understand the directions of anterior and posterior, observe the worm's swimming response to touch while in the Petri dish in spring water. Use the side of a dissection needle to very gently touch the anterior end of the worm. Repeat just a few times to be sure you know the magnitude and mechanism of the response. Allow the worm to calm down, then repeat this process but touching the side of the needle to the posterior end of the worm. Compare the two responses.

Which of the touches resulted in the **most intense** response? [ anterior posterior ]

Slide a disc of filter paper into the water under your worm to "scoop" it out. Observe the worm's **crawling movement** on this drier surface in the lid of the dish.

The worm crawls most like a: [ snake inchworm ].

Which movement is achieved by alternately contracting longitudinal muscles on the two sides (left and right) of the worm? [ swimming crawling ]

Which movement is achieved by alternately contracting circular muscles in the middle of the body and then contracting the longitudinal muscles symmetrically at the posterior?

[ swimming crawling ]

Annelid worms have simple digestive, nervous, and circulatory systems. With *Lumbriculus* we can observe these systems at least in superficial ways and in non-invasive ways because of their small size and almost transparent body wall. Keep the worm moist on the filter paper, without putting so much water as to allow swimming…blot with paper towel if needed.

Observe the mudworm with your dissection microscope, move to higher magnification and examine the segments closely. You should be able to locate the dorsal blood vessel running the length of the body; it should be pulsing rhythmically, serving as a pump. The direction of blood flow in this vessel is:

from ☐ posterior to anterior or ☐ anterior to posterior.

Observe and record the normal pulse rate of your worm over 15 seconds. As with almost all data, you need to take several replicate measurements and calculate an average.

| Trial: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Ave. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pulse/15s: | | | | | | | | | | | |

Now, blot the spring water from the paper and immediately flood your worm with several drops of a test solution and observe the effect of the test solution on the pulse rate. Record your data as before.

What is the drug you are testing?___________________________

| Trial: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Ave. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pulse/15s: | | | | | | | | | | | |

All solutions were prepared in warm spring water and cooled to room temperature before class: Nicotine (1 mg per 10 mL), Loperimide (1 2mg tablet per 100 mL), Caffeine (200 mg tablet per 50 mL), Alcohol (5% ethanol), Diphenhydramine (25 mg tablet per 25 mL), and Pseudoephedrine (30 mg tablet per 25 mL).

Is there any difference in the averages you calculated? To decide this, perform a t-test and provide the p-value comparing these two means. Show 3 decimal places.

The p-value from the t-test was [          ].

The treatment [ increased    had no significant effect on    decreased ] the pulse rate.

At the end of the treatments and observations, rinse and blot your worm repeatedly to remove the chemicals, and rinse it back into the Petri dish with fresh spring water. <u>If your treatment has executed your worm, discard it and get a fresh one to continue</u>.

Lower animals have the ability to regenerate. If a portion of the body is removed, one or both portions are able to regenerate the missing portion. Use a razor blade to cut your worm into three equal portions: an anterior portion, a central portion, and a posterior portion.

Cover your Petri dish with all three portions in spring water and leave it in the designated area. After one week, record the results:

The new segments appear to be [ lighter    darker ] in color than older ones.

The anterior portion regenerated a new posterior section: [ true    false ].

The posterior portion regenerated a new anterior section: [ true    false ].

The central portion regenerated a new anterior section: [ true    false ].

The central portion regenerated a new posterior section: [ true    false ].

30-

***Lumbricus terrestris***

This annelid is larger than the aquatic relative and is easier to handle in the laboratory because of its lack of autotomy. You have observed that the simpler aquatic worm possesses a nerve system and sensors for light and touch. While we will be studying these live earthworms, we will understand that reasonable care and due respect are to be given to the organisms. I won't say "humane treatment" here because treatment of other organisms by humans has not historically been up to the standards I am expecting from you.

Obtain a moist paper towel and your nightcrawler. If your nightcrawler is extremely agitated, you can use a really cold moist paper towel to calm it down. For severely agitated animals, you can provide a 5% alcohol bath for a minute or two to calm them into letting us observe them.

Again, for live behavior projects and external observations, cold temperature or 5% alcohol may provide the animal with more comfort. If you choose to dissect your earthworm, a soak in 10% alcohol will provide the euthanasia needed to properly prepare your animal for cutting inside.

How long is your animal? ________cm.

Is this a reliable measurement? [ yes no ]

There are _____ segments before the clitellum,

and this is a [ more less ] reliable number.

At the anterior, the color on the dorsal surface is [ darker lighter ] than the ventral surface.

On the dorsal surface, the anterior color is [ darker lighter ] than the posterior color?

The anterior part of the body responds [ more less ] strongly to touch than the posterior.

One [ can cannot ] feel the setae on handling,

and [ can cannot ] hear the setae when the animal moves on a dry paper surface.

The worm crawls most like a: [ snake inchworm ].

Does a nightcrawler swim using different motion than it uses to crawl? [ yes no ]

**If you choose to dissect:** After euthanasia, slit open the skin, cutting as shallowly as possible to expose internal organs without damage. Scissors are superior to blades for this! Use dissection pins to help hold the animal's skin open and to anchor the animal. Insert the pins at a 45° angle to hold best into the tray and also to permit you to get closer to observe. You won't get much from this dissection unless you put your tray under the lighting and magnification of the dissection microscope. Diagram all you find on the back of this page using the directory below:

# Major Systems And Organs Of The Earthworm
# Structure-Function-Location

**Nervous System**

| | | |
|---|---|---|
| Brain | Sends signals to body | Segment 3 |
| Ventral Nerve Cord | Transmits signals from brain | Length of body |
| Ganglia | Groups of nerves | Along nerve cord |

**Digestive System**

| | | |
|---|---|---|
| Mouth | Opening at anterior end | Segment 1 |
| Pharynx | Pulls food into body | Segments 3-6 |
| Esophagus | Narrow passage for food | Segments 7-14 |
| Crop | Thin-walled food storage and digestion | Segments 14-16 |
| Gizzard | Thick walled muscular grinding of food with sand | Segments 17-18 |
| Intestine | Largest internal organ; absorptions | Segments 19 to end |

**Circulatory System**

| | | |
|---|---|---|
| Aortic Arches | Pump blood through vessels; 5 pairs connect D/V blood vessels | Segment 7-11 |
| Dorsal Blood Vessel | Carries blood to anterior end | Length of body |
| Ventral Blood Vessel | Carries blood to posterior end | Length of body |

**Reproductive System**

| | | |
|---|---|---|
| Ovary | Produces eggs | Segment 13 |
| Seminal Receptacles | Receive and store sperm from "male" | Segments 9-10 |
| Testis | Produces sperm | Segment 10 |
| Seminal Vesicles | Store sperm prior to copulation | Segment 9-11 |
| Vas Deferens | Ventral swollen lips where sperm enters | Segment 15 |

**Excretory System**

| | | |
|---|---|---|
| Anus | Releases solid waste castings | Posterior end |
| Nephridia | Kidney-like organ; releases liquid waste | All except first 3 and last 1 |

**Respiratory System**

| | | |
|---|---|---|
| Skin | Water film based gas exchange | All moist surfaces |