Teacher Guide
Open Inquiry using *C. elegans*

Lesson Summary: Students pose questions, design, conduct, and analyze a controlled experiment testing different behavioral stimuli of the worm *C. elegans*.

Grade Level 9-12

Lesson Length
1-2 class periods

Next Generation Science Standards – Alignment Matrix at brainu.org/science-standards

- 3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Objectives—Students will be able to

- Select among questions and pose new questions.
- Design and conduct a controlled experiment to test behavioral stimuli of *C. elegans*.
- Analyze their experimental data and present their results.

Assessment Options

- Discuss students' design and procedures for testing behavioral stimuli of worms.
- Evaluate lab reports.
- Ask students to present their results and conclusions to the class.

Teacher Notes —See procedure overheads for

- Concentrating Worms
- Setting up Test Plates
- Getting Worms out of the Tube and onto the Plate

NOTE: This activity works best as a follow up to *Caeno*-WHAT?? This activity allows for open inquiry and may replace the Chemotaxis in *C. elegans* activity.

Materials (for each pair of students)

- light microscope
- petri dish containing *C. elegans*
- another petri dish without anything on it
- pipette or eyedropper
- snap cap vial (eppendorf tube)
- permanent pen (Sharpie)
- small beakers of distilled water (maybe 4-5 per class)
- styrofoam cup of ice (or 3-4 larger buckets of ice for the entire class)
- toothpick
- supplies available to stimulate worm behavior – supplied by teacher and/or students (light, soil, foods, alcohol, temperature gradient, etc…)

Procedures

Engage – What is Normal Worm Behavior?

1. Observe the *C. elegans* under the microscope using a scope-on-a-rope or other video camera. Engage students in observing normal worm behavior. Ask the students to write down three observations that represent movements or behaviors that are occurring under normal conditions and room temperature with the worms on a petri dish containing bacteria and worm media.
2. Generate a list on the board of normal behaviors.
3. Now change the worms' environment by adding peanut butter to one side of the petri dish.
4. Ask students to carefully observe the worms after the peanut butter is added. Generate a second class list noting any new behaviors. Discuss as a class. Ask students to consider what question we could pose to research this change in worm behavior and to write this in their notebooks. (Or pose the question below.)

Explore – Experimental Design

1. Suggest a general question to the students and ask them to pose a new more specific question to test what stimulates a change in the worms' behavior. i.e. What environmental factor can we change that will stimulate a change in the worms' behavior? Students may work in pairs.
2. Ask students to describe an environmental change they can manipulate in the lab that they think will stimulate a change in the worms' behavior. Students list the potential environmental factors in their notebooks. A class discussion may follow to generate a list.
3. Inform students that they will be designing an experiment to test behavioral stimuli of *C. elegans*. Ask them how they might know if:
   - the environmental factor changes the worms' behavior.
   - if so, what changes the environmental factor causes in the worms' behavior.
   - the environmental factor will not change the worms' behavior.
4. Students may bring in 1 or 2 substances to test or you can supply them.
5. The following is a list of aspects of experimental design to consider. Allow students to work through these problems on their own as much as possible.

a. Students will need **experimental controls** (something that has not been changed in any way by the experiment) to determine if the variables that were changed actually had an effect.

b. Students will need to know how they could tell if the worms just wander around or have actually changed their behavior due to the environmental change.

c. Students need to consider what they might use as a control substance that won't alter the worms' behavior.

d. Students should discuss where they will place the worms and substances to test on the petri dish. Perhaps students draw an example in their notebooks.

e. You may wish to demonstrate for your students the techniques of Concentrating the Worms, and Getting Worms Out of the Tube and Onto the Plate; see overheads.

Develop Questions – Experimental Design

1. Students propose which substance(s) they want to use that may stimulate a change in *C. elegans* behavior.
2. Students develop a prediction about what will happen to the worms.
3. Students draw where they plan to put their worms, control substance, and test items on the test plate.
4. Students prepare data tables representing what data they will collect and how frequently they'll collect it.
5. Students share their experimental design with the teacher to receive feedback prior to beginning the experiments. If time permits, they may also share their designs with the class.

Explore – Conducting Experiments

1. Teacher facilitates as the students conduct their open inquiry experiments.
2. Students collect data and complete data tables or graphs.

Explain – Analyzing Results

Ask students to write a summary sentence or two about their results.

Students share their results and conclusions with the class.

Expand (Optional)

Students may write a lab report for their experiment.