Lesson Summary: Students pose question, 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

Standards Alignment - Minnesota Science Standards

- Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review. Benchmark codes: 9.1.1.1.1 & 9.1.1.1.4
- Scientific inquiry uses multiple interrelated processes to investigate and explain the natural world. Benchmark codes: 9.1.1.2.1, 9.1.1.2.2, & 9.1.1.2.3
- Natural and designed systems are made up of components that act within a system and interact with other systems. Benchmark codes: 9.1.3.1.1, 9.1.3.1.2, & 9.1.3.1.3
- Science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding. Benchmark codes: 9.1.3.4.2, 9.1.3.4.3, & 9.1.3.4.4
- Organisms use the interaction of cellular processes as well as tissues and organ systems to maintain homeostasis. Benchmark codes: 9.4.1.1.1 & 9.4.1.1.2
- Cells and cell structures have specific functions that allow an organism to grow, survive, and reproduce. Benchmark codes: 9.4.1.2.2, 9.4.1.2.4, & 9.4.1.2.5

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 testing behavioral stimuli of worms.
- Evaluate lab reports.
- Have students present their results and conclusions to their 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.

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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; room temperature, 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 was added. Generate a second class list, including 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. However, allow students to work through these problems on their own as much as possible.
    a. The 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. The 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 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 their 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.
5. Students share their experimental design with the teacher to receive feedback prior to beginning their experiments. If time permits they may also share them with the class.

Explore – Conducting Experiments

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