



Lesson Summary: Students design, conduct, and analyze a controlled experiment testing the taste and/or smell preferences of the worm *C. elegans*.

Grade Level 5-8

Lesson Length
1-2 class periods

Standards Alignment

Next Generation 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.
- **Framework for K-12 Science Education:** Science & Engineering Practices 1,3,4,6,8

National Science Standards – Project 2061: Atlas of Science Literacy reference

- a) Scientific inquiry: Evidence and reasoning – lines of reasoning and observations and evidence (p. 17, Atlas Vol. 1)

Research on student learning: “When asked to use evidence to judge a theory, students of all ages may make only theory-based responses with no reference made to the presented evidence. Sometimes this appears to be because the available evidence conflicts with the students’ beliefs.” (p.16, Atlas Vol. 1)

- b) Scientific inquiry/Scientific theories – making sense of evidence and alternative explanations (p.21, Atlas Vol. 1)

Research on student learning: “Although most students believe that scientific knowledge changes, they typically think changes occur mainly in facts and mostly through the invention of improved technology for observation and measurement.” (p.20, Atlas Vol. 1)

Objectives—Students will be able to

- Design and conduct a controlled experiment to test the preference of *C. elegans*.
- Analyze their experimental data and present their results.

Assessment Options

- Discuss students’ design and procedures for testing worms for food preferences.
- 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



Teacher Guide

Chemotaxis using *C. elegans*

Materials (for each pair of students)

- light microscope
- petri dish containing *C. elegans*
- another petri dish nothing 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 buckets of ice for the entire class)
- toothpick
- worm "attractants" and "repellents" – supplied by teacher and/or students

Procedures

Engage – What is a Controlled Experiment?

1. Engage students in a discussion on “Controlled” laboratory experiments by involving the class or student volunteers in an uncontrolled experiment. (Ex. Test to see if the color of the paper affects how far a paper airplane will fly).
 - a. Ask 3 students to make a paper airplane, each using a different color of paper, but don't give them instruction on how to make the airplane.
 - b. After the students throw their airplanes, measure how far they flew.
2. Ask the class to come up with variables that were not controlled in the experiment (ex. the airplane design was different for each student, a different amount of force was applied to the airplanes, different throwing techniques were used, etc).
3. Ask the class to come up with variables that were controlled in the experiment (ex. same size and weight of paper used to make the airplane, etc).
4. Ask the class what was purposefully changed in the experiment (ex. color of paper, different students made each plane, etc).

Explore – Experimental Design

1. Ask students to bring in 1 or 2 substances they think will attract and/or repel worms. List the substances on the board or overhead.
2. Inform students that they will be designing an experiment to test substances that will attract and/or repel *C. elegans*. Ask them how they might know if:
 - the substance attracted the worms.
 - the substance repelled the worms.
 - the worm was neither attracted nor repelled by the substance.
3. Discuss the need for **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.
4. Discuss with students how they could tell if the worms just wander around or are actually attracted and/or repelled by something.
5. Generate ideas from students about what they might use as a control substance or something that won't attract or repel the worms.
6. Discuss where students should place the worms and items on the petri dish.



Develop Questions – Experimental Design

1. Have students work in pairs and have them decide which substances they want to use to test the *C. elegans* preference (substances that will attract or repel the worms).
2. Have students develop a prediction about what will happen to their worms.
3. Have students draw where they plan to put their worms, control substance and test items on the test plate.
4. Depending on time, have students share their experimental design to the class and teacher to receive feedback prior to beginning their experiments.

Explore – Conducting Experiments

Concentrating the Worms

1. Give each pair a petri dish with *C. elegans* on agar, a pipette or eyedropper, and a snap cap vial.
2. Have students pipette out 1 ml of distilled water and gently put it into the petri dish with worms.
3. Have them gently swirl the petri dish, while keeping it horizontal, to get the worms into the water.
4. Have student tilt the dish at a 30 degree angle and use the pipette/eyedropper to GENTLY suck up the water with worms.

You might get students first to practice keeping the water at the end of the dropper by sucking up a little distilled water.

5. The worm containing water should be gently squeezed into the snap cap vial.
6. The snap vials should be capped, labeled with initials, and put upright in ice for 5-10 minutes; a cloud of cold worms will be form on the bottom of the vial.

Ask students: What will happen to the worms when the ice cools them? (The worms will stop moving and settle to the bottom of the vial).

7. Preparing the test dish
8. Give each pair a petri dish with only agar.
9. Ask students to write their initials on the bottom, agar dish on the side of that piece.
10. On the BOTTOM of the petri dish, students should label where they will put each substance.
11. Students will then place small amounts (pinch of solid or drop of liquid) of their chosen substances onto the marked spots of the test dish. Toothpicks for solids and an eyedropper for liquids are good tools to use.



Retrieving the Worms

1. Ask students to gently remove the vials from the ice while keeping the vial upright. If students drop or shake the vial, they will need to put the worms back on the ice for 5 minutes.
2. Students can then use the pipette/eyedropper to gently remove as much of the CLEAR water, which contains no worms, from the vials and squirt the water into an empty cup.

Make sure students squeeze out the bulb of the pipette/eyedropper BEFORE putting it into the water to prevent disturbing the worms. If students disturb the worms, they will need to put them back on ice for 5 minutes.

3. After removing as much of the clear water as possible, direct students to remove the cloudy worm water using the pipette/eyedropper and gently squeeze it out onto the center of their test dish.

Gathering Data

1. Ask students to observe the worms on the test plate with the naked eye and using the microscope.

They may notice that all of the worms are initially trapped in the water because the worms can't break the surface tension of the water. Students can try gently blowing on the worms to try evaporating the water.

2. Ask students to record their results by making drawings or counting how many animals move to different locations on the plate. Students can look at their plates the next day to make additional observations.

Explain – Analyzing Results

- Ask students to write a summary sentence or two about their results.
- Students should share their results and conclusions with the class.

Expand (Optional)

- Students may write a lab report for their experiment.
- Students could design an experiment using *C. elegans* that tests something other than worm preference.

