



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.
- 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- 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.
- MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
- HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- **Framework for K-12 Science Education:** Science & Engineering Practices: 1,2,3,4,5,6,7,8

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

- design and conduct a controlled experiment to test the effects of alcohol on *C. elegans*.
- analyze their experimental data and present their results.

Assessment Options

- Discuss students' design and procedures testing the effects of alcohol on the worms.
- Evaluate lab reports.
- Have students present their results and conclusions to the class.

Teacher Notes



Teacher Guide

C. elegans + Alcohol

In the **Explore** section, you'll notice that there are blank lines. This format allows maximum flexibility and lets you determine the concentration of alcohol, the size of Petri dish, and the strain of worms that you'll be using in your experiments.

Once you have determined these values, you can write them on the Student Guide then make copies for the class. Alternatively, you could announce this information and let the students write it on their own copy.

Materials for each pair of students

- light microscope
- petri dish containing N2 *C. elegans* (wild type)
- slide with 2 depressions (concavity culture slides) **or** 2 small petri dishes with agar
- worm picker(s)
- 95% alcohol—diluted and prepared
- permanent pen (sharpie)
- timer with seconds feature
- distilled water in a small cup
- 10-100 μ l pipettor with tips
- disposable plastic pipettes

Engage – What do you remember about *C. elegans*?

Engage students in a discussion on the *C. elegans* worms from the chemotaxis experiment. What did they look like? How did they move?

Ask the class to think about and share what might happen if the worms were placed into alcohol? Why? Record this list on the whiteboard or overhead.

Develop Questions – Experimental Design

Discuss with students how they should watch the worms' behavior and record any changes they see. What ways could you (students) measure movement? Qualitatively? Quantitatively? Discussion may lead to watching thrashing. This is a good behavior to track.

One way to quantify locomotor activity (i.e. thrashing)

- Decide how you are going to define “thrashing” behavior and describe it below.
- Decide which person will keep time and who will count the thrashes.
- Set the timer for 30 seconds.
- Have one partner look at the worms from one petri dish or depression in the slide under the microscope. Focus on one worm and start counting the number of thrashes or movements it makes after the timer is on.
- Stop for 2-3-minutes, then once again, set the timer for 30 seconds, and follow step C. Do this step one more time.
- After counting the thrashes, do steps B and C for the worms on the second petri dish or slide well in the slide.



Explore – Experimental Design

Setting up the experiment: Preparing alcohol infused plates

If using petri dishes that have alcohol on them, _____% alcohol needs to be placed on the surface of the ____ mm dishes in order to be absorbed into the agar. Alcohol should be placed on the dishes at least one hour prior to use.

Picking the worms individually from the petri dish

1. If a slide is being used, put two drops of water in one well, and one drop of water + one drop of _____% alcohol in the other well.
2. Place the petri dish with the worms under the microscope. Using the worm picker, carefully slide the picker on the surface of the agar. Try to get a small amount of bacteria on the pick.
3. Once bacteria are on the pick, place the pick on top of a worm or slide the pick near a worm. Imagine the bacteria are like glue to stick the worms to the picker.
4. Take the worm and gently place it on the surface of petri dish or into the water or alcohol on the slide.

Explore – Conducting Experiments – Collecting data

petri dish or slide depression 1: _____ solution used

	# of thrashes
Trial 1 (1st 30 seconds)	
Wait! For how long?	N/A
Trial 2 (2nd 30 seconds)	
Wait! For how long?	N/A
Trial 3 (3 rd 30 seconds)	
Total	

petri dish or slide depression 2: _____ solution used

	# of thrashes
Trial 1 (1st 30 seconds)	
Wait! For how long?	N/A
Trial 2 (2nd 30 seconds)	
Wait! For how long?	N/A
Trial 3 (3 rd 30 seconds)	
Total	

What do you notice about how the worms move in each solution?

Explain – Analyzing Results



- Direct students to write a summary sentence or two about their results.
- Invite students to share their results and conclusions with the class.

Expand (Optional Activity)

Goal

To compare and contrast the movement of different strains of *C. elegans* when placed in water or alcohol environments

Materials:

- petri dish 1—contains water
 - petri dish 2—contains water
 - petri dish 3—contains alcohol
 - petri dish 4—contains alcohol
- and**
- N2 worms
 - slo-1 strain worms
 - npr - Hawaiian strain worms
 - worm pickers
 - 10-100 μ l pipettor with tips
 - disposable pipettes
 - stable magnifiers and/or microscopes
- or**
- 2 slides with two depression wells (concave indents); one with water in both indents and the other with alcohol in both indents

Explore 1 — Setting up the experiment

Picking the worms from the petri dish

1. Place the petri dish with the N2 worms under the microscope or magnifying glass. Using the pipette pick, carefully slide the pick on the surface of the agar. The goal is to get a small amount of bacteria on the pick.
2. Once bacteria are on the pick, place the pick on top of a worm or slide the pick near a worm.
3. Take the N2 worm and place it on petri dish 1 (water).
4. Do step 3 until there are at least 3 N2 worms on petri dish 1 (water).
5. Follow steps 3-4 but place the _____ strain worms on petri dish 2 (water).

How many N2 worms did you put on petri dish 1? _____

How many _____ strain worms did you put on petri dish 2? _____

Explore—Observations

- Compare the movement and behavior of the worms on each petri dish.
- How does each strain of worm move in/on water?

N2s? _____



_____ Strain? _____

Explore 2 — Now try looking at how the worm strains behave in alcohol

Picking the slo or npr worms from the petri dish

1. Place the petri dish with the N2 worms under the microscope or magnifying glass. Using the pipette pick, carefully slide the pick on the surface of the agar. The goal is to get a small amount of bacteria on the pick.
2. Once bacteria are on the pick, place the pick on top of a worm or slide the pick near a worm.
3. Take the N2 worm and place it on petri dish 3 (alcohol).
4. Do step 3 until there are at least 3 worms on petri dish 3 (alcohol).
5. Follow steps 3-4 but place the _____ strain worms on petri dish 4 (alcohol).

How many worms did you put on petri dish 3? _____

How many worms did you put on petri dish 4? _____

Explore 2—Observations

- Compare the movement and behavior of the worms on each petri dish.
- What do you notice about how the worms move?
- What do you think is happening to the worms?
- Looking at the N2 and the other strains of worms, **what do you notice is similar** about the two types of worms?
- Looking at the N2 and the other strains of worms, **what do you notice is different** about the two types of worms?