Curriculum Enduring Understandings

• 2D1: Reinforce the concept that all biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

• 2E3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.

• 4A6: Interactions among living systems and with their environment result in the movement of matter and energy.

• 4B4: Interactions between and within populations influence patterns of species distribution and abundance.

Curriculum Learning Objectives

• The student is able to refine scientific models and questions about the effect of complex biotic and abiotic interactions on all biological systems from cells and organisms to populations, communities, and ecosystems (2D1 & SP 1.3, SP 3.2).

• The student is able to design a plan for collecting data to show that all biological systems (cells, organisms, populations, communities, and ecosystems) are affected by complex biotic and abiotic interactions (2D1 & SP 4.2, SP 7.2).

• The student is able to analyze data to identify possible patterns and relationships between a biotic or an abiotic factor and a biological system (cells, organisms, populations, communities, or ecosystems) (2D1 & SP 5.1).

• The student is able to analyze data to support the claim that response to information and communication of information affect natural selection (2E3 & SP 5.1).

• The student is able to justify claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms (2E3 & SP 6.1).

• The student is able to connect concepts in and across domain(s) to predict how environmental factors affect response to information and change behavior (2E3 & SP 7.2).

• The student is able to apply mathematical routines to quantities that describe interactions among living systems and their environment that result in the movement of matter and energy (4A6 & SP 2.2).

Lab Objectives

In this laboratory, you will

• observe various aspects of the behavior of a terrestrial isopod

• conduct experiments examining the responses of isopods to various environmental factors

• design and conduct an investigation of animal behavior

• hypothesize as to the reasons for the behaviors you observe

Required Knowledge

Before beginning this laboratory, you should understand

• the concept of distribution of organisms in a resource gradient

• the difference between kinesis and taxis

Expectations

At the completion of this laboratory, you should be able to

• describe some aspects of animal behavior, such as orientation behavior

• understand that behaviors are adaptations of an animal to its environment
Isopods: Pill bugs and Sow bugs (*Armadillidium vulgare*; *Porcellio laevis*)

Terrestrial isopods are land dwelling crustaceans, commonly known as sow bugs or pill bugs. They have many other common names: potato bugs, wood lice (no relation to body lice), and roly-poly are just a few. Related to lobsters, crabs, and shrimp, terrestrial isopods breathe with gills. Although similar in size, color, and life cycle, pill bugs and sow bugs are different. When threatened, pill bugs can curl up into a tight ball for protection, while sow bugs either attempt to flee or remain perfectly still, appearing to be dead.

Ethology is the study of animal behavior. Many behaviors involve movement of the animal within its environment. In this exercise you will investigate some innate (inherited, as opposed to learned) behaviors of isopods.

Orientation is the process by which animals position themselves with respect to spatial features of their environments. **Taxis** involves the turning of an animal’s body relative to a stimulus. The animal may turn away from, toward, perpendicular to (etc.), the stimulus. The turning may or may not be followed by a corresponding movement of the animal in relation to the stimulus. **Kinesis** is random turning or movement of an animal in relation to a stimulus. Consider the following experiment: a researcher places a dead, rotting mouse in the center of a test surface of 1 m². The researcher then places a carrion beetle (an insect that eats dead animal tissue) somewhere on the test surface and observes. The beetle crawls forward for three seconds, turns, and crawls in a different direction for three seconds, and so on. The researcher concludes that the beetle is moving randomly in relation to the dead mouse. Continued observation reveals that the beetle crawls faster (and covers more ground) when it happens to turn in the direction of the dead mouse. In addition, the beetle crawls more slowly (and covers less ground) when it happens to crawl away from the mouse. In this way, the beetle’s random movements will eventually bring it to the dead mouse, at which point other behavior patterns, such as feeding, will take over.

**Exercise A: General Observation of Isopod Behavior**

**Procedure:**

1. Use a sorting brush to transfer 10 isopods into the “choice” chamber. Try to choose isopods of similar size.

2. Observe the isopods for 10 minutes. Make notes on their general appearance, movements, and interactions with each other. Note whether they seem to stay in one area, or if they move sporadically or continuously. Note any behaviors in which two or more isopods interact. Make observations without disturbing the animals in any way. Do not move the dish, make loud noises, or subject the animals to bright light. The goal is to observe their behavior while influencing it as little as possible.

3. Record your observations in the results section of your lab book. Below are some questions to think about as you watch them. Some of these questions you can answer through observation; others require you to read about pill bugs and crustaceans or think about what you already know.

   - What type of environment do pill bugs prefer in nature?
   - When are pill bugs the most active? Least active?
   - What do pill bugs eat? How do they get their food? When do they eat?
   - How do the pill bugs seem to sense their environment?
   - Are they all the same species?
   - Can you tell differences in males and females?
   - How many eyes do they have?
   - How many legs?
   - Do they exhibit any dominance behaviors?
   - How do they respire?
   - How do they grow?
   - What are some stimuli they seem to respond to?

4. Along with your observations, make a detailed sketch of an isopod. Label your drawing. When you make your sketch of a pill bug, don’t just draw an oval with a few squiggly legs — you are expected to

do a scientific illustration similar to the sketch of the earthworm below. You will need to draw your organism from various angles in order to record all the details.

Here are some tips for making an accurate sketch of your pill bug:

- Determine the relative proportions:
  - width length; height length;
  - distance between eyes; width of body;
  - length of antennae; length of body;
  - Count the number of body segments.
  - Count the number of legs.
  - Label the body parts.

**Exercise B: Orientation in Isopods**

**Procedure:**

1. Place clean filter paper into each side of your Choice Chamber.
2. Using a dropping pipet, saturate the filter paper on one side of the chamber. Pour off any excess water so that it cannot run into the other side of the chamber and moisten the paper there.
3. Use a sorting brush to transfer five (5) isopods to each side of the chamber. Put on the lids.
4. Count and record, in a table in your lab book (similar to Table 1 below), the number of animals on each side of the chamber every 30 seconds for 10 minutes. Continue to record, even if the isopods all move to one side or stop moving at all.

<table>
<thead>
<tr>
<th>Time (min:sec)</th>
<th>Number in Wet Chamber</th>
<th>Number in Dry Chamber</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continue table recordings every 30 seconds for 10 minutes

5. Return your isopods to the stock culture or separate holding area.
6. Graph your results using two sets of data: the number of isopods on the wet side of the chamber and the number of isopods on the dry side of the chamber over time.

**Exercise C: Student-Designed Experiments on Isopod Behavior**

**Procedure:**

1. Select one factor to investigate. Some possible factors are listed below. However, you are not limited to this list. You may come up with your own ideas; just get teacher approval first.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>cool vs. warm</td>
</tr>
<tr>
<td>light</td>
<td>light vs. dark; light vs. shade</td>
</tr>
<tr>
<td>pH</td>
<td>low pH vs. high pH</td>
</tr>
<tr>
<td>substrate (surface texture)</td>
<td>smooth vs. rough</td>
</tr>
</tbody>
</table>
2. Your teacher will now point out the materials available for conducting your investigation. In designing your experiment, be careful not to injure the isopods. Lamps placed too close to the organisms, for example, may generate dangerous heat.

3. Complete a full pre-lab write-up for your investigation. In your procedure (flowchart) section, include an actual list of the materials you will need. In addition to your data table (Table 2), in your results section, include a place to record your observations about other groups’ results about the isopods’ preferred environmental conditions.

4. Conduct the experiment. Share your results for 5 min and 10 min on the board. Record results from other groups.

5. Return the isopods to the stock culture.

6. Graph your results using two sets of data.

**Post-Lab Questions:**

1. Based upon your observations in part B, do isopods orient with respect to moisture in the environment? Explain your answer.

2. If you answered “yes” to Question 1 above, was the orientation achieved through taxis or kinesis? Support your answer.

3. How might this behavior be advantageous to isopods?

4. Considering the factors tested by your group, what type of environment do isopods seem to prefer?

5. How do you think isopods locate appropriate environments?

6. If you suddenly turned a rock over and found isopods under it, what would you expect them to be doing? If you watched the isopods for a few minutes, how would you expect to see their behavior change?

**Conclusion:** In your conclusion, restate your hypotheses (exercises B and C). [Address the exercises separately.] Describe some of the behaviors you observed with the isopods in the basic experiment and yours. Don’t forget to include actual data (reference the data table)! Discuss some of the factors tested by your class, what overall type of environment do isopods seem to prefer? Explain how the observed behaviors are adaptations of the isopod to its environment.