Module 1: Mealworms

3rd Grade

About the Instructions:

This document is intended for use by classroom teachers, SciTrek leads, and SciTrek volunteers. The document has been composed with input from teachers, leads, volunteers, and SciTrek staff to provide suggestions to future teachers/leads/volunteers. The instructions are not intended to be used as a direct script, but were written to provide teachers/leads/volunteers with a guideline to present the information that has worked in the past. Teachers/leads/volunteers should feel free to deviate from the instructions to help students reach the learning objectives of the module. Places in which you can be creative and mold the program to meet your individual teaching style, or to meet the needs of students in the class are: during class discussions, managing the groups/class, generating alternative examples, and asking students leading questions. However, while running the module make sure to cover all the material each day within the scheduled 60 minutes. In addition, no changes should be made to the academic language surrounding questions or the Question Activity.

Activity Schedule:

There are no scheduling restrictions for this module.

Day 1: Question Assessment/Observations/Reproducibility Discussion/Variables (60 minutes)
Day 2: Question Activity/Questions/Materials Page/Experimental Set-Up (60 minutes)
Day 3: Technique/Procedure/Results Table/Experiment (60 minutes)
Day 4: Graph/Results Summary/Poster Making (60 minutes)
Day 5: Poster Presentations (60 minutes)
Day 6: Question Assessment/Tie to Standards (60 minutes)

The exact module dates and times are posted on the SciTrek website (http://www.chem.ucsb.edu/scitrek/elementary) under the school/teacher. The times on the website include transportation time to and from the SciTrek office (Chem 1105). Thirty minutes are allotted for transportation before and after the module, therefore, if a module was running from 10:00-11:00, then the module times on the website would be from 9:30-11:30.

Student Groups:

Students are divided into four groups of ~five students each for the entire module. One volunteer is assigned to help each group. We find groups work best when they are mixed levels and mixed language abilities.

NGSS Performance Expectation Addressed:

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.

Learning Objectives:

1. Students will know that when an organism’s habitat changes the organisms can move, die, or adapt.
2. Students will know that adaptations take many generations to occur.
3. Students will know the importance of repeating their experiments.
4. Students will be able to find the median number of a given set of numbers composed of an odd number of data points.
5. Students will be able to generate at least two testable questions and recognize when questions are not testable by science.
6. Students will be able to suggest revisions for questions that are not testable by science in order to make them testable.
7. Students will be able to list at least one way that they behaved like scientists.

**Classroom Teacher Responsibilities:**

In order for SciTrek to be sustainable, the program needs to work with teachers on developing their abilities to run student-centered inquiry-based science lessons on their own in their classrooms. As teachers take over the role of SciTrek lead, SciTrek will expand to additional classrooms. Even when teachers lead the modules in their own classrooms, SciTrek will continue to provide volunteers and all of the materials needed to run the module. Below is a sample timeline for teachers to take over the role as the SciTrek lead.

*Groups are made up of ~five students.

1. **Year 1**
   a. Classroom teacher leads a group (Role: Group Lead; this role is referred to as a volunteer in these instructions)

2. **Year 2**
   a. Classroom teacher co-leads the modules with a SciTrek staff member (Role: Co-Lead)
      i. Classroom teacher will be responsible for leading entire class discussions (Ex: Question Activity).
      ii. Classroom teacher will be responsible for time management.
      iii. Classroom teacher will be responsible for overseeing volunteers and helping any groups that are struggling.
      iv. Classroom teacher will be responsible for all above activities, the SciTrek co-lead will only step in for emergencies.
      v. The SciTrek co-lead will run the Tie to Standards Activity.

3. **Year 3 and beyond**
   a. Classroom teacher leads the modules (Role: Lead)
      i. Classroom teacher will be responsible for leading entire class discussions (Ex: Question Activity).
      ii. Classroom teacher will be responsible for time management.
      iii. Classroom teacher will be responsible for overseeing volunteers and helping any groups that are struggling.
      iv. A SciTrek staff member will co-lead the Tie to Standards Activity with the classroom teacher for year 3.

SciTrek staff is counting on teacher involvement. Teachers should notify the SciTrek staff if they will not be present on any day(s) of the module. Additional steps can be taken to become a SciTrek lead faster than the proposed schedule above. Contact scitrekelementary@chem.ucsb.edu to learn more.

In addition, teachers are **required** to come to UCSB for the module orientation, ~one week prior to the start of the module. Contact scitrekelementary@chem.ucsb.edu for exact times and dates, or see our website at http://www.chem.ucsb.edu/scitrek/elementary under your class’ module times. At the orientation, teachers will go over module content, learn their responsibilities during the module, and meet the volunteers that will be helping in their classroom. If you are not able to come to the orientation at UCSB, you must complete an online orientation. Failure to complete an orientation for the module will result in loss of priority registration for next year.
Prior to the Module (at least 1 week):

1. Come to the SciTrek module orientation at UCSB.

During the Module:

If possible, have a document camera available to the lead every day of the module. If you do not have a document camera, please tell the SciTrek staff at orientation.

Days 1-4:
Have the students’ desks/tables moved into four groups and cleared off. This ensures that each student has a desk during SciTrek activities and that students can begin the module as soon as SciTrek arrives.

Days 5-6:
Have the students’ desks/tables cleared off. The desks/tables do not need to be moved into groups.

Scheduling Alternatives:

Some teachers have expressed interest in giving the students more time to work with the volunteers throughout the module. Below are options that will allow the students more time to work with the volunteers. If you plan to do any of the following options, please inform the SciTrek staff no later than your orientation date (~one week before your module, exact orientation times are found at: http://www.chem.ucsb.edu/scitrek/elementary). This will allow the SciTrek staff to provide you with all needed materials.

Day 1:
If you would like to have more time for your students to make observations and generate variables, you can do the Question Assessment before SciTrek arrives.

Day 2:
If you would like to have more time for your students to generate testable and non-testable questions and design their experiments, you can go over the Question Activity before SciTrek arrives.

Day 3:
If you would like to have more time for your students to perform their experiments, you can do the Technique Activity before SciTrek arrives.

Day 5:
If you would like to have more time for your students to discuss their experiments during poster presentations, you may take more time for each presentation and finish the presentations after SciTrek leaves.

Day 6:
If you would like more time for the Tie to Standards Activity, you may give the Question Assessment before SciTrek arrives.

Materials Used for this Module:

1. Mealworms
2. Magnifying Glasses (Fisher Part Number: S19230C)
3. Pillboxes (Weekly Classic Pill Planner Clear – 2XL dimensions 9\(\frac{1}{8}\)” x 13\(\frac{3}{4}\)” x 1”) with 6, 0.7 cm holes drilled through all of the days, except Wednesday. Masking tape is put on the two ends of the pillbox. This keeps the mealworms contained to Sunday, Monday, and Tuesday or Thursday, Friday, and Saturday (Apothecary Products part number 67198)
4. Bedding Materials (cotton balls, moss, bark, shredded paper (red, yellow, green, white), woodchips, fresh grass, dry leaves, and rocks)

5. Food (Cheerios, Frosted Flakes, pretzels, dried peppers, raisins, mandarin oranges, lettuce, lemons, cookies, sour candy (soft), and oatmeal)

6. MyChron Timers (Fisher Part Number: S65330) and replacement batteries (Fisher Part Number: 50-212-755)

7. 5 oz Plastic Bowls (Smart and Final) with days of the week (except Wednesday) written on the inside bottom in Sharpie

8. 1 oz Containers with lids to hold mealworms (Smart and Final) (Be sure to poke holes in the lid using a paper clip and store mealworms with a small piece of bread)

All printed materials used by SciTrek (student notebooks, materials page, lead picture packet, poster parts, instructions, and nametags) can be made available for use and/or editing by emailing scitrekelementary@chem.ucsb.edu.

**Types of Documents:**

**Student Notebook:**
One given to every student and is filled out by the student. In these instructions, the examples are rectangular and filled out in black. The lead will use a student notebook to write in as an example for students. The notebook that the lead uses is referred to as the class notebook in these instructions.

**Notepad:**
One given to every group and is filled out by the volunteer. In these instructions, the examples are squarer and filled out in blue.

**Picture Packet:**
One per class that, if needed, the lead fills out. In these instructions, the examples are rectangular, labeled, and, if applicable, filled out in blue.

In these instructions, all other example documents are labeled.
Day 1: Question Assessment/Observations/Reproducibility Discussion/Variables

Schedule:

- Introduction (SciTrek Lead) – 2 minutes
- Question Assessment (SciTrek Lead) – 5 minutes
- Observation Discussion (SciTrek Lead) – 2 minutes
- Observations (SciTrek Volunteers) – 23 minutes
- Reproducibility Discussion (SciTrek Lead) – 8 minutes
- Variable Discussion (SciTrek Lead) – 2 minutes
- Variables (SciTrek Volunteers) – 13 minutes
- Wrap-Up (SciTrek Lead) – 5 minutes

Materials:

(4) Volunteer Boxes:
- □ Student nametags
- □ Volunteer instructions
- □ Picture of experimental set-up
- □ Volunteer lab coat
- □ (2) Pencils
- □ (2) Wet erase markers
- □ Paper towels
- □ Timer
- □ Water (8 oz)
- □ Pillbox with tape
- □ (6) Magnifying glasses
- □ (2) Sets of 6 bowls labeled: Su, M, Tu, Th, F, Sa
- □ (2) Bags of woodchips
- □ (2) Containers of 20 mealworms each
- □ Container of 10 mealworms

Other Supplies:
- □ (4) Large group notepads
- □ (4) Trays

Lead Box:
- □ (3) Blank nametags
- □ Picture of experimental set-up
- □ Lead instructions
- □ Mealworms picture packet
- □ Lead lab coat
- □ (25) Question Assessments
- □ Time card
- □ (2) Pencils
- □ (2) Wet erase markers
- □ (4) Markers (orange, blue, green, purple)
- □ Paper towels
- □ Timer
- □ Water (8 oz)
- □ Masking tape
- □ Pillbox with tape
- □ (6) Magnifying glasses
- □ (2) Sets of 6 bowls labeled: Su, M, Tu, Th, F, Sa
- □ (2) Bags of woodchips
- □ (2) Containers of 20 mealworms each
Preparation:

SciTrek Lead:

1. As you are signing volunteers into the school, have the volunteers pour water into one of their bags of woodchips that are in their group boxes. Then have the volunteers put the woodchips into the compartments of the pillbox (dry woodchips in Su and Th and wet woodchips into Tu and Sa).
Make sure the compartments are only filled approximately three quarters full so that the mealworms can still travel through the bedding (woodchips).

2. Make sure volunteers are passing out nametags.

3. Make sure volunteer are setting up for the initial observation. Details of how to do this are on a picture in the volunteer boxes.

4. If the classroom has a document camera, ask the teacher to use it to share the class data (page 1, picture packet). If the classroom does not have a document camera, then tape the example poster-size class data chart to the front board.

SciTrek Volunteers:

1. Do the following outside before arriving to the classroom:
   a. Pour water into one of the bags of woodchips.
   b. Verify the pillbox has masking tape blocking the holes on the ends of the box. If not, ask the lead for tape.
   c. Fill Sunday and Thursday compartments three quarters full of dry woodchips.
   d. Fill Tuesday and Saturday compartments three quarters full of wet woodchips.
   e. Compartments Monday, Wednesday, and Friday will be empty.

2. Pass out student nametags.

3. Assemble the experimental set-up (shown in picture below as well as in color in the experimental set-up picture in your group box) on a tray.
   a. Remove the bread (or food) from the containers of mealworms.
   b. Set the pillbox, two containers of 20 mealworms each, 6 magnifying glasses, timer, and 12 bowls on the tray.
   c. Have the container of 10 mealworms close so that you can add/subtract mealworms or replace any dead mealworms.

4. If they have not done so already, have volunteers get student nametags out of their group boxes and walk around the room quietly setting each student’s nametag on their desk. After, they should assemble the experimental set-up.

For UCSB Lead:

“Hi, we are scientists from UCSB and we want to show you what we do as scientists. We will show you an experiment and then you can make observations, ask questions, and design your own experiment to help answer the class question. We want to show you that you can do science and have fun.”
For Teacher Lead:
“I have asked some scientists from UCSB to come and help us with a long-term science investigation. We will make observations, come up with a class question, and you will design your own experiment to help answer the class question.”

Allow the UCSB volunteers to introduce themselves and share their majors.

**Question Assessment:**
(5 minutes – Full Class – SciTrek Lead)

“Before we start with the module, we will determine how your ideas on testable questions are developing.” Pass out the Question Assessment and tell students to fill out their name, teacher’s name, and date at the top of the assessment. Remind the students that it is important that they fill out this assessment on their own.

Read the instructions to the students. Then read each of the questions and tell students to circle “testable” for questions that science can answer or “not testable” for questions that science cannot answer. When students are finished, collect the assessments and verify that the students’ names are on the papers.

**Observation Discussion:**
(2 minutes – Full Class – SciTrek Lead)

Tell the students that scientists make many observations. Ask the class, “What is an observation? What are the types of things that you can record for an observation?” If they have trouble, show them an object and let them make some observations. Turn these specific observations into general features of an observation. Examples of possible general observations are: color, texture, size, weight, temperature, material, etc. Lead students to understand that an observation is a description using your five senses.

Tell students, “In this experiment we are going to make observations of mealworms. The mealworms will be put in a central area and then will be able to crawl to one of two environments. These observations will help us determine if the environment affects the direction a mealworm travels.” Therefore, as a class we will be answer the question: “What variables affect the direction mealworms travel?”

Tell the class they will now get in their groups and make observations. To determine their group, they will need to look at the color of their nametag (orange, blue, green, or purple). Tell each colored group where to go.

If a student does not have a nametag, identify the group with the least number of students in it and write the student’s name on one of the extra nametags that are in the lead box using that color of marker.

**Observations:**
(23 minutes – Groups – SciTrek Volunteers)

Once the students come over to your group, have them sit in boy/girl fashion. Verify the table is set up as described in the Set-Up Section.

As a group, have the students generate observations about the experimental set-up before they put the mealworms in the pillbox. This should take you no longer than 10 minutes. Observations should be recorded on page 1 of the group notepad. Have students observe the contents of each compartment of the pillbox before the start of the experiment. Make sure that the students understand that one compartment contains dry woodchips and that one compartment contains wet woodchips. Students
should also notice that there are holes between the compartments, which will allow the mealworms to travel between the different environments. In addition, have students verify that there are actually 20 mealworms in each of the containers labeled 20 before starting their experiment. If there are not 20 mealworms either add mealworms from the extra mealworms (container of 10) or subtract mealworms by putting them into the extra mealworms.

Once students have exhausted these observations, assign one student to be the timer and two other students to release the mealworms when the timer says go. The food should have been removed from the mealworms containers during the experimental set-up. If the food is still in the containers, remove it before pouring the mealworms into the pillbox. Have the timer count down by saying, “Ready, set, go.” When the timer says “go” have the two students pour 20 mealworms each into Monday and Friday at the same time and shut the lid of the pillbox. Have the students make observations and record these on the group notepad. Once they have exhausted these observations, give each student a mealworm (from the extra container of 10) and a magnifying glass and have them make observations about the mealworms. Remind the students that if they hurt any of the mealworms they will not be able to participate for the rest of the day. If a student doesn’t want to hold the mealworm, you can put a mealworm in a bowl and hand it to the student to make observations. Approximately thirty seconds before the timer reaches 5 minutes, collect all the mealworms and put them back in the extra mealworm container. In addition, collect all of the magnifying glasses and put them in the group box.

At 5 minutes, stop the timer and pour each of the compartments of the pillbox into a separate bowl labeled with the matching day of the week. Give each student two bowls, one with the mealworms/woodchips and one empty bowl with the corresponding day of the week. Have students count the mealworms by moving the counted mealworms into the empty bowl with the corresponding day of the week. Record the number of mealworms in each compartment on the group notepad in the appropriately labeled section. Have students confirm that the total number of mealworms for each of the two trials adds to 20. If the number of mealworms does not add to 20, have the students recount the mealworms. If the number still does not equal 20, then record the number of mealworms that the students counted. Do NOT make up data so that the numbers add to 20 mealworms. If there is additional time have the students summarize what they observed. Ask students what claims they can make about the habitat that mealworms live in based on their data.

The lead will come around to write down each group’s data on the class data sheet.

An example filled out initial observations is shown below.
Reproducibility Discussion:
(8 minutes – Full Class – SciTrek Lead)

Have the students look at the class data sheet (page 1, picture packet) seen below. As students, “Did every group get the same results?” They should reply, “No.” Ask students, “Did all of the groups run the same experiment?” Have students explain the experiment they carried out, as well as what they counted in their groups. They should all realize that they did the same experiment. Ask students, “Why did groups get different numbers if they all did the same experiment?” A possible response might be, “Animal motion is not completely predictable.”
Tell students that scientists often perform multiple trials of the same experiment to try to account for any error or inconsistency in their data. However, when they present their data, they like to report one number instead of all the numbers they counted.

Ask the class, “What number would you pick if you had to pick one data point to represent the number of mealworms in each of the three compartments (dry, none, wet)?” Students may say the number that occurs the most, the largest number, the smallest number, or a number that is in the middle. Tell the students that scientists often take the middle number, the median, because the middle number can be representative of all the collected data.

Tell the students that they are going to find the median number in each set of numbers. Starting with the trial with the dry woodchips, have the students rearrange the numbers so that they are in increasing order. Then, have the students identify the middle number. With both the lab data and the students’ data, there should be nine numbers, which will give one middle number. Repeat this process for the empty compartment and the wet woodchip compartment.

Ask students, “What did you learn about the habitat that mealworms live in from this experiment?” Students should be able to tell you that mealworms live in a dry environment because more of the mealworms traveled to the dry woodchips than the wet woodchips.

**Variable Discussion:**
*(2 minutes – Full Class – SciTrek Lead)*

Tell students they are now going to think about other variables they could test to help them better understand the mealworm’s habitat.

Ask students the following questions:
- What does the word “variable” mean to a scientist?
(variables are the parts of the experiment that you can change)
What was the changing variable in the experiment that we just did?
(moisture amount)
Do you think that there are multiple variables that will affect the direction mealworms travel?
(multiple variables might affect the direction mealworms travel)
Explain that this is why we will need to work as a class to answer the class question: “What variables affect the direction mealworms travel?”

Tell the class that they are going to think about variables in the experiment that they could change to help us answer the class question. In addition to generating variables, they should think about how/why these variables might affect the outcome of the experiment. Ask the class, “What do you think is a variable that might affect the direction mealworms travel?” Then, have them tell you how/why they think that variable would affect the experiment. Probe them on how they would design an experiment to test if this variable affected the direction mealworms travel. Finally, have the students make a prediction of the results for the experiment they proposed. Remind students that predictions can be wrong, and we will not know the correct answers until we carry out the experiment.

Ex: Variable: food type
Why might this variable affect the direction mealworms travel? The mealworms might travel towards foods that they eat in their natural habitat.
How would you test this variable? I would choose a wet food (fruit or vegetable) and a dry food (bread or grain) and put one on each side of the container and then allow the mealworms to crawl towards one of the environments.
Prediction: The mealworms will crawl to the bread or the dry food.

Tell students they will now generate more variables and analyze them in their groups.
Variables:
(13 minutes – Groups – SciTrek Volunteers)

As a group, generate a variable and make a prediction about which direction the mealworms will travel. Encourage and challenge students to explain why they think their prediction is correct and how this variable will affect the direction mealworms travel. Record both the variable and the prediction on the group notepad. After each prediction, survey your group and write down how many students agree with the prediction and how many disagree. If there is extra time, go around the table a second time. An example filled out variables is shown below. Students do not need to record the variables or predictions into their notebooks.

Prepare one student to share a variable and why they think it will affect the direction mealworms travel during the class discussion.

![Example Variables Table]

Wrap-Up:
(5 minutes – Full Class – SciTrek Lead)

Have one student from each group share a variable that they generated and how/why they think it will affect the direction mealworms travel. Make sure that students tell you their predictions about how different values of that variable will affect the direction mealworms travel.

Tell the students that during the next session they will design an experiment to answer the class question: What variables affect the direction a mealworm travels?, which will help them learn about a mealworm’s habitat.

Clean-Up:

1. Collect nametags.
2. Pour the used woodchips into the wet woodchips bag. Make sure to seal the bag so it does not spill.
3. Remove any woodchips from the mealworms and put mealworms back into the containers.
4. Place all materials into your group box and bring materials back to UCSB.
Day 2: Question Activity/Questions/Materials Page/Experimental Set-Up

Schedule:

- Introduction (SciTrek Lead) – 2 minutes
- Question Activity (SciTrek Lead) – 20 minutes
- Question Discussion (SciTrek Lead) – 3 minutes
- Testable Questions (SciTrek Volunteers) – 8 minutes
- Question Discussion (SciTrek Lead) – 3 minutes
- Non-Testable Questions (SciTrek Volunteers) – 4 minutes
- Question/Experimental Set-Up Discussion (SciTrek Lead) – 3 minutes
- Question (SciTrek Volunteers) – 4 minutes
- Materials Page (SciTrek Volunteers) – 5 minutes
- Experimental Set-Up (SciTrek Volunteers) – 5 minutes
- Wrap-Up (SciTrek Lead) – 3 minutes

Materials:

(4) Volunteer Boxes:
- ☐ Student nametags
- ☐ (7) Student notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ Materials page
- ☐ (2) Pencils
- ☐ (2) Wet erase markers

Other Supplies:
- ☐ (4) Large group notepads

Lead Box:
- ☐ (3) Blank nametags
- ☐ (3) Extra student notebooks
- ☐ Lead instructions
- ☐ Mealworms picture packet
- ☐ Lead lab coat
- ☐ Materials page
- ☐ Time card
- ☐ (2) Pencils
- ☐ (2) Wet erase markers
- ☐ (4) Markers (orange, blue, green, purple)
- ☐ Light/Dark pillbox
Notebook Pages and Notepad Pages:

### SCIENTIFIC PRACTICES Testable Questions

Circle TESTABLE if the question can be tested by science. Circle NOT TESTABLE if the question cannot be tested by science.

1. What is the length of a brown bear’s front paw? **TESTABLE**
2. Do bears like to swim? **TESTABLE**
3. Are black bears smarter than brown bears? **TESTABLE**
4. How many brown bears are at the Santa Barbara Zoo? **NOT TESTABLE**
5. What type of bear is the most dangerous? **NOT TESTABLE**
6. How much honey does Winnie the Pooh eat in 24 hours? **NOT TESTABLE**
7. In one day, what is the total amount of berries that all brown bears eat? **TESTABLE**
8. Are polar bears fast? **NOT TESTABLE**
9. Is putting panda bears on the endangered species list important? **NOT TESTABLE**
10. Can a mother bear find her cub among 6 other cubs? **NOT TESTABLE**

### SCIENTIFIC QUESTIONS

If we change the **light amount** what will happen to the **number of mw in each compartment**?

- What will happen if I change the number of mealworms in the container?
- If I change the bedding, where will more mw go?
- After 5 minutes, will more mealworms be in the grass or rocks?
- If I change the food type, what will happen to the number of mealworms in each compartment?

### NON-SCIENTIFIC QUESTIONS

- Do mealworms like apples?
- Do mealworms think flowers are pretty?
- Do mealworms have friends?
- Are mealworms fast?
Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. You will run an odd number of trials.
3. Each trial may take no longer than 5 minutes.
4. You will only get one trial in which you may do two trials at the same time.
5. No more than two versions of the changing variable can be used.
6. You may only have a food or a bedding, but not both. For example, if your changing variable is food type, your bedding type must be no bedding.
7. If you are changing the light amount and using a bedding or a food, the bedding/food must be half filled in all three compartments.

Changing Variable (Independent Variable): light amount

Discuss with your group how you think your changing variable will affect the direction mealworms travel.

**QUESTION**

Question our group will investigate:

- If we change the **light amount**
  - what will happen to the **number of mealworms in each compartment**

**EXPERIMENTAL SET-UP**

Write your changing variable (e.g. food type) and the values (e.g. cookies) you will use in the compartments.

Changing Variable: **light amount**, **light**, and **dark**

Controls (variables you will hold constant):

<table>
<thead>
<tr>
<th>Insect Type</th>
<th>Mealworms</th>
<th>Food Type</th>
<th>Bedding Type</th>
<th>Container Type</th>
<th>Pulled Box</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>30</strong></td>
<td><strong>30</strong></td>
<td>Food type, no food</td>
<td>no bedding</td>
<td>container-type</td>
<td>pullbox</td>
</tr>
</tbody>
</table>

**Prediction:**

- I predict the **light amount** the mealworms will travel to is
  - the **light**
  - the **dark**
Preparation:

SciTrek Lead:
1. Make sure volunteers are writing their name and group color on the whiteboard.
2. Make sure volunteers are setting out nametags.
3. If the classroom has a document camera, ask the teacher to use it for the Question Activity (page 2, student notebook). If the classroom does not have a document camera, then tape the poster-size notebook pages to the front board.

SciTrek Volunteers:
1. On the front whiteboard in the classroom, write your name and the color of the group (orange, blue, green, or purple) you are working with.
2. Set out nametags.

Note: If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

Introduction:
(2 minutes – Full Class – SciTrek Lead)

If they have not done so already, the volunteers should write their name and group color on the front whiteboard and then set out student nametags where they would like students to sit. Tell students that a nametag will be put on their desk, which is not their nametag and they should not move it.

Ask students, “What did we do and learn during our last meeting?” Possible student response: we did an experiment in which we observed if mealworms traveled to a dry or a wet environment and we saw that more of them traveled to the dry environment.” Ask the class, “What is the class question we will be investigating?” Students should reply, “What variables affect the direction mealworms travel?”

Ask students, “Why might scientists study the direction mealworms travel?” Students should explain that studying where mealworms travel will help them predict an ideal mealworm habitat. For instance, the first experiment showed that mealworms travel away from wet woodchips, which suggests that they live in a dry environment.

Tell students that one way scientists answer questions is by performing experiments; today they are going to generate testable questions about the mealworms system. After, they will be able to pick a question and design an experiment to answer that question. First, we are going to look at a list of questions and decide whether each question is testable by science.

Question Activity:
(20 minutes – Full Class – SciTrek Lead)

Have volunteers pass out notebooks. Then have students write their name, teacher’s name, group color (color of their name on their nametag: orange, blue, green, or purple), and their volunteer’s name on the front cover of their notebooks.
Ask students, “What type of questions can be tested by science?” You should get answers that revolve around the idea that science can test things that are measurable, observable, or countable. Write on the board:

Testable Questions:
- Measurable
- Observable
- Countable

Ask students, “What type of questions cannot be tested by science?” You should get the following two groups of untestable questions:

1) Questions in which the data cannot be acquired.
   - Data cannot be acquired on objects or characters that do not exist. Ex: How many fingers do fairies have? Since we cannot catch fairies, we would not be able to answer this question.

2) Questions that are not well defined or are opinions.
   - Opinion questions contain opinion words such as prettier, nicest, better, etc. Ex: Which are prettier, lilies or daisies?
   - Not well defined questions contain words such as affected, react, etc. Ex: Do squirrels react to dogs?
   - Not well defined questions can contain semi-measurable words such as big, wide, heavy, etc. Ex: Is the Golden Gate Bridge wide? The problem with this question is you do not know how the questioner defines the word wide. A scientist could answer this question “yes” if they were comparing the Golden Gate Bridge to a typical overpass bridge while another scientist could answer the question “no” because they were comparing the Golden Gate Bridge to the Pacific Ocean.

Write on the board:

Not Testable Questions:
- Can’t acquire data
- Not well defined/Opinion

Tell the students to turn to page 2 of their notebooks, while you place the class notebook under the document camera and turn to page 2. Read the directions aloud to the class. Tell the students we will go over each of the questions as a class. Read each of the questions to the class and then ask a student to tell you whether it is testable or not and why. After the class has come to a consensus, tell students that they will circle the correct answer.

If the question is testable, have students tell you what they would measure/count/observe to find the answer to the question. Then, write what they would do next to the question (measure, count, or observe). If the question is not testable, first, have the students identify the part of the question that is not testable and why (if applicable, underline the non-testable word in the question). Write why the question is not testable next to the question (can’t acquire data or not well defined). Second, have the students propose a related question that is testable.
Below are the answers to 1-10 on page 2 in detail.

Number 1: What is the length of a brown bear’s front paw?
*Testable (Easy to Test–Measurement)*

Is this question testable?
Yes.

What could be measured/observed to answer this question?
Measure the length of a brown bear’s front paw in cm.

Number 2: Do bears like to swim?
*Not Testable (Not Well Defined/Opinion–Contains the Word Like)*

Is this question testable?
No.

Why is the question not testable?
The word “like” is an opinion and it is impossible to measure if a bear likes to swim. (A bear could swim because it likes swimming or because it is a necessity in order to get food.)

How can we revise this question to make it testable?
In a 24-hour period, does a bear spend more time in the water or on land?

Number 3: Are black bears smarter than brown bears?
*Not Testable (Not Well Defined/Opinion–Comparison)*

Is this question testable?
No.

Why is the question not testable?
The word “smarter” is not well defined/opinion. (Smarter could mean that the bear is able to gather more food or that more bear cubs are able to make it to adulthood.)

How can we revise this question to make it testable?
Does a black bear eat more berries than a brown bear?
Number 4: How many brown bears are at the Santa Barbara Zoo?
Testable (Easy to Test-Counting)
Is this question testable?
Yes.
What could be measured/observed to answer this question?
Count the number of bears at the Santa Barbara Zoo.

Number 5: What type of bear is the most fearsome?
Not Testable (Not Well Defined/Opinion)
Is this question testable?
No.
Why is the question not testable?
The word “fearsome” is not well defined/opinion. (Fearsome could mean that other animals run when they see the bear or could mean that a bear can make a very loud noise.)
How can we revise this question to make it testable?
Do other animals run when they see a bear?

Number 6: How much honey does Winnie the Pooh eat in 24 hours?
Not Testable (Can’t Acquire Data)
Is this question testable?
No.
Why is the question not testable?
We will not be able to acquire data on Winnie the Pooh because he is a fictional character.
How can we revise this question to make it testable?
How much honey does a black bear eat in 24 hours?

Number 7: In one day, what is the total amount of berries that all brown bears eat?
Testable (Hard to Test)
Is this question testable?
Yes. (Even though this question is hard to test, it still can be tested.)
What could be measured/observed to answer this question?
Observe all brown bears for a day and determine, by weighing, the total mass of berries that they all ate.

Number 8: Are polar bears fast?
Not Testable (Not Well Defined/Opinion-Semi Measurable)
Is this question testable?
No.
Why is the question not testable?
The word “fast” is not well defined in this context. (Polar bears are fast compared to ants but are slow compared to rockets.)
How can we revise this question to make it testable?
Is a polar bear faster than a cow? Or, what is the top speed of a polar bear?
Number 9: Is putting panda bears on the endangered species list important?
Not Testable (Not Well Defined/Opinion-Students Think the Answer is Yes)

Is this question testable?
No.

Why is the question not testable?
The word “important” is not well defined/opinion. (Important could mean putting panda bears on the endangered species list will increase awareness about hunting practices or could mean more of the bears will be able to survive.) Note: this question is particularly hard for students because they think the answer to the question is yes. Instead of thinking about if the question is testable or not, they try to argue the answer is “yes.”

How can we revise this question to make it testable?
Did the number of panda bear cubs born in China increase after they were put on the endangered species list?

Number 10: Can a mother bear find her cub among 6 other cubs?
Testable (Easy to Test-Observation)

Is this question testable?
Yes.

What could be measured/observed to answer this question?
Observe if a mother bear could find her cub among 6 other cubs.

Question Discussion:
(3 minutes – Full Class – SciTrek Lead)

Tell students that they are going to generate their own testable questions about the mealworm set-up that they used last session. They will be able to use the variables that they generated last time to help them with their questions. Make sure that students understand that scientists define a variable as something that can be changed in an experiment to learn something about the system. Have a few students share variables that they generated last class session.

Hold up one of the group notepads with the following sentence frame:

If we change the ________________, what will happen to the ________________?

variable what you are measuring/observing

Tell students that they can insert a variable into blank 1 and something that they can measure/observe into blank 2 to generate a testable question.

As a class, come up with one question that fits this sentence frame.

Ex: “If we change the light amount, what will happen to the number of mealworms in each compartment?”

Tell the students that they will now work together to generate as many testable questions about the mealworm system as possible.
**Testable Questions:**
*(8 minutes – Groups – SciTrek Volunteers)*

As a group, have the students come up with a question in the form: “If we change the __________, what will happen to the __________?” After they have generated one question in this form, they may generate other questions in any form they want. If students do not generate testable questions in the form provided, try to have students identify what data they would need to collect to answer their question. Example: What is the fastest worm? The data that would need to be collected is the measurements of times for different types of worms to travel a certain distance. If students are having trouble generating questions, have them review the variables that they generated during the previous meeting.

Prepare one student to share a question with the class. An example filled out Scientific Questions is shown below.

![Scientific Questions]

**Question Discussion:**
*(3 minutes – Full Class – SciTrek Lead)*

Have one student from each group share one of their testable questions with the class. After a group’s question is presented, ask the rest of the class, “Is the question testable and, if so, what data would the group need to collect to answer the question?”

Tell students there are many questions that science cannot answer. Ask students, “Do you know the types of questions science cannot answer?” They should be able to generate the following two categories of questions:

Category 1: Can’t acquire data
Category 2: Not well defined/opinion

Ask students, “Can someone give an example question about the mealworm set-up that science cannot answer?”

Ex: Category 1 Question: Would Tinker Bell move towards wet or dry woodchips?
Ex: Category 2 Questions: Do mealworms like dry woodchips? Or, is learning about mealworms important?

Tell students that they are now going to generate questions that science cannot answer about the mealworm system with their group.

**Non-Testable Questions:**
*(4 minutes – Groups – SciTrek Volunteers)*

Have the students generate a list of questions that science cannot answer and record them on the group notepad. Encourage students to generate questions that are in both of the non-testable categories. If they are struggling, have them turn to the question activity and look at the questions that are not testable. Ask students, “Why is this question not testable?” Then have them use it as a model to generate a question about the mealworm system.

Prepare one student to share one of their questions with the class. An example filled out Non-Scientific Questions is shown below.

![Non-Scientific Questions](image)

**Question/Experimental Set-Up Discussion:**
*(3 minutes – Full Class – SciTrek Lead)*

Have each group share one question that they generated that science cannot answer. After a group’s question is presented, ask the rest of the class, “Is the question testable and, if not, why?”

Tell students that they are going to design an experiment to determine how one variable affects the direction mealworms travel. First, they will pick their changing variable and record it in their notebooks. Tell students that their options for their changing variable are light amount, food type, and bedding type. Second, they will discuss why they think this variable will affect the direction the mealworms travel and determine their experimental question. Third, they will use the materials page to determine the values of their changing variable and controls. Fourth, they will determine their experimental set-up. Ask students how scientists define controls. By the end of the conversation make sure students understand that
controls are variables that could have changed but are kept constant for their experiment. Tell students that they need to keep a few things in mind when they are going through this process.

**Experimental Considerations:**
1. You will only have access to the materials on the materials page.
2. You must run an odd number of trials.
3. Each trial may take no longer than five minutes.
4. You will only get one pillbox in which you may do two trials at the same time.
5. No more than two versions of the changing variable can be used.
6. You may only have a food or a bedding, but not both. For example, if your changing variable is food type, your bedding type must be no bedding.
7. If you are changing the light amount and are using a bedding or food, the bedding/food must be filled half-full in all three compartments.

Tell students that if they pick a food source, they will not be able to eat any of the food that is provided for the mealworms.

**Question:**

*4 minutes – Groups – SciTrek Volunteers*

Have students turn to page 3 of their notebooks. Then have them decide (by voting) what changing variable they want to explore for their experiment. If there is a tie, then the volunteer will make the deciding vote. It is best if groups have different changing variables. The lead will help coordinate between groups to ensure there is a variety of changing variables.

As a group, discuss why/how they think their changing variable will affect the direction mealworms travel. Record their thoughts on the group notepad; students will not write this in their notebooks. If students choose a changing variable that has many different values, try to get students to determine the types of values they would like to investigate. You should not show them the materials page yet. For example, if students choose bedding type as their changing variable, have them think about large categories of bedding that they could choose from such as: soft/hard, manmade/natural, large bedding pieces/small bedding pieces. Then have them choose the two categories that they are most interested in, example: soft/hard. If applicable, record the large categories that they picked as well as why they think their changing variable will affect the direction mealworms travel in the group notepad.

Use their changing variable to generate the question that the group is going to investigate. Write the question in the group notepad, and have students copy it into their notebooks. An example filled out question is shown below.

Select a student to read the group question during the wrap-up.
Materials Page:  
(5 minutes – Groups – SciTrek Volunteers)

Get the materials page (shown below) from your box and have students use it to determine the values for their changing variable and controls. If they chose two broad categories during the predictions section, remind them that they should be looking for values that meet that criteria. For instance, if they picked food type and were interested in salty versus sugary foods, they should be looking for a salty (pretzels) and a sugary (cookies) food. Encourage your group to explain why they are picking the values they are selecting. For instance, if they were interested in salty versus sugary, but they chose lettuce as a variable value, ask them if that value fits with the broad categories they were interested in investigating.

For controls in which students can pick more than one value (bedding type, food type, time, etc.), have students discuss if the value that they select for their control would make it easier or harder to answer their question. For example, if students chose a time of 1 min, ask them how this would affect answering their question. This might get them to realize that 1 min is a very short time, resulting in most of the mealworms being in the central compartment at the end of the trial. If they decide a different control value is better, allow them to switch control values.

Make sure that your group checked off all of the materials that they will need from the materials page and that your group color is written on the top of the page. Make sure that students are within the limitations set on the materials page. An example of a materials page is seen below.
**Experimental Set-Up:**

*(5 minutes – Groups – SciTrek Volunteers)*

Turn to page 7 of the group notepad while students turn to page 4 in their notebooks. Ask your group, “What did we decide was going to be the changing variable and what values of the changing variable did we choose for each compartment?” Record these on the group notepad. After, have students copy the changing variable and its values into their notebooks. If your group is changing light amount, get a light/dark pillbox from the lead box to show students.

Ask your group, “What controls and values did we select?” Write the control on the left side of the slash and the value of the control on the right side of the slash (Ex: bedding type / no bedding). In addition, have students copy these into their notebooks. An example filled in experimental set-up is shown below.

Once your group has filled in their controls and values, have them fill in what they will be putting in each of the pillbox compartments. Make sure that if your changing variable is **not** light amount that Sunday and Thursday have one value of your changing variable, Tuesday and Saturday have the other value of your changing variable, and Monday and Friday contain the mealworms. If your changing variable is light amount, pull out the light/dark pillbox and have the students tell you which days will be light and which days will be dark. They should tell you that Sunday and Saturday will be dark, Tuesday and Thursday will be light, and Monday and Friday will contain the mealworms. If you are using a food type or a bedding type, also include that value in the pillbox picture on everyday including Monday and Friday as seen in picture below.

Once the experimental set-up is complete, have students predict what will happen in the experiment and fill in the sentence frame on page 4. The prediction sentence can be different in each student’s notebook.

If you have additional time, have your group summarize the experiment that they are going to run and what they are hoping to learn from the experiment.
Wrap-Up:
(3 minutes – Full Class – SciTrek Lead)

Have one student from each group share the question that they will investigate. Tell students that during the next session they will start their experiment. Tell students that all of their experiments will help us answer the class question: what variables affect the direction mealworms travel? This will help us learn about the habitat that mealworms live in.

Clean-Up:

1. Collect notebook with attached nametags.
2. Place all materials into your group box and bring materials back to UCSB.

Day 3: Technique/Procedure/Results Table/Experiment

Schedule:

- Introduction (SciTrek Lead) – 3 minutes
- Technique (SciTrek Lead) – 7 minutes
- Procedure (SciTrek Volunteers) – 18 minutes
- Results Table (SciTrek Volunteers) – 5 minutes
- Experiment (SciTrek Volunteers) – 25 minutes
- Wrap-Up (SciTrek Volunteers) – 2 minutes
Materials:

(4) Volunteer Boxes:
- Student nametags
- Student notebooks
- Volunteer instructions
- Volunteer lab coat
- (2) Pencils
- (2) Wet erase markers
- Paper towels
- Timer
- Pillbox with tape
- (2) Sets of 6 bowls labeled: Su, M, Tu, Th, F, Sa
- (2) Containers of requested number of mealworms each
- Other supplies requested

Other Supplies:
- (4) Large group notepads

Lead Box:
- (3) Extra student notebooks
- Lead instructions
- Mealworms picture packet
- Lead lab coat
- Time card
- (2) Pencils
- (2) Wet erase markers
- Paper towels
- (2) Timers
- Masking tape
- Pillbox with tape
- (2) Sets of 6 bowls labeled: Su, M, Tu, Th, F, Sa
- (4) Containers of 20 mealworms
- Bag of backup materials (contains 3 bedding materials and 3 food types)

Notebook Pages and Notepad Pages:

<table>
<thead>
<tr>
<th>Bedding</th>
<th>Final Number of Mealworms (in Increasing Order)</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>2, 1, 5</td>
<td>3</td>
</tr>
<tr>
<td>Rocks</td>
<td>5, 6, 7, 5</td>
<td>4</td>
</tr>
<tr>
<td>Grass</td>
<td>15, 15, 17</td>
<td>17</td>
</tr>
<tr>
<td>Dirt</td>
<td>13, 15, 14</td>
<td>13</td>
</tr>
<tr>
<td>Wood Chips</td>
<td>12, 10, 10, 10, 12</td>
<td>10</td>
</tr>
</tbody>
</table>

When running multiple trials in an experiment it is necessary to find one number to represent all of the data. The middle number, also known as the median number, is sometimes used to represent all the data. To find the median, first place all of the numbers from each trial in increasing order, second circle the middle number.
PROCEDURE

1. Get pillbox that is dark on Su and Sa and light on Tu and Th.
2. Put no bedding and no food in all compartments.
3. Put 20 mealworms in M and F.
4. Wait 5 minutes.
5. Count the number of mealworms in each compartment.
6. Repeat and find the median of trials.

RESULTS Table

<table>
<thead>
<tr>
<th>Variables</th>
<th>Compartment A (Su and Sa)</th>
<th>Compartment B (M and F)</th>
<th>Compartment C (Tu and Th)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect Type</td>
<td>Mealworm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>5 min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Type</td>
<td>no food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedding Type</td>
<td>no bedding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Amount</td>
<td>dark/light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Container Type</td>
<td>pillbox</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial Number of Mealworms</th>
<th>Compartment A</th>
<th>Compartment B</th>
<th>Compartment C</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Put 1.5 in decreasing order:</th>
<th>10</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median of 1.5:</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>
Preparation:

SciTrek Lead:

1. Make sure volunteers are setting out notebooks.
2. If the classroom has a document camera, ask the teacher to use it for the Technique Activity (page 5, student notebook). If the classroom does not have a document camera, then tape the poster-size notebook page to the front board.

SciTrek Volunteers:

1. **If your group is experimenting with light/dark verify that** both the group notepad and the student notebook results tables are modified so the days under compartment 1 (which must be dark) are a) Su, b) Sa, c) Su, d) Su, and e) Sa and compartment 2 (which must be light) are a) Tu, b) Th, c) Tu, d) Tu, and e) Th.
2. Set out notebooks/nametags.

**Note:** If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

Introduction:

*(3 minutes – Full Class – SciTrek Lead)*

If needed, while you are doing the introduction have volunteers set out the notebooks/nametags where they would like students to sit. Tell students that a notebook will be put on their desk, which is not their notebook and they should not move it.

Ask the class, “What is the class question we are investigating?” Students should reply, “What variables affect the direction the mealworms travel?” Ask students, “Why are we interested in studying this?” Possible student response: exploring the direction in which mealworms travel will help us learn about a mealworm’s habitat. Ask students, “What have we already learned about a mealworm’s habitat?” Possible student response: we saw that more mealworms go toward the dry woodchips than wet, therefore, they live in dry environments. Remind students that last time they picked another variable that they are going to explore today. Ask students, “Are you going to run one or multiple trials?” They should reply, “Multiple trials.” Ask students, “If you count multiple different numbers for each trial, what number will you use for your graph?” Students should reply. “The middle number, which is called the median.” Ask students, “Why is the median the best option to graph?” Possible student response: the median is a good representation of the data. Tell students that we will practice finding the median from other scientists’ data.

Technique:

*(7 minutes – Full Class – SciTrek Lead)*

Have students turn to page 5 in their notebooks while you do the same thing to the class notebook under the document camera. Tell students, “To find the median, you need to arrange the numbers in increasing order. Once the numbers are arranged in order, the number in the middle is the median number, which you should identify by circling.” Go over how to find the median in the first two examples and then have the students work on the rest by themselves. After students have finished, go over the answers. An example of a student notebook page can be found below.

Tell students they will use this technique of finding the median when they perform their experiment.
Tell students that before they can carry out their experiment, they need to write a procedure. Ask the class, “What is a procedure?” Lead students to understand that it is a set of steps to conduct an experiment. Tell them once they have determined their procedure, they will fill out their results table and carry out their experiment.

Remind students that some of the groups have requested different food types for their experiments. The food that they will use in the experiment has been sitting in the lab for a long time and it is important that they do not eat any of the food.

![Table showing different bedding types and the number of mealworms in each]

**Procedure:**
*(18 minutes – Groups – SciTrek Volunteers)*

Ask students, “What did you pick for the changing variable and what do you think we will learn from the experiment?”

Tell students they will now generate a procedure for their experiment. Ask students, “What is a procedure?” Students should reply, “A set of steps to conduct an experiment.” Then, help students generate a procedure. Keep the procedure as brief as possible while still including the important information (control values, changing variable values, and what data they will collect). An example step for bedding type as the changing variable would be: “Put rocks in Su and Th and put moss in Tu and Sa.” Have students dictate the procedure to you while you transcribe it onto the group notepad. As each step is completed, have students copy it from the group notepad into their notebooks. Make sure that you do not continue on to the next step until each student has completed writing that step. An example filled in procedure is shown below.
Results Table:
(5 minutes – Groups – SciTrek Volunteers)

Fill out the variables section of the results table while students fill out the same section in their notebooks. When writing the values, make sure that for controls, they only write the value of the control in the compartment A box and then draw an arrow through the remaining compartments’ boxes; for the changing variable, they write the value in each compartment’s box. An example filled out results table is shown in the Experiment Section.

Experiment:
(25 minutes – Groups – SciTrek Volunteers)

Once students have completed the variables section of their results table, give students their materials for their experiment. During the experiment, make sure that students do not eat any of the food provided for the experiment.

Help students set up and complete their experiment. Record the data that the students collect in the group notepad (see sample group notepad below). Help students copy the data into their notebooks.

Groups will be doing 3 or 5 trials. Make sure to perform the first run with both sides of the pillbox filled (2 trials). The second run will be performed with only 1 side of the pillbox filled (1 trial). If there is time, students can perform a third run with both sides of the pillbox filled (2 trials). It is fine if groups only get to do 2 runs (3 trials).

When the students are finished with the experiment, as a group, have students put the number of mealworms for compartment A in ascending order and determine the median number for that compartment. Then have students work independently to find the median number for the other two compartments. After students are finished, go over the median numbers as a group and record the numbers on the group notepad. An example filled out results table is shown below.
If there is additional time, have students explain to you how they set up their experiment and what they learned from their experiment. Try to have students explain this without looking at their notebooks.

**Wrap-Up:**
*(2 minutes – Full Class – SciTrek Lead)*

Tell students that during the next session they will analyze their data by making a graph as well as a poster, which they will use to present their findings to the class. These posters will help us learn about what variables affect the direction that mealworms travel.

**Clean-Up:**

1. Collect student nametags with attached nametags.
2. Put mealworms back into containers.
3. Place all materials in your group box and bring materials back to UCSB.

**Day 4: Graph/Results Summary/Poster Making**

**Schedule:**

Introduction (SciTrek Lead) – 2 minutes
Graph (SciTrek Volunteers) – 10 minutes
Results Summary (SciTrek Volunteers) – 10 minutes
Poster Making (SciTrek Volunteers) – 33 minutes
Wrap-Up (SciTrek Lead) – 5 minutes
Materials:

(4) Volunteer Boxes:
- ☐ Student nametags
- ☐ Student notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ Poster diagram
- ☐ Sticker for how to present graph

☐ (2) Pencils
☐ (5) Paperclips
☐ (2) Wet erase markers
☐ Highlighter
☐ Scissors
☐ (2) Glues
☐ Poster Parts packs (Scientists’ names, question, experimental set-up, procedure, results table, results graph, results summary, (6) “I acted like a scientist when,” (6) Picture spaces)

Other Supplies:
- ☐ (4) Large group notepads
- ☐ Poster paper tube

Lead Box:
- ☐ (3) Extra student notebooks
- ☐ Lead instructions
- ☐ Mealworms picture packet
- ☐ Poster diagram
- ☐ Lead lab coat
- ☐ Time card

- ☐ (2) Stickers on how to present graph
- ☐ (2) Pencils
- ☐ (5) Paperclips
- ☐ (2) Wet erase markers
- ☐ (2) Highlighters
- ☐ Scissors
- ☐ (2) Glues
- ☐ Scotch tape
- ☐ (1 each color) Poster part pack

Notebook Page and Notepad Page:

![Notebook Page and Notepad Page](image-url)
Preparation:

SciTrek Lead:
1. Make sure volunteers are setting out notebooks.
2. Ask the classroom teacher for a place to leave the student posters in the classroom.

SciTrek Volunteers:
1. Set out notebooks/nametags.

Note: If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

Introduction:
(2 minutes – Full Class – SciTrek Lead)

If needed, while you are doing the introduction have volunteers set out the notebooks/nametags where they would like students to sit. Tell students that a notebook will be put on their desk, which is not their notebook and they should not move it.

Ask the class, “What is the class question that we have been investigating?” Students should reply, “What variables affect the direction mealworms travel?” Ask the class, “Why are we interested in this question?” Possible student response: this will help us learn about mealworms habitats. Tell students that today they are going to analyze the results from their experiments, which will allow them to start answering the class question. Then they will put together a poster to show their findings to the class. Tell students they should write as neatly as possible on the poster parts so that the other class members can read their poster.

Graph:
(10 minutes – Groups – SciTrek Volunteers)

Ask your group, “What did we do last time in SciTrek?” Have them explain their experiment to you without looking at their notebooks.

Help the students fill out the graph. First decide on the appropriate scale for the y-axis. You will either count by ones or twos. The example graph has a scale of one. In addition, as a group have the students fill out the x-axis (their changing variable and the values of this variable that they used). The values of the changing variable should be filled out in order of compartment. For example, if your group changed food type and you used cookies in compartment A and lemons in compartment C, you would write “cookies” on the first blank, “none” on the second blank, and “lemons” on the third blank. Once the axes are filled out, graph the first compartment with the students. Ask students, “How many mealworms were in compartment A?” Tell students to tell you to stop when your finger gets to the appropriate level on the graph. Place your finger at zero and slowly move it up the graph until the students tell you to stop. If the students miss the stopping mark, repeat the process. Once you have identified where the line goes, draw a line across the column showing the number of mealworms as well as write in the numerical value on top of the line. Then quickly fill in the area below the mark. Tell students that they should try to beat how fast you filled in under the line when they draw the graph in their notebooks. Have students attempt to graph the other 2 compartments on their own and then check their work and record the results in the group notepad. An example filled graph can be seen below.
Results Summary:
(10 minutes – Groups – SciTrek Volunteers)

Have students use their graph to summarize their findings. Challenge students to think about how their changing variable relates to the habitat in which they would find a mealworm.

When writing their results summary (page 10, student notebook), make sure that students start the statement with a claim (a statement that can be tested) about their data. Have students generate a claim that focuses on what their experiment implies about the environment in which mealworms live. An appropriate claim could be: mealworms live in dark environments. This is an appropriate claim because it allows the students to make a prediction about what would happen if new values of their changing variable were introduced.

After generating a claim about the experiment, write the word “because” and follow it with supporting data. Make sure students are using their changing variable values (not trial letters) and specific numbers to support their claim. The supporting data for the previously mentioned claim would be: because 10 mealworms went to the dark and 2 mealworms went to the light.

Results summaries are still valid, and important, if they show that the changing variable tested did not affect the direction the mealworms travel. Even if their results summary is contrary to what you think, have students make a claim based solely on their data. Help students copy this statement into their notebooks.

Before starting their poster, have students fill in the sentence frame (page 9, student notebook): “I acted like a scientist when.” Each student’s response should be unique and specific. They should NOT write, “when I did an experiment,” because this is general and applies to all of the students in the class. If students are having trouble with this sentence frame, ask them what they did during each SciTrek session.
Poster Making:
(33 minutes – Groups – SciTrek Volunteers)

Pass out the writing portions (general poster parts and “I acted like a scientist when”) and have students write their names on them and complete them. In addition, have each student write their name on the scientists’ names poster part. Use the following guidelines when assigning poster parts:

<table>
<thead>
<tr>
<th>Number of Students in Group</th>
<th>Poster Division</th>
<th>Each student gets an “I acted like a scientist when” and picture space.</th>
</tr>
</thead>
</table>
| 4                           | 1. Question and Experimental Set-Up  
2. Procedure  
3. Results Graph*  
4. Results Summary | Student that finishes 1st completes the results table (not presented) |
| 5                           | 1. Question  
2. Experimental Set-Up  
3. Procedure  
4. Results Graph*  
5. Results Summary | Student that finishes 1st completes the results table (not presented) |
| 6                           | 1. Question  
2. Experimental Set-Up  
3. Procedure (Presents 1st half of procedure)  
4. Results Table (Presents 2nd half of procedure)  
5. Results Graph*  
6. Results Summary | *Give the results graph to the student that is most confident in presenting. |

Once students have finished the writing section(s), have them draw a picture of their experiment or how they acted like a scientist.

In the students’ notebooks, highlight and number the section(s) that they will present. The parts should be numbered as follows: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) results summary (see example below). Students will NOT present the results table or “I acted like a scientist when” parts from their poster. If a student is presenting multiple sections, use the paperclips in your group box to clip together the sections that they are reading so that when presenting, it will be easy to flip back and forth between pages.

Example Highlighted Notebook Pages
Place the following sentence frame sticker on the notebook page of the student that is presenting the results graph (page 8, student notebook). If your group is testing light amount cross out the “with” on the sticker and write in “in the” instead.

The compartment with ______________ had ______________ mealworms.

<table>
<thead>
<tr>
<th>changing variable value</th>
<th>number of mealworms</th>
</tr>
</thead>
</table>

Then practice reading the three sentences with that student. For the graph above, the first sentence would be: The compartment with **in the dark** had **10 mealworms**. Leave the “changing variable value” and the “number of mealworms” blanks empty.

As soon as students have completed some of their pieces, start gluing them onto the large poster paper, in landscape orientation, **exactly** as they are arranged in the example below. Do not allow students to glue the poster parts on the poster. Do not wait until students have completed all the pieces to start gluing them onto the poster.

Once the poster is complete, have students start practicing for the presentation. Make sure that students read from their notebooks instead of off the poster.
Ask your group a few questions about their poster. Have them use their findings to predict what would happen to the direction the mealworms travel for other experiments that they did not perform but are related to their experiment. In addition, have them state how their findings apply to mealworms in the wild. For instance, if the group’s results summary was, “My experiment shows that mealworms eat dry foods because 12 mealworms went to the cookies (dry) and 5 mealworms went to the oranges (wet),” ask the group, “If there was a bowl of salad and a bowl of crackers on the table which would you be more likely to find a mealworm in?” They should be able to predict that it would more likely be in the crackers.

If there is additional time, tell students that the other students will ask them questions during their poster presentations. Tell them that they should think about what questions they will be asked and then think of the answers to those questions so that they will be prepared during their presentation.

Wrap-Up:
(5 minutes – Full Class – SciTrek Lead)

Ask students the following questions:
How did you act like a scientist during this project?
What did you do that scientists do?

After having a discussion about how they acted like scientists and talking about how everyone does things that scientists do in their everyday lives, tell students that they will present their findings during the next session and that you are looking forward to hearing about all of their experiments.

Clean-Up:

1. Collect student notebooks with attached nametags.
2. Leave posters in the classroom.
3. Place all other materials in your group box and bring materials back to UCSB.

Day 5: Poster Presentations

Schedule:

Introduction (SciTrek Lead) – 2 minutes
Practice Posters (SciTrek Volunteers) – 15 minutes
Poster Presentations (SciTrek Volunteers/SciTrek Lead) – 41 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Materials:

(4) Volunteer Boxes:
- ☐ Student nametags
- ☐ Student notebooks
- ☐ Volunteer instructions
- ☐ Volunteer lab coat
- ☐ (2) Pencils
- ☐ (2) Paperclips
- ☐ Highlighter
- ☐ (8) Sharpened SciTrek pencils (all same color)

Lead Box:
- ☐ (3) Extra student notebooks
- ☐ Lead instructions
- ☐ Mealworms picture packet
- ☐ Lead lab coat
- ☐ Time card
- ☐ (2) Stickers on how to present graph
- ☐ (2) Pencils
- ☐ (2) Wet erase markers
- ☐ (4) Paperclips
- ☐ (2) Highlighters
- ☐ Scotch tape

*Student posters should already be in the classroom.

Picture Packet Page:

![Image of a table showing different groups and their experiments with mealworms]

Preparation:

SciTrek Lead:
1. Make sure volunteers are setting out notebooks.
2. Assign volunteers a new group to work with. This will allow students to explain what they found and practice their poster with a new person.
3. If the classroom has a document camera, ask the teacher to use it for the Notes on Presentations (page 2, picture packet). If the classroom does not have a document camera, then write the class question on the board, “What variables affect the direction mealworms travel?” Leave enough room to record student findings under the question.

4. Organize posters so experiments featuring the same changing variable are presented back to back and posters are presented from easiest to understand to hardest to understand (suggested order: light amount, food type, bedding type).

SciTrek Volunteers:
1. Today you will initially work with a new group of students. When your original group presents their poster, go up with them.
2. Set out notebooks/nametags.
3. Have pencils ready to distribute to your group after the poster presentations.

Note: If students are not in the classroom before SciTrek starts, notebooks should be set out where students should sit when they come into the classroom. If students are in the classroom before SciTrek starts, notebooks should be set out where students should sit during the module; they will move to these spots after the introduction.

Introduction:
(2 minutes – Full Class – SciTrek Lead)

Tell students that today they will present their posters to the class. Inform students that this is a common practice in science. Scientists go to conferences where they present posters about the experiments they conducted. At these presentations, other scientists give them feedback on their experiments, which allows them to return to the lab with new ideas for future experiments.

Tell students that today they will work with a new volunteer. They will have 15 minutes to discuss their experiment/results and practice presenting their poster with their group. While discussing their experiment/results, students should not look at their notebooks or poster. Remind students to read from their notebooks when presenting. Tell students that after practicing, they will return to their normal classroom seats.

Practice Posters:
(15 minutes – Groups – SciTrek Volunteers)

Have volunteers rotate groups.

If the posters are not already in order, the lead should organize posters so experiments featuring the same changing variable are presented back to back and that posters are presented from easiest to understand to hardest to understand (suggested order: light amount, food type, bedding type).

Have students explain what they did and what they learned from their experiment, without looking at their notebooks, if possible. Ask students questions to make sure that they understand what they did during their experiment. Make sure that you also have them use their results to predict what would happen for other systems that they did not test. Remind them to think about patterns or trends that they saw for their own results and apply these trends to make predictions about the direction that mealworms travel. For instance, if the group’s changing variable was food type and their changing variable values were lettuce and Cheerios ask them, “What do you think is another food that mealworms might move towards and why?” Possible student response: Rice Krispies because they are another dry food source. Try to make sure that each student in your group answers one question.
Once the group has an understanding of their experiment, have them practice their poster presentation, making sure they are reading the poster parts in the correct order (scientists’ names, question, experimental set-up, procedure, results graph, and results summary). Make sure each student’s part is highlighted in their notebook. If students are reading from multiple pages, use a paperclip to clip these pages together to make it easier for them to flip back and forth. Remind students to read from their notebook rather than from their poster.

If there is additional time, tell the group that the other students will ask them questions during their poster presentations. Tell them that they should think about what questions they will be asked and then think of the answers to those questions so that they will be prepared during their presentation.

Do not let poster practice go over 15 minutes.

**Poster Presentations:**

*(41 minutes – Full Class – SciTrek Volunteers/SciTrek Lead)*

Have students return to their original class seats. Ask the class, “What is the question we have been working on solving?” Students should reply, “What variables affect the direction mealworms travel?” Ask the class, “Why are we interested in answering this question?” Possible student response: if we can determine the variables that affect the direction mealworms travel, we will be able to predict the mealworms’ ideal habitat. Tell students that during the presentations you are going to take notes. Turn to page 2 in the picture packet. Tell them that they need to tell you each group’s changing variable after the group says their question so that you can record it. In addition, you will record the values of the changing variable when the group presents the experimental set-up, and the data that was taken when the group presents their graph.

After each presentation, students will be given the opportunity to ask scientific questions to the presenting group to help them determine if/how the variable investigated affected the direction the mealworms traveled. Tell them these questions are important because they will have to summarize for you what they learned from the group so you can record it on the group notes. Therefore, their questions should focus on helping them be able to summarize the group’s findings. Tell them that if they ask a scientific question during the presentation, they will get a SciTrek pencil at the end of the presentations.

Volunteers should make sure that students are quiet and respectful when other groups are presenting. When your group is presenting, go to the front of the room with them; prompt students if they do not know who talks next and remind them to read from their notebooks.

During the student question time, the lead and/or volunteers should ask at least one question. Examples of possible questions are: “How do you know...?” or “Is there anything else you can do to get more information about your question?” Each group should answer approximately five questions (one question per student).

When students are done asking questions, have them summarize what the group found. This is challenging for 3rd graders, therefore, you need to break it down into the following five question 1) What was the group’s changing variable? 2) (point to the notes where you recorded the values of the changing variable) What value of the changing variable did more mealworms travel to? 3) Why did they go to (insert what they went to)? 4) What does this mean about a mealworms habitat? 5) Can someone put what we learned into a sentence? If they are still having trouble give them the sentence frame “Mealworms live in (insert why the mealworm went to the changing variable value) habitat.” Ex: Mealworms live in a dark habitat. Once they have generated a summary, record this on the notes page.
An example filled out Notes on Presentations is shown below.

After all poster presentations have been given, ask the class, “What did we learn about the direction mealworms travel?” Have them summarize the class findings. The highlights from many experiments are shown below. Do not expect students to know highlights from experiments that were not run.

- The dimmer the light amount the more mealworms there will be.
- Mealworms move towards food types that are dry.
  **Note:** Mealworms will travel to both sweet and salty foods.
- Mealworms move towards bedding types that are loosely bound or they can burrow into.

When summarizing experiments, use student-collected data and not what they should have found from the list above. Ask students, “What is the ideal habitat for a mealworm?”

- Moisture Level: Dry
- Light Amount: Dark
- Food Type: Dry bread or other bready material
- Bedding Type: Cotton or other materials that they can burrow into

If no one in the class did experiments on one of the variables above, then they will not know how that variable affects a mealworm’s motion and do not expect them to tell you which value to use. Tell students they have taught you a lot about mealworms’ ideal habitats.
Wrap-Up:
(2 minutes – Full Class – SciTrek Lead)

Tell the students that the volunteers that have been working with them are undergraduate and graduate students that volunteer their time so that they can do experiments. Have the students say thank you to the volunteers. This is the last day with their volunteers, therefore, they should say goodbye to them. Tell students that you will be back one more time.

Tell students to remove the paper part of their nametag from the plastic holder and that they can keep the paper nametag, but they need to give the plastic holder back to their volunteer.

Have volunteers pass out pencils to the students that asked questions. If a student did not ask a question during the poster presentations, have them ask/answer a question about the experiments before the volunteer gives them a pencil.

Clean-Up:

1. Collect plastic nametag holders and allow students to keep the paper part of their nametag.
2. Collect notebooks.
3. Leave posters in the classroom.
4. Place all other materials into your group box and bring materials back to UCSB.
5. If you will not be attending the Tie to Standards day, remove all materials from your lab coat pockets, remove your nametag, unroll your lab coat sleeves, and put your lab coat into the dirty clothes bag at UCSB.

Day 6: Question Assessment/Tie to Standards

Schedule:

Question Assessment (SciTrek Lead) – 5 minutes
Tie to Standards (SciTrek Lead) – 55 minutes

Materials:

Lead Box:

☐ (3) Extra student notebooks  ☐ Mealworms picture packet  ☐ Time card
☐ Student notebooks  ☐ Lead lab coat  ☐ (2) Pencils
☐ Lead instructions  ☐ (25) Question Assessments  ☐ (2) Wet erase markers
I acted like a scientist when I counted the number of mealworms and recorded the amount in my notebook.

TIE TO STANDARDS
1. From the class experiments write 2 factors you would expect to find in a mealworm’s ideal habitat.
   a. dry
   b. dark

2. What would happen if the climate changed where the mealworms lived?
   a. They would have to move.

3. Overall, what are the three things that species can do when the environment changes?
   a. move
   b. die
   c. adapt

4. PANDA
   a. What were the environmental changes that caused the panda’s habitat to decrease?
      hunting deforestation
   b. What type of changes were these? POSITIVE NEGATIVE
   c. What was the response of the panda to this environmental change? move
   d. Can this response occur within the panda’s lifetime? YES NO

5. LOCUST
   a. What was the environmental change that caused the locust’s habitat to increase?
      more resources, close by
   b. What type of changes were these? POSITIVE NEGATIVE
   c. What was the response of the locust to this environmental change? move
   d. Can this response occur within the locust’s lifetime? YES NO

6. a. What is it called when animals move for only part of a year? migration
   b. What is an example of an animal that does this? whales, birds
   c. What are possible reasons animals may do this? reproduce
      weather
      food
   d. What is the response of migrating animals to environmental changes? move
   e. Can this response occur within the animal’s lifetime? YES NO

7. CAMEL
   a. What does burning fat provide for an animal? energy
   b. This can be used by the animal as a substitution for food and water
   c. Would it be a problem if a camel stored fat all over its body? YES NO
   d. What is stored in a camel’s hump? fat
   e. What was the response of camels to environmental changes? adapt
   f. Can this response occur within a camel’s lifetime? YES NO

8. GIRAFFE
   a. List two other animals that live in this environment:
      zebras and gazelles
   b. What do the animals listed above eat? grass
   c. Is there competition for this food source? YES NO
   d. What other type of food might giraffes eat? leaves on trees
   e. What was the response of the giraffe to environmental changes? adapt
   f. Can this response occur within the giraffe’s lifetime? YES NO

9. SABER-TOOTHED CAT
   a. What adaptation did the saber-toothed cat have to live in its environment? large teeth
   b. What did they eat? large prey
   c. What kept the saber-toothed cat eating smaller prey? its teeth
   d. What was the response of the saber-toothed cat to environmental changes? Die
   e. Could this response occur within the saber-toothed cat’s lifetime? YES NO

10. LITTLE SWAN ISLAND BUTTA
    a. Where did the hutta live? on island
    b. The two environmental changes to the island were: house cats and hurricane
    c. Adaptations take a long time and must occur over many generations of a species.
    d. Are large or small habitat ranges beneficial for survival of species?
       LARGE SMALL
    e. What was the response of the hutta to environmental changes? die
    f. Could this response occur within the hutta’s lifetime? YES NO

11. a. What is it called when an entire species dies off? extinction
     b. Does this usually occur over one generation? YES NO
Preparation:

SciTrek Lead:

1. If the teacher is not leading the Tie to Standards Activity, do the following:
   a. Give the teacher an extra student notebook and have them fill it out with their students to follow along.
   b. Collect the teacher’s lab coat and put it in the lead box.
2. Pass out the Question Assessments and notebooks to students or get the classroom teacher to pass them out.
3. If the classroom has a document camera, ask the teacher to use it for the Tie to Standards Activity (pages 9-12, student notebook and pages 3-9, picture packet). If the classroom does not have a document camera, then tape poster-size notebook pages to the front board.
4. Put your lab coat in the lead box at the end of the day.

Question Assessment:
(5 minutes – Full Class – SciTrek Lead)

“Before we start our activity today, we will determine how your ideas on testable questions are developing. One of the ways that we get program funding is by demonstrating program effectiveness. Therefore, we need you to do your best on the assessment.” Pass out the Question Assessment and tell students to fill out their name, teacher’s name, and date on the top of the assessment. Remind the students that it is important that they fill out this assessment on their own.

Read the instructions to the students. Then read each of the questions and tell the students to circle “testable” for questions that science can answer or “not testable” for questions that science cannot answer. When students are finished, collect the assessments and verify that the students’ names are on the top of the papers.

Tie to Standards:
(55 minutes – Full Class – SciTrek Lead)

A Mealworm’s Ideal Habitat (15 minutes)

Tell the class that you enjoyed their poster presentations the last time you were there. Tell the students that today they are going to revisit some of the variables that affected the direction that mealworms traveled. Have students turn to page 9 of their notebooks. Place the class notebook under the document camera and turn to page 9.

Ask students, “What do you think a wild mealworm’s habitat is like and why?” Tell students to think about all of the experiments that their class did and record student ideas on the board (or on the bottom of page 9, student notebook). They should be able to use experimental evidence they gathered to determine a mealworm’s ideal habitat or the variables that affect the direction mealworms travel. For example, from the observational set-up run the first day, students should know that mealworms move towards dry places as opposed to wet. Therefore, they probably live in a dry environment. Their experiments should let them determine other things about mealworms’ preferred habitats such as light/dark (mealworms move towards the dark), food sources (mealworms move towards dry bread-like foods), bedding materials (mealworms move towards loosely bound beddings like woodchips or dry leaves), etc. After, have students pick two of these responses and copy them into their notebook for question 1. Example student work can be seen below.
Ask students, “What would happen if the climate changed where mealworms lived?” For example, what would happen if the place in which mealworms lived started to get more rain so that their living space was always wet? What could the mealworms do? Allow students to talk in groups about this and then have them record some of their ideas into their notebook on page 9. After, have one or two students share. Record one of these responses into the class notebook under the document camera for students to copy. An example of student work can be seen above.

Tell the students that there are three things a species can do when its habitat changes. Most of the time students will have already come up with two answers for this question, move or die. Have them write these on the first two lines of question 3. Tell them that the third option for the species can only occur if the habitat change is very slow. Species can slowly adapt to the new environment, however, this cannot happen in one generation. For instance, if a mealworm’s habitat became permanently wet, many of the mealworms would die off. The mealworms that would survive would have adaptations that would allow them to handle the new wetter environment. These mealworms would have offspring that could also deal better with a wetter environment and slowly over many generations the mealworms would adapt to their new wetter habitat. Have students fill in “adapt” on the last line of question 3. An example of student work can be seen above.
Move/Migration (10 minutes)

Have the students turn to page 10 in their notebooks.

Show the students the picture of the Giant Panda (page 3, picture packet).

Tell students that pandas originally lived in all of the green areas on the map but now they only live in the red areas. Ask students, “What were the environmental changes that caused the panda’s habitat to decrease?” Allow one or two students to share their answers. Tell students that the pandas had to move to this new environment because of two reasons: deforestation and hunting. Record these answers for question 4a. Ask students, “Was this a positive or negative change for the pandas?” They should respond, negative. Circle this answer for question 4b.

Ask students, “What was the response of the pandas to this environmental change?” They should respond, move. Record this answer for 4c. Then ask students, “Can this response (moving) occur within a panda’s lifetime?” They should respond, yes. Record this answer for 4d. An example of student work can be seen below.
Tell students that although in the pandas’ case the move was a response to a negative change in the pandas’ habitat that there are also positive reasons that would cause an animal to move.

Show the students the picture of the locust (page 4, picture packet).

Tell the students that originally, the locusts were in the green area on the map but now they live in both the yellow and the green areas. Ask students, “What was the environmental change that caused the locusts’ habitat to increase?” Allow one or two students to share their response. Tell students that the locust moved because there were abundant resources close by. This allowed them to expand their habitat range and the locust population grew. Record this answer for question 5a.

Ask students, “Was this a positive or negative change for the locusts?” They should respond, positive. Circle this answer for 5b. Ask students, “What was the response of the locusts to this environmental change?” They should respond, move. Record this answer for 5c. After, ask students, “Can this response occur within a locust’s lifetime?” Student should respond, yes. Record this answer for 5d. An example of student work can be seen above.

Tell students that some animals only move for part of the year or for a season because the environment that they live in becomes temporarily undesirable. Ask students, “What it is called when animals only move temporarily to another location?” Students should know that this is called migration. Record this answer for question 6a. Ask students, “What are examples of animals that migrate?” Allow one or two students to share their responses. Record one of these responses for answer 6b (examples: birds, butterflies, whales, caribou, penguins, and salmon).

Show students the picture of whales and birds, page 5 of picture packet.
Ask students, “Why do animals migrate?” Allow students to talk in groups and then allow some students to share. Animals migrate to reproduce, to search for food, or to search for better weather (warmer water). Record these responses for question 6c.

Ask students, “What is the response of migrating animals to environmental changes?” They should respond, move. Record this answer for 6d. After, ask students, “Can this response (move) occur within an animal’s lifetime?” They should respond, yes. Record this answer for 6e. An example of student work can be seen above.

Adapt (15 minutes)

Have the students turn to page 11 in their notebooks.

Show the students the picture of the camel (page 6, picture packet).

Ask students, “Can someone describe the environment in which camels live?” They should be able to respond, camels live in the desert, where it is very hot, and there is little food and water.

Tell students that animals store fat so that, when needed, their bodies can burn the fat to produce energy. Have students record this for question 7a. Tell the students the burning of fat by animals can be a substitute for food and water. Have students record this for question 7b.

Ask students, “Do you think fat is important for camels and why?” Make sure by the end of the discussion that students understand that fat is important for camels because it allows camels to go for long periods of time without eating or drinking.

Ask students, “Why do whales have fat (blubber) all over their bodies?” They should respond, whales have blubber all over their bodies to keep warm. Therefore, animals that do not burn their fat/blubber can use it for insulation. Now ask students, “Would it be a problem if a camel stored fat all over its body and why?” They should realize that having fat all over a camel’s body would be a problem because it would make them very hot, and they already live in a warm environment. Record this response for question 7c.

Ask students, “Why is it important for camels to store fat?” They should realize that camels store fat not to keep warm, but to utilize as food (energy) when they have to go long periods of time without any food or water. Now, ask students, “What adaptation have camels made to survive in the harsh conditions of the desert?” They should respond, the hump on the camel’s back is its adaptation. Ask students, “What they think is stored in the camel’s hump?” By the end of the conversation make sure that students understand that fat is stored in the camel’s hump which allows camels to have stored energy (food/water) without causing them to overheat, which would happen if fat was evenly dispersed over their bodies. Record this response for question 7d.
Ask students, “What was the response of the camels to the environmental conditions?” They should respond, adapt. Record this answer for question 7e. Then, ask students, “Can this response (adapt) occur within a camel’s lifetime? They should respond, no. Record this response for question 7f. In other words, if you put a camel in a cold environment would it lose its hump as the fat redistributed around its body? Students should be able to realize that this adaptation would need to take place over many generations of camels and would therefore not occur during one camel’s lifetime.

Ask students, “What would happen if a camel was born without a hump?” They should respond, the camel might not be able to go long periods of time without food/water because they would have no way to store fat (food/water). This might cause the camel to die. Therefore, over time the camels that could store more fat in their humps had more offspring, which lead to the hump adaptation.

Note: The camel’s hump stores two different kinds of fat, one of which can be used as a form of energy and the second is very dense and gives the hump its rigidity and shape. When the camel is underfed or has to go long time periods without any food or water the camel can burn the extra stored fat that is in its hump to get energy instead of having to eat food. In addition, when the fat is burned water is also released as a byproduct. Unlike sheep and cows, which have similar energy needs to the camel, in terms of the amount of food, camels are able to over eat and under eat because they have adapted to survive in an environment where food is limited. The camel’s hump does change size slightly as the camel has more or less fat reserves but since the rigid fat is always there, the hump does not completely go away.

Show students the picture of the giraffe, (page 7, picture packet).
Ask students to describe the environment in which giraffes live. Giraffes live in Africa on the savanna or grassy plains, which have some tall trees. Ask students, “What do giraffes eat?” They should respond, grass and leaves. Ask students, “Do other animals live in this type of environment? They should respond, other animals like zebras, lions and gazelles also live there. Record two of their responses (choose animals that eat grass) for question 8a.

Now ask students, “What do zebras and gazelles eat?” They should realize that gazelles and other animals that live in the grassy plains eat grass. Record this answer for question 8b. Ask students, “Is there competition with other animals for the food that giraffes eat?” They should realize, because both of these animals eat grass, there is competition for this food source. Circle this answer for question 8c. Ask students, “Besides grass, what other type of food might giraffes eat?” They should respond, giraffes eat the leaves off of trees. Record this answer for question 8d. Now, ask students, “Why are giraffes better equipped to eat leaves on a tree than gazelle?” They should respond, giraffes have long necks and long legs to help them reach the tall tree leaves.

Ask students, “What was the response of the giraffes to the environmental conditions?” They should respond, adapt. Record this answer for question 8e. Then ask students, “Can this response (adapt) occur within a giraffe’s lifetime? They should respond, no. Record this response for question 8f. In other words, if you put a giraffe in an environment with lots of low vegetation would it lose its long neck/long legs? Students should be able to realize that this adaptation would need to take place over many generations of giraffes. An example of student work can be seen above.

Tell students that if they are wondering why giraffes’ necks don’t just keep evolving to be even longer, it is because giraffes with longer necks would need more nutrients than giraffes with smaller necks. During drought seasons it is hard to get enough nutrients to sustain large giraffes, which causes them to die off. Therefore, there is an ideal neck length that allows giraffes to reach most of the tall leaves without needing too many nutrients. In addition, during a drought, leaves only grow closer to the ground which makes competition for the longer neck giraffes greater.

Ask students, “What would happen if a giraffe was born with a short neck?” They might say, there would be too much competition for food, therefore, the giraffe might not be able to get enough food and would then die.

**Die (15 minutes)**

Have the students turn to page 12 in their notebooks.

Show students the picture of the saber-toothed cat (page 8, picture packet).
Ask students, “What adaptation did the saber-toothed cat have to live in its environment?” They should respond, they had two large front teeth to catch prey. Record this answer for question 9a. Ask students, “What did the saber-toothed eat?” They should respond, they ate large prey, such as deer. Record this answer for question 9b. Ask students, “Do you think it was possible for a saber-toothed cat to catch small prey such as a mice?” They should say, the saber-toothed cat would not be able to catch smaller prey because their two large teeth would get in the way. Record this answer for question 9c.

Tell students that during the time the saber-toothed cat lived, the weather conditions on the planet changed and the planet became much colder. This caused most of the large prey (deer-like animals) to die off because a lot of the vegetation froze and there was no food for the large herbivores (prey) to eat. Because there was less large prey, this resulted in less food for the saber-toothed cats. Since the saber-toothed cats were not able to catch smaller prey (because of their large teeth), they all died off. Record this response for question 9d.

Ask students, “What was the response of the saber-toothed cats to environmental changes?” They should respond, die. Record this answer for question 9d. Then, ask students, “Could this response (death) occur within a saber-toothed cat’s lifetime?” They should be able to realize that death (although not favorable) is a possibility within an animal’s lifetime. Record this response for question 9e. An example of student work can be seen below.
Show the students the picture of the little swan island hutia (pronunciation: hoo-TEE-uh), (page 9, picture packet).

Tell students that this rodent lived on a small island in Honduras until a hurricane (Hurricane Janet, 1955) came and devastated the island. In addition, house cats were introduced to the island and they hunted this animal. Because of the hurricane and the addition of house cats, these animals became extinct in 1955. Record these answers for questions 10a and 10b.

Ask students, “Why was the rodent not able to adapt to these new conditions?” They should realize that they did not have enough time to adapt because the hurricane and the house cats were introduced so fast. Ask students, “How long does it take for a species to make adaptations?” They should respond, it takes many generations for a species to make adaptations. Students should realize that because hutias could not adapt quickly enough, they were not able to survive and died. Fill in the following sentence frame with students (10c): adaptations take a long time and must occur over many generations of a species.
Ask students, “Are large or small habitat ranges beneficial for survival of species and why?” They should respond, it is more beneficial for a species to live in a large area in case of an event like a hurricane so that an entire species does not die out. Circle the correct answer for 10d.

Ask students, “What was the response of the hutias to environmental changes?” They should reply, die. Record this answer for question 10e. Then, ask students, “Could this response (die) occur within a hutia’s lifetime?” They should be able to realize that death (although not favorable) is a possibility within an animal’s lifetime. Record this answer for question 10f. An example of student work can be seen above.

Ask students, “What is it called when an entire species dies off?” They should respond, extinction. Record this answer for question 11a. Tell students that both the saber-toothed cats and the hutias are examples of animals that became extinct. Ask students, “Does extinctions usually occur over one generation?” By the end of the conversation, make sure that students understand that many times there is a slow decline in the number of animals in that species until finally the species becomes extinct and this process can occur over many generations. Tell students that if the decline in species is slow enough humans can help prevent extinctions. Ask students, “Do you know of any ways that humans have been able to help animals from going extinct?” They should respond with ideas like habitat restoration, nature preserves, placing animals on the endangered list, making efforts to stop poaching, and placing animals in zoos to reproduce. Tell the class that the example of the saber-toothed cat extinction took place over many generations because the changing climate and the death of large prey took place over a long period of time. However, the example of the hutia extinction took place over a single generation because the effect of the hurricane and introduction of cats was so dramatic. In addition, the habitat size for this animal was very small, which made it difficult for it to find available food and shelter.

Tell the students that they can keep their notebooks, and that you have enjoyed learning science with them, and they will get another opportunity for SciTrek to come to their class and run another long-term investigation with them later in the year. Tell them to remember what they have learned from their module for their next module.

**Clean-Up:**

1. Leave notebooks with students.
2. Place materials in your group box and bring materials back to UCSB.
3. Remove all materials from your lab coat pockets, remove your nametag, unroll your lab coat sleeves, and put your lab coat into the dirty clothes bag at UCSB.
Extra Practice Solutions:

EXTRA PRACTICE
Questions
Circle TESTABLE if the question can be tested by science. Circle NOT TESTABLE if the question cannot be tested by science. If the question is NOT TESTABLE, change (revise) the question to be something that is testable.

1) How fast can Wonder Woman run?
   Testable Not Testable
   Revision: How fast can Darcy run?

2) What species of animal has the thickest fur?
   Testable Not Testable
   Revision: ?

3) Is learning how to write in cursive valuable?
   Testable Not Testable
   Revision: How many people learned to write in cursive?

4) How many hours does a giraffe sleep in a day?
   Testable Not Testable
   Revision: ?

5) Do ants like sugar?
   Testable Not Testable
   Revision: Do ants eat sugar?

6) What is the total number of cups of coffee that people in the United States drink in a week?
   Testable Not Testable
   Revision: ?

7) Is soap easy to pour?
   Testable Not Testable
   Revision: Is soap easier to pour than water?