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Overview

Mealworms are small, harmless animals that make ideal lab specimens for experiments on animal behavior. In this Delta Science Module, students investigate mealworm responses to a variety of environmental stimuli and then infer why the animals behave as they do.

In Activity 1, students are introduced to the life cycle stages and characteristics of the mealworm, which is the larval stage of a type of beetle. In Activity 2, students observe the movements of their mealworms and investigate which senses they think the mealworms use to move around on a tray.

Students are introduced to the concept of variable in Activity 3. They question whether mealworms prefer a black or a white surface, and then conduct an experiment in which surface color is the variable being tested. The students observe their mealworms on each surface color and draw conclusions about color preference based on their observations.

In Activity 4, students examine the behavior of mealworms as they search for food. Hungry mealworms are placed on one end of a tray and food is placed on the other end. Students predict how the mealworms will behave and then observe and record the details of how their mealworms find food.

In Activity 5, students operationally define stimulus and response. They help design their own experiments to determine mealworm responses to two stimuli: heat and light.

Students examine two other stimuli in Activity 6. They conduct experiments to determine mealworm responses to odor and barriers. Vinegar is used as the odor stimulus and kit materials and common classroom items are used as barriers.

In Activity 7, students conduct three more experiments, each one designed to determine mealworm responses to a single, different stimulus. The stimuli tested in this activity are those of touch, water, and air movement.

In Activity 8, students conduct an experiment to determine whether they can direct the path that a mealworm takes. They discover that a mealworm usually follows along the edge of a wall as it travels. They apply this knowledge to arrange inverted trays so that mealworms follow the edge that students present to them.

In Activity 9, students investigate the behavior of mealworms in a T-maze. When a mealworm reaches the T-choice point of the maze, it must make either a right or a left turn. Students conduct several trials and record and discuss the results.

In Activity 10, students investigate the behavior of their mealworms in another kind of maze—a forced-turn maze. Students predict which way the mealworm will turn at the T-choice point of this maze, after it has already made a forced right turn. Teams compare the results they obtained using the two kinds of mazes.

In Activity 11, students apply what they have learned about mealworm behavior to design an experiment to investigate a variable of their choice. Class discussions raise several questions about mealworm behavior and teams are encouraged to choose a variable that is of interest to them.

Activity 12 concludes this module with the students comparing the behavior of the mealworm (larval stage) with that of two other life cycle stages (pupal and adult stages). Students observe that the pupae and adults look and behave differently than do the mealworm larvae.

Materials List

Qty	Description	Qty	Description
32	c batteries, AA	160	tiles, ceramic
1	c bran flakes	1	transparency, acetate
16	clothespins	32	trays, plastic
1	c cotton swabs	1	c vinegar, 8 oz
16	cups, plastic, 9-oz	1	c Living Material Order Card
1	c drinking straws, p/50		Shipment includes:
16	droppers		1000 mealworms (with bran)
16	magnifiers	1	teacher's guide
16	maze card sheets		
1	Mealworm Picture Set		
1	nails, p/30		
4	c paper, construction, black, 23 cm x 30 cm		
4	c paper, construction, white, 23 cm x 30 cm		
1	c paper plate		
16	penlights		
16	petri dishes, with lids		
1	pipe cleaners, p/36		
1	poster, Beetle Life Cycle		
1	spoon, plastic		
2	c tape, transparent		

Teacher provided items

1	clock
2	containers, with perforated lids
11	cotton balls
-	crayons
1	marker, for overhead projector
1	overhead projector
1	scissors
1	tape, masking
1	vacuum bottle
-	c water, tap

c = consumable item

Activity 1

Meet the Mealworm

Objectives

In this activity, students are introduced to the mealworm, its life cycle stages, and some of its characteristics. They examine several mealworms and record the mealworm characteristics they observe.

The students

- learn the life cycle stages of mealworms
- discuss proper handling and treatment techniques
- observe mealworms in a petri dish
- draw, label, and describe their mealworms

Schedule

About 50 minutes. Begin Activity 1 after the Living Material Shipment arrives.

Vocabulary

characteristic
larva
life cycle
pupa

Materials

For each student

1 Activity Sheet 1

For each team of two

1 magnifier
1 petri dish, with lid

For the class

1 † mealworm culture
1 Mealworm Picture Set
1 poster, Beetle Life Cycle
1 roll tape, transparent

†in Living Material Shipment

Preparation

1. Make a copy of Activity Sheet 1 for each student.
2. Place five mealworms in a petri dish (and add the lid) for each team.
3. Tape together the two pieces of paper which form the large picture of a mealworm in the Mealworm Picture Set.
4. Put the Beetle Life Cycle poster on a classroom wall where students can see it.
5. If a pupa and adult beetle exist in your mealworm culture, you may wish to place one of each in a covered petri dish to show students as the life cycle stages are explained.
6. Each team of two will need a petri dish of five mealworms and a magnifier.

Background Information

Mealworms are not worms at all; rather, they are the larval stage of a type of beetle called the darkling beetle.

A *life cycle* is the sequence of changes an organism undergoes as it develops from an egg to an adult. Some insects and animals

look very different from one stage of life to the next. Such is the case for the mealworm.

The eggs of the mealworm are too small to see with the unaided eye. Once these eggs hatch, it marks the beginning of the larval stage. A mealworm *larva* looks worm-like, as do the larvae of many types of insects. For instance, maggots are the larvae of flies, and caterpillars are the larvae of butterflies.

A *pupa* is an animal in the relatively inactive, transitional stage between larva and adult. Some insects' pupal stage is spent in a cocoon, but this is not true of the mealworm. Some mealworm pupae may be present in the Living Materials Shipment when it arrives. More mealworms will develop into pupae within a few days.

Expect to see adult beetles in the class culture after about 2 weeks. When they first emerge, adults are beige in color. As they mature, they turn brown and then black. Notice, too, that the beetles have wings which are protected by a hard covering.

Students may be interested to know that 25% of all species on earth are beetles. Some members of the beetle family that they may be familiar with include ladybugs and fireflies.

A *characteristic* is a distinguishing feature or quality of an organism. Examples of a

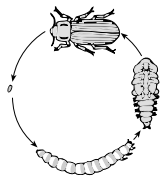
mealworm's characteristics are that it is worm-like in shape, beige to light brown in color, has 2 antennae, 6 legs, and 13 body segments.

In this activity, students will observe mealworms and identify and describe the mealworms' characteristics.

Name _____ Activity Sheet 1

Meet the Mealworm

1. On the diagram, label the life cycle stages of the mealworm.



2. List rules for proper handling and treatment of the mealworms.

- Always handle mealworms gently.
- Wash your hands before and after handling mealworms.
- Do not poke or stick mealworms with anything at any time.
- Do not press down on them or lay any objects other than food on top of them.

3. List the characteristics of mealworms that you observe.

- They are a light brown color.
- They look like worms.
- They have six tiny legs.
- They wiggle and crawl.

4. On the back of this sheet, draw a mealworm. Label the parts of the mealworm.

Teaching Suggestions

Explain to students that they will be investigating and observing a living animal—the mealworm.

Show the large, two-part picture of the mealworm to the class. Tell students that mealworms are odorless, will not crawl out of the class containers, and will not bite.

Discuss any prior knowledge students may have of mealworms or larval stages of other insects.

Additional Information

1

Write the words *life cycle* on the board. Explain that all organisms go through a sequence of changes as they develop from an egg to an adult. This sequence of changes is called a life cycle.

2

Point to the Beetle Life Cycle poster on the wall, and tell students that sometimes an organism looks very different at the different stages of its life cycle. The mealworm life cycle includes four stages: *egg*, *larva*, *pupa*, and *adult*, the last being the stage at which eggs are laid to begin the life cycle of the next generation.

Write the word *larva* on the board. Show students a mealworm, and tell them that mealworms are the larval stage of a particular kind of beetle. The larvae look like worms, but they are not worms.

Write the word *larvae* on the board, and explain that this is simply the plural form of larva.

Write the words *pupa* and *pupae* on the board, again pointing out the singular and plural forms. Tell students that the pupa is the stage between larva and adult. Ask, **Have you ever seen a cocoon?**

3

Most students have probably seen a cocoon made by a caterpillar.

Tell them that a cocoon is created during the pupal stage of an animal's life cycle. In the case of the caterpillar, the animal in the cocoon will change from a caterpillar (larva) into a moth (adult).

Mention that not all animals require cocoons during this stage. Refer back to the poster and point out that mealworms do not form cocoons to pupate.

Explain that the mealworm pupae will develop into beetles.

Show a pupa and an adult to the students, if these stages exist in the class culture.

Tell students that the pupal and adult life cycle stages will be examined in a later activity. In this and the next several activities, students will focus on the mealworm, or the larval stage of the beetle.

Distribute a copy of Activity Sheet 1 to each student. Call their attention to the diagram of the mealworm life cycle on the activity

4

sheet. Have each student point to the correct life cycle stage as you call out *egg*, *larva*, *pupa*, and *adult*.

Tell them to label each picture of the four life cycle stages of the mealworm on the activity sheet. Encourage them to do this without looking at the poster.

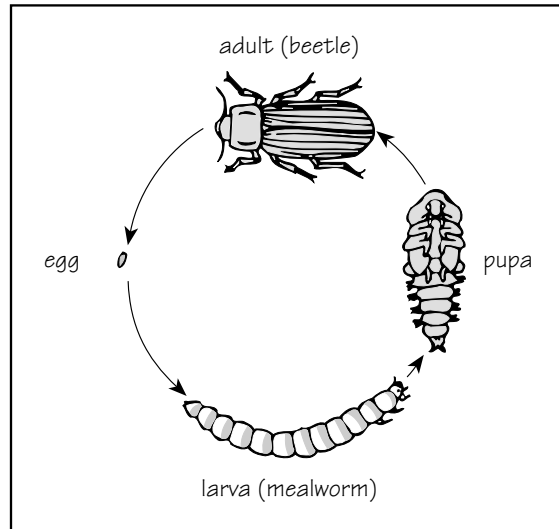


Figure 1-1. Life cycle stages of the mealworm.

Lead a discussion of rules for the proper handling and treatment of mealworms—the foremost rule being to always treat the mealworms gently.

5

Write the rules on the board and tell students to list these rules on their activity sheet.

- always handle mealworms gently
- wash your hands before and after handling mealworms
- do not poke or stick mealworms with anything at any time
- do not press down on them or lay any objects other than food on top of them

Add any other instructions that you feel are appropriate for your students.

Write the word *characteristic* on the board. Explain that a characteristic is a distinguishing feature or quality. Tell students that when you describe what an animal looks like, you are describing its characteristics.

6

Distribute a magnifier and five mealworms in a petri dish to each team. Have students observe their animals and list on Activity Sheet 1 all of the mealworm characteristics that they observe.

Students may want to take the mealworms out of the petri dishes. Show students how to pick up and handle the mealworms. To pick them up, pour them into your palm from the petri dish or, if they are on a flat surface, gently slide them to the edge of the table so that they drop into your palm.

If the mealworms are in a tray, students may find it easier to slide a piece of paper under the mealworms and lift the paper to move them.

7

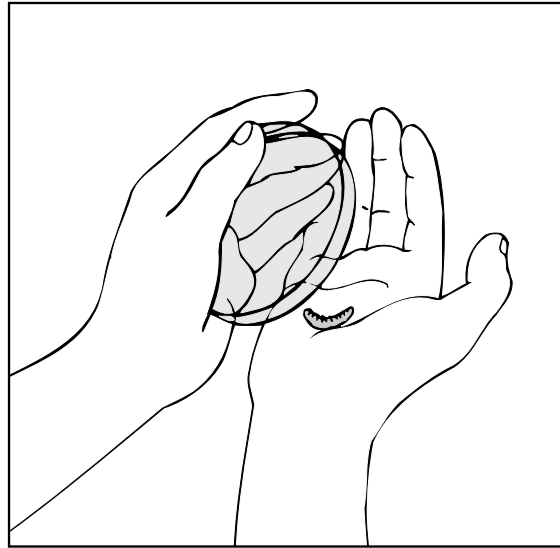


Figure 1-2. Picking up a mealworm.

Tape the labeled diagram of a mealworm (from the Mealworm Picture Set) to the front board, so that everyone can see it. Point out the names of the parts of the mealworm.

8

Some of the terms used for body parts may be for students at a higher reading level. Select the names of the body parts that are appropriate for your students' level of understanding.

Tell students to draw one of their mealworms on the back of their activity sheet and to label the drawing.

Tell them to use the diagram on the front board for reference.

After everyone has finished observing, recording, drawing, and labeling, ask, **What are some of the characteristics that you observed? How are individual mealworms alike and how are they different?**

9

All mealworms have a head, mouth parts, 2 antennae, 6 legs, and 13 body segments. They are different from each other in that they are different sizes and shades of beige.

Reinforcement

Ask students to think of other animals that have a larval stage during their life cycle. Students may have seen a maggot, which is the larval stage of a house fly. Ask if

R

students have ever seen a tadpole. Students may or may not know that tadpoles are the aquatic larvae of frogs and toads.

Cleanup

Return the mealworms to the class culture and rinse and dry the petri dishes. Return them, along with the magnifiers and the

C

Mealworm Picture Set, to the kit. Leave the poster up for the remainder of the module.

Connections

Science Challenge

Support your explanation that mealworms are not really worms by having students research the differences between true worms and the wormlike larval stage of insects. Students will discover two major differences that they can observe: (1) True worms have no legs, whereas insect larva do, although the legs may be very tiny and difficult to see. (2) True worms do not go through changes in form as they develop. The tiny worm that emerges from an egg is fully developed and simply grows larger throughout its life.

Provide an opportunity for students to observe differences between true worms and mealworms by setting up a classroom culture of earthworms as described below. Besides observing differences, students could use the earthworms in investigations such as those suggested in the Science Challenge for Activities 2, 3, 4, 5, 7, 9, and 12. (Also see the Science Challenge for Activity 11 involving frogs.)

Earthworm culture: If earthworms cannot be collected in your area at the time of year you are doing this module, you could purchase them from a commercial worm farm. Any plastic bucket or bin with a lid will make a suitable culture container. Fill the container about two thirds full of potting soil. (Make sure the soil is free of insect larva, pupae, and adults.) Mix in some shredded newspaper, leaves, or grass clippings, moisten the soil, and add the worms. Let students bury food scraps in the container from time to time. Explain that earthworms will not eat meat scraps or bones but will eat almost all types of fruits and vegetables cut into small pieces. At the conclusion of the module (or when the season is appropriate), the soil and worms can be added to an outdoor garden.

Science Extension

Encourage students to look in encyclopedias and other sources to find out what the mealworm's natural habitat is. Ask them whether they or other family members have ever found mealworms (or other insect larvae, pupae, or adults) in flour, cereal, or any other grain products at home.

Science and the Arts

Discuss human life stages and the characteristics of each stage. Then ask students to cut from magazines pictures of people at all life stages and use the pictures to create a "Human Life Stages" collage on the bulletin board or on individual posters, arranging them from youngest at the left to oldest at the right.

Science and Health

Possible contamination by insects and other pests is a serious concern for manufacturers of grain products and for businesses that sell or use those products. Ask students to investigate the methods used by manufacturers to ensure that the products they ship to grocery stores, restaurants, and bakeries are pest-free and safe for human consumption. How do restaurants and bakeries store grain products to make sure they remain clean?

Science and Language Arts

Some students may think that "meal" in "mealworm" refers to the meals they are most familiar with: breakfast, lunch, and supper. Suggest that students look in a dictionary to find definitions of both meanings of *meal*—the food served and eaten in one sitting, and coarsely ground grain—and then write a sentence using the word with each meaning.