Teacher Guide

Manduca sexta: Caterpillar Dissection

Lesson Summary: The Carolina Sphinx Moth, *Manduca sexta*, spends its youth or larval phase as a Tobacco Hornworm. Students observe and dissect a Manduca sexta caterpillar to learn about the structure and function of an invertebrate nervous system.

Grade Level 5-12

Lesson Length
1-2 class periods

Standards Alignment

Next Generation Science Standards

- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
- MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- **Framework for K-12 Science Education**: Science & Engineering Practices 1,2,7,8

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

a) Scientific inquiry: Evidence and reasoning – lines of reasoning and observations and evidence (p. 17, Atlas Vol. 1)
Research on student learning: "When asked to use evidence to judge a theory, students of all ages may make only theory-based responses with no reference made to the presented evidence. Sometimes this appears to be because the available evidence conflicts with the students' beliefs." (p.16, Atlas Vol. 1)

b) Cells: Cell functions – basic needs and basic functions (p. 73, Atlas Vol. 1)
Research on student learning: "Preliminary research indicates that it may be easier for students to understand that the cell is the basic unit of structure (which they can observe) than that the cell is the basic unit of function (which has to be inferred from experiments)." (p.72, Atlas Vol. 1)

Objectives—Students will be able to

- practice observation and dissection skills using the Manduca sexta.
- learn about changes in human adolescent behaviors by investigating an invertebrate model system.

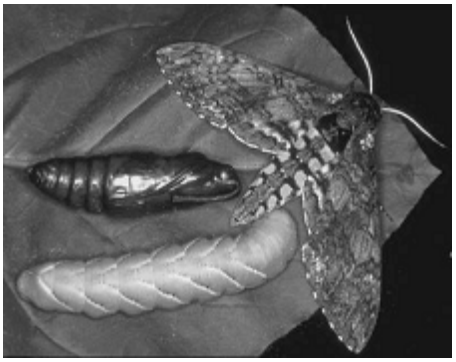
Assessment Options

- Collect and grade student lab guides.
- Students draw and label parts of nervous system of Manduca sexta.
- Informal assessment of participation in lab and discussions.

Teacher Notes — Additional materials needed are:

- water with ice to prep caterpillars for dissection (40+ minutes)
- student activity guides

Materials (for each pair of students)



- Tobacco Hornworm (*Manduca sexta*)
- dissecting plate with vinyl pad
- dissecting scissors
- dissecting forceps (blunt works best)
- small glass or beaker with distilled water
- 10-12 dissecting pins
- ***Manduca* Life Cycle** handout
- dissection instructions in pictures

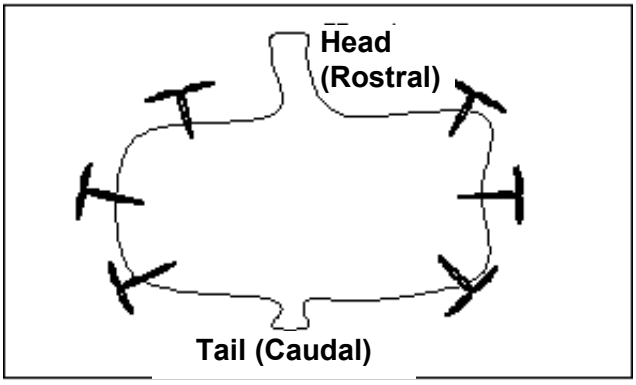
Procedures

Engage – Observe and discuss live Manducas (Note: some caterpillars may be submerged in icy water at this point.)

1. Generate a list of behavior observations—what do you see the caterpillar doing?
2. List reasons why a caterpillar needs a nervous system (respiration, movement, feeding, reproduction, sensing).
3. What do you think the caterpillar's nervous system might look like based on your observations?
4. When a caterpillar undergoes metamorphosis (or changes from a caterpillar into pupa into a moth), what changes do you expect to happen?
5. What does a moth do that is different from a caterpillar?

Explore – Dissection Lab (following picture dissection instructions)

1. Take the caterpillar out of the water and place on dissection plate.
2. Cut off the horn at its base located on the caterpillar's caudal (tail) end.
3. Insert scissors into the hole from the cut-off horn and cut through skin and body muscle along a line down the center of the caterpillar's dorsal side (the back).

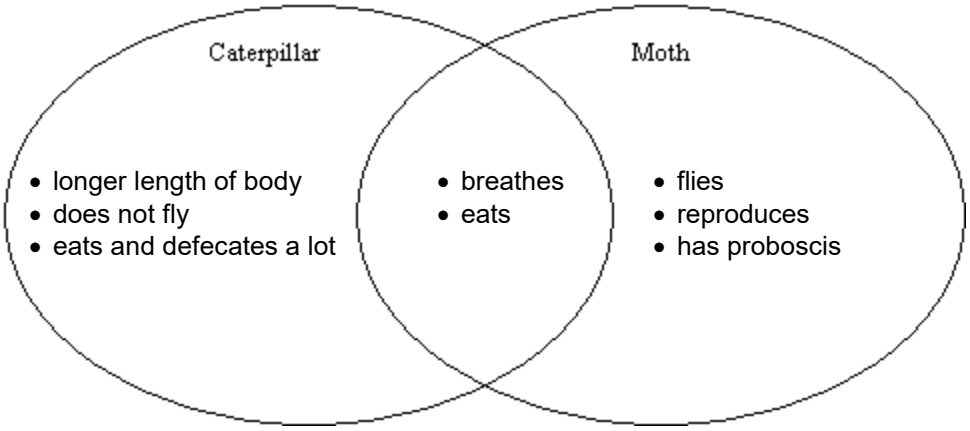


4. Cut from caudal (tail) to rostral (head) end.
5. Pull open the skin. Use dissection pins to hold the skin and body muscles open by pinning through the body wall at an outward angle.
6. Use forceps to lift out the digestive track (the long, brownish cylinder that fills up the body cavity) carefully.
7. Use a magnifying glass or dissection microscope to examine the insides of the caterpillar. Describe and draw what you see underneath the gut.

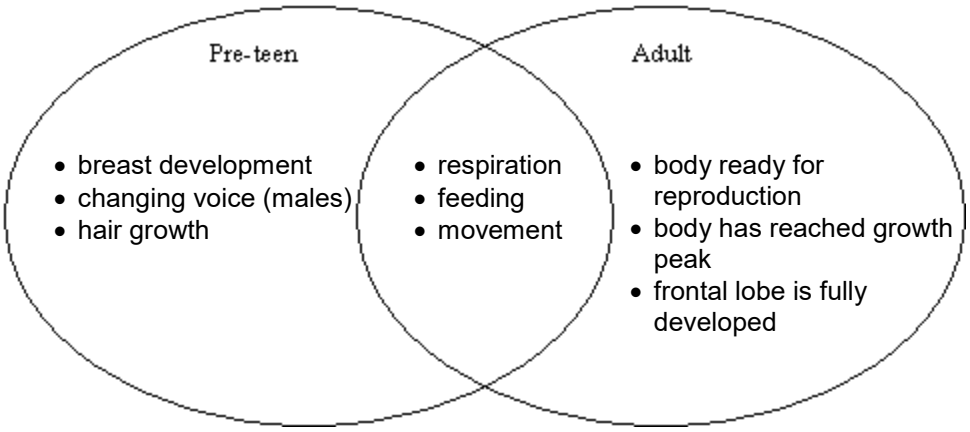
8. Locate the following:
   - caterpillar's nervous system. You may need to gently scrape away fat to see the nervous system.
   - the ganglia (groupings of neuronal cell bodies). How many can you locate?
   - the nerves connecting the ganglia to the muscle and skin.
   - the ganglion connectives, which connect different ganglia.
9. Draw the caterpillar's nervous system.

Explain – Discussion

1. How does the caterpillar's nervous system compare with what you thought its nervous system would be like?
2. When a caterpillar goes through metamorphosis to become a moth, how does its body change?
   - Prompt students to look at the picture and make measurements of the length of the body.
   - Physical changes—caterpillar: has legs, antennae are not salient, has 8 legs; moth: has proboscis, has wings, shorter body length, flies to get around
   - Behavioral changes—caterpillar: senses environment, eat, defecate; moth: reproduce, senses environment primarily to mate
3. How would you expect the nervous system to change when a caterpillar becomes a moth?
   - Shrinkage of the moth's nervous system to change compared to the caterpillar
   - Presence of hormones that trigger reproductive behavior
4. How is the behavior of a caterpillar different from the behavior of a moth?



5. How is a pre-teen different than an adult?



What do you think cause the changes that happen from a caterpillar to moth and/or pre-teen to adult? Modulation of hormones such as testosterone and estrogen initiates the development of breasts, larger hips, etc.

Expand – Extension to lesson

Save a few live *Manduca* and allow to pupate and then further change to a moth to observe the full life cycle.

1. When the *Manduca* begins its wandering stage (mushing food rather than eating it), remove it from the container and place it in a toilet paper roll with several layers of toilet paper wrapped and secured over both ends.
2. Periodically check on it. Within a week or so, the caterpillar will pupate.
3. Approximately 12-14 days later, loosen one end of the paper or start a hole in one end. Place the whole tube into a glass jar with a loosely-placed but secure lid.
4. The moth will work its way out of the tube into the jar.

Please note: the *Manduca* moth cannot be released, so either place the jar in a freezer or place a cotton ball with rubbing alcohol into the jar after the moth has emerged. When the moth has died, it then can be disposed of or kept for observation.