Activity 4
Animal Behavior and Adaptations

Objectives
Students will be able to define the words behavior and adaptation and understand how they relate to living organisms in an ecosystem using earthworms as the study animal.

Terminology
Adaptation, annelid, annuli, behavior, burrows, castings, classification, clitellum, cocoon, comparison, consumers, data, earthworm, environment, experiment, food chain, food web, gizzard, hypothesis, humus, independent variable, inference, instinct, invertebrate, learning, mucus, nocturnal, nutrients, observation, obstacle, odor, oligochaetologists, omnivore, organic matter, phylum, predators, prediction, prefer/preference, prey, reaction, setae, soil, stimulus, texture, topsoil, vibration.

Grade Level: 3rd –6th

Ideal Class Size: 24 students divided into six groups of four

Subject Areas
Life Science, physical science, process skills, inquiry skills, math: Alg-S1-S4.

Time
1 hour introduction and presentation.
1 hour activity/experiment.

Materials
- PowerPoint presentation or slide projector w/slides
- Flip chart or writing board and eraseable colored markers
- Earthworms (European night crawlers or red wigglers): 6 per student pair + extra for worm races and worm habitats. (At least 100 worms per class of 24 students. Remember to use fresh worms for each class. Worms should rehabilitate overnight.)
- Demonstrations
  - "Do worms prefer heat or cold?"
    - earthworms: 6
    - heating pad
    - ice pack
    - 9"x12" baking pan (dark sides)
    - moist paper towels
    - 10"x13" dark cover
  - Worm habitats: one per class
    - Large clear glass or plastic jars
    - Lids with holes or nylon screen with rubberbands
    - Black construction paper covers with directions
    - Topsoil
    - Sand
    - Clay

        - Gravel
        - Cooked coffee grounds
        - Water
    - Earthworm races
        - earthworms: 6
        - long clear plastic tubes w/caps and side hole
        - rack to hold tubes
        - cotton balls
        - odors: water, vanilla extract, cologne, ammonia, etc.
        - cheering banners and pom-poms
- Experiment equipment
    - Observation trays: 1/pair of students
        - Waterproof tray: one per pair
        - Paper towels
        - Wash bottles: one/pair
        - Small millimeter rulers: one/pair
        - Magnifying glasses: one/pair
        - Small cups or beakers
        - Sand paper
        - Worms: 2/student pair
    - Experimental chambers
        - Light chambers: 4 - 6
            - Plastic shoe-sized boxes with modified lids
            - Flashlights
            - Moist paper towels
            - Cooking timers
            - Worms: 4 per student pair

        - Moisture chambers: 4-6
            - Plastic shoe-sized boxes with regular lids
            - Moist paper towels
            - Cooking timers
            - Worms: 4 per student pair

        - Odor chambers: 4-6
            - Plastic shoe-sized boxes with regular lids
            - Paper towels moistened with water
            - Ammonia in small dropper bottles
            - Cooking timers
            - Worms: 4 per student pair
- Posters:
    - "Earthworm Anatomy"
    - Large, laminated class data collection sheet
- Handouts (1 each/student):
    - Earthworm experiment data sheets: light, moisture, or odor
    - "Animal Behavior & Adaptations" word search

Advanced Preparation

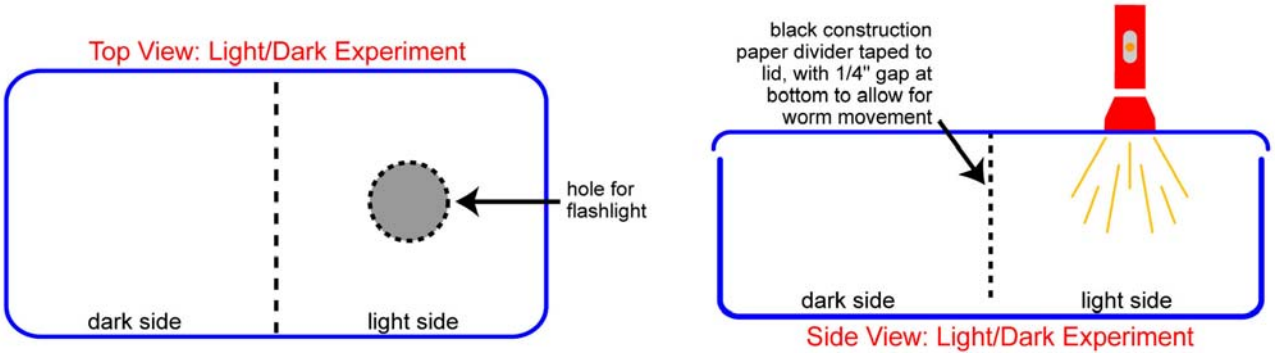
1) Obtain healthy earthworms from a local bait shop. European nightcrawlers (*Eisenia hortensis*) are large worms and thrive between 45°F and 75°F. About 30 worms will come in each small plastic container so they will have to be divided up between the student groups; eight worms per table of four students. Each container must have air holes in them and at least 2" of moist soil.

2) "Do worms prefer heat or cold?" demonstration: Before class place a heating pad under one half of a baking tray and an ice pack under the other half. Line the bottom of the baking tray with moist paper towels and place four worms in the center of the tray. Cover the tray completely so that no light gets in and set aside until needed.

3) Earthworm habitats: Assemble habitats, one for each class, by filling one-gallon wide mouth jars (preferably plastic) two-thirds full with alternating layers of moist sand, clay, and or top soil. Tape together black construction paper tubes to completely cover jars when not being observed. Cover the jars with nylon window screening held in place with a rubber band or a metal lid with holes punched in the top. Feed the worms two tablespoons cooked coffee grounds once/week and keep the soil moist. Students can observe worm activity as an addition to classroom science lessons.

4) Earthworm races: Cut one 2" diameter hole in the side of each of six clear 24" long plastic tubes; holes should be ~ 2" from a caped end. This hole will be the entry point for the racing worm. A scented cotton ball will be inserted into the other end of the tube at race time and the tube will be recapped.

5) Prepare experimental chambers by marking the midpoint widthwise of all the containers. Light chamber lids will need to be adapted by cutting a 2" diameter hole in one half of the lid to accommodate a standard size flashlight that will rest on top of the lid. A piece of black construction paper should then be taped to the underside of the lid at the midpoint widthwise to block light from entering the other half of the container.



6) Copy the "Workshop Outline," onto a writing board or flip chart. This will help you complete all the steps in the scheduled amount of time.

Safety Notes

Animal safety should always be addressed when working with living creatures. Explain to students that worms have nervous systems and that they can be injured if handled roughly. Care should be taken to prevent the worms from dehydrating, or from getting too hot or too cold. After working with worms and soils students should wash their hands.

Activity 4 – 4th Grade
Animal Behavior and Adaptations
Workshop Outline

LECTURE AND DEMONSTRATIONS (1 hour)

1. Introduction (10 minutes)
- A. Today's topic – Animal Behavior and Adaptations
- B. Today's task list/workshop outline
- C. Review SAFE Rules
- D. Review the Methods of Science from last month's activity

II. PowerPoint Presentation (15 minutes)

III. Demonstrations (35 minutes)
- A. Earthworm physiology and behavior
- B. Do worms prefer heat or cold?
- C. Earthworm habitats

TITLE ACTIVITY/EXPERIMENT (1 hour)

I. Conduct and experiment (40 minutes)
- A. Classroom preparation
- B. Experiment

II. Science seminar (10 minutes)
- A. Sharing the Results
- B. Graphing and Interpreting the Data

III. Closer (10 minutes)
- A. Wrap-up Questions

Background Information

Ecology is the study of interactions between living organisms, like plants and animals, and the non-living environment, like sunlight, air, water, and soil. Ecosystems are specific habitats that can be identified and classified by their physical make-up, climactic conditions, and the presence of particular plants and animals. Plants and animals are able to survive in their unique habitats because their bodies and behaviors have adapted to their surroundings.

Living organisms do not exist in isolation from one another. Ecologists describe a group of one species of a plant or animal living together as a population, such as a flock of mallard ducks. A group of different species of plants and animals living together, such as mallards, geese, beavers, cattails, and water bugs in a pond, are described as a community.

An ecosystem needs energy to function and the primary source of energy for all life on earth comes from the sun. Ecologists diagram the movement of energy through an ecosystem by constructing food chains and food webs. Plants capture the sun's energy, a non-living part of the ecosystem, and turn it into food using the plant pigments such as chlorophyll. Plants are referred to as primary producers. Animals that eat plants, or herbivores, are called primary consumers or grazers. Primary consumers are in turn eaten by secondary consumers, or carnivores, which may be eaten by even larger tertiary consumers. A simple example of a food chain would be a hawk that eats a snake that eats a rabbit that eats grass. When food chains become more complicated than the example given above the system is called a food web. There are many predators who could eat a rabbit, not just a snake or a hawk, and many animals graze on green plants.

Living organisms compete for resources such as food, water, shelter and mates. Physical and behavioral adaptations help them survive and thrive. Earthworms are animals that exhibit many observable physical and behavioral adaptations and are easy to obtain and maintain in the classroom. This activity uses the Methods of Science to illustrate the earthworm's physical and behavioral adaptations to light, moisture, and odors. Experimental chambers are constructed to house worms for a short length of time. Each chamber simulates an environment where earthworms are given a choice between different stimuli such as light or dark, moist or dry, sweet smelling or odiferous. Students identify independent (manipulated) variables and dependent (responding) variables and make "If/Then" predictions based on what they have learned and observed about earthworms, conduct an experiment, collect data, and determine if the results of their experiment support their predictions.

Earthworms are considered animals and are members of the Phylum Annelida. They have long, round, segmented bodies with bristles or hairs, but because they lack eyes and feelers, they are classified as Oligochaeti. Oligochaeti have only a few, very tiny setae (bristles) on their bodies, and are great burrowers. A person who studies earthworms is called an Oligochaeteologist**.** There are over 2,700 different species of worms living in all types of soils all over the world. European nightcrawlers (*Eisenia hortensi)* tolerate temperatures between 45^{o}F and 75^{o}F, unlike their Canadian nightcrawler cousins who can only tolerate temperatures between 42^{o}F and 47^{o}F. Redworms or "wigglers" (*Eisenia fetida*) can also be used as they are hardy, but they are somewhat smaller than nightcrawlers and may be harder for small hands to manipulate. To find out more about worms refer to the resource section at the end of this lesson plan.

LECTURE AND DEMONSTRATIONS (1 hour)

1. Introduction (10 minutes)

A. Today's topic
"Animal Behavior and Adaptations" highlights the work of SREL wildlife ecologist Karen Gaines who studies the interconnectedness of animals and their habitats. We'll learn about ecosystems and food webs and how different species have adapted physically and behaviorally to allow them to survive. Then we'll conduct some experiments using the earthworms.

B. Today's task list / workshop outline

C. Review SAFE Rules

D. Review the Methods of Science

II. PowerPoint Presentation (15 minutes)

III. Demonstrations (30 minutes)

A. Earthworm physiology and behavior
[Brainstorm with the students everything they have ever heard about earthworms. Group their ideas into two categories on the board: physical and behavioral. Then show the students the earthworm poster and go over worm anatomy and physiology and explain how students might see these adaptations exhibited in live worms.]

B. Do worms prefer heat or cold?
[Describe the experimental heat-cold chamber that was set up before class in which you placed four worms in the center of the tray to see which temperature the worms prefer. Have students identify the independent/manipulated variable(s) and the dependent/responding variable. Ask the students to make predictions and form an if/then hypothesis based on what they have learned so far. Then uncover the chamber and see where the worms ended up and record your findings. Explain that this is exactly the type of experiment they will be conducting in a few minutes.]

C. Earthworm habitats
[Show the students the earthworm habitats that were assembled before class. Explain to them that earthworms help break down and process organic matter in the soil to produce nutrient-rich castings. They also aerate the soil because they burrow deep in the ground and help mix different soil types together. Explain to them that they will be responsible for a habitat for one month and are expected to observe and maintain their habitat. They will return it at the end of a month with any observations/drawings they have made. They will be considered successful earthworm farmers if they bring their worms back alive!]

EXPERIMENT (1 hour)

I. Introduction and Classroom Preparation (10 minutes)

[Take a few minutes to pass out all the required materials to each table along with the appropriate data sheets. Remind the students about the specific experiment that they will be conducting, then proceed.]

II. Conduct the Activity (30 minutes)

[Follow the directions outlined on the three student data sheets]

III. Science Seminar (10 minutes)

A. Sharing the results

[Collect the data from all the students and compare results.]

B. Graphing and interpreting the data

[Where appropriate, graph the data that was collected.]

IV. Close out (10 minutes)

[Take this time to conduct the "earthworm races" using the tubes that were constructed before class. Pass out pom-poms, banners, and posters for the students to cheer on their worms. Don't forget to place different scents in each tube to see how the worms react to the odors.]

RESOURCES

Additional Earthworm Information:

Earthworms are considered animals and are members of the phylum Annelida. Most earthworms are reddish-brown and are about as long as your hand lengthwise when they are stretched out. They have round, segmented bodies with bristles or hairs, but because they lack eyes and feelers, they are classified as Oligochaeti. Oligochaeti have only a few, very tiny bristles on their bodies, and are great burrowers. Worms that live in the soil are called "earthworms." There are over 2,700 different species of worms living in all types of soils all over the world. Worms come in many colors and sizes. Some are so tiny that they are hard to see without a microscope. Others, such as the giant earthworm of Australia are as long as 4 meters. Some live in lakes or ponds. Earthworms live wherever the soil is warm and wet. They live in every part of the world except deserts and very cold areas. When the soil gets too dry or cold, the earthworm starts to dig. It goes deeper and deeper until it finds some warm, moist soil. It stays deep underground until the surface soil is just right again.

Experts believe that most native species were wiped out wherever glaciers covered North America. Early settlers imported most earthworms we see today, mainly from Europe. The worms or worm cocoons traveled in the rootstocks of plants brought by the settlers from their homelands. Europeans also added soil, with its earthworms or worm cocoons, to ships for ballast. Once anchored in North American harbors, ships released their ballast along with living worms, which found new homes in North America.

Earthworms are invertebrates and therefore have no skeleton. They also lack lungs, eyes, and ears. Earthworms have tiny mouths that are very hard to see. The body is really just a long stomach inside a soft, tube-like body. The tube is made up of many tiny segments and each segment is filled with fluid and has bristles, or *setae*, which help the worm grasp the ground and move about. A light-colored swollen band called the *clitellum* is nearer the front of the worm. Earthworms don't even have real heads! Worms usually move front end first, but they can also crawl backwards.

Worms have strong ring-shaped muscles inside each of their segments that help them move. Their body lengthens when these muscles contract. Their body gets pulled along when long muscles that run the length of their body contract and pull them forward. Also, each section of their bodies has four pairs of setea that grip the soil and help the worm move. You can feel these hairs if you gently rub the worm's underside. A worm moves by pointing its head in the direction it wants to go. It anchors the back of its body, and the head end becomes thicker. The worm then stretches its body to push through the soil. It anchors the front of its body and brings up the rear.

Earthworms can feel a little slimy. They are covered with a thin, clear layer of *mucus* that helps them slide through their underground tunnels. But mucus also has another job. It helps the worm breathe. Remember, earthworms don't have lungs. An earthworm breathes with its whole body. It uses the mucus to help it absorb oxygen from the air around it. There is plenty of air trapped between soil particles under the ground. Soil must also be moist or earthworms will dry out and suffocate. Earthworms can live in water for extended periods of time if there is enough oxygen in the water. Some worm experts like, Dr. Dennis Linden, and Cindy Hale say that worms surface during rainstorms (especially in the spring) so they can move overland. The temporarily wet conditions give worms a chance to move safely over ground to new places.

Earthworms are very important members of our environment. They help turn dirt into nutrient-rich soil for plant growth. Worms tunnel their way into the earth by eating the dirt that is in their way. An earthworm can eat up to 1/3 its own body weight each day. Dirt is made up of inorganic soil particles like sand and clay, dead and decaying organic matter like leaves, roots, and animal parts, along with microscopic living organisms such as nematodes, protozoa, rotifers, bacteria, and fungi. Worms are nature's clean-up crew! As the earthworm eats, it mixes the dirt with nutrients inside its body. The nutrients are vitamins and minerals that all plants and animals need to grow. As it moves along, the earthworm pushes a newer, richer soil out of its body. This earthworm waste is called castings. One earthworm can make 8 pounds of castings in a year! The worms also loosen soil while they tunnel for their food. Worm tunnels allow oxygen to reach plant roots and rainwater to drain through soils.

Some worms burrow deeper underground when the weather is too cold or dry. Earthworms escape by either burrowing deeply into the soil (up to 2 meters), or entering a reduced metabolic state known as *estivation*. During estivation, each worm forms a tight ball deep in the soil and its metabolism slows down. If frozen, they will die. When conditions are favorable, they will emerge and resume normal activities.

Earthworms are nocturnal and spend their days underground. They come to the surface only at night. Sunlight can dry out a worm, but it can also paralyze them if they're exposed for more than about an hour. If you want to see earthworms at night, put some red cellophane over a flashlight. Earthworms do not sense red light as well, so they will stay on the surface longer. At night, when it is dark and damp, they crawl out of their burrows and up to the surface in search of food. They especially like

to feed on the rotting parts of dead plants. A pile of dead leaves is a favorite feeding place for worms. They may drag the food back to their burrows where they store it in their tunnels until it rots. Since they have no teeth or jaws their food must be very soft.

Some earthworms could live to be 10 years old, but most only live one year. Worms are low on the food chain and have many predators, including snakes, birds, moles, toads, foxes, beetles, centipedes, leeches, slugs, and flatworms. Moles sometimes eat 30 worms a day as they tunnel under the ground and they store extra worms in a special burrow space. Moles keep worms from escaping from their space by biting off the heads. This does not kill the worm. Its head end grows again, and the worm might be able to escape. Birds look and listen for tiny movements of earthworms on the ground. When a bird finds a worm, it grabs it by the tail. The worm anchors itself in the ground with its setae, pulls back hard with its powerful muscles, and simply breaks into two pieces. The longer part of the worm gets away by digging underground where it will re-grow its missing part, and the bird is left with the tail.

Earthworms cannot see or hear. Even so, they sense when predators are near. They are very sensitive to movements or vibrations. When an animal walks on the ground, it makes the ground vibrate. If an earthworm feels the vibrations, it digs deeper underground until the danger is gone.

Like most animals, worms reproduce, but unlike most animals a worm has both male and female parts. When two worms mate both of them form a cocoon from a thick layer of mucus around the clitellum where the eggs are laid. The worm wiggles forward, leaving behind in the soil a cocoon smaller than a pea. In about two months, tiny, yellow eggs hatch within the cocoon and one or two baby earthworms emerge. It takes about 18 months for a young worm to mature to lay eggs of its own.
There can be more than one million earthworms in an acre of healthy soil. And if you could weigh all the animal life on the planet, over half of the weight would be made up of worms.