

Lesson 1: Magnificent Macroinvertebrates: Build-a-Bug

Lesson Summary:

Students will learn about macroinvertebrates by working in teams to design and build model organisms that demonstrate adaptations needed to survive relative to conditions of the stream they will live in.

Materials:

- Build-a-Bug PowerPoint
- Macroinvertebrate Identification Cards
- Materials for building macroinvertebrates
 - pipe cleaners
 - empty toilet paper rolls
 - plastic googly eyes of different sizes
 - feathers
 - pieces of fabric
 - cotton balls
 - toothpicks
 - colorful beads

Knowledge and Skills developed:

- Students will be able to define macroinvertebrate.
- Students will learn about common macroinvertebrates that live in aquatic environments.
- Students will understand how macroinvertebrates are adapted to live in their environments.

Next Generation Science Standards

| Practices | Crosscutting Concepts |
|---|---|
| <input type="checkbox"/> Asking questions <input checked="" type="checkbox"/> Developing and using models <input type="checkbox"/> Planning / carrying out investigations <input type="checkbox"/> Analyzing / interpreting data <input type="checkbox"/> Math / computational thinking <input type="checkbox"/> Constructing explanations <input type="checkbox"/> Engaging in argument from evidence <input type="checkbox"/> Obtaining / evaluate / communicate | <input type="checkbox"/> Patterns <input type="checkbox"/> Cause and effect: Mechanism / explanation <input type="checkbox"/> Scale, proportion, and quantity <input type="checkbox"/> Systems and system models <input type="checkbox"/> Energy / matter: Flows, cycles, conservation <input checked="" type="checkbox"/> Structure and function <input type="checkbox"/> Stability and change |

Disciplinary Core Ideas and Concepts

3-LS4.C: Adaptation

- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Environmental Literacy Strands

2. Physical, living and human systems

- b. Structure, function, interaction and change in living systems. Explain the dynamic and interconnected nature of Earth's living systems

Teacher Background Information:

Macroinvertebrates are organisms without internal skeletons that can be seen with the unaided eye. Aquatic macroinvertebrates live in different types of water bodies and are found in every part of a waterway. Most make their homes in the rocks, gravel, sediments, leaves, and other debris in the water. Examples of aquatic macroinvertebrates include mayfly nymphs (larvae), stonefly nymphs, dragonfly larvae, midge larvae, crayfish, leeches, aquatic worms, water penny, water beetles, mites, and scuds..

Just like other organisms, aquatic macroinvertebrates are specially adapted to their environment, or home. Adaptations are specialized characteristics that animals and plants have developed over time in response to environmental pressures. They may be physical features or specialized behaviors. These tools help the organism to survive in specific conditions. For example the water strider and the whirligig beetle both have adaptations that help them live on the surface of the water. Water pennies, mayflies, caddisflies, and some other insects are well adapted to life on the stream bottom. Other insects like the water boatman have adaptations for living within the water column. Oftentimes, adaptations can be seen in the body shape and structure of insects. Yet some adaptations are behavioral rather than physical in nature.

Some adaptations are very easily seen on aquatic macroinvertebrates. Swimming insects, like the water boatman, have adapted hairy paddle-like legs that allow them to swim easily. They are herbivores with sucking mouth parts to help them eat vegetation. The whirligig beetle has a unique adaptation for life at the surface; they have two pairs of eyes, one ventral pair and one dorsal pair. This allows them to see above and below the water at the same time. The water penny is adapted for life on the stream bottom. Near the stream bottom there is a thin layer of water that moves slowly due to friction; water pennies have flattened bodies that allow them to reside within this thin layer.

Mayflies tend to be very good swimmers as they have plate like gills on the abdomen, and most have three tails. As strong swimmers, mayflies may often be found in the stream drift but do often prefer areas near stream beds for vegetation. They have a claw on the end of each leg that helps them hang on in the riffles and to gather food. Caddisflies have adapted hook claws that allow them to anchor to the substrate in swift water. Most caddisflies build gravel casings to help camouflage themselves, and to avoid drifting in fast water.

The water strider is adapted for life on the surface with claws; the claws are not at the ends of the legs but rather are located higher up. This allows the water strider to skate on the surface without breaking the surface film. Many have different mouth parts, claws, or teeth for feeding on certain algae or prey. These are just a few examples of adaptations; the amount of adaptations present in macroinvertebrates is almost endless.

Introduction:

Tell the students that they are going to learn about some very cool critters that live in the rivers, streams, and ponds called “macroinvertebrates”. Let them know that they will use their imagination to design their own aquatic macroinvertebrate. As they build their own organism they will begin to think about what kinds of adaptations macroinvertebrates have and why.

Procedure:

1. Use the PPT to show a picture of a stream. As a class, brainstorm a list of organisms that might live in the water.
2. Show students the picture of a stream WITH macroinvertebrates in it. Ask students, “would you expect to find these organisms living in a stream?” Yes! There are many aquatic bugs that live in streams and we are going to be learning about them today.
3. Ask students “What is a macroinvertebrate?” A scientific name for bug or insect! Macro: large enough for us to see with our naked eye. Invertebrate: without a backbone.
4. Macroinvertebrates play an important role in the stream ecosystem and are food for other organisms that live there. Just like other organisms, aquatic macroinvertebrates are specifically adapted to their environment.
5. Tell students that they are going to look at some pictures of macroinvertebrates to help them think of some ways that they might be adapted to live in an aquatic environment. Have students work in groups of 3-4 and pass out 4-5 macroinvertebrate cards per group. Have students take a moment to make some observations about their cards and then group them based on similarities &/or differences.
6. Have students share and compare observations and discuss how they grouped their macroinvertebrates. Have students describe some of the structures they can see in the pictures. Structures they might observe include: spines, hairy-looking, many legs, worm like, etc.

7. Have a group discussion about benefits of structures. Then ask the question: “How might some of those structures help the macroinvertebrate survive in its environment?” **Camouflage, predator avoidance, prey capture, flotation, hanging on.**
8. Have students make a hypothesis about which organisms would live in fast moving, slow moving, pools, shallow water. Why? Share ideas. **Paddle like legs for swimming in slower water; thin or flattened body size for staying in slow moving water underneath faster currents; claws, hairs or suction cups for hanging onto rocks, woody debris, and leaves in faster flowing water; claws and hooks for catching prey and hanging on in faster water; gills for breathing dissolved oxygen in faster water.**
9. Use Lesson 1 PPT to show students pictures of macroinvertebrates and to talk about specific adaptations of some common macroinvertebrates. Have students describe some of the structures they can see **(spines, shell, gills, hairy-looking, many legs, etc.)**
10. Have students discuss the benefits of structures. Ask: “How might some of those structures help the macroinvertebrate survive in its environment?” **Camouflage, predator avoidance, prey capture, hanging on in fast currents, breathing in dissolved oxygen, swimming, etc.**
11. Tell students that they will be working in small groups to design and build their own macroinvertebrate. Give each group materials to work with. **Make a couple of suggestions to get students started or have a bug you already created to demonstrate. Pipe cleaners are good for tails, claws, and legs, plastic googly eyes in different sizes for the various positioned eyes, feathers and cotton balls for hair, popsicle sticks for paddle-like legs, toothpicks for teeth, etc.**
12. Have the students build macroinvertebrates based on differing conditions:
 - That can withstand fast/slow moving water. **Paddle-like legs for swimming in slow water; hooks/claws/suction cups for the hanging onto rocks in fast water, and gills for breathing dissolved oxygen in fast water**
 - That lives on the surface of the water/burrows in the sand **Special claws, legs, and hairs that help them hang-on or dig, different sized eyes and eye location for seeing depending upon where they live**
 - Scrapes algae off of rocks/hunts for other macroinvertebrates. **Special mouth parts like the lower lip of the dragonfly that can extend to grab prey, hairs, claws, net-like material, and suction cups for scraping algae or catching prey**
13. After each design, have groups present their macroinvertebrates and explain their design.
14. Lead a discussion about the different adaptations necessary to live in a stream environment.
 - What happens when there are disturbances in a stream ecosystem?

- How macroinvertebrates might react to environmental changes such as in temperature, the addition or removal of other organisms, acid rain, less dissolved oxygen in the water, and various types of pollution? Some macroinvertebrates are more tolerant to these changes and are able to continue to breath and feed in more polluted waters. Others however are very sensitive to pollution and their adaptations and body structures may not allow them to survive as well in polluted water. Will they be able to move to a place to get what they need to survive? Some are stronger swimmers and may be successful, but others are not able to move habitats until they are adults and can fly away.

Resources:

Create an Aquatic Macroinvertebrate:

https://docs.google.com/document/d/1qT9mE_AVCXy22MjTHo-rT0SGr_xEUy34Fc9q7pL-J0k/edit

The Great Plankton Race:

http://www.cosee.net/best_activities/activity/The_Great_Plankton_Race.pdf

Biodiversity: Diversity in a Leaf Pack: Teaching Materials for Middle and High School Science Teachers; Pathways to Environmental Literacy Project