Aquaponics in a bottle!

Name: _____ Date: _____

Instructions:

1. Gather your materials to build your experiment:
    a. One clear, two-liter plastic bottle (soda, juice, or iced tea containers work well)
    b. Extra container to hold water for water changes
    c. Serrated bread knife and cutting board, or scissors
    d. Aquarium gravel, or small rocks (enough for about 2 inches at the bottom of your bottle)
    e. Drill with small drill bit (or alternative tool to poke a hole in the bottle cap for plant roots to go through)
    f. Water
    g. One aquatic organism: One small fish (a snail and/or shrimp may also be used)
    h. Fish food (can be purchased from a pet store)
    i. Small starter plant or a cutting that has been rooted (herbs like basil grow easily and work well)
    j. Optional: Two skewers for holding the top of the bottle in place
    k. Optional: Aquarium aerator, with tubing and airstone. (You can purchase splitters so multiple tubes with airstones can be divvied to separate aquaria.)

2. Before you begin, answer these questions:
    a. How do scientists study plants and animals in their natural habitats?

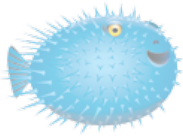
    b. What might be some limitations, challenges, or risks with studies in the natural environment?

    c. What is the ethical treatment of living things? How will you ensure your animals are being treated ethically?

    d. Why do animals, including humans, eat things?

    e. Do plants eat?

    f. What is a producer? Consumer? Decomposer?



NOTE *The procedural steps call for letting your water sit, rocks soak, and rinsed plant roots soak for 24 hours. You can do all these steps at the same time before you start constructing the aquaponics-in-a-bottle.*

Build your aquarium!

3. Prepare your water by allowing it to sit in a container exposed to the air for 24 hours. This will allow the chlorine to evaporate. (Chlorine is used to keep tap water from becoming contaminated with algae or bacteria). You can also use commercial drops to treat your water before using it in your aquaponics system.

4. Rinse your aquarium gravel and allow it to sit in water for 24 hours to remove any toxins.

5. Rinse and scrub the two-liter bottle with clear water to get rid of any residue inside and to remove any labels from the outside. Do not use soap!

6. Cut off the bottle top at the shoulder (where the bottle tapers).

Note: cut the bottle so the lower aquarium portion will have a bit of curvature at the top.

7. Add a layer of small aquarium rocks to cover the bottom two inches. Rocks are important for two reasons:

a. Rocks provide a surface for good bacteria to live on. These bacteria help to convert the fish waste into nutrients that are usable by plants.

b. Rocks keep the water clearer by holding fish poop and uneaten food particles, which keeps them from floating in the water.

8. Fill the bottle with prepared water. Leaving about an inch and a half of space at the top.

Get your plant zone ready!

9. Use a drill to make a hole in the bottle cap. The hole should be big enough to pull the plant roots through, but small enough that the plant stem will not slide through.

10. Prepare your plant roots to pull through the hole in the bottle cap.

a. Rinse the roots. This is especially important if you are using a plant that was in dirt.

b. We recommend soaking your plant roots in clean water for 24 hours.

11. Pull your plant roots gently through the hole in the bottle cap.

Note: Some of the roots will break off. That is okay!

12. Set your plant zone on top of your aquarium, or a another water source, while you continue to set up your aquaponics-in-a-bottle.

13. If the bottle top doesn't rest on the brim of your aquarium, you can use wooden skewers as support beams.

a. With help from a teacher, poke two holes on opposite sides of the bottle top and slide wooden skewers through them. Allow them to protrude about an inch on each side. Do this on both sides. Rest it on top of the bottle aquarium.

Add your fish!

14. Make sure your water has been sitting out and rocks and roots have soaked in clean water for 24 hours.

15. Add your fish to the aquarium!

16. You may add another small creature, like a snail, that you think would be a good fit for the ecosystem. *Note: Keep in mind this is a very small aquarium, so don't add very much. One small fish and one snail are a good amount!*

17. You may add an aquarium decoration if you like (but make sure it is non toxic and has rested in clean water for 24 hours).

18. If you have an aerator, position your aquarium near a plug and plug in the aerator. Place the airstone in the aquarium.

19. Put the plant side on top of the aquarium.

20. Make sure the water level is correct.
    a. Your plant roots should be in the water, but there should not be standing water inside the plant dome.
    b. Add or pour out water as needed to get the right level.

21. Your aquaponics-in-a-bottle is now complete!

Care for your ecosystem!

NOTE *In nature, the cycling of matter between producers, consumers, and decomposers allow the ecosystem to thrive without external input. However, since this system is small and will likely not represent all aspects of a natural ecosystem, you will still need to feed the fish and water the plant to ensure they are getting enough energy.*

22. **FEEDING**: Drop a few flakes or pellets (depending on food choice) on the surface of the water to feed the fish few days (every 2 or 3 days should be fine).

23. **CLEANING**: You will need to replace about 1/3 of the water every 1-2 weeks as needed. This will prevent algae buildup and ensure enough oxygen is available (The plants will contribute to the oxygen available).

    a. Prepare replacement water the day before, allowing it to sit out for 24 hours to evaporate any chlorine.
    b. Remove the top and scoop out about 1/3 of the water using a cup (a soup ladle works well). Be careful not to scoop the fish with the water!
    c. If there is algae build up on the exposed walls, you can wipe it off with a paper towel or clean sponge to prevent overgrowth.
    d. Pour in fresh water slowly so as not to stir up any loose particles.

24. Make observations of your system over time and answer the questions on your worksheet.

25. Engineer changes to your system! Aquaponics systems benefit from regular attention and tinkering. Do not be afraid to change things in your system as time goes on!

Activity Questions

1. Match the vocabulary words with their definitions below. Then use the information to answer the activity questions.

Vocab Word	Answer	Definition
Matter		A. An organism requiring food, which it gets by eating other organisms
Consumer		B. An organism, often bacteria, fungus, or invertebrate, that breaks down waste from other organisms.
Decomposer		C. Organisms that use energy from the sun and matter in air and water to grow.
Primary Producer		D. Any substance that has mass and takes up space by having volume.

2. What role does your plant play in making food from matter your ecosystem-in-a-bottle?

3. What role does your fish/snail play in moving matter your ecosystem?

4. What role does the bacteria living on the rocks play in recycling matter in your ecosystem?

5. Which organism in your ecosystem is a:
   a. Primary producer?

   b. Consumer?

   c. Decomposer?

6. How do the organisms in your ecosystem work together to recycle matter and produce food?

7. Draw your own food web based on your ecosystem in a bottle (there are many correct food webs!). Label the primary producer, consumer, and decomposer.

8. What might happen if a higher level predator was introduced to your ecosystem (such as a crayfish, large fish, or large frog)?

9. Is there evidence of any other plant life in the aquarium? (Hint: It is possible that microscopic freshwater algae may have grown, and if it becomes dense enough may appear either as a greenish film, or perhaps a greenish hue in the water.)

10. How are models beneficial to scientists when studying plants and animals?

11. How could you improve your design for a future aquaponics system?