Part 3
What If?

Remind students that when we change one part of an experiment to see how it affects our results, this change is known as a variable.

BRAINSTORM

Brainstorm with students some additional variables that could be tested (e.g. amount of water, number of eggs, amount of light, temperature, type of liquid, pollution etc.) .

Ask students:

- Which variables would you want to change?
- Which variables would you want to keep the same?

If time permits, allow students to test the variables they identified during the brainstorming sessions.

WRAP-UP

To wrap-up the investigation, bring your students together for a group discussion to help them understand why and how they achieved their results. It is important to share results so that everyone has a clear picture of what happened. To help you facilitate the discussion, review the explanation in "The Why and The How" using the Group Discussion questions as a guide.

GROUP DISCUSSION

Explain to students that scientists learn from each other through discussion, and they build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their experiments, students will now come together as a group to share their results and make conclusions about the investigations they've conducted. Have students record their final results and the explanation in their journals.

marine coral

References:
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- What was the outcome of your experiment containers?
- Which amount of salt worked the best? The worst?
- How long did it take for the eggs to hatch? Did the amount of salt make a difference?
- What temperature was the water when the eggs hatched?
- How did your group's results compare to the results of other groups?
- What surprised you?

The "Why" and the "How"

Brine shrimp, also known as Artemia or Sea Monkeys, are small **euryhaline** (salt-tolerant) crustaceans that live in saltwater lakes. The shrimp start out as very small dormant eggs known as cysts. If kept dry, the cysts can survive for many years. In lakes the cysts can become so numerous, that they cause reddish brown streaks to form on the surface of the water. Temperature and salinity changes in the water cause the cysts to open and release the first growth stage of the brine shrimp, known as **nauplius** larvae. The larvae remain in this stage for approximately 12 hours, living on leftover yolk from the cyst. The larvae then molt into the second nauplius stage, which eat small algae in the water.

In waters with higher salinity and dissolved oxygen, cysts may hatch immediately into nauplii, resembling live birth. Depending on environmental conditions, female shrimp can reproduce anywhere from every four days, to two to three times per year. In some populations of brine shrimp, adult females can produce female offspring even if there are no males present. This is known as **parthenogenesis.**

Before reaching adulthood, the nauplii molt about 15 times. Male brine shrimp can be recognized by their large antennae which are used during mating to hold onto females. Brine shrimp typically eat algae floating in the water.

Curriculum Match-Up

- Create a table for the data collected.
- Calculate the salt to water ratio for each container.
- Create a bar graph for each group's finding.
- Photograph the brine shrimp at different stages in their life cycle.

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Marine Ecosystems

Learning Objectives

Students will:

1. Describe and draw brine shrimp larvae.
2. Test variables that may affect the hatching of brine shrimp eggs.
3. Identify the optimal salinity for hatching brine shrimp eggs.

Vocabulary Ventures

brine shrimp
crustacean
cyst
euryhaline
marine regions
nauplius larva
parthenogenesis
salinity
stenohaline

Marine or saltwater regions, along with freshwater regions make up the aquatic biome. These environments cover over 70% of our planet. Bodies of water that are part of **marine regions** include oceans, estuaries and salt marshes, lagoons, coral reefs, seagrass beds and muddy shores.

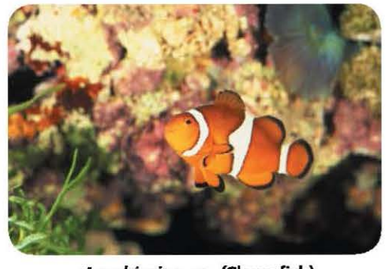
Water found in marine regions is identified by the presence of the dissolved salts sodium (Na) and chlorine (Cl). The concentration of salt in water is known as salinity.

All organisms, including humans, must maintain a level of water and salts inside their bodies to keep their cells alive. Very small marine organisms get salt from the surrounding saltwater. Larger organisms must eat or drink substances containing salts to obtain the proper balance.

A. salina (Brine Shrimp)

Water salinity in marine regions can fluctuate, or change. Some organisms living in these areas are able to adapt to the changing salinity. These are referred to as **euryhaline**, or salt-tolerant organisms. However, other species known as **stenohaline**, or salt-intolerant organisms, must migrate to other locations when the salinity of the water changes.

Marine ecosystems are a valuable food source for humans. They also provide ingredients for many of the products that we use in our everyday lives. Despite the value of marine ecosystems, they are being threatened by many human activities such as pollution, overfishing, development of coastlines and the introduction of invasive species.



Amphiprion sp. (Clownfish)

Time Needed to Conduct Investigations

This investigation has three parts.

Organize and set up materials: 10 minutes
Introduce the lesson: 10 minutes
Conduct the investigation: 30 - 60 minutes over several days
Student journaling/group reflection: 15 – 20 minutes over several days
Total estimated time: 65 - 100 minutes over several days

Investigation: Brine Shrimp Hatcheries

Materials

For groups of three
Student journals and writing tools

Part 1
- Brine shrimp eggs (cysts)
- Paper
- Magnifying lenses
- Three 500 mL clear containers (beakers, jars, plastic cups, or measuring cups) rinsed
- Dechlorinated or spring water
- Graduated cylinders
- Instant ocean sea salt or aquarium salt
- Measuring spoons
- Markers
- Masking tape
- Thermometer

Part 2
- Magnifying lenses
- Baker's yeast
- Small dip net
- Flashlight
- Spoon
- Petri dish
- Microscope

Part 3
- Three 500 mL clear containers (beakers, jars, plastic cups, or measuring cups),rinsed
- Brine shrimp eggs (cysts)
- Dechlorinated or spring water
- Graduated cylinders
- Rock salt
- Measuring spoons
- Markers
- Masking tape
- Thermometer
- Magnifying lenses
- Baker's yeast
- Small dip net
- Spoon
- Petri dish
- Microscope

Part 1
Salty Shrimp

GET READY!

Share with students that the aquatic biome is divided into freshwater and saltwater regions. Ask students to list the names of saltwater regions that they know. Record their responses on a flipchart or chalkboard. Ask students to brainstorm what they know about marine ecosystems:
- In what bodies of water would we typically find marine ecosystems?
- What is the water like in a marine ecosystem?
- What types of animals would you find?
- What kinds of plants would exist in a marine ecosystem?

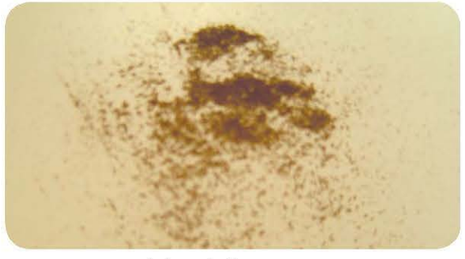
Discuss with students the property of water known as salinity. Ask students:
- Do you think that all marine environments have the same salinities?
- Do you think that the salinity of a body of water remains the same over time?
- Do you think that all organisms can survive in salt water?
- Do you think that all marine organisms can survive in water with different or varying salinities?

Review any relevant concepts/vocabulary from previous investigations.

PROCEDURE

Discuss with students that brine shrimp are small crustaceans (organisms that have hard protective coverings over their bodies called an exoskeleton, segmented bodies and jointed limbs) that live in marine environments; specifically saltwater lakes. Inform students that they will be conducting an experiment to test the effects of the salinity of water on the hatching of brine shrimp.

1. Break students up into groups of three.
2. Provide each group with ½ tsp of brine shrimp eggs (cysts) on a piece of paper. Invite students to examine the brine shrimp eggs using the magnifying lens. Ask students to describe how the brine shrimp eggs look and draw them in their journals.



brine shrimp eggs

3. Inform students that each group will be setting up three different experiment containers, each with a different amount of salt.

4. Have students measure 500 mL or 2 cups of dechlorinated tap or spring water, and fill each container with this amount of water. Students should record the amount of water used in their journals.
5. Each group should choose the three different quantities of salt they would like to test in this experiment and record these amounts in their journals. Students should use the masking tape and markers to label each container with the amount of salt they will add.
6. Students should measure and add the amounts of salt they have selected to each of their three containers.

TIP
One tablespoon (15 mL) of salt in 2 cups (500 mL) of water should enable the brine shrimp eggs to hatch in 24 – 36 hours. Let students experiment with their own proportions. Hatching will most likely occur at higher and lower salinities

7. Next, students can add ½ tsp of brine shrimp eggs to each of the three containers.
8. Students should use thermometers to measure the temperature of the water in each container and record these temperatures in their journals.

TIP
The optimal temperature for hatching brine shrimp eggs is between 82 - 86 °F. Brine shrimp will hatch at temperatures in the 70 °F range but it may take day a day or so longer. It is unlikely that shrimp will hatch at temperatures above 86 °F.

9. The containers should be allowed to sit for a few days.

PREDICT

Students should make the following predictions:
- What do you think will happen to the brine shrimp eggs in each of the containers?
- How long do you think it will take for the eggs to hatch?
- Which container do you think will have the best results? Why?

Part 2
Brine Shrimp Life Cycle

When the brine shrimp have hatched, the larvae will separate from the shells. The eggs will float on the surface of the water and the larvae will swim in the saltwater solution. Use a small dip net to remove the spent shells from the surface of the water. Brine shrimp larvae are quite small, so they are difficult to see without the use of a magnifying glass or microscope.

TIP
To see the larvae better, shine a flashlight into the container. The shrimp will move towards the light. The shrimp are much easier to see as a colony. Use a spoon to collect a few larvae and transfer them to a Petri dish. Have students place the Petri dish under a microscope (10X – 30X magnification) to get a closer look at the larvae.

OBSERVE

Students can make observations about the larvae.
- How do the larvae look in the container and under the microscope? Students can draw the larvae in their journals.
- How would you describe their anatomy?
- Can you differentiate the males versus the females?
- How large do you think they will grow?
- How do they move?
- How do they respond to light?
- What do you think they eat?

TIP
To feed the brine shrimp, add a few grains of baker's yeast to the containers. Too much baker's yeast will cloud the water and decrease the amount of dissolved oxygen in the water, killing the brine shrimp. Explain to students that the brine shrimp eat algae in the wild, but baker's yeast can be used as a substitute in this artificial environment. The shrimp can be fed once a week.

It is much more difficult to raise brine shrimp to adulthood than it is to hatch them. Without food, they should live approximately 3 days. It takes 2 - 3 weeks for the shrimp to reach their adult size. The larvae survive best if the container is connected to an air pump. The water also needs to be changed regularly because as the shrimp molt their exoskeletons, the water quality decreases. If time and resources permit, you can try raising the larvae to adulthood.