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. Ask students:

- What did you learn about water in this investigation?
- What surprised you?
- What new questions do you have?
- What role did the ice have in this investigation?

Answer: it cooled the air inside the jar, helping the water vapor condense onto the sides.

- What do you think would happen if one part of the water cycle was left out?
- How do these investigations help us understand weather?

The "Why" and The "How"

This lesson demonstrates how water travels up into the atmosphere, and how it returns to the Earth's surface in a continual process called the water, or **hydrologic** cycle. The water cycle has no beginning and no end. During this cycle, water that has **collected** in oceans, swamps and rivers is heated by the sun. Heat causes water to escape from oceans and other bodies of water in a process called **evaporation**. When water evaporates, it rises into the atmosphere, changing from a liquid to a gas called water vapor. In the cool atmosphere, water vapor **condenses** (changes from a gas state to a liquid state) into millions of liquid water droplets that form clouds. When these water droplets get heavy, they fall to the Earth as **precipitation** -- rain, sleet or snow.

Temperature played an important role in these investigations. In the *"Making a Terrarium"* investigation, heat from the sun caused water to evaporate from the moist soil. In the *"Rain in a Jar"* investigation, warm water at the bottom of the jar represented the ocean. The warm "ocean" water evaporated inside the jar. As water vapor rose in the jar, it was cooled by the colored ice on the

terrarium set-up

lid. The ice represented the cool air in the Earth's atmosphere. The aerosol spray allowed you to see how water vapor gathers and condenses into tiny droplets forming a cloud. Water fell from the "cloud" as precipitation and collected on the sides and at the bottom of the jar. If you wear glasses, your lenses may have fogged up with small water droplets when you entered a cold room -- a common example of condensation.

When it rains or snows, precipitation falls into rivers, lakes and streams, and seeps into the soil and into underground aquifers. Water soaks into soil and is absorbed (taken in) by the roots of plants and trees. Water travels through the stems of plants and trees through a process called **capillary action**. Plant leaves eventually release water back into the air as water vapor through a process called **transpiration**. This cycle of water collection, evaporation, condensation and precipitation occurs continuously around Earth.

Curriculum Match-Up

- Use a thermometer to measure the temperature of the air inside the terrarium over a period of days.
- Create a chart of your results.
- Draw each phase of the water cycle that you observed in these investigations.
- Describe how temperature affects different forms of precipitation.
- Research and discuss ways that pollution might affect weather.
- Make a list of places you see condensation and evaporation everyday.

References:
Adapted from materials prepared by Liberty Science Center and the U.S. Geological Survey.
NOAA

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

The Water Cycle

Learning Objectives

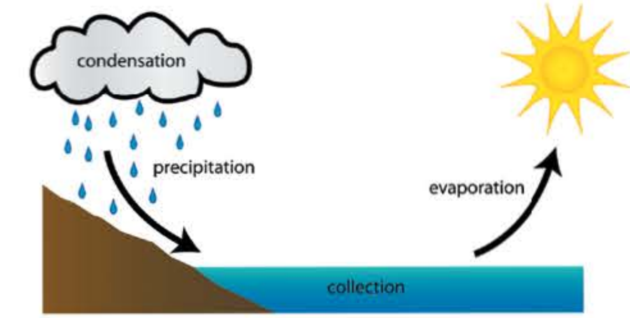
Students will:

1. List the phases of the water cycle.
2. Conduct experiments that demonstrate the phases of the water cycle.
3. Create an ecosystem.

Vocabulary Ventures

aquifers
atmosphere
boiling
collection
condensation
evaporation
gaseous
hydrologic cycle
liquid
oxygen
precipitation
solid
terrarium
transpiration
water
water cycle
water vapor

There is probably no liquid that scientists have studied more than **water**. Water is constantly moving, changing, and interacting with other substances. Water is the only natural substance that exists as a solid (ice), liquid, and a gas (steam or vapor) at normal temperatures.



The Water Cycle

At average room temperature, water exists in a **liquid** state. Water freezes into a **solid** called ice at 32 degrees Fahrenheit (0 degrees Celsius). Water can absorb a lot of heat and will boil when it reaches a temperature of 212 degrees Fahrenheit (100 degrees Celsius). At this temperature, water changes from a liquid to a **gaseous** state called **water vapor**.

Did you know that the water we use today is the same water found on Earth millions of years ago? The Earth constantly uses and recycles water in a process known as the **water cycle**.

There are four main parts to the water cycle: **evaporation, condensation, precipitation** and **collection**. The sun is the "engine" of the water cycle, heating water that has collected in oceans, lakes and puddles.

As water is heated, it evaporates (changes from a liquid to a gas) from the Earth's surface into the air. Water vapor rises into the atmosphere where it cools and condenses (changes from a gas to a liquid) and falls back to the earth as precipitation, collecting again in oceans, streams, and **aquifers** (underground layers of stone where water is filtered and stored naturally). Water continually goes through each of these changes everyday.

Time Needed to Conduct Investigations

Investigation 1: This investigation has two parts.
Organize & set up materials: 10 - 15 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 15 – 20 minutes
Student journaling / group reflection: 10 - 15 minutes
Total estimated time: 40 - 55 minutes

Investigation 2: This investigation has two parts and can be done over a period of 2 to 4 days.
Organize & set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 15 – 20 minutes
Student journaling/group reflection: 10 - 15 minutes
Total estimated time: 40 - 50 minutes
5 minutes each day for observations

Investigation 1: Rain in a Jar

Materials

For groups of three or four
Student journals and writing tools

Investigation 1
Part 1
- Glass jar with lid (mayonnaise jar), or Pyrex bowl and large plate to cover the bowl
- Hot water
- 2 cups of ice made with food coloring (dark red or dark blue)

**NOTE: 240 mL equals 1 cup*

Part 2
- Can of aerosol spray (air freshener)
- Lid

Investigation 2
- Small plastic container
- Clear lid to cover the container, plastic wrap or a large re-sealable storage bag
- 1 - 1½ cups potting soil
- Lima beans or sunflower seeds
- ½ liter bottle of water
- Ruler
- Marker
- Masking tape
- Small to medium-sized box to secure projects
- Thermometers (optional)

Inform students that they will conduct an investigation that creates a water cycle inside a jar.

Part 1
It's Raining in a Jar

Caution: This activity requires hot water!

GET READY!

Discuss the main parts of the water cycle with students: evaporation, condensation, precipitation and collection. Share with students that there is a limited amount of water on our planet, and that the Earth continually uses and recycles water. Remind students to document observations and findings in their student journals.
Ask students:
1. Do you think the Earth has the same amount of water today that was here when dinosaurs roamed the Earth millions of years ago?
2. How do you think water gets into the ground? The air? The oceans?
3. How does rain form?
4. How do you think clouds form?
5. Where do you think water goes after it rains?

PROCEDURE

TIP
Make sure the glass jar is clean, dry and free of condensation.

1. Have students carefully fill the bottom of the glass jar with 2 - 3 inches (10 oz - 13.5 oz) of hot water.
2. Next, have students turn the lid of the glass jar upside down so that it acts as a small bowl, forming a seal over the jar.
3. Fill the lid with the colored ice.

NOTE: The colored ice is used to demonstrate to students that condensation forms from the hot water inside the jar. The changes may take several minutes to occur. The hotter the water, the faster you will observe results.

OBSERVE

Ask students to make and discuss the following observations:
- What is happening inside the jar?
- What evidence of the water cycle do you observe?
- What do you observe on the sides of the jar?
- What role do you think heat plays in the water cycle?

Part 2
Cloudy with a Chance of Rain

Students will continue the investigation using the set-up from Part 1.

PROCEDURE

1. Holding a can of aerosol spray (air freshener, for example), have students carefully lift the lid of colored ice and spray a small amount of aerosol into the jar.
2. Students should quickly replace the lid of ice back on the jar.

adding air freshener to jar

OBSERVE

Ask students to make and diagram the following observations:
- What do you notice about the water inside the jar?
- What states of water do you observe inside the jar?

Answer: water as a liquid, and as a vapor or gas.
- How do you think the cloud was formed?
- How does this experiment demonstrate the water cycle?

Investigation 2: Making a Terrarium

GET READY!

Inform students that they will conduct another investigation that demonstrates the phases of the water cycle. Explain that students will make a **terrarium**, a container that is used to keep and observe small living plants or animals.

BRAINSTORM!
Ask students to share what they know about water and the water cycle. Make a list of the group's ideas on a flipchart or chalkboard.

PROCEDURE

1. Break students up into groups of 3 or 4.
2. Provide each group with a small plastic container that can be covered tightly with a clear, see-through lid or with plastic wrap.
3. Have students pour 1 - 1 ½ cups of soil into the container.
4. Next, ask students to use their fingers or a pencil to make 3-4 holes (approximately 1 inch deep) into the soil. They should then place a seed/bean into each hole and cover completely with soil.
5. Students should water the soil until well moistened and cover the terrarium with the lid or plastic wrap. Make sure that the terrarium is well sealed.
6. Have students make a label for their terrarium using the marker and masking tape.
7. Place each labeled terrarium in the box and place in a warm, sunny location. (Once the seeds sprout, they will need sunshine.)

TIP Keep the terrarium sealed to prevent water from escaping.

PREDICT

Ask students to predict what they think they will observe in the terrarium over the next few days.

OBSERVE

Over the next several days, have students make some simple observations about what is happening inside the terrarium. Students should record and diagram their observations in their journals.
Ask students:
- What do you observe happening in the terrarium?
- Is there evidence that the seeds have sprouted?
- Do you see water inside the terrarium? Where? Is the water in a liquid, gas or solid state?
- How did the water get under the cover of the lid? Which parts of the water cycle occurred?
- Remove the lid from the terrarium and rub some of the soil between two fingers. Is the soil wet? Has any of the water evaporated from the soil?

TIP Remind students to re-seal the terrarium after they have examined the soil. The terrarium will not need water for a few weeks. Replenish the water when the soil feels dry.

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.

Ask students:

- When we remove certain elements from the ecosystem, what is the impact on the living and non-living elements of the ecosystem?
- What did you learn about water in this investigation?
- Why is water important in an ecosystem?
- How do biotic elements interact with water?
- How does water affect abiotic elements?
- What surprised you?
- What new questions do you have?

The "Why" and the "How"

Abiotic elements are those non-living physical and chemical parts of an ecosystem which affect the ability of organisms to survive and reproduce. Chemical and geological elements such as rocks and minerals, and physical elements such as temperature and weather are considered abiotic. The abiotic elements of an aquatic ecosystem include water, nutrients, weather, gravel or sand, sunlight, cloud cover and oxygen levels.

The biotic elements in an active aquatic ecosystem include wildlife, aquatic plants, fungi and microscopic soil organisms. Biotic elements also include the stuff that living things leave behind or feed upon. As organisms go through a life cycle and leave behind things such as leaves, sticks, shells, skin or hides, feces or waste, teeth and bones. Even though these things are no longer living, they are biotic elements because they came from living things and are used as food by other living things such as scavengers and decomposers. A pile of earthworm dung is considered biotic because it is the waste of a living organism. A rotting log and leaves are biotic elements because they came from a tree that was once living.

Aquatic plants and animals are interdependent (rely on each other), and they provide for each other's needs. For example, plants need water, sunlight and nutrients from biotic waste to create their own food; and plants provide oxygen, food and shelter for wildlife. Biotic and abiotic elements in all ecosystems interact in a number of ways. Since living things are dependent on abiotic elements, such as water, sunlight, air and nutrients to survive, the more abiotic factors are available in an environment, the more biotic factors there are likely to be.

Not all environments have the same abiotic factors. Some environments have warmer temperatures than others. Some aquatic habitats have more salt than others. Some environments may have rockier terrain than others. These abiotic factors affect the organisms that live in those environments. To survive, these organisms must adapt or adjust to these abiotic conditions. For example, polar bears have thick coats of fur, black skin and layers of fat to insulate them from the cold temperatures. Because a polar bear is adapted to cold climates and cannot survive in warm climates, temperature is an important abiotic element.

The abiotic elements of an aquatic ecosystem are equally as important as the biotic elements. All of the parts of an aquatic ecosystem are essential to its health and sustainability.

Curriculum Match-Up

- Define the following terms in your own words: ecosystem, biotic, abiotic.
- Make a data table of the biotic and abiotic elements found in a local body of water and the source of pollutants in the water.
- Write a poem about the biotic and abiotic elements found in your favorite aquatic ecosystem.
- Make a web of biotic and abiotic elements in an estuary.

References
Edelstein, Karen. 1999. Pond and Stream Safari. A guide to the ecology of aquatic invertebrates. Cornell Cooperative Extension. Ithaca, NY 14850.
Hall, Jody S. 1998. Organizing Wonder: Making Inquiry Science Work in the Elementary School. Heinemann. ISBN 0-325-00045-X.
Hunken, Jorie. 1994. Ecology for All Ages: Discovering nature through activities for children and adults. The Globe Pequot Press. ISBN 1-56440-138-3.
Ruef, Kerry. 1998. The Private Eye: (x5) Looking, Thinking by Analogy. The Private Eye Project. P.O. Box 646 Lyle, WA 98635 www.the-private-eye.com ISBN 0-9605434-1-4
LaMotte Company. 1994. The Pondwater Tour: Hands-on test kit and mini curriculum for exploring lakes, streams and ponds. LaMotte Company, P.O. Box 329, Chestertown, MD 21620. (800) 344-3100.
Canterbury Environmental Education Centre, UK. Website of pond activities and organism identification. www.naturegrid.org.uk/pondexplorer/pond1.html
http://olympiccoast.noaa.gov/living/marine_wildlife/invertebrates/invertlist.html
http://www.estuaries.gov/pdf/EstuaryParty.pdf

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

What's in the Water?
Biotic & Abiotic Elements in Aquatic Ecosystems

Learning Objectives

Students will:

1. Identify abiotic and biotic elements of an aquatic habitat.
2. Explain the relationship between abiotic and biotic elements in an ecosystem.
3. Identify variables that affect the sustainability of an ecosystem.

Vocabulary Ventures

abiotic
aquatic
biosphere
biotic elements
ecosystem
terrestrial

An **ecosystem** is an area that contains living things such as plants, animals and microorganisms (bacteria, for example) that interact with one another and the environment in which they live.

Ecosystems can be of any size – small like a rotting log, or large like a beach or a forest. Ecosystems are identified as either **aquatic** (water) or **terrestrial** (land). The **biosphere** is the parts of the Earth and the atmosphere that contain living organisms. Every ecosystem is a part of the biosphere.

The organisms that make up the living part of an ecosystem are called **biotic,** which means *"living or having lived"*.

aquatic ecosystem

Some examples of biotic elements in an ecosystem include snails, flowers, butterflies, leaves, or a piece of wood. Living things are affected by the physical conditions in the environment and by other living things in an ecosystem.

Nonliving things found in an ecosystem are called **abiotic,** which means *"non-living, or never having lived"*. Abiotic elements have an effect on the type and number of organisms living in an ecosystem. Examples of abiotic elements in an ecosystem include soil, rocks, water, air, temperature and sunlight.

Water plays a special role in every ecosystem, interacting with all of the biotic and abiotic elements. As a result, these elements affect the quality and amount of water in the biosphere.

We are going to examine biotic and abiotic elements in an aquatic ecosystem.

T. scripta (yellow-bellied slider)

L. terrestris (earthworm)

Time Needed to Conduct Investigation
This investigation has two parts.
Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 30 minutes
Student journaling/group reflection: 10 - 15 minutes
Total estimated time: 55 - 60 minutes

Investigation: Exploring Aquatic Ecosystems

Materials

For the entire group of students
Student journals and writing tools

Part 1
- Flipchart or chalkboard
- 4 - 5 pictures of an aquatic ecosystem

Part 2
- Shoebox or plastic bag
- 30 index cards, each labeled with a biotic and abiotic element given on the chart on page 3
- Ball of yarn or string
- Clock or watch with a minute hand

Part 1
Biotic and Abiotic Identification

In this investigation, students will identify biotic (living) and abiotic (non-living) elements in an aquatic ecosystem.

GET READY!

Remind students to use their student journal to document their predictions, observations and findings. Divide students into groups of three or four. Provide several photos of aquatic ecosystems for each group of students, such as a freshwater ecosystem; or an aquarium with sand, plants, water, fish or snails.
NOTE: Photos are provided in the Appendix.

How do you know that something is alive? Share the following characteristics of biotic elements with students. Have students record these characteristics in their student journals:

Biotic Organisms:
- Live, grow and die (i.e. they have a lifespan)
- Reproduce
- Use resources such as food and water for energy
- Interact with their environment
- Are made up of small units called cells
- Use respiration (exchange gases to get oxygen to the blood)
- Produce waste

Ask students to examine the photo examples and document the following observations in their student journals. As the groups are brainstorming, record their ideas on a flipchart or chalkboard.
Ask students:
1. Which elements in each of these is living, or biotic? What evidence supports your answer?
2. Which elements in each of these examples is an abiotic (non-living) element?
3. Did everyone in your group agree with your description? What did you agree on? Disagree on?
4. Based on previous investigations, what are some factors that impact an aquatic ecosystem?
   Answer: pollution, pH levels, destruction of habitats, climate change, salinity levels.
5. What do you think is needed for the living organisms in an aquatic ecosystem to survive?
Answer: food, shelter, oxygen, suitable pH levels, clean water, etc.
6. What is the relationship between the living and non-living elements of these ecosystems?

Ask students to think of other characteristics that are unique to living organisms.

Part 2
Making Connections

Students will now participate in an activity that shows the connections between all of the elements of an aquatic ecosystem.

TIP
This exercise may generate healthy discussion and debate among students. Encourage critical thinking instead of "right" or "wrong" by asking students to support their findings.

PROCEDURE

Encourage students to think about the relationships between living and non-living elements of an aquatic ecosystem.

1. Place the nametags labeled with biotic and abiotic elements into a shoebox or plastic bag.
2. Have each student choose one of the nametags.
3. Have students form a circle in the middle of the room and place their nametags on their shirts or in front of them in the circle.
4. Next, give a ball of yarn or string to one student. Have that student identify the element that he or she has chosen and pass the ball of string to another student while still holding on to the string.
5. As the ball of string moves through the circle, each student should state whether his/her element is abiotic or biotic and then identify the connection between his/her element and the next student's element.
   For example, one student with a seed tag (biotic element) passes the string to another student with a sunlight tag (abiotic element) and explains that seeds need sunlight to grow.
6. Students should continue passing the ball of string for 5 to 10 minutes making as many connections as possible.

As students are passing the ball of yarn around the circle, ask students to share how they decide where the ball of yarn should travel in the ecosystem. What do they consider to make their decision?

OBSERVE

After 10 minutes, encourage students to make and discuss their observations. Ask students:
1. How does the circle look?
2. Has every element made a connection? Why or why not?
3. Which element has the most connections? Why do think this is?
4. Which element has the least connections?
5. What does this investigation demonstrate?
6. How do you think pollution affects these connections?
7. What would happen if we removed an element from this ecosystem?

To demonstrate what happens when an element is removed from an ecosystem, have students decide as a group which biotic or abiotic element to remove from the ecosystem. When the element is identified, have the student representing that element pull gently on the ball of yarn.
Ask students:
- Who felt the pull on the string?
- How are you affected by the removal of this element?
- What factors are you taking into account to determine if the removal of an element will affect you?

Continue removing or adding elements or other ideas suggested by the students. Remind students to share and record their findings in their student journals.

BIOTIC AND ABIOTIC CARDS

Sunlight	Temperature	Air	Rain	Tadpoles
Mosquito	Tree	Weather	Banded Sun Fish	Garter Snake
Bacteria	Phytoplankton *(floating plant)*	Saltwater	Freshwater	Sunflower seeds
Aquifer	Clouds	Snail	Soil	Tree
Plant	Sand	pH Level	Venus Flytrap	Clam
Acid Rain	Pollution	Heron *(bird)*	Nutrients	Rotting log

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.

- What happened to your ecosystem?
- How did it change over time?
- How did your result compare to the results of other groups?
- What surprised you?

The "Why" and the "How"
Your students have created a small-scale aquatic ecosystem. If properly cared for, the ecosystem should last for some time. Every **element** plays a valuable role in the **ecosystem**.

Duckweed, also known as Lemna, is a green floating plant. Each individual plant looks like a miniature lily pad and only grows to be a few millimeters in length. Duckweed serves as a source of food and oxygen for organisms in the ecosystem.

L. catebeianus (Bullfrog) covered in duckweed

Elodea, also known as Waterweed, is a stalk-like freshwater plant. Elodea lives entirely underwater, except for small white flowers that grow at the surface. Elodea serves as a source of both food and oxygen within the ecosystem.

E. canadensis (Elodea)

Water snails are **gastropods** which have spiral shaped shells that grow with them. They have soft muscular bodies. The part of the snail's body that sticks out of the shell is known as the foot. The snails eat algae as they crawl.

Guppies are small fish that give birth to live young. Females are typically gray or brown in color and are larger than the males. Males are smaller, have longer tails, and are usually more colorful than the females. Guppies breed frequently, and may give birth in the bottled ecosystems. The parents may eat their young after they are born, so it is important to have Elodea in the bottled ecosystems for the babies to hide.

Care Tip:
When you receive your guppies, place the unopened bag into an aquarium of dechlorinated or spring water for about 15 minutes to equalize the temperatures. Use a dipnet to transfer fish from the bag to the aquarium of dechlorinated/spring water containing Elodea and Duckweed. Feed the guppies a small pinch of fish food every day. If any of the guppies die, remove them from the ecobottle and dispose of them.

CAUTION:
Never release any organisms from the ecobottles into the environment, as they may disrupt the local ecosystem! If you cannot keep the ecobottles, try to find them a new home. If a suitable home cannot be identified, put the organisms in a plastic bag with a small amount of water and place them in the freezer. This will cause them to enter hibernation and then expire.

Curriculum Match-Up

- Take pictures of the ecosystems at each observation and create a book or webpage.
- Create a table for the data collected.
- Create line graphs for the changes in water clarity, water temperature, plant growth and animal populations.
- Make a double bar graph comparing the number of animal populations at the beginning and at the end of the activity.

References:
www.eduref.org/cgi-bin/printlessons.cgi/Virtual/Lessons/Science/Ecology/ECL0014.html
www.ucmp.berkeley.edu/glossary/gloss5/biome/aquatic.html
www.epa.gov/bioindicators/aquatic/freshwater.html
www.lawrencehallofscience.org/foss/fossweb/teachers/materials/plantanimal.html
www.fws.gov/pantherswamp/images/BULLFROG%20IN%20DUCKWEED.jpg
www.epa.gov/owow/invasive_species/invasives_management/images/brazilian-waterweed.jpg
www.fws.gov/pantherswamp/images/BULLFROG%20IN%20DUCKWEED.jpg
www.epa.gov/owow/invasive_species/invasives_management/images/brazilian-waterweed.jpg

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Freshwater Ecosystems

Learning Objectives

Students will:

1. Identify the biotic and abiotic elements of a freshwater ecosystem.
2. Build a freshwater ecosystem.
3. Students will describe how a freshwater ecosystem changes over time.

Vocabulary Ventures

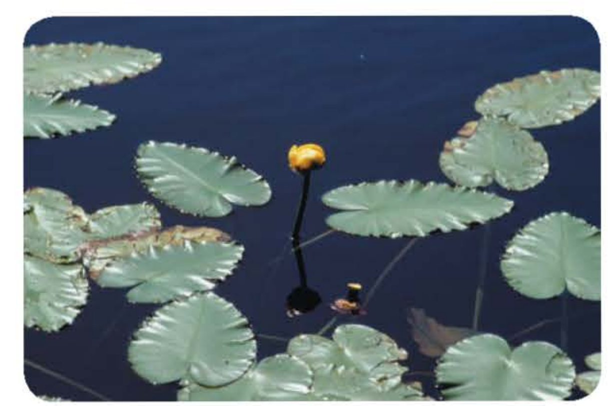
abiotic
biome
biotic
duckweed
ecosystem
elodea
freshwater regions
guppy
marine regions
water snail

Have you ever wondered about all of the aquatic (water) habitats around our planet? How are they different? What do they have in common? How are they important to life on Earth?

The Earth's environments are organized into five **biomes**, which are areas of the planet that share a similar climate, plant life and animal life. These include the desert, tundra, forest, grassland and aquatic biomes. The aquatic **biome** is the Earth's largest, covering 75% of the planet.

freshwater lake

The aquatic biome can be divided into two regions, **freshwater** and **marine** (saltwater). The freshwater regions include ponds, lakes, rivers, streams, wetlands, reservoirs and groundwater. Freshwater regions make up less than 1% of all the water on Earth. Most of the freshwater on the Earth can be found in the polar ice caps. Freshwater regions provide most of our drinking water supply.



freshwater pond with water lillies

Freshwater regions are host to very unique ecosystems. An **ecosystem** is a community of living organisms and the nonliving things in an environment. The living elements are known as **biotic** and the nonliving elements are known as **abiotic.** Plants and animals living in freshwater habitats have adapted (adjusted) to these environments and would usually not be able to survive in water with higher salinity. Almost half the fish on Earth live in freshwater ecosystems.

Time Needed to Conduct Investigation
This investigation has three parts.
Organize and set up materials: 20 – 30 minutes
Introduce the lesson: 10 minutes
Conduct the investigation: 30 minutes
Student journaling/group reflection: 10 – 15 minutes
Total estimated time: 70 – 85 minutes

Investigation: Freshwater Ecosystem in a Bottle

Materials

For groups of three or four
Student journals and writing tools

- Dip net
- Dechlorinated or spring water
- Large aquarium containing guppies, snails, Elodea and Duckweed
- Small containers for offspring
- Hammer
- Nail

Part 1
- Colorless, rinsed 2-liter soda bottle (label removed)
- Colorless, rinsed 2-liter soda bottle with air holes poked in the bottom (label removed)
- Dechlorinated tap or spring water
- Markers
- Scissors
- Masking tape
- Sand (rinsed with plain water)
- Three Elodea plants
- A scoop of Duckweed
- Thermometers

NOTE: Rinse soda bottles and sand with plain water.
Use a hammer and nail to create holes in the bottom of one of the two soda bottles that will be given to each group.

Part 2
- Two Water snails in a 16 oz clear plastic cup of dechlorinated water
- Two Guppies in a 16 oz clear plastic cup of dechlorinated water
- Fish food

Part 3
- Magnifying lenses
- Thermometers

TIP
To dechlorinate tap water, pour water into a bucket or container with a large opening and let sit for at least 24 hours.

NOTE: Background information and care instructions for each organism are found at the end of this lesson. Upon receipt, rinse all living materials with dechlorinated tap or spring water and place immediately into an aquarium away from direct sunlight. The aquarium serves as a storage and observation tank until students make their own ecosystems.

Part 1
Setting the Stage

GET READY!

BRAINSTORM
Share with students that the aquatic biome is divided into freshwater and saltwater regions. Ask students to brainstorm and list some different bodies of water that they know. Record their responses on a flipchart or chalkboard. Ask students to identify which of these are freshwater.

Next, ask students if they know what an ecosystem is. If not, provide students with the definition. *Answer: An ecosystem is a community of living organisms and the nonliving things in an environment.* Ask students to brainstorm what they know about freshwater ecosystems:
- What is the water like in a freshwater ecosystem?
- What types of animals would you find?
- What kinds of plants exist in a freshwater ecosystem?

PROCEDURE

Inform students that they will be making a small freshwater ecosystem in a bottle. Ask students to share some of the elements they think would need to be included in a freshwater ecosystem (e.g. animals, plants, water, oxygen, sunlight etc.).

1. Have students use their markers to draw a line around the circumference of the soda bottle without holes two or three centimeters from the curved top end of the bottle.
2. Next, have students draw a line around the circumference of the bottle with holes two or three inches from the curved bottom end of the bottle.
3. Students should then cut along each line with a scissor.

TIP
If students are having difficulty cutting the bottles, help them create the initial puncture with the pointed tips of the scissors. The cut-off top of the bottle can also be used as a funnel

4. Students should use the masking tape and marker to put their names on the bottle without holes. Explain to students that the bottom portion of the other soda bottle (with the holes) will serve as the lid to their freshwater ecosystem.
5. Students should fill the bottle without holes with 6 cm (2.5 inches) of sand.

6. Then, they should slowly fill the bottle two thirds of the way with dechlorinated or spring water, trying not to disturb the sand.
7. Students should plant their three Elodea plants securely in the sand at the bottom of the soda bottle.
8. They should then sprinkle their scoop of Duckweed on the surface of the water.

OBSERVE

Students should record the biotic and abiotic elements they added to their freshwater ecosystems in their journals.

Have students make observations about the Elodea plants and the Duckweed. Students should describe and draw each of these elements in their journals. Discuss a bit more about each of these plants with students. (See "The Why and The How" section.) Have students measure and record the water temperature of the ecosystem.

TIP
The bottles should be allowed to sit overnight to allow the sand to settle before proceeding to Part 2.

ecobottle set-up

Part 2
Adding Some Key Players

TIP
Students should always wash their hands before and after handling live organisms.

GET READY!

Students will add some additional biotic elements to their freshwater ecosystems. Remind students to use the student journal to document their predictions, observations and findings.

Ask students to observe their freshwater ecosystem bottles after they have been allowed to settle and record these observations in their journals. Have students measure and record the water temperature of the ecosystem.

OBSERVE

Distribute prepared cups of guppies and snails to students. Ask students to make the following observations about the water snails and the guppies in their cups:
- How does each organism look?
- How does each move?

Have students draw each of these organisms in their journals. Discuss a bit more about each of these organisms with students. (See "The Why and The How" section.)

PROCEDURE

1. Have students first add the two snails to the ecosystem using the nets, or by gently pouring them from the cups.
2. They should then add the guppies to the ecosystem using the nets, or by gently pouring them from the cups.
3. Ask students to observe how the snails and guppies behave when added to the bottled ecosystems and also record their observations in their field journals.
4. Next, have students place their bottled ecosystems in a well lit area, but not in direct sunlight.
5. Feed the guppies with a very small pinch of fish food every day.

Ask students to make and record the following predictions:
- What do you think will happen to your freshwater ecosystem over time?
- How do you think it will change?
- What do you think will stay the same?

Part 3
Watch What Happens

OBSERVE

Explain to students that they will be making the following observations about their ecosystems over the next few weeks:
- Has the color of the water changed? If so, how? Why do you think these changes occurred?
- Did you notice any change in water temperature? If so, how?
- Has there been any plant growth or changes?
- How did the organisms behave?
- Did any of the populations change?

Students should record and draw each observation in their journals.

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:
www.epa.gov/bioindicators/aquatic/marine.html
www.sciencenetlinks.com/lessons.cfm?Grade=6-8&BenchmarkID=5&DocID=103
www.afsc.noaa.gov/Kodiak/images/photo/algaduart.jpg
ut.water.usgs.gov/shrimp/index.html
ut.water.usgs.gov/shrimp/images/naupli2.jpg
ut.water.usgs.gov/shrimp/images/naupli2.jpg

- 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.

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

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.

PROCEDURE

1. Have students fill three separate cups with 60 mL (1/4 cup) of each of the three water samples.
2. Next, have students label the samples, 1, 2, 3.
3. Students should mark the water level on each cup with the marker.
4. Next, they should place the cups on a sunny windowsill.

PREDICT

Ask students to predict what they think will happen if they leave the three cups out overnight.

- What will happen to the water?
- Do you think there will be a difference in the results of each sample?
- Will there be anything left over besides water in any of the cups?
- What will happen after two days? One week?
- How long do you think it will take for the water to evaporate completely?

OBSERVE

Have students check the water samples daily, or after 24 hours, 48 hours and one week. They can mark the water level on their cup at each interval. Have students observe and record the following observations:

- How much water evaporated after each time interval? Ask students to draw what they observe in their journals.
- Do you notice anything left behind from any of the samples? What does that tell you about the water?

Discuss with students how dissolved salts form solid crystals and get left behind when the water in saltwater evaporates. Ask students:

- Which sample(s) do you think were freshwater?
- Which were saltwater?
- Which sample had the most dissolved substances in it? Which were saltwater?

Note: Inform students that they will be continuing this investigation in Water Detectives II.

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.

References:
www.epa.gov/bioindicators/aquatic/marine.html
www.onr.navy.mil/Focus/ocean/water/salinity1.htm
www.oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar10c.html
www.njmsc.org/Education/Lesson_Plans/Salinity.htm
www.epa.gov/owow/estuaries/about1.htm
www.swrcb.ca.gov/nps/docs/cwtguidance/3130fs.pdf
www.waterencyclopedia.com/Re-St/Sea-Water-Freezing-of.html
pbskids.org/zoom/activities/sci/saltwatertester.html
www.msc.ucla.edu/oceanglobe/pdf/densitysalinity/densityentire.pdf
www.saltinstitute.org/11.html
quickfacts.census.gov/qfd/maps/stout34.gif
http://www.bigelow.org/shipmates/salinity.html
USCG SOFIA
Map Resources.com
Wikipedia Commons
NASA

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.

Ask students:

- What were the results of your experiments?
- What new things did you learn?
- Do you think you know which water sample is which?
- What surprised you?
- What new questions do you have?

The "Why" and the "How"

There are a number of ways that we can gather information about water salinity, including testing for conductivity and for evaporation. Conductivity is the ability of a material to conduct, or carry, an electrical current. Pure freshwater is a poor conductor of electricity. The higher the amount of dissolved salt in water, the better it conducts electricity. In this investigation, the dissolved salt in the "ocean" and "estuarine" samples conducted electricity and completed the circuit to light the bulb or ring the buzzer. A circuit is a path or route on which an electric current travels.

As saltwater evaporates, the water turns to vapor, but any dissolved substances such as salt get left behind. The "ocean" and "estuarine" samples will evaporate and leave behind salt crystals. Since freshwater contains little-to-no dissolved salts, there should be few or no crystals left behind after the water in the "river" sample evaporates.

NOTE: The complete data recording table from Lessons 5 and 6 is available in the appendix and in the student journal.

Curriculum Match-Up

- Try painting with colored saltwater and colored freshwater on two different pieces of construction paper. Observe your results after the water has evaporated.
- Take a field trip and collect real river, ocean and estuary water samples. Repeat the investigations and compare your results with this lesson.

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Water Body Salinities I

Learning Objectives

Students will:

1. Correctly identify local water bodies on a map. Use water samples to compare the salinities of a river, an estuary and an ocean.
2. Test water samples based on conductivity and evaporation.

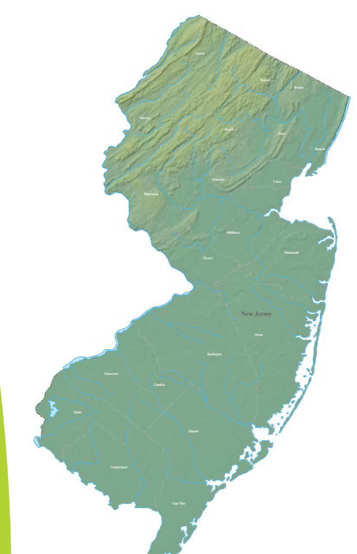
Vocabulary Ventures

biome
brackish
headwater
ocean
saltwater
river
freshwater
estuary
freezing point
conductivity
evaporation
hydrometer
salinity


salinity testing in a wetland

Different bodies of water make up the freshwater and marine (saltwater) regions in the aquatic **biome.** A biome is a large **ecosystem** (such as a desert or an ocean) with specific types of plants and animals that have adjusted, or adapted, to the conditions in their environment. Water found in freshwater and saltwater regions contains varying amounts of salt. Salinity is the amount of dissolved salts found in water. Saltwater is mostly made of water (H_2O) and the dissolved salts sodium (Na) and chloride (Cl).

An **ocean** is a large body of saltwater. Oceans make up approximately 70% of the water on Earth. Our planet actually has one ocean -- the World Ocean -- that is divided into five smaller ocean basins: Atlantic, Pacific, Indian, Arctic and Southern. The Atlantic Ocean borders the New Jersey coastline.



NJ water bodies (see Appendix)

Salinity is calculated as the amount of salt (in grams) dissolved in 1,000 grams (1 kilogram) of seawater. Salinity is often expressed as "parts per thousand" (ppt). The average salinity level of the ocean is 35 parts per thousand, which means that about 3.5% of the seawater is dissolved salt. Ocean salinity can range from approximately 32 – 37 ppt.

A river is a large flowing body of **freshwater** that typically empties into an ocean. A river's source may be a spring, a lake, or a series of small streams, known as **headwaters.** There are several rivers in New Jersey, including the Raritan River, the Hackensack River and Toms River (see enclosed map). The water found in rivers tends to range in salinity from 0 - 3 ppt.

Estuaries are bodies of water that are partially surrounded by land, and where freshwater from rivers meets with saltwater from the ocean. In an estuary, the salty water from the ocean mixes with freshwater from rivers to form a layer of **brackish** water. Estuarine water has a salinity between 0 - 30 ppt. The salinity of an estuary can vary depending on a number of factors, including the tides and the amount of freshwater runoff. Areas of the estuary closest to the freshwater source typically have a lower concentration of salt, while the waters nearest the ocean have a much higher concentration of salt.

Time Needed to Conduct Investigation

This investigation has three parts.

Organize and set up materials: 15 minutes
Introduce the lesson: 15 – 20 minutes
Conduct the investigation: 45 – 55 minutes over several days
Student journaling/group reflection: 15 – 20 minutes over several days
Total estimated time: 95 - 110 minutes over several days

Investigation: Water Detectives I

Materials

For groups of four
Student journals and writing tools

Preparation
- three 1000 mL graduated cylinders or 2-liter soda bottles
- Distilled water
- Kosher salt
- Balance
- Roll of insulated wire
- Wire stripper

Part 1
- Large map: NJ water bodies (See Appendix) *or your program's state
- Individual outline maps of NJ
- Colored pencils

Part 2
- 250 mL (1 cup) of water samples #1, #2 & #3
- Three 16 oz plastic cups
- 9-volt battery
- Small light bulb or buzzer with 2 insulated wires attached
- Masking tape or alligator clips
- One 12-inch length of insulated wire (ends stripped)
- Two Popsicle or craft sticks
- Aluminum foil

Part 3
- 60 mL (1/4 cup) of water samples #1, #2 & #3
- Three 9 oz plastic cups
- Permanent marker

TIP
Use a 1-liter water bottle to measure 1000 mL (4 cups) of water into a 2-liter colorless soda bottle if graduated cylinders are not available. This lesson will be continued in Water Detectives II. You will need to make fresh solutions for each of these lessons, unless they are done on the same day.

Part 1
Oceans, Rivers and Estuaries

GET READY!

In this two-part investigation, students will conduct experiments using samples from different bodies of water to learn about salinity.

BRAINSTORM
Ask students to brainstorm what they know about oceans, rivers and estuaries. Make a list of their ideas on a flipchart or chalkboard. Students can record their ideas in their student journals.
Ask students:
- How are they similar? How are they different?
- How does the water move in each?
- Do you know of any examples in our area? Where are they located?
- What is the salinity of the water like in each?

Preparation:
Gather all materials prior to the start of the activity. Label the 1000 mL graduated cylinders #1, #2 and #3, and fill each cylinder with 1000 mL (4 cups) of distilled water. In cylinder #1, mix 35 g (2 tablespoons + 1 teaspoon) of Kosher salt. This is your "ocean" sample. In graduated cylinder #2, mix 17 g (1 tablespoons + 1/2 teaspoon) of Kosher salt. This is your "estuary" sample. Graduated cylinder #3 will serve as your "river" sample (no salt). Use the wire stripper to cut and strip one 12-inch length of wire for each group.

PROCEDURE

1. Review the property of water known as salinity. Discuss the differences in salinities between oceans, rivers and estuaries.
2. Explain to students that you recently collected three water samples, one from the Raritan River, one from the Hudson River Estuary and one from the Atlantic Ocean. *Feel free to substitute names of oceans, estuaries or rivers close to the location of your program.*
3. Show students where these bodies of water are located on the large map of NJ (or your program's state).
4. Have students label these bodies of water on their small maps.
5. Students should create a key on their maps for the salinities of river water (0 - 3 ppt), estuarine water (0 – 30 ppt) and ocean water (32 - 37 ppt), assigning a different color to each.
6. Students should then color each of the three bodies of water with the appropriate salinity color from the key.
7. Explain to students that you need their help solving a problem. The problem is that the three water samples got mixed up before you could label them. Inform students that they will conduct a series of tests on the salinity of the water samples to try to identify the samples from each body of water.

TIP
Do not tell the students what is in each of the three containers. They will discover this information through their tests.

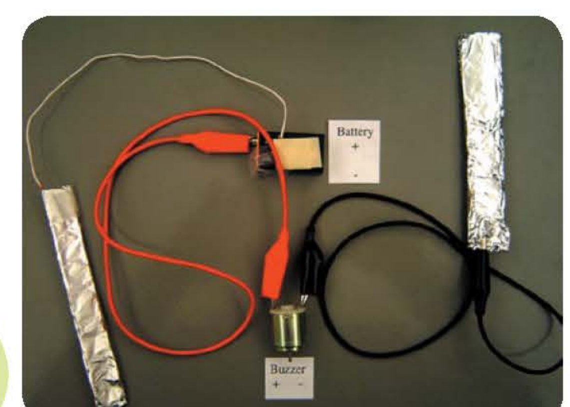
Part 2
Conductivity

Share with students that there are different ways to determine the salinity of water. One way is by measuring its conductivity. Conductivity refers to how well a material conducts or carries an electrical current.

Explain to students that they will create an electrical circuit, a device that creates a path for electricity to follow. Students will test each water sample to see if any of the samples can complete the electrical circuit by lighting the bulb or ringing the buzzer.

PROCEDURE

1. Students should wrap their popsicle sticks in aluminum foil.
2. Next, have students tape or clip the red wire of the light bulb or buzzer to the positive end of the battery. (On a 9V battery the positive and negative symbols can be found on the sides.)
3. Students should then tape or clip one foil-covered popsicle stick to the black wire of the bulb or buzzer.
4. Students should tape the other foil-covered popsicle stick to one end of the 12-inch length of insulated wire.
5. Next, have students tape the end of the other 12-inch length of wire to the negative end of the battery. (It can also be clipped directly to the battery.)
6. Students can check to see if their circuits are complete by touching the foil-wrapped popsicle sticks together. (If the circuit is complete, the bulb will light or the buzzer will ring.)
7. Students should then half-fill each separate plastic cup with the water samples and label them 1, 2, 3.



conductivity set-up

PREDICT

Students should record their predictions in their student journals. Ask students:
- Do you think any of the solutions will conduct electricity? Why do you think so?

To test each water sample, students should place both popsicle sticks into the first water sample. Students should not touch the sticks together in the water as this will alter their results. They should then repeat these steps with the other two water samples.

TIP
The popsicle sticks should be dried off between each test toensure that residual salt on the popsicle sticks does not affect the tests. Students should make sure their circuits still work between each test by touching the sticks together.

OBSERVE

Students should make and record their observations in their student journals. Ask students:
- Which solution was the best conductor of electricity? The worst?
- How did you come to that conclusion?

Discuss with students the relationship between salinity and conductivity. Share that conductivity is a good way to tell if salts are dissolved in a water sample. Ask students:
- Based on our discussion, which solution do you think had the greatest salinity?
- Which solution has the lowest salinity?

Part 3
Evaporation

Explain to students that they will do an additional experiment to identify the origin of each water sample.

BRAINSTORM
Ask students:
- What happens over time when water is left out in the open?
- How does this relate to the water cycle?
- Do you think that there is a difference in what happens to saltwater and freshwater as they evaporate?
- How do you think evaporation can give us clues about water's salinity?

Review the concept of evaporation with students. Evaporation occurs when liquid water turns into water vapor (a gas).

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.

Ask students:
- Which water sample do you think came from the ocean, the river and the estuary?
- Did all of the groups get the same results? If not, why do you think this occurred?
- What surprised you?
- What new things did you learn?

man floating in water with high salinity ©Eve Anderson

References
www.epa.gov/bioindicators/aquatic/marine.html
www.onr.navy.mil/Focus/ocean/water/salinity1.htm
www.oceanservice.noaa.gov/education/kits/estuaries/media/supp_estuar10c.html
www.njmsc.org/Education/Lesson_Plans/Salinity.htm
www.epa.gov/owow/estuaries/about1.htm
www.swrcb.ca.gov/nps/docs/cwtguidance/3130fs.pdf
wow.osu.edu/experiments/statesofmatter/psm2/hydrometers.html
www.waterencyclopedia.com/Re-St/Sea-Water-Freezing-of.html
www.msc.ucla.edu/oceanglobe/pdf/densitysalinity/densityentire.pdf
www.saltinstitute.org/11.html

The "Why" and the "How"

There are a number of ways that we can gather information about water's salinity. Conductivity and evaporation were explored in the previous investigation. We can also examine water's density and its freezing point. The saltier a body of water, the denser it is. A hydrometer is used to measure the density of water. Objects will float higher in denser liquids than in less dense liquids. In the hydrometer investigation, the "ocean sample" was both the saltiest and the densest. Therefore, when the hydrometer was placed into this sample it should have floated the highest of the three samples, and had the fewest number of markings below the surface of the water. On the other end of the spectrum, the "river sample" was both the least salty and the least dense. Therefore, when the hydrometer was placed into this sample, it should have floated the lowest, and had the greatest number of markings below the surface of the water.

The salinity of water determines its freezing point, the temperature at which it freezes. The higher the salt content, the lower the temperature needed for the water to freeze. Freshwater freezes at 0 °Celsius (32 °F). However, the freezing point for ocean water can be as low as -2.2 °Celsius (28 °F). The freshwater sample should have frozen first because it had a higher freezing point. The two saltwater samples should have had lower freezing points, with the estuary sample freezing before the ocean sample.

NOTE: The complete data recording table from Lessons 5 and 6 is available in the appendix and in the student journal.

Curriculum Match-Up

- Try painting with colored saltwater and colored freshwater with a paintbrush on two different pieces of construction paper. Observe your results the next day after the water has evaporated.
- Create a bar graph for each group's finding.
- Take pictures of the tests for each sample and make a book or showcase them on the Internet.
- Take a field trip and collect real river, ocean and estuary water samples. Compare your results with the simulation.

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Water Body Salinities II

Learning Objectives

Students will:

1. Correctly identify local water bodies on a map.
2. Use water samples to compare the salinities of a river, an estuary and an ocean.
3. Test water samples based on density and freezing.

Vocabulary Ventures

biome
brackish
headwater
ocean
saltwater
river
freshwater
estuary
freezing point
conductivity
evaporation
hydrometer
salinity

NOTE: This introduction is repeated from Lesson 5, Water Detectives I.

Different bodies of water make up the freshwater and marine (saltwater) regions in the aquatic **biome.** A biome is a large **ecosystem** (such as a desert or an ocean) with specific types of plants and animals that have adjusted, or adapted, to the conditions in their environment. Water found in freshwater and saltwater regions contains varying amounts of salt. Salinity is the amount of dissolved salts found in water. Saltwater is mostly made of water (H_2O) and the dissolved salts sodium (Na) and chloride (Cl).

An **ocean** is a large body of saltwater. Oceans make up approximately 70% of the water on Earth. Our planet actually has one ocean -- the World Ocean -- that is divided into five smaller ocean basins: Atlantic, Pacific, Indian, Arctic and Southern. The Atlantic Ocean borders the New Jersey coastline.

Salinity is calculated as the amount of salt (in grams) dissolved in 1,000 grams (1 kilogram) of seawater. Salinity is often expressed as "parts per thousand" (ppt). The average salinity level of the ocean is 35 parts per thousand, which means that about 3.5% of the seawater is dissolved salt. Ocean salinity can range from approximately 32 – 37 ppt.

marine water body

A river is a large flowing body of **freshwater** that typically empties into an ocean. A river's source may be a spring, a lake, or a series of small streams, known as **headwaters.** There are several rivers in New Jersey, including the Raritan River, the Hackensack River and Toms River. (See enclosed map.) The water found in rivers tends to range in salinity from 0 - 3 ppt.

Estuaries are bodies of water that are partially surrounded by land, and where freshwater from rivers meets with saltwater from the ocean. In an estuary, the salty water from the ocean mixes with freshwater from rivers to form a layer of **brackish** water. Estuarine water has a salinity between 0 - 30 ppt. The salinity of an estuary can vary depending on a number of factors, including the tides and the amount of freshwater runoff. Areas of the estuary closest to the freshwater source typically have a lower concentration of salt, while the waters nearest the ocean have a much higher concentration of salt.

Time Needed to Conduct Investigation

This investigation has two parts.

Organize and set up materials: 15 minutes
Introduce the lesson: 5 - 10 minutes
Conduct the investigation: 45 - 55 minutes over several days
Student journaling/group reflection: 15 minutes over several days
Total estimated time: 75 - 95 minutes over several days

Investigation: Water Detectives II

Materials

For groups of four
Student journals and writing tools

Preparation
- Three 1000 mL graduated cylinders or 2-liter soda bottles
- Distilled water
- Kosher salt
- Balance

Part 1
- Plasticine or clay
- Drinking straw, clear
- Ruler
- Permanent marker
- Tap water
- Four 16 oz clear plastic cups
- Small nails or steel shot to fit inside straw
- 375 mL (1 ½ cups) of water samples #1, #2 & #3
- Paper towels
- Optional Hydrometer Lab Kit from sciencekit.com

Part 2
- 250 mL (½ cup) of water samples #1, #2 & #3
- Plastic ice cube tray
- Freezer
- Thermometers
- Real hydrometer, optional

Continued from Water Detectives I

Preparation:
Gather all materials prior to the start of the activity. Label the 1000 mL graduated cylinders #1, #2 and #3, and fill each cylinder with 1000 mL (4 cups) of distilled water. In cylinder #1, mix 35 g (2 tablespoons + 1 teaspoon) of Kosher salt. This is your "ocean" sample. In graduated cylinder #2, mix 17 g (1 tablespoons + 1/2 teaspoon) of Kosher salt. This is your "estuary" sample. Graduated cylinder #3 will serve as your "river" sample (no salt).

TIP
You may need to make multiple batches of the samples depending on the number of students in your group. You will need to make fresh solutions for each of these two investigations unless they are being done on the same day.

Part 1 Making a Hydrometer

Review with students what they learned in Water Detectives I. Explain to students that they will continue conducting experiments to identify each water sample.

Inform students that they are going to create hydrometers. Hydrometers measure the density of a liquid.

BRAINSTORM
Ask students to brainstorm what they know about density:
- What is density?
- What clues does the density of water tell us about its salinity?

Answer: Density is how much stuff is packed into a certain amount of space. In this investigation, density is a measure of how much salt is packed into a container of water.

PREDICT

Invite students to record the following prediction in their journals:
- Based on our previous tests, can you predict which water sample will have the greatest density? The least? Why do you think so?

PROCEDURE

1. Students should press a small ball of clay the size of a marble into one end of a straw to form a plug.
2. Starting at the top of the straw, students should draw horizontal lines with a permanent marker down the length of the straw at 1 cm intervals.
3. They should then half-fill one of the cups with tap water.
4. Students should put the straw hydrometer clay-end down into the tap water.
5. They should remove or add clay until the hydrometer floats without touching the bottom of the cup.

hydrometer set-up

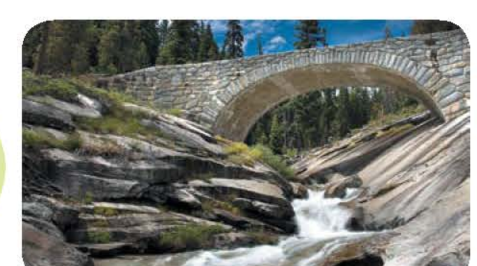
TIP
If the hydrometer is not floating upright, add two or three small nails or steel shot to the straw.

OBSERVE

After they have created their hydrometers, students can use them to test each of the water samples in the other three plastic cups. After placing the hydrometer clay side down into a sample, students should count the number of markings below the surface of the water. The fewer the number of marks below the surface (or the higher the straw floats), the greater the density (and salinity) of the water.

TIP
Students should dry their hydrometers with a paper towel between each sample test so their results are not affected by the previous sample.

Students should make the following observations and record findings in their journals. Ask students:
- Which water sample had the greatest density? The least?
- Which sample had the greatest salinity? The least?
- Did all groups get the same results? If not, why do you think that is?



Part 2 Freezing Point

Invite students to think about what happens to a freshwater lake versus an ocean when the weather gets very cold. Ask students:
- What happens to water when it gets cold?
- What does this have to do with the water cycle?
- At what temperature does freshwater freeze? *Answer: Freshwater freezes at 32 °F (0 °C).*
- Do you think that there is a difference between how saltwater freezes and how freshwater freezes?

PROCEDURE

1. Have students label three sections of a plastic ice cube tray: #1, #2 and #3.
2. They should then fill each section with the appropriate water sample.
3. Place the trays in the freezer.

OBSERVE

Ask students to make observations and record the temperature of each water sample after 1 hour, 24 hours and 48 hours in their journals. Temperature readings should only be taken for liquid water in the ice cube tray. If no liquid water is present, students should record this result in their journals.

TIP
If your program does not meet daily, take photos of the trays at these intervals and share them with students after they have completed the set-up.

Ask students:
- Which water samples experienced some freezing?
- Which sample froze first?
- Did you notice any layering of ice and water? Draw what you see in your journals.
- What is the texture of the water samples after being in the freezer?

Discuss with students that the salinity of a body of water determines its freezing point -- the temperature at which water freezes.

Ask students:
- Based on our investigation, which water sample do you think has the greatest salinity? The least?
- What does this investigation tell you about how icebergs form?

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. Ask students:

- What were the results from each group for the salt wedge investigation? Are there any differences? What might explain these differences?

Answer: how fast each student poured the water, the angle of the baking dish, etc.

- Do you think this was a good model of a salt-wedge estuary? What objects could be added to this model?
- What were the results from the freshwater plant investigation?
- What did you learn about water from this investigation?

aerial photo of saltwater intrusion into freshwater

References:
http://oceanservice.noaa.gov/education/kits/estuaries/media/
http://www.bbep.org/
http://www.delawareestuary.org/
http://www.ozestuaries.org/indicators/salinity.jsp
http://omp.gso.uri.edu/doee/science/descript/saltwedg.htm
http://www.saltwedge.org/
http://www.estuaries.gov/welcome.html
http://www.noaa.gov
Wikipedia Commons

The "Why" and The "How"
Stratification occurs when waters of different densities form layers in an estuary. Density is how much material is packed into a certain amount of space. Seawater has high amounts of salt, making it denser than freshwater, so it sinks below freshwater in an estuary. There is very little salt in freshwater lakes, rivers and streams. Freshwater and saltwater can mix in an estuary, forming a layer of brackish water.

Salt wedge estuaries occur when the mouth of a river flows directly into seawater. When this happens, freshwater from the rivers pushes against the saltwater flowing in from the ocean, resulting in wedge-shaped layers of water of different salinities. In the salt wedge model, the denser layer of saltwater flows below the less dense layer of freshwater. The Hudson River is an example of a salt wedge estuary.

Plants and animals are affected by changing salinity levels in their habitats. Each estuarine plant and animal must adjust to changes in salinity or they may not survive. When aquatic organisms are not able to control the amount of salt in their bodies, they become vulnerable to predators, competition from other species, sickness and death. Exposure to saltwater can cause freshwater organisms to become dehydrated (lose water from their cells), a process called plasmolysis. Freshwater plants such as Elodea are not salt-tolerant and cannot grow in saltwater environments.

Curriculum Match-Up

- Repeat the salt wedge experiment using smaller amounts of salt. What is the smallest amount of salt that will form a wedge?
- List some of the ways that humans rely on estuaries.
- Research and compare plants from saltwater and freshwater environments. How are they similar? Different? Cut open the stems and leaves of the plants and examine them using a microscope or magnifying lens.
- Research estuarine organisms. Write a "name poem" using the names of plants and animals that live in the estuary. Each letter of an organism's name serves as the first letter for each line of the poem. For example, C - R - A - B:

  Can walk sideways
  Really small
  Algae it eats
  Bottom dweller

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Estuaries

Learning Objectives

Students will:

1. Explain what an estuary is and its important role in the environment.
2. Build a model of a salt wedge estuary.
3. Examine how salinity affects aquatic plants.

Vocabulary Ventures

aquatic
brackish
current
ecologist
estuary
freshwater
marine
plasmolysis
salinity
salt-tolerant
salt wedge
saltwater
stratification

An estuary is a body of water that is created when freshwater from rivers and streams flows into the saltwater of an ocean. Estuaries are partially surrounded by land. They provide shelter to unique plants and animals that have adjusted to waters that are ***brackish*** – a mixture of **freshwater** draining from land and rivers and **saltwater** from the ocean.

Hudson River Estuary

Estuaries vary in their levels of **salinity** – the amount of dissolved salts. Areas of an estuary closest to its freshwater source generally have a lower concentration of salt, while waters nearest the ocean have a much higher concentration of salt. The salinity of estuaries changes depending on the seasonal climate, wind and water currents. Salinity levels are highest in estuaries during the summer months when there is less rainfall. During the winter and spring months, salinity levels are lower because there is more freshwater draining into the estuary diluting the amount of salt in the water.

Ecologists and other scientists study estuaries for a number of reasons. Estuaries provide habitats, or homes, for very diverse wildlife and have unique water movements called **currents** and **tides**. Tides create ocean currents that move saltwater in and out of the estuary, mixing freshwater and seawater. Scientists identify the different types of estuaries based on how their water circulates, or moves, and the way the layers of salt and freshwater are formed. As water moves in an estuary, it carries tiny organisms, circulates nutrients and oxygen, and transports sediment and waste. Plants and animals that are able to grow in salt-rich habitats such as estuaries are called **salt-tolerant**. These organisms have adapted to saltwater environments.

Estuaries in the New York/New Jersey region include the Hudson River Estuary, Barnegat Bay (Little Egg Harbor Estuary) and the Delaware Estuary.

Time Needed to Conduct Investigation
This investigation has three parts.
Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 25 minutes
Student journaling/group reflection: 10 - 15 minutes
5 minutes each day afterwards for 7 – 14 days
Total estimated time: 50 - 55 minutes

Investigation: Exploring Estuaries

Materials

For groups of three
Student journals and writing tools

Part 1
- 9 oz clear cup
- Measuring spoons
- Kosher salt or sea salt, 2 tablespoons
- Magnifying lens or microscope
- Microscope slide or clear plate
- Plastic stirrer or spoon
- ½ liter bottle of water
- Eyedropper or medicine dropper

Part 2
- Large clear plastic tub or Pyrex baking dish, (9 x 13)
- Ruler
- Tap water, 1 liter (room temperature)
- ½ liter bottle of saltwater solution (½ liter of water & 6 tablespoons of salt)
- Food coloring (blue, red or green)
- Paper cup, 3 oz or 5 oz
- Small marbles, stones or pebbles
- Pencil or pen with a pointed tip or other object with a sharp point
- Book or wooden block, at least 1-inch in width

Part 3
- Salt
- Four Elodea or other freshwater plant or fresh celery (all cut the same length)
- Magnifying lens
- Ruler (cm)
- Four 1000 mL graduated cylinders or 1-liter clear plastic bottles
- Four Test tubes or small jars
- Permanent marker
- Masking Tape
- Dechlorinated tap or spring water
- Measuring spoons

TIP
De-chlorinate the water by letting it sit in an open container for 24 hours to allow the chemicals to evaporate.

Part 1
Salt and Water

GET READY!
Tell students they will dissolve salt crystals in water to observe their effects on water. Remind students to use the journal to document their predictions, observations and findings.

OBSERVE
Invite students to take a pinch of salt and examine it using the magnifying lens or microscope. Have students share the following observations with their partners or groups:
- How would you describe what you see?
- Sketch your observations in your student journal.

PROCEDURE
1. Have students fill the cup with 100mL (about 3 ½ oz) of water.
2. Next, have them pour 1 tablespoon of salt into the cup and stir the solution until all of the salt dissolves.
3. Using the eyedropper, have students place one drop of the saltwater solution on a microscope slide or onto the clear plate.
4. Invite students to use their magnifying lenses or microscopes to examine a drop of the saltwater solution on the microscope slide.

Ask students to share their observations of the saltwater solution:
- How would you describe what you see?
- What happened to the salt when you mixed it into the water?

Part 2
Making a Salt Wedge

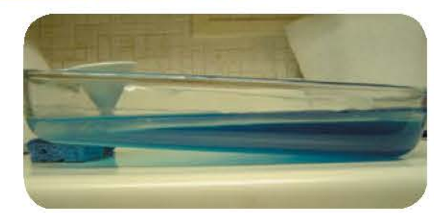
Tell students they will now make their own model of a salt wedge estuary. Salt wedge estuaries occur when the mouth of a river flows directly into seawater.

PROCEDURE
1. Have students place a small wooden block or book securely under one end of the baking dish, raising it approximately one inch from the table.
2. Next, have students make several tiny holes in the bottom of the cup using the tip of a pencil or a pair of pointed-tip scissors.
3. Drop marbles, small stones or pebbles into the cup and place the cup into the lower end of the baking dish.
4. Now, have students pour a liter of the room temperature tap water into the pan until it is about ½ inch from the top of the pan.
5. Allow the water to settle.
6. Have students add several drops of food coloring to the ½ liter saltwater solution, making it a dark color.

PREDICT
Tell students they will now add the saltwater solution to the tap water. Ask students to make a prediction about what will happen and record the prediction in their journals. Ask students:
- What do you think will happen when you pour the saltwater solution into the freshwater?

OBSERVE
Next, have students slowly pour the saltwater solution into the cup of marbles, being careful not to overfill the cup. Ask students to make observations as the water settles in the baking dish. Have students get at the table level and look at the pan from the side.
- What do you observe happening?
- Diagram what you see in your journal.
- Was your prediction correct? Why or why not?
- How do you think this activity relates to estuaries?

Answer: As river water flows into seawater, it pushes against the denser saltwater, creating wedge-shaped layers of water.

salt wedge set-up

Part 3
Plant Dehydration

Ask students what it means to be "salt-tolerant". Salt-tolerant organisms can live in habitats with high levels of salts. These organisms have special adaptations or abilities that enable them to absorb water from soils and marine water. Invite students to hypothesize why some organisms are salt-tolerant while others are not. Tell students they will investigate the effects of saltwater on freshwater plants.

TIP
Trim the plants from the top if they are not equal in length.

PROCEDURE
First, students should make their saltwater solutions:
1. Ask students to fill each graduated cylinder or soda bottle with 1000 mL (about 4 cups) of water and label the containers "1 Tbsp", "2 Tbsp", "3 Tbsp", and "no salt" using the masking tape and marker.
2. Have students measure 1 tablespoon of salt and pour the salt into container #1.
3. Next, students should measure 2 tablespoons of salt and pour the salt into container #2.
4. Students should measure 3 tablespoons of salt and pour the salt into container #3. *NOTE: No salt will be added to container #4.*
5. Have students use a long-handled spoon or stirrer to dissolve the salt in each container of water.

OBSERVE
Have students examine the freshwater plants and share the following observations:
- What is the color of the plants? The texture? Shape?
- What other characteristics describe the plants?
- Do these plants appear to be healthy? Why do you think so?

PREDICT
Invite students to predict what will happen when freshwater plants are added to saltwater. Have them document their predictions in their journals.

Have students place one plant into each of the containers labeled #1, #2, #3 and #4.
Ask students:
- Why is there one container with no salt?
- Why is it important to have this control in an experiment?

Answer: To ensure that we're only measuring changes caused by the amount of salt added to the water.

Students should observe the plants over the next several days and document their observations in the chart in their student journals. Place the plants in an area where they will not be disturbed. Do not place plants directly on or near a heat source.

salamanders can be found in wetland vernal ponds formed from melted snow and heavy spring rains. Spotted salamanders eat insects, worms, snails, and small fish. Their skin is bluish-black or dark gray, and they have two rows of round yellow or orange spots down their backs. Their bellies are slate gray.

Red-spotted newts are amphibians that live near fens, marshes and emergent wetlands. Newts have long and slender bodies and a flattened tail. In its larval stage, this newt is called a red eft because of its bright reddish-orange color. After reaching maturity, this newt's skin will turn olive, and its sides will acquire red spots that are surrounded by black.

Spring peepers are small tree frogs that live near marshes, ponds, streams, or vernal pools (water that forms in large pools in the spring, but dries up in the summer.) Like all amphibians, spring peepers must lay their eggs in water. Like many salamanders, spring peepers are nocturnal – highly active at night. They grow less than an inch and a half in length and can be tan, gray or dark brown with a dark "X" on their backs. Spring peepers also have large toe pads to grip plants when they climb.

Muskrats are large rodents that live in aquatic environments throughout New Jersey watersheds, swamps, lakes and marshes. They prefer to make their home in aquatic habitats where the water level remains fairly stable, preferably at a depth of four to six feet. The muskrat's thick, glossy pelt (skin with fur) is dense and waterproof. It has a rudder-like, scaly tail to help it easily move backwards and forward in water. Muskrats have partially webbed hind feet that make them strong swimmers and divers. Muskrats are generally herbivores, eating plants such as cattails, water lilies, sedges and rushes; but they may also feed on fish, crayfish, frogs and freshwater clams. Muskrats have strong lungs and can swim underwater for up to 17 minutes before surfacing to take a breath.

Fiddler crabs live near water on the mud or sand. They dig burrows during high tides that can reach a foot deep. These burrows are often linked to other tunnels and have more than one entrance to provide fiddler crabs with an escape route from predators like fish, raccoons and aquatic birds. Male fiddler crabs have one large front claw and one small one, while females and young fiddlers have two small claws. The male fiddler crab uses the large claw to wrestle other males, to mark his territory and to attract a mate. The small claw is used to gather food. Fiddlers roll a ball of mud and use it to plug the hole of their burrow during high tides. The ball of mud traps a tiny pocket of air inside for them to breathe. All crabs have gills, which they must keep moist in order to breathe, so they stay near water at all times. Fiddler crabs grow between one and two inches and may be tan, blue-green, turquoise, black, yellow, or orange in color. Fiddler crabs eat algae, microbes, fungus and other decaying detritus. Some scientists believe that fiddler crabs help preserve wetland habitats because they aerate the soil and prevent anaerobic conditions as they forage for food and burrow in the sand.

Banded sunfish live in heavily vegetated areas of bogs, lakes and streams with sandy or muddy bottoms. Its body is lined by six or seven dark vertical stripes. The banded sunfish has rounded pectoral (front side) fins, a gill cover spot that is larger than its eye, and an arched line on the side of its body that ends just before its tail. It has an olive-colored body sprinkled with iridescent gold, green and purple markings. Banded sunfish feed mostly on aquatic insect larvae, scuds and other small crustaceans. They grow two to four inches in length and live up to four years. Spawning can occur from early spring into summer. The female lays eggs in a small, round nest built by the male.

River otters are expert swimmers and divers. They can stay underwater for up to two minutes. They have specially built ears and diamond-shaped noses with a valve-like skin that closes when the otter swims underwater. Otters have webbed and clawed feet that are useful for running on land and swimming. They can run up to 15 - 18 mph. River otters are three to four feet long and weigh 15 to 25 pounds. Their colorful coats range from nearly black to reddish or grayish brown on their backs. Their belly is silvery or grayish brown. The throat and cheeks are silvery to yellowish gray. Otters eat fish, crustaceans, and other aquatic invertebrates and they have few natural enemies, especially in water. On land, young otters are vulnerable to a variety of predators such as the fox, wolf and raptors.

An **osprey** is a raptor (bird of prey.) Raptors are at the top of their food chain and prey on smaller animals. The osprey has special adaptations to hunt fish but will occasionally eat rodents, birds, small vertebrates and crustaceans. The adult is blackish-brown above and white below; the breast is white or sometimes shows a brown band. The head is mostly white with a broad black stripe extending from the eye to the back. Bill and talons are black and eyes are yellow to orange. Ospreys range in size from 21 to 25 inches long with a wingspan of 59 to 67 inches. They are the only raptor that will plunge into the water for prey. Ospreys will hover 30 - 100 feet above the water looking for fish. When a fish is spotted, the osprey dives feet first into the water. The osprey's method of catching prey calls for some adaptations not found in more terrestrial hawks. The osprey's feathers are slightly oily to limit water absorption. The shank of the leg is scaled, not feathered, with short, dense feathering on the thighs. The pads of the toes are covered with spicules (small spikes) for grasping slippery fish. The osprey also has a reversible outer toe that can either be at the front of the foot or moved to the back for a two toe forward, two toe back formation for carrying fish. They build nests close to water near the tops of trees. The nest is built of sticks and lined with grasses, seaweed, moss, lichens, bark and mud.

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Wetlands Addendum

Types of Wetlands Found in New Jersey

The Great Swamp Refuge is located in Morris County, New Jersey. The refuge holds 7,600 acres of varied wetland habitats, serving as a breeding, nesting and feeding ground for birds, foxes, deer, muskrats, turtles, fish, frogs, wildflowers and plants.

Aquatic beds are found near the edges of lakes or streams, and are dominated by plants that generally grow on or below the surface of the water. Water lily, duckweed and pondweed grow in aquatic beds three to six feet deep. Waterfowl such as ducks and herons feed and rest in aquatic beds because they offer food and protection. Fish spawn (deposit their eggs) and feed in aquatic beds.

Emerging wetlands are found next to lakes and streams. They are home to green plants that produce flowers and fruit. Plants in emerging wetlands have soft stems, roots that are submerged in the water or wet soil, and leaves that are above the water or wet soil.

Bogs are covered by thick carpets of moss, lichen and peat (dead plant material.) The water in bogs is low in oxygen, highly acidic and usually cold. Almost all of the water found in bogs comes from precipitation (rain and snow.) Plants and animals that live in bogs have adapted to the low nutrient levels and acidic waters. Carnivorous (meat-eating) plants such as Venus flytraps eat insects because the water and soil in bogs lack the minerals and other nutrients needed for survival. Cranberries are harvested from bogs in New Jersey.

Fens have slow moving water that rinses acid from the soil. Minerals and nutrients drain into fens from surrounding soils and from groundwater. Fens are covered by grasses, rushes, sedges and wildflowers – mostly vascular plants with specialized tissues that transport water and minerals. These plants provide food and shelter for other aquatic organisms. Fens provide shelter to insects such as mosquitoes; amphibians such as the Eastern tiger salamander; birds, and mammals such as shrews, voles and muskrats.

Marsh wetlands usually have shallow, standing water throughout the year. Marshes are often "riparian," meaning they form a transition or buffer zone between water and land. Marshes contain lots of nutrients for plants and animals, but the water and soil found in marshes are "anaerobic" or lacking oxygen. Marsh plants adapt to the low levels of oxygen by drawing air through hollow spaces from their leaves to their roots and to the soil around their roots. There are several types of marshes, including freshwater and saltwater. Saltwater marshes can be found at the edges of estuaries (where freshwater flows into the ocean.) Saltwater marsh plants have adjusted to growing in salty, waterlogged soil and can excrete excess salt from specialized cells in their stems, roots and leaves. Cattails, rice, crabs, shrimp, tadpoles and insect larvae can all be found in marshlands.

Forested wetlands or swamps are covered by large trees and woody plants more than twenty feet tall. Swamps have water-saturated soils during the growing season and standing water during other times of the year. Both evergreen trees (having foliage that stays green throughout the year, such as the Eastern white pine), and deciduous trees (having leaves that fall off or shed seasonally, such as the Willow oak), grow in swamps. Few green plants grow in forested wetlands because of the acidic soil and lack of oxygen. Swamps also contain a layer of rotting plants called "peat."

Scrub/shrub wetlands are densely populated by small trees and bushes that are less than 20 feet in height. These wetlands are flooded with shallow, standing water for extended periods during the growing season. Their thick vegetation protects small birds and amphibians from larger prey. Scrub/shrub wetlands are important breeding areas for amphibians because of the absence of predator fish. Pussy willow, dogwood and elderberry are typical shrubs found in this type of wetland. Wood ducks, song birds, herons, muskrats and deer can also be found in scrub/shrub wetlands.

Wetland Plants and Animals

Plants of Aquatic Wetlands
Duckweed has many rounded leaves that float on the water. Duckweed leaves are small and serve as food for water birds and beavers. Cattails are the most common wetland plants. They grow more than eight feet tall on stiff stems. Cattails have flower spikes shaped like hot dogs. Muskrats, beavers and geese eat cattails. Birds nest among the cattails. Muskrats use this plant to build their homes. Early Americans used cattail stems to weave baskets and bedding. Cattail spikes could be torches when soaked in oil. Cattails were once used to insulate gloves and shoes, and cattail pollen is used to make flour.

Plants of the Bogs
Peat moss has a unique structure that allows it to hold 15 times as much water as the weight of the plant. Because of its ability to hold water, peat moss can survive during long dry periods.

Plants of Forested Wetlands
The forest wetland is full of Venus flytrap plants. This carnivorous plant has pointed hairy leaves that trap insects for food. Venus flytraps are becoming endangered because people dig them up to sell for a profit. Willow trees grow in forested wetland. Their roots trap sand and other sediment, preventing erosion and helping other trees grow in the wetland. Some of the trees that grow in swamps form a set of roots above the soil surface or above the water that allows them to get oxygen to the lower roots.

Plants of Emergent Wetlands
Purple loosestrife grows faster than any other wetland plant. It is a non-native and invasive plant that thrives in freshwater wetlands, crowding out native plants. Yellow iris is another invasive plant. Native Americans used Iris flowers as perfume and Iris leaves to make ropes and snares to trap elk for food. Iris is poisonous to humans, but it can be used to make a paste to stop swelling.

Plants of Shrub/Scrub Wetlands
Blackberry shrubs can grow roots from the branches if the branch is resting in a wet area. Blackberry thorns protect small animals hiding in the branches. Birds and bears eat blackberries. Birds and insects are protected in the cover of willow. Rats, birds and rabbits eat willow twigs. Willow trees also grow in shrub/scrub wetlands. Its branches are flexible and can be used to make baskets, twine, dye and furniture. Native Americans chewed willow bark for pain relief since it contains a chemical similar to aspirin.

Plants of Saltwater Marshes
Saltwater marsh plants include salt marsh grass and spartina. These plants have special glands that allow them to eliminate excess salt that they take in from the water and soil.

Insects of the Wetlands
Wetland insects include mosquitoes, water striders, dragonflies and mayflies. Mayfly larvae and adults serve as a food source for fish and amphibians. Water striders use a property of water called surface tension to walk on water. The surface of water acts likes a skin to help water striders and pond skaters. Pond skaters have specialized, paddle like legs that enable the insect to "skate" on the surface of the water.

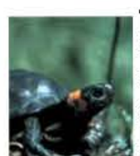
Cranberries are red berries used in foods and in herbal products. Cranberries are a unique fruit. They can grow and survive only in acid peat soil, an adequate fresh water supply, and a growing season that extends from April to November. Cranberries grow on low-lying vines in bogs or marshes layered with sand, peat, gravel and clay.

Cape Cod Cranberry Growers' Association

Blackberry grows in relatively open, disturbed, and moist sites such as shrub/scrub wetlands. Blackberry shrubs grow quickly and tolerate poor soil. Blackberry bushes are often called brambles, from a word that means prickly. The plants have stiff, sharp prickles along the stems and midrib of leaves. White-tailed Deer, Eastern Cottontail, and Beaver eat the leaves and stems of the blackberry shrub. The shrub also provides great cover and protection for birds and small animals. Many plants often grow closely together to form a thicket. Several species of birds nest in blackberry shrubs. Birds and other animals eat blackberries and spread the seeds through their droppings.

Community Mapping Network

Cattails or bulrushes are wetland plants, typically 1 to 3 meters tall, with spongy, strap-like leaves and starchy, creeping stems. Cattails grow along lake margins and in marshes, often in dense colonies, and are sometimes considered a weed in managed wetlands. The plant's root systems help prevent erosion, and the plants themselves are often home to many insects, birds and amphibians. The disintegrating heads are used by some birds to line their nests. The downy material was also used by Native Americans as tinder for starting fires.



The **bog turtle** is found in the eastern United States in colonies from New York and Massachusetts south to southern Tennessee and Georgia. This is a semi-aquatic species, preferring habitats with cool, shallow, slow-moving water, deep soft mucky soils, and herbaceous vegetation. Bog turtles live in shallow, spring-fed fen, sphagnum bogs and swamps, marshy meadows and pastures generally dominated by sedges or sphagnum moss with soft, muddy bottoms, slow-flowing water and open canopies. Like other cold-blooded or ectothermic species, they require habitats with regular solar penetration

for basking and nesting. The bog turtle is one of the smallest North American turtles with the adult shell measuring 3 to 4 ½ inches in length. It has a large, bright orange, yellow or red blotch on each side of its head. When danger threatens, the turtle burrows rapidly into the mucky bottom. They eat beetles, insect larvae, snails, seeds and millipedes.

U.S. Fish and Wildlife Service

The **pitcher plant** is a carnivorous, or meat-eating plant. Carnivorous plants have adapted to living in low-nutrient environments by developing features to attract, trap, kill, digest prey and absorb nutrients. They eat invertebrates and occasionally small frogs and mammals. The most common habitat for pitcher plants is in bogs and fens, where nutrient concentrations are low but water and sunshine are seasonally abundant. Most plants absorb nitrogen from the soil through their roots; but carnivorous plants absorb nitrogen from their animal prey through their leaves that are specially modified as traps. Pitcher plants use "pitfall" traps with leaves folded into deep, slippery pools filled with digestive enzymes.

The Botanical Society of America

Mosses are small, low-lying, soft plants that grow 1 - 10 cm tall. They usually grow close together in clumps or mats in moist, shady areas. They do not have flowers or seeds, and their simple leaves cover thin wiry stems. Mosses are non-vascular plants. Unlike flowering plants, they do not have special channels to transfer nutrients up the stalk. Moss plants do not possess true roots. Instead, mosses get their nutrients and moisture from the air. Because of this they prefer damp places and have adapted to dealing with long dry periods. Mosses use spores to reproduce. Sphagnum peat-mosses are large mosses that form extensive acidic bogs in peat swamps. The leaves of peat-mosses have large dead cells alternating with living photosynthetic cells. These dead cells help to store water. Because of its water-holding capacity, peat moss is added to soil to improve its water-holding capacity and has been used as an absorbing material for oil spills. The Eskimo used peat moss to curb diaper rash.

College of Natural Sciences & Mathematics, University of Massachusetts Amherst

Herbaceous angiosperms (flowering plants) are the dominant and most familiar group of land plants. They have true roots, stems, leaves and flowers. They also have seeds. Angiosperms are more highly evolved than algae, mosses, fungi and ferns. Their advanced structures allow angiosperms to thrive on land. They have roots that hold the plant in place and take in needed minerals and water. They have leaves. They have stems that hold the plants up and move nutrients and water through the plant. Angiosperms are the primary food source for animals and provide oxygen to breathe.

Monroe County Women's Disability Network

Mosquitoes are two-winged insects. Female mosquitoes have mouth parts that form a long proboscis for piercing the skin of mammals, birds and sometimes reptiles and amphibians to suck their blood. The mosquito proboscis is serrated. The females need protein to produce and lay their eggs, while male mosquito diets consist of nectar and fruit juice. The females lay their eggs in water and the larvae and pupae live entirely in water. When the pupae change into adults, they leave the water and become flying land insects. Mosquitoes lay their eggs on the surface of woodland pools, tidal floodwaters, freshwater swamps, standing water or containers of collecting water.

Eastern garter snakes live in moist fields, forests, meadows and marshes. They are non-venomous and feed on small fish, frogs, toads, salamanders, earthworms, tadpoles, mice, bird eggs, slugs, crayfish, leeches, insects and other small snakes. They grow between 14 and 48 inches in length and have narrow heads and bodies. They range in color from light brown to black with two alternating rows of black spots. Eastern garter snakes have black lines on their lip scales. They also have three long stripes, usually with a yellow dorsal stripe. The lateral stripes are cream to yellow and are located on the second and third scale rows. There can also be a row of black spots below the lateral stripes.

American black ducks are large ducks found in wooded ponds, salt marshes and estuaries. The American black duck is chocolate brown with bright white feathers on its underwings. They have a lighter brown neck and head, red legs and feet. Males have a flat, broad yellow bill, while females have a darker olive bill. The American black duck feeds mainly on aquatic plants, but will also forage near the shore for seeds and insects. They float high in the water and are strong fliers. Their legs are placed towards the center of their bodies. Nests are built close to the water, often on the ground and lined with soft plant material.

Spotted salamanders are amphibians -- vertebrates that begin the first part of their lives under water (breathing with gills) and the rest of their lives on land (breathing with lungs.) Amphibians are ectothermic – they warm themselves by obtaining heat from the environment. Salamanders have soft, moist skin covering their long bodies and tails. They have no scales, claws or external ear openings. Most have four short legs, but some species only have front legs. Salamanders must return to the water to mate and lay their eggs. Females lay a milky egg mass about four inches long and attach the eggs to sticks or plant stems submerged in water. During the rainy season and early summer, spotted

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.

Ask students:

1. What did you learn about water in this investigation?
2. How do you think a wetland helps clean and filter water?

Answer: The dense plants and plant roots and soil help trap sediment and pollutants.

3. What do you think happens when people build homes or businesses on wetlands? What materials might pose a problem for the wetland environment?
4. What new things did you learn?

The "Why" and The "How"

Wetlands hold water and filter out sediment, pollution and decomposing plant matter from water. The sponge in your wetland model played a similar role. Wetlands help feed the underground water supply by collecting water from melting snow and rain, filtering out pollutants, sediment and decomposing plants; and controlling flooding by slowly releasing water into the surrounding land and bodies of water.

Many wetlands are found near floodplains that surround rivers. When these rivers overflow from heavy rainfall, wetlands store the excess water and release it gradually into groundwater. Human activities have destroyed and polluted many wetland habitats. We have built homes, shopping malls and factories on top of wetland areas. When ocean, lake or river levels rise, the excess water cannot go underground because the ground has been made impermeable, or solid, by concrete and asphalt. Instead, the water floods houses, roads and farmland. Many communities are beginning to realize how important wetlands are to the environment and are trying to preserve them.

Wetland plants such as grasses, sedges and cattails reduce the impact of waves, currents and soil erosion. Their roots trap soil, preventing the loss of land. Wetlands also lessen the impact of coastal storms because tree roots are able to hold onto large amounts of soil. For this reason, coastal wetlands are often referred to as "speed bumps". However, wetlands along the southern coast of the United States in areas such as New Orleans have been deteriorating and shrinking for years because they no longer receive the large amounts of sediment and nutrients provided through natural river floods.

In addition, the building of shipping channels along the Mississippi River has caused saltwater from the Gulf of Mexico to penetrate freshwater wetlands. Plants and animals from freshwater wetlands are not salt-tolerant, meaning that they have not adapted to high levels of salinity from marine water flooding the wetlands. As a result, they are unable to control the amount of salt in their bodies, and are vulnerable to predation, competition from other species, sickness and death. As the loss of freshwater wetlands continues, future hurricanes will further damage the Gulf Coast region of the United States.

References
http://www.epa.gov/owow/wetlands/types/
http://vathena.arc.nasa.gov/curric/land/wetland/
http://www.uen.org/Lessonplan/preview.cgi?LPid=2484
http://dnr.state.il.us/lands/education/CLASSRM/AquaticILLessons/U2L3A4.htm
http://www.successlink.org/gti/gti_lesson.asp?lid=3300
http://www.nhptv.org/Natureworks/nwep7f.htm
http://www.nwf.org/nationalwildlife/article.cfm?articleId=577&issueId=46
http://www.dnr.state.mn.us/wetlands/
http://www.cotf.edu/ete/modules/everglades/FEwetlands1.html
http://www.csc.noaa.gov/crs/lca/class_groups/essw.html
http://www.deq.state.mi.us/documents/deq-ead-tas-wetland3.pdf
http://digitalsportsman.com/wetlands/plant.htm
http://www.physicalgeography.net/fundamentals/10t.html
Another Use For...101 Common Household Items: Vicki Lansky (The Book Peddlers, 1991)

Curriculum Match-Up

- Use a Venn diagram to compare and contrast different types of wetlands. What plants and animals do they have in common? What are the differences?
- Write a magazine article about the importance of wetlands in your area.
- Do a mock interview of one of the wetland animals -- what does this animal have to say about what is happening in its habitat?
- Think of some of the ways that plants and animals would have to adapt in order to live in a wetland habitat. Adaptations can be physical (such as the size or shape of the teeth; the color, or the shape or type of the animal's body), or behavioral (activities that help an animal survive by avoiding predation or capturing prey). Make a list of your ideas in your student journals.
- Participate in a community project that improves habitats located near water sources such as wetlands.
- Get the New Jersey freshwater wetlands map from the NJ Department of Environmental Protection's Maps and Publications Office at (609) 777-1038, or, check to see if your public library has a GIS (Geographic Information System) to view the maps on its computer.

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Wetlands

Learning Objectives

Students will:

1. Define what a wetland is and explain its important role in the environment.
2. Identify and discuss the characteristics that help aquatic plants and animals adapt to wetland habitats.
3. Build a model of a wetland habitat.

Vocabulary Ventures

adapt
adaptation
bog
hydric
marsh
scrub/shrub
swamp
waterlogged
wetland
wet meadow

Wetlands are low-lying areas of land that are covered by water for all or part of the year. There are different kinds of wetland habitats, including marshes, swamps, bogs, wet meadows, river overflow lands and tidal flats. Wetlands can be found in valleys and along the shorelines of oceans, lakes and rivers.

wetland

Wetlands provide many benefits to the environment. They are often described as the "kidneys" of the environment because they filter out sediment and pollution from the surrounding land, slowly releasing cleaner water into land and into neighboring bodies of water. Wetlands are densely populated with mosses and grasses that can absorb large amounts of water. These grasses help reduce the number of floods and effects of drought, hold soil in place to prevent erosion (wearing away), and protect land from drastic water level changes. Wetlands along the southern coastlines of the United States defend the Gulf Coast against approaching hurricanes by depriving storms of warm ocean water and creating a physical barrier to flood waters generated by the storm.

Wetlands:

- are covered by water or have **'waterlogged'** soil for all or part of the year. Waterlogged soil contains so much water that there is very little room for oxygen.
- have unique plants that have adapted (adjusted) to life in the wetlands. These plants can grow in soil with little oxygen.
- contain soil that is **"hydric"** (moist or wet). Wetland soil often does not have enough oxygen for many types of plants to grow.

Wetlands are identified by:

- how long they are covered by water (year-round, when the tide is in, or during the rainy or growing season).
- the kind of plant life they support (grasses, mosses, shrubs or trees).
- by their water source (precipitation, surface water or groundwater). *Surface water includes ponds, streams, rivers, lakes, bays and oceans. Groundwater flows underground in spaces between soil, sand and gravel.*
- their salinity levels.

Time Needed to Conduct Investigation

This investigation has three parts.

Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 35 - 45 minutes
Student journaling/group reflection: 10 - 15 minutes
Total estimated time: 60 - 75 minutes

Investigation: Wetlands Discovery

Materials

For groups of two to four
Student journals and writing tools

Part 1
- Small aluminum foil pan or food storage container
- 1 lb. Plasticine or Crayola clay
- Cellulose sponge with no scrub side cut to fit the pan
- ½ liter bottle of water or spray bottle of water
- Ruler (cm)
- Cup of potting soil
- Toothpicks or small craft (popsicle) sticks
- Permanent marker

Part 2
- Photos or pictures of different wetland habitats
- Photos or pictures of different wetland plants and animals

Part 1
Build a Wetlands Model

GET READY!

Inform students that they will create a model of a wetland to learn how it absorbs and filters water from the environment. Discuss some characteristics of wetlands and share the descriptions and photos of different wetlands and wetland plants and animals with students. Ask students to share some observations about the wetlands.

PROCEDURE

1. Students should measure the aluminum pan and divide the pan into three parts, identifying each part by marking a line on the side of the pan with a permanent marker.
2. Ask students to flatten a piece of clay and use it to cover 1/3 of the aluminum pan, being sure to seal the clay along the edges of the pan. This represents land.
3. Now, have students place the sponge firmly in the middle third of the pan. The sponge should fill the middle third of the pan and touch the edges of the pan.
4. Next, have students layer about 1 cm of the potting soil onto the clay bottom. This represents soil.
5. Leave the remaining third of the pan exposed/uncovered.

wetland model set-up

OBSERVE

Ask students to make and record the following observations:
- Which part of this model do you think represents the wetlands?
- How did you come to that conclusion?

PREDICT

Next, students will make it "rain" on their wetland model. First, they should predict what they think will happen when it rains. Remind students to record their predictions in their journals. Ask students:
- What do you think will happen when it rains on the wetland?
- Where do you think the water will go?

OBSERVE

Using the ½ liter water bottle or spray bottle, students should slowly pour water onto the land. Have students discuss the following observations with their partner. Ask students:
- What happened to the soil as you poured water onto the wetland model?
- What did you notice happening to the sponge as it "rained"?
- How do you imagine this model is similar to a true wetland habitat?
- What are the characteristics of a wetland? What items in your model represent some wetland characteristics?
- Explain why the sponge acts as a barrier. What part of a wetland has the same job?

After making observations, ask students:
- What would happen if you tried this experiment again without the sponge to act as a barrier?

Invite students to try the experiment again without the sponge. Have students remove the sponge and observe what happens when they pour water onto the soil. Ask students:
- What happened to the soil and the water after you poured water onto the model?
- What clues does this provide about the role of wetlands in the environment?

Part 2
Match-Making

Explain to students that they will now learn about plants and animals that make their homes in wetland habitats.

Show students pictures of different types of wetlands such as bogs, swamps and marshes. Read the description of each wetland type aloud. Ask students to match the pictures with the descriptions.

OBSERVE

Have students make and discuss the following observations:

- What characteristics do you observe about the different wetlands in each picture?
- What words would you use to describe these different wetland habitats?
- Can you identify the wetland that fits each description?

Now, show students some pictures of different types of plants and animals that live in or near wetlands. Ask students to try to match the plants and wildlife to each type of wetland. Have students make the following observations and record their matches in their journals:
- What characteristics do you see in the plants? What about the animals?
- Can you match the proper wetland to each plant, bird, fish, amphibian, and mammal?
- How much sunlight do you think each different wetland type receives?
- How does the amount of sunlight affect the plants and wildlife living in wetland habitats?

L. canadensis (Northern River Otter)

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.

- What did you learn about water in this investigation?
- What surprised you?
- What new questions do you have?
- Where there any differences or similarities in seed growth?
- How can you explain any differences?
- What does this investigation tell you about pH levels and seed growth?
- How do you think acid rain affects plant growth?
- What evidence have you observed to support this?

The "Why" and the "How"

pH tablets are used to indicate the presence of acids and bases. Under acidic conditions, pH tablets will turn a solution red, and under basic conditions the solution turns green. Scientists use the pH scale to measure the strength of a solution. Acids have a pH range from 0 - 6, and basic solutions have a pH range from 8 - 14. Strong acids have a low pH between 0 - 4, while strong bases have a pH ranging from 10 - 14.

The seeds in the plain water dish have a neutral pH of 7 and should sprout in every group, growing an average of 6 cm. The pH of the acidic vinegar solution was approximately 5. The pH of the basic baking soda solution was approximately 8. The seeds in these solutions will have little or no growth.

Many substances dissolve in water. This is why water is often called a universal solvent. However, water does not reduce the effects of acids and bases. Acid rain is an abiotic element that can affect the pH of an aquatic ecosystem. Acid rain occurs when gases from the atmosphere (such as sulfur dioxide from coal-burning factories) fall to the earth in precipitation (rain, snow, sleet and fog). Acid rain washes into aquatic ecosystems, changing the pH levels of the water. Aquatic organisms are particularly vulnerable to acid rain because they spend all or part of their life cycle in the water. Many species of amphibians, fish and insects lay their eggs in the water. Changes in pH levels cause deformities in the young of aquatic organisms, or cause fish to produce weak or brittle eggs. Acids can also interfere with a fish's ability to absorb oxygen, salt and nutrients needed for survival.

During summer months, pH levels of a lake or stream will range between 7.5 and 8.5. Small, free-floating aquatic plants called phytoplankton produce much of the oxygen in aquatic ecosystems. They also serve as the primary food source for other aquatic organisms that cannot produce their own food such as fish and crayfish. Phytoplankton can thrive and provide a nutrient source for the entire aquatic ecosystem if the ecosystem can maintain a pH level at or above 6.5.

When the pH level of an aquatic ecosystem becomes lower than six, phytoplankton and other basic foods such as mayflies and stoneflies die. When the pH level is lower than 5.5, fish cannot reproduce and their young have difficulty staying alive. At this pH level, fish become affected by the lack of nutrients and may die of suffocation. When an aquatic ecosystem reaches a pH level lower than five, the entire fish population begins to die off. Most aquatic organisms cannot survive a pH level lower than 4.

Curriculum Match-Up

- Repeat Part 1 of this investigation using other materials such as salt, milk, apple juice, hydrogen peroxide, shampoo, soda and soapy water. Record your results.
- Design an experiment to test the effects of other pollutants on aquatic ecosystems. What would happen if an ecosystem had too much salt, for example?
- Draw a diagram showing where acid rain and other pollutants travel through the environment.
- Collect water samples from an aquarium or from local bodies of water and test their pH levels. What can these levels tell you about the organisms living in these environments?
- Look at the shampoo bottles at home or in the store. Why does the pH level of shampoo or the pH level in a pool need to be a certain level?
- Plant the sprouted seeds from this investigation and chart their growth.

References
www.rci.rutgers.edu/~dougproj/programs/outreach/Life/AbioticpH.pdf
http://www.global-pollution.com/land-pollution/definition.php
http://www.hydrogennow.org/Facts/whatishydrogen.htm
http://ipm.missouri.edu/ipcm/archives/v9n21/ipmnews.txt
http://www.projectview.org/SERC/Lessons/Watertesting.one.htm
http://ns.doe.ca/aeb/ssd/acid/acidFAQ.html)
http://dwb.unl.edu/Teacher/NSF/C14/C14Links/qlink.queensu.ca/4lrm4/lakes.htm

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Water Quality and pH Levels in Aquatic Ecosystems

Learning Objectives

Students will:

1. Test and determine pH levels of liquid solutions.
2. Identify solutions of acid, base, and neutral pH using indicators.
3. Determine the optimal pH for the growth of plant seeds.

Vocabulary Ventures

abiotic
acid
acid rain
alkaline
amphibian
aquatic
base
biotic
ecosystem
electron
element
hydrogen
neutral
pH level
phytoplankton
run-off
viscosity

Aquatic ecosystems include ponds, wetlands, estuaries, streams, lakes and oceans. These ecosystems must maintain proper levels of **abiotic**, (non-living), elements in order for biotic (living) organisms to survive. Examples of abiotic elements include sunlight, water temperature, nutrient levels, dissolved oxygen and soil composition.

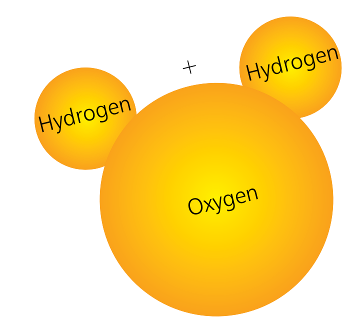
U. maritimus (polar bear)

Living organisms are highly dependent upon certain abiotic elements in every **ecosystem.** For example, a polar bear (biotic organism) is dependent on the cold temperature (abiotic element) of its environment for food, shelter and camouflage.

The **pH** levels of soil and water are important abiotic elements that affect the survival of many organisms. pH (potential hydrogen) level measures the strength of a chemical. pH is measured on a scale from 1 to 14 and tells how much hydrogen is found in a particular substance. Hydrogen is a naturally-occurring element and is one of the building blocks of Earth. You may remember that two **hydrogen** atoms combine with one **oxygen** atom to form a molecule of water.

Hydrogen is found in all living things. The amount of hydrogen makes a solution acidic or basic.

If you've ever used vinegar or baking soda, you're already familiar with acid-base chemistry. In this activity, you will observe the relationship between pH levels and living organisms.



the water molecule

Time Needed to Conduct Investigation

This investigation has two parts.

This Investigation will be done over a period of weeks.
Organize and set up materials: 10 minutes
Introduce the lesson: 10 minutes
Conduct the investigation: 20 minutes to start, 10 minutes each following week
Student journaling/group reflection: 10 - 15 minutes
Total estimated time: 55 - 65 minutes

Investigation: Understanding pH

Materials

For groups of two to four
Student journals and writing tools

Part 1
- Four 3 - 5 oz clear plastic cups or 50 mL test tubes
- Distilled water (approximately 13.5 tablespoons)
- Lemon juice (approximately 3.5 tablespoons)
- Baking soda solution (1 teaspoon of baking soda / 3.5 tablespoons of water)
- Vinegar
- pH wide range test tablets
- pH color chart

Part 2
- Three small plastic-coated plates or Petri dishes
- 24 corn seeds, radish seeds or lima beans
- Vinegar solution (1 cup vinegar / 1 cup water)
- Baking soda solution (1 cup of baking soda / 1 cup of water)
- 1-liter water sample (rainwater, tap water or water from a local pond or lake)
- Paper towel sheets (cut to fit the plates)
- 1-gallon clear plastic storage bags
- Ruler (cm)
- Permanent marker

Part 1
Acid or Base?

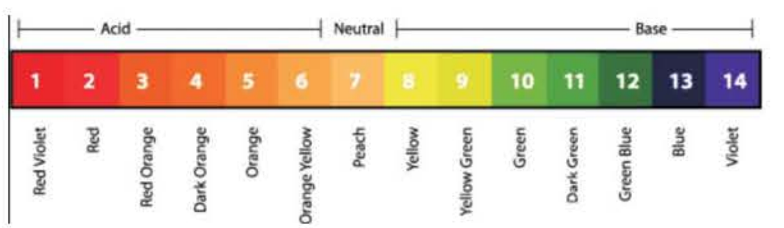
Tell students that they are going to test various liquid samples to determine their pH levels.

GET READY!

Share with students that all chemicals can be divided into three categories: acid, base or neutral. Ask students if they've ever tasted lemonade -- this is an example of an **acid**. Acids have a sour taste. The opposite of an acid is a **base**. Some common bases are baking soda, bleach and antacids such as Tums (for acid indigestion or "heartburn"). Water is an example of a neutral chemical because it is neither an acid nor a base.

The pH scale is used to identify acidic, alkaline (or basic) and neutral chemicals. The pH scale ranges from 0 to 14. A pH level between 0 - 6 indicates a higher concentration of hydrogen. Solutions with pH levels from 0 - 6 are considered **acidic.** The higher the pH level, the lower the concentration of hydrogen. Solutions with pH levels from 8 - 14 are considered basic, or alkaline. A pH of 7 is considered **neutral**.

pH Color Chart



Source: National Aeronautics & Space Administration

OBSERVE

Pour each of the four liquids into a different test tube. Ask students to examine the liquids and document the following observations in their journals:
- Use the "wafting method" (move your hand back and forth over the top of the test tube) to determine how each liquid sample smells.
- Describe the smell, color, viscosity (how easily it flows) and other physical properties of the liquid samples.

PREDICT

Have students predict the pH of each liquid sample and record predictions in their journals.
- Predict the pH level of each sample. Is it an acid, a base (alkaline) or a neutral solution?

PROCEDURE

1. Have students test the samples by dropping one pH tablet into each of the cups.
2. Have students compare the test tube with the pH color chart and record their observations in the chart in their journals.

Ask students:
- Was your prediction accurate?
- Is the liquid sample an acid, base or neutral?

ph Levels

	pH Prediction (write the number)	pH Results	Acid, Base or Neutral?
Distilled water			
Lemon juice			
Vinegar			
Baking soda & water			

Part 2
pH and Plants

Tell students that they will now observe how pH levels affect seed germination.

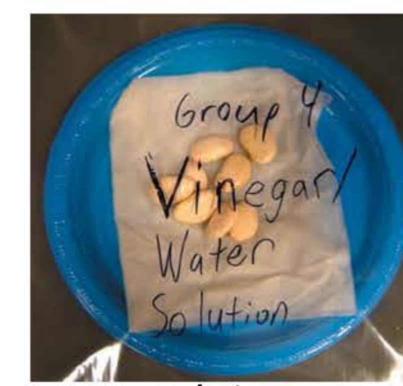
PREDICT

Ask students to predict what effect each solution will have on the seeds and document their predictions in their journals.
- What effect will the vinegar-water solution have on the seed? The baking soda-water solution? The plain tap water?
- Why do you think that is?

PROCEDURE

Inform students that they will place seeds in each solution and measure their growth rate.

1. Have students label the plastic storage bags vinegar/water solution, baking soda/water solution, and plain tap water using the permanent marker.
2. Next, students should place a paper towel onto each of the three plates.
3. Have students count out eight corn seeds and place them on the paper towel in each of the plates.
4. Next, have students pour plain water onto one plate of seeds until the paper towel is saturated.
5. Students should place the plate into the matching plastic storage bag and seal the bag almost completely, leaving room for air to circulate.
6. Have students repeat the process, pouring the vinegar/water solution onto one plate of seeds, and the baking soda/water solution onto the remaining plate of seeds.
7. Students should place each plate into the matching plastic storage bag and seal each bag almost completely, leaving room for air to circulate.
8. Have students place the seed plates near, but not directly under, a light source.
9. Students should check the seeds daily to see if any of them are germinating (sprouting or growing).
10. Check the seeds every week and measure the growth of any sprouts using a centimeter ruler.
11. Save the remaining solutions and keep the paper towels moist by refilling the solutions as needed – don't let the seeds dry out.



seed set-up

OBSERVE

Students should record their observations in the Seed Germination chart in their journals.
Ask students:
- Was your prediction correct?
- Did the seeds grow in each solution? Why or why not?
- What was the best possible pH for seed growth?
- How do the seeds look? Draw your observations in your journals.

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.

Ask students:
- What surprised you?
- What new questions do you have?
- What are some threats to the water supply?
- Who do you think should be responsible for cleaning up polluted water?
- How would you go about enforcing the clean up?

The "Why" and the "How"

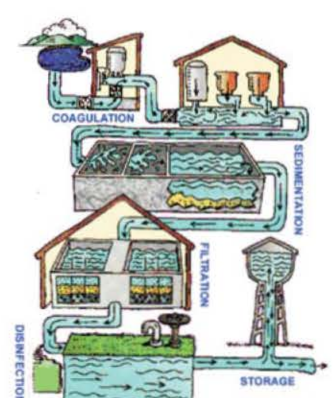
Humans alter the environment by dumping waste and other pollutants into rivers, streams and storm drains. Pollution creates poor water quality and destroys **biodiversity**, causing aquatic organisms to stop reproducing and die off.

Pollution enters water in different ways. When it rains, soil and other solid matter such as animal waste, sewage, leaves and grass clippings, and runoff from livestock farms wash away from plowed fields, construction sites and eroded river banks. Dirty water is not just unpleasant -- it is harmful to humans and aquatic life. Toxic chemicals can reduce the growth, survival, reproduction and disease resistance of exposed organisms, including humans.

Water treatment plants use different methods to filter and clean water, depending on the quality of the water that enters the facility. Groundwater is filtered naturally by aquifers and usually requires less treatment than water from lakes, rivers and streams. Treatment methods include disinfection with chlorine or other **chemicals** to kill any germs in the water.

In this investigation, we used the following treatment methods:

1. **Aeration:** Aeration is the first step in the treatment process in this investigation. Aeration adds air to the water sample, allowing trapped gases to escape and adding oxygen to the water.
2. **Coagulation:** Coagulation is the second step in the treatment process. When students added alum to the aerated water, this step allowed dirt and other suspended solid particles to mix together into a substance called **floc** that could easily be removed from the water.
3. **Sedimentation:** Sedimentation is the third step in the treatment process in this investigation. It occurs when gravity pulls the particles of floc to the bottom of the container. Water treatment plants have large beds that collect floc after it has floated to the bottom, allowing the clear water to be drained from the top of the beds and continue moving through the treatment process.
4. **Filtration:** Filtration removes most of the impurities remaining in water after coagulation and sedimentation steps. Water treatment plants use carbon filters and coarse sand filters to trap any remaining particles. In this investigation, the coffee filter helped remove large particles from the dirty water sample.
5. **Disinfection:** This is the final step in the water treatment process. Water treatment plants often add a disinfectant such as chlorine to kill any bacteria that may have entered the water during the treatment process. The water in this investigation was not disinfected and is not suitable for drinking".



water treatment process

U.S. Environmental Protection Agency

Curriculum Match-Up

- Research which sources contribute the most and the least amount of pollution.
- Get a map of your state or town and chart the pollution in the area using colored pins.
- Find out which methods are used to clean the water in your area.
- Contact programs in your state that monitor and assess water quality. Visit http://yosemite.www.epa.gov/water to learn more.
- Adopt a watershed in your state to protect and restore rivers, estuaries and wetlands in your area.

References:
The American Water Works Association.
The Soil and Water Conservation Society.
http://www.epa.gov/safewater/kids/watertreatmentplant/index.html
http://www.lenntech.com/Water-Purification-FAQ.htm
http://www.umich.edu/~gs265/society/waterpollution.htm
Department of Natural Resources and Environmental Sciences at the University of Illinois, Urbana; http://www.nres.uiuc.edu/outreach/esm_il_lo/esm.html
http://www.afrpa.hq.af.mil/kelly/Terms/wterms.html
U.S. Geological Survey

This lesson was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

Water Treatment

Learning Objectives

Students will:

1. Develop methods to clean a polluted water sample.
2. Describe components of a water treatment process.
3. Learn how humans impact the Earth's freshwater supply.

Vocabulary Ventures

aquatic
aquifer
biodiversity
carcinogenic
chemical
coagulation
disinfectant
ecological
fertilizer
filtration
floc
pollutant
pollution
potable
sedimentation
solvent
water treatment

Every ecosystem, community, person and animal on Earth needs clean water to live. Only 3% of water on the Earth is freshwater; and 2/3 of freshwater is frozen in glaciers and polar ice caps. Humans use water for many different purposes, including agricultural, industrial, household, recreational and environmental activities. Almost all of these activities require freshwater.

Unfortunately, we often pollute water with contaminants when we use it. Because water is a good **solvent** (it dissolves lots of substances), it picks up all sorts of **pollutants**, including bacteria, fertilizers, oils and dirt. Humans have a responsibility to treat, or clean, water after polluting it.

Water treatment makes water safer for people to use by eliminating some pollutants such as sediments and bacteria. However, heavy metals and other **carcinogenic** (cancer-causing) substances are more difficult to remove. In 1902, Belgium became the first country to use chlorine to clean a public water supply. Today, almost every city in the world treats their drinking water. But, many rural communities lack the resources to build water treatment facilities, so clean water is not always available to drink.

treated tap water

The Egyptians were the first people to document how they cleaned water. These records date back more than 1,600 years. The most common ways of cleaning water in 400 A.D. were boiling it over a fire, heating it in the sun, or by dipping a heated piece of iron into it. They would also filter boiling water through sand and gravel.

Removing metals and other pollutants from water can be a difficult and often impossible task. Communities and businesses must find ways to keep harmful chemicals and other pollutants out of the water supply.

water treatment plant

Time Needed to Conduct Investigation

This investigation has three parts.

Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 45 minutes
Student journaling/group reflection: 10 - 15 minutes
Total estimated time: 70 - 85 minutes

Investigation: To Drink or Not to Drink?

Materials

For groups of three or four
Student journals and writing tools

NOTE: Invite students to help prepare the dirty water sample in advance by mixing 1½ cups of potting soil with 2 liters of water in a clear 2-liter soda bottle (top cut off) or other container.

Part 1
- 16 oz cup of dirty water sample
- Measuring spoons and cups
- One coffee filter
- One rubber band
- One table
- Cotton fabric or cheesecloth
- Funnels
- Paper towels
- Screen remnants
- Nylon stockings
- Plastic containers of various sizes

Part 2
- Materials from Part 1
- 2-liter dirty water sample
- Two 2-liter colorless plastic soda bottles (one with a tight fitting cap)
- One 2-liter colorless plastic soda bottles with the top cut off
- Two tablespoons of alum powder
- Large spoon
- Clock with second hand or a stopwatch

Part 3
- Materials from Parts 1 and 2
- One 2-liter colorless plastic soda bottle with the bottom cut off
- One unused coffee filter
- One rubber band
- One 2-liter colorless plastic soda bottle with the top cut off
- 1½ cups fine sand (white play sand or beach sand)
- 1½ cups coarse sand (multipurpose sand)
- 1 cup small pebbles (washed natural color aquarium rocks work best)
- Two liters of clean tap water

Part 1
Pollution Solution

In this investigation, students will explore methods used to clean water. Students will work in groups to find a way to clean their polluted water sample. They can use any of the materials on the table to develop a method to remove the pollutants.

GET READY!

Ask students to make observations about the dirty water sample. How does the water look? Smell? Remember to use the wafting method to draw the odors toward your nose.

PREDICT

Invite students to make predictions about their ability to clean their polluted water sample. Ask students:
- What challenges do you think you will encounter?
- Which pollutants in your water sample are the most difficult to remove? Why?
- Should you try to remove each pollutant separately or all together at once?

PROCEDURE

Give students 7 - 10 minutes to try to clean their water sample using the materials provided. Ask students to share and document their filtration methods.

OBSERVE

Ask students:
- What were some techniques that you used to clean the water?
- Which materials did you use to try to clean your water sample? How well did they work?
- Were your filtration techniques successful? Why or why not?

Allow students to share their ideas and try to clean their water sample for an additional five minutes. Ask students:
- Did you try any new techniques to clean the water?
- Which new materials did you use to try to clean your water sample?
- How successful were your filtration methods?

Part 2
Make it Clean, Make it Safe

Students will now learn how communities clean water at water treatment plants. Share with students that water is cleaned to make it safer for activities such as drinking, cooking and cleaning. Water treatment can eliminate pollutants such as sediment and bacteria.

PROCEDURE

1. Have students set aside their dirty water sample from Part 1.
2. Using the funnel, students should pour half of the 2-liter dirty water sample into the 2-liter bottle with a cap.
3. Place the cap on the bottle and shake it for 30 seconds.

4. Next, students should pour the water into another 2-liter bottle using a funnel, and pour the water back and forth between the bottles approximately 10 to 15 times.
5. Once the gases have escaped (the bubbles will stop forming), have students pour the water into the bottle with its top cut off.
6. Next, students should add two tablespoons of alum powder to the water.
7. Have students slowly stir the mixture for 3 - 5 minutes.

OBSERVE

Students should let the water sit undisturbed in the container for 5 minutes, then make observations about their water samples for the next 10 minutes. Students should record the following observations in their student journals.
- How does the water sample look now?
- Is anything floating in the water?
- Are there layers in the water sample?

TIP
Students will see particles forming larger clumps in the water. Alum is used to help particles to clump together, making it harder for waste to get through a filter at a water treatment plant. These clumps float to the top as a "sludge" and are skimmed off the surface fo the water.

Part 3
Make a Water Filter

In this part of the investigation, students will construct a filter using the bottle with no bottom.

water filter set-up

PROCEDURE

1. Using a rubber band, students attach the coffee filter to the outside neck of the bottle with the bottom cut off.
2. Students should then place the bottle neck-side down into the cut-off bottom of a 2-liter bottle, which will serve to catch the filtered water.
3. Next, have students pour a layer of pebbles into the bottle with the bottom cut off.

NOTE: the filter will prevent the pebbles from falling out of the neck of the bottle.

4. Students should pour the coarse sand on top of the pebbles.
5. They should then pour the fine sand on top of the coarse sand.
6. Students should slowly and carefully pour 2 liters of clean tap water through the filter to rinse it. Students should be sure not to disturb the top layer of sand as they pour the water.
7. Students should discard the tap water that collects in the catcher after it has gone through the filter and then replace the catcher to its original position.
8. After a large amount of **sediment** has settled to the bottom of the dirty water sample to which the alum powder was added, students should carefully pour the cleaner top part of the dirty water sample (without the clumps) through the filter so that collects in the catcher.
9. After the dirty water has gone through the filter completely, students should set aside the catcher containing the filtered water.
10. They should set aside the portion of the dirty water sample that ***was not*** poured through the filter, so that they can compare it to the filtered sample.

OBSERVE

Now, have students make and share observations about the filtered and unfiltered water samples.
- How does your water sample look? Smell?
- Has the filtration process changed your dirty water sample?
- Do you think your water sample is safe for drinking? Bathing? Cooking?
- Compare the water samples from Part 1 and Part 2. What are the differences? Similarities?
- What is the most difficult substance to remove? Why do you think that is?

SAFETY TIP
Inform students that the final step at the treatment plant is to add disinfectant to the water to kill any harmful organisms. Disinfectants are strong chemicals, so we are not using them in this investigation. The water that was just filtered is not safe to drink.

Unit 2: The World of Water
Aquatic Ecosystems

Student Journal

Name

TABLE OF CONTENTS

This journal was funded in (whole or part) with federal funds from Title IV, Part B, 21st Century Community Learning Centers program of the No Child Left Behind Act of 2001 awarded to the New Jersey Department of Education.

The Scientific Method

Science is examined using a process known as the **scientific method.** There is no magic formula to doing science, but there are commonly accepted techniques that help scientists conduct fair and unbiased experiments.

The scientific method involves the following steps:

1. Develop a question about something interesting, puzzling or problematic;
2. Gather information about your questions;
3. Form a hypothesis (a proposed explanation or an educated guess) and make predictions based on the information gathered;
4. Perform experiments and make observations to test the hypothesis and predictions;
5. Analyze your findings or results of the experiments;
6. Make conclusions based on the findings; and
7. Share the results of your investigation.

Good scientists use their senses (in a safe manner) to investigate certain subjects; however, because some substances are harmful, we will not be using our sense of taste during these experiments.

Scientists also record their questions, predictions, observations, diagrams and findings in a field journal similar to this one so they may refer back to them at a later time. Keep in mind that scientists don't usually have answers until they seek them out by investigating and exploring possible answers to questions.

The beauty of science is that you don't have to know the answers before you get started!

Student Lab Safety Agreement

Hands-on activities are important to learning in any science program. Students must be safe while doing any science investigations.

1. Never eat, chew gum, or drink while doing these investigations.
2. Never taste any of the materials that you will be handling in these investigations.
3. Follow all instructions carefully. If you do not understand a direction or part of a procedure, ask the instructor before you continue.
4. Don't touch any equipment, or other materials until you are told to do so.
5. Keep hands away from your face, eyes, mouth and skin while using investigation materials. Wash your hands with soap and water after doing all experiments.
6. Clean, rinse, and wipe dry all work surfaces (including the sink) and equipment at the end of the experiment. Return all equipment clean and in working order to the proper storage area.
7. When transferring materials from one container to another, hold the containers over a table or sink.
8. Carry glass tubes in a vertical (straight up) position to prevent damage and injury.
9. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass.
10. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be dry before touching an electrical switch, plug or outlet.
11. Examine glassware and other containers before each use. Never use chipped, cracked or dirty containers.
12. Notify your instructor immediately if you find damaged equipment or materials. Look for cracks, chips, frayed cords, exposed wires, and loose connections. Do not use damaged equipment.
13. If you do not know how to use a piece of equipment, ask the instructor for help.
14. Do not place hot glassware in cold water – it may shatter.
15. Allow heated metals and glass to cool before use. Use tongs or heat-protective gloves if necessary.
16. Never look into a container that is being heated.
17. Do not place hot equipment directly on the desk. Always use an insulating pad. Allow plenty of time for hot equipment or tools to cool before touching them.
18. Use a wafting motion of the hand to check odors or fumes.
19. Never force rubber stoppers into glassware.
20. Know where the fire extinguisher, eyewash, shower, and exits are located.
21. Report all injuries to the instructor immediately.

I, ____________________________________ (student's name) have read and agree to follow all of the safety rules stated in this contract. I realize that I must obey these rules to insure my own safety, and that of my fellow students and instructors. I will cooperate with my instructor and fellow students to maintain a safe lab environment. I will also closely follow instructions provided by the instructor. I understand that if I violate this safety contract, I may be removed from the after school science laboratory.

____________________________________ ______________________________

Student Signature Date

____________________________________ ______________________________

Parent / Guardian Signature Date

The Water Cycle

Investigation 1: Rain in a Jar

OBJECTIVE
In this investigation, you will learn how the Earth uses and recycles water in different phases called the water cycle.

Part 1: It's Raining in a Jar

GET READY!
You will conduct an investigation that creates a water cycle inside a jar. Do you think the Earth has the same amount of water today that was here when dinosaurs roamed the Earth millions of years ago?

PROCEDURE
1. Carefully fill the bottom of the glass jar with 2 to 3 inches (10 oz - 13.5 oz) of hot water.
2. Next, turn the lid of the glass jar upside down so that it acts as a small bowl, forming a seal over the jar.
3. Fill the lid with the colored ice.

PREDICT
What do you think will happen inside of the jar?

OBSERVE
Discuss your observations with your partner or group. What is happening inside the jar? Draw your observations.

Part 2: Cloudy with a Chance of Rain

PROCEDURE

1. Holding a can of aerosol spray (air freshener, for example), carefully lift the lid of colored ice and spray a small amount of aerosol spray into the jar.
2. Quickly replace the lid of ice back on the jar.

OBSERVE

Discuss and diagram the following observations:

- What do you notice about the water inside the jar?

- What states of water do you observe inside the jar?

Investigation 2: Making a Terrarium

OBJECTIVE

In this investigation you will observe the water cycle by creating a terrarium, a container that is used to keep and observe small living plants or animals.

GET READY!

BRAINSTORM!

Share what you know about water and the water cycle. Make a list of the group's ideas.

PROCEDURE

1. Pour 1-1 ½ cups of soil into the plastic container.
2. Use your finger or a pencil to make 3-4 holes (approximately 1 inch deep) into the soil.
3. Add a seed/bean to each hole and cover completely with soil.
4. Water the soil until well moistened and cover the terrarium with the lid or plastic wrap. Make sure tha the terrarium is well sealed.
5. Make a label for your terrarium using a marker and masking tape.
6. Place each labeled terrarium in a warm, sunny spot.
7. Draw a picture of your terrarium.

TIP
Keep the terrarium sealed to prevent water from escaping.

PREDICT
Predict what you think will happen in the terrarium over the next few days.

OBSERVE
Over the next several days, make some observations about what is happening inside the terrarium. Record and diagram your observations int he chart below.

- What do you observe happening in the terrarium?
- Is there evidence that the seeds have sprouted?
- Do you see water inside the terrarium? Where? Is the water in a liquid, gas or solid state?
- Remove the lid from the terrarium and rub some of the soil between two fingers. Is the soil wet? Has any of the water evaporated from the soil?

TIP
Seal the terrarium after you have examined the soil. If the terrarium is well-sealed, it will not need water for a few weeks. Water the soil only when it feels dry.

Terrarium Observations

	Observations	Results	Diagram Observations
Day ________			
Day ________			
Day ________			
Day ________			

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION

What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION

What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Words of Wisdom!

Flowing water never gets dirty.

--Chinese Proverb

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Use a thermometer to measure the temperature of the air inside the terrarium over a period of days. Create a chart of your results.
- Draw each phase of the water cycle that you observed in these investigations.
- Describe how temperature affects different forms of precipitation.
- Research and discuss ways that pollution might affect weather.
- Make a list of places you see condensation and evaporation every day.

Understanding Condensation

Water comes in different forms, or states. At room temperature, water exists in a liquid state. Water freezes into a solid state called ice at 0 degrees Celsius (32 degrees Fahrenheit). When water reaches a temperature of 100 degrees Celsius (212 degrees Fahrenheit), it changes from a liquid state to a gas state called water vapor. Water is constantly being reused in the water cycle. Here is an experiment that demonstrates how water is recycled. Ask an adult to help you with this experiment. Record your observations and results.

Materials

- 4 identical clear plastic cups
- Masking tape
- Marker
- Scissors
- Ice water
- A refrigerator and freezer
- Clock or watch with a minute hand

Investigation

1. Cut the masking tape into four (4) strips, about 1-inch in length.
2. Use the marker and tape to make labels for each cup. Label the first strip "A", the second strip "B", the third strip "C", and the fourth strip "D."
3. Place a strip of tape on each drinking cup.
4. Fill cup "A" with ice water and set it on a table. Wait for 1 ½ minutes (90 seconds).
5. Feel the outside of the cup and make observations:
   - What do you observe?
   - How did the outside of the cup get wet?
6. Place cup "B" on a table. Place cup "C" in the refigerator and cup "D" in the freezer. Do not place any water or other liquid in cups "B", "C", or "D".
7. After 7 minutes, remove the cups from the refrigerator and freezer. Line up the four cups on the table and make observations.

Explanation

Air contains water vapor. When warm air touches a cool surface such as the sides of a drinking cup, water vapor condenses (changes from a gas into a liquid) onto that surface. You've observed part of the water cycle when drops of water collect on the outside of a cup. Condensation is proof that there is water vapor in the air. In this investigation, water vapor moving around in the warmer air changed to a liquid when it came into contact with the cup of ice water. In order for condensation to take place, water vapor must collect onto a surface that is colder than the surrounding air. You will notice condensation on the outsides of the cup of ice water (cup "A"), and on the outsides of cups "C" and "D" when you remove them from the refrigerator and freezer, and water vapor begins to attach to the sides of the icy cold cups. You will not observe condensation on cup "B" because the air inside the cup is the same temperature as the air outside the cup, preventing water vapor from condensing onto the sides of the cup.

Source: http://www.teachtsp.com/products/productextras/SCISCI/watercycle.html (modified)

LESSON 2

What's In the Water?
Biotic and Abiotic Elements in Aquatic Ecosystems

Investigation: Exploring Aquatic Ecosystems

OBJECTIVE
In this investigation, you will examine the relationship between biotic (living) and abiotic (non-living) elements in an aquatic ecosystem.

Part 1: Biotic and Abiotic Identification

GET READY!
For each part of this investigation, you will make predictions about whether the objects are living or non-living elements of an ecosystem.

BRAINSTORM
How do you know that something is alive? Record the characteristics of biotic (living) organisms in the chart below.

Biotic Organisms:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________

PROCEDURE
Examine the photo examples.

OBSERVE
- Which organisms in each of these examples is a biotic (living) organism? What evidence supports your answer?

- Which elements in each of these examples is an abiotic (non-living) element?

Part 2: Making Connections

You will now participate in an activity that shows the connections between all of the elements of an aquatic ecosystem.

PROCEDURE

1. Think about the relationship between biotic and abiotic elements of an aquatic ecosystem.
2. Choose one of the nametags.
3. Listen for directions on how to play the game.

OBSERVE

- What if the water in the ecosystem became totally polluted? How would this affect the connections made in the string game?

- What if one of the biotic elements was totally eliminated from the ecosystem? How would this affect other biotic elements? Give an example.

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Define the following terms in your own words: ecosystem, biotic, abiotic.
- Make a data table of the biotic and abiotic elements found in a local body of water and the source of pollutants in the water.
- Write a poem about the biotic and abiotic elements found in your favorite aquatic ecosystem.
- Make a web of biotic and abiotic elements found in an ocean or a pond.

Science @ Home!

Turbidity

You will learn how to measure turbidity -- the amount of sediments suspended in water -- and learn how turbidity affects aquatic life.

Materials

- 2 sheets of black construction paper
- 1 sheet of white paper
- Tape
- Large, clear glass jar
- Empty soda can or jar lid
- Flashlight
- Dirt
- Water

Procedure

1. Line up two pieces of black construction paper and trace a circle in the center using the empty soda can.
2. Cut out the circles.
3. Tape the two pieces of construction paper around the glass jar so that the two holes are opposite each other. You might have to trim the construction paper so your pieces fit the jar.
4. Make sure that there are no gaps between your pieces that will let light through, and that the second circle is on the opposite side of the jar from the first circle.
5. Fill the jar three-quarters full with tap water.
6. Using the flashlight, shine the beam of light through the holes in the side of the jar. On the opposite side of the jar, hold up a sheet of white paper about one inch from the holes.
7. Observe and note the level of light intensity (low, medium, high).
8. Slowly add measured amounts of dirt to the water and monitor the change in light intensity.

Explanation

As you add more dirt to your jar, you increase the turbidity of water, and less light is able to shine through. Turbid water can also be described as “murky.” The clearer a body of water is, the lower its turbidity. When turbidity is high, solid particles (such as sediment) can block light that aquatic plants and organisms need to survive. Sediment can also clog the gills of fish. Suspended solids can also absorb heat from sunlight, raising the temperature of the water. As the water warms, it loses its ability to hold oxygen. This causes dissolved oxygen levels to drop, further reducing the number of plants and animals that can live in the water.

Source: http://www.tryscience.org/experiments/experiments_begin.html?turbidity (modified)

Investigation: Freshwater Ecosystem in a Bottle

OBJECTIVE
In this investigation, you will build a small freshwater ecosystem in a bottle.

Part 1: Setting the Stage

GET READY!

BRAINSTORM
Brainstorm and identify some different bodies of water that you know. Identify which bodies of water fall into the freshwater category and those that fall into saltwater category. As the group is brainstorming, make a list of the ideas that come to mind:

PROCEDURE

1. Use your markers to draw a line around the soda bottle without holes. Draw the line approximately two or three centimeters from the curved top end of the bottle.
2. Next, draw a line around the bottle with holes two or three inches from the curved bottom end of the bottle.
3. Cut along each line with a pair of scissors.
4. Use the masking tape and marker to put your name on the bottle without holes. The bottom half of the other soda bottle with holes will serve as the lid to your freshwater ecosystem.
5. Fill the bottle without holes with 6 cm (2 ½ inches) of sand.
6. Then, slowly fill the bottle two thirds of the way with dechlorinated or spring water, trying not to disturb the sand.
7. Plant three Elodea plants securely in the sand at the bottom of the soda bottle.
8. Sprinkle a scoop of Duckweed on the surface of the water.
9. Set the bottles aside overnight to allow the sand to settle.

OBSERVE

- Record the biotic and abiotic elements that you have added to the freshwater ecosystem.

- Make observations about the Elodea plants and the Duckweed.

- Draw and label your freshwater ecosystem.

- Measure and record the water temperature of your ecosystem.

Part 2: Adding Some Key Players

SAFETY TIP
Always wash your hands before and after handling live organisms.

GET READY!

1. Observe the freshwater ecosystem bottles after they have been allowed to settle and record these observations in your journal.
2. Measure and record the water temperature of the ecosystem.
3. Make observations about the water snails and the guppies in their cups and share your observations with your partner or group.
4. Draw the organisms in the space below.

5. You will now add these biotic organisms to your ecosystem.

PROCEDURE

1. Gently add the two snails to the ecosystem.
2. Next, add the guppies to the ecosystem.
3. Observe how the snails and guppies behave when they are added to the bottled ecosystems. Discuss your observations with your partner or group.
4. Next, place the bottled ecosystems in a well-lit area, but not in direct sunlight.
5. Feed your guppies with a very small pinch of fish food.

PREDICT

What do you think will happen to your freshwater ecosystem over time?

Part 3: Watch What Happens

OBSERVE

You will be making the following observations about your ecosystems each week over the next few weeks:

- Has the color of the water changed? If so, how? Why do you think these changes occurred?
- Did you notice any change in water temperature? If so, how?
- Has there been any plant growth or changes?
- How did the organisms behave?
- Did any of the populations change?
- Draw and record and draw your observations each time.

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Take pictures of the ecosystems at each observation and create a book or webpage.
- Create a table for the data collected.
- Create line graphs for the changes in water clarity, water temperature, plant growth and animal populations.
- Make a double bar graph comparing the number of animal populations at the beginning and at the end of the activity.

Science @ Home!

Build an Underwater Scope

Sometimes the best way to observe what happens underwater is to jump right in. Since humans can't breathe underwater, we need special equipment to explore aquatic environments. SCUBA (Self Contained Underwater Breathing Apparatus) divers use air tanks or submarines to study aquatic organisms and their habitats. One way to get closer to the animals that make their homes in lakes, rivers, and streams is to make your own underwater scope.

Materials

- An old coffee can or large juice can
- Plastic wrap
- A sturdy rubber band
- Scissors
- Can opener

Procedure

1. Ask an adult helper to help you remove both ends of the coffee can using a can opener.
2. Next, cut a piece of plastic wrap to fit over one end of the can. Make sure it covers the sides of the can by at least two inches.
3. Stretch the plastic wrap tight and secure it with a rubber band. You may want to tape the edges of the plastic wrap down with duct tape or some other strong tape.

Practice placing your underwater scope with the plastic side down in a tub of water. With the open end of the can facing up, place the covered end of the tube about one inch below the surface of the water. Look down into the water through the scope to discover a whole different world!

Source: http://www.dnr.state.wi.us/org/caer/ce/eek/cool/h20scope.htm

Marine Ecosystems

Investigation: Brine Shrimp Hatcheries

OBJECTIVE

In this investigation, you will learn about different types of marine ecosystems and explore the life cycle of a brine shrimp.

Part 1: Salty Shrimp

GET READY!

BRAINSTORM

Brainstorm what you know about marine ecosystems. As the group is brainstorming, make a list of the ideas that come to mind. What is the water like in a marine ecosystem?

PROCEDURE

You will conduct an experiment to test how water salinity affects the hatching of brine shrimp.

1. Examine the brine shrimp eggs (cysts) under the magnifying lens. Describe how the brine shrimp eggs look and draw them in the space below:
2. Fill each container with 500 mL (2 cups) of water. Record the amount of water in the chart below.
3. Choose three different quantities of salt to test in this experiment and record these amounts in the chart.
4. Use the masking tape and markers to label each container with the amount of salt you will add to the containers of water.
5. Measure and add the amounts of salt your group has selected to each of the three containers. Record the amount of salt added to each container in the chart below.
6. Next, add ½ tsp of brine shrimp eggs to each of the three containers.
7. Use thermometers to measure the temperature of the water in each container and record these temperatures in the chart.
8. Allow the containers to sit for a few days, but first make predictions below.

PREDICT
Make and record your predictions. What do you think will happen to the brine shrimp eggs?

Salinity and Brine Shrimp Hatching Chart

	Container One	Container Two	Container Three
Amount of Water			
Amount of Salt			
Amount of Brine Shrimp Eggs			
Temperature			
Prediction			
Observations			

Part 2: Brine Shrimp Life Cycle

OBSERVE
Make observations about the larvae once the eggs have hatched. How do the larvae look in the container and under the microscope? Draw the larvae in the space below:

Part 3: What If?

GET READY!

BRAINSTORM!

When we change one part of an experiment to see how it affects our results, this change is known as a variable. Brainstorm some additional variables that could be tested. Which variables would you want to change?

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION

What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION

What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- 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.

Science @ Home!

Marine Ecosystems

In this experiment, you and your adult helper can demonstrate that ocean currents are influenced by changes in water density and observe how temperature and salinity affect water density.

Materials

•NOTE: Advanced preparation is needed for this experiment.

- Food coloring
- Ice cube tray
- Fish bowl, small aquarium or any glass bowl of similar size
- Salt
- Small cup
- Hot tap water (43 °C or 110 °F)
- Thermometer

Procedure

Set up

1. Several hours before you begin the experiment, add 5 - 7 drops of food coloring to a small amount of water.
2. Pour the colored water into an ice cube tray to make 1 colored ice cube. Make sure the color is very dark.

Temperature (Part 1)

- Fill a fish bowl, aquarium, or other glass container to the rim with room temperature water. Let it stand for about a minute so that the water will have a chance to settle before you start.
- Place the colored ice cube into the water very gently and observe for 1 minute or more. Do not disturb the glass container until after the ice cube has completely melted.

Temperature (Part 2)

- Empty the glass container and then refill it with fresh water at room temperature.
- Run hot water until the temperature is at least 110 °F (43 °C). Fill a small cup half-full with this water. Add 5-7 drops of food coloring until the color is very dark. Very gently pour this colored hot water into the tank. Observe for a minute or more.

Salinity

- Empty the fish bowl or glass container and then refill it with fresh water at room temperature.
- Fill the test tube or cup half-full of colored salt water; use 5-7 drops of food coloring to give it a dark color and 1/2 teaspoon of salt. Very gently pour the colored salt water into the tank and observe.

Explanation

Ocean water is salty and usually cold. Most ocean water is less than 36 °Fahrenheit. But in the tropics (the warmest and most humid regions of the Earth), surface water may reach 82 °Fahrenheit, and water can be much hotter near underwater volcanoes. Differences in water density associated with temperature and salinity play an important role in shaping ocean currents.

Source: http://www.mos.org/oceans/motion/density.html (modified)

LESSON 5

Water Body Salinities I

Investigation: Water Detectives I

OBJECTIVE
In this investigation, you will conduct experiments using samples from different bodies of water to learn about salinity.

Part 1: Oceans, Rivers and Estuaries

GET READY!

BRAINSTORM!
Brainstorm what you know about oceans, rivers and estuaries. Make a list of the ideas that come to mind.

PROCEDURE
1. Label the three bodies of water that will be examined during this investigation on your map. (Map on other side of page).
2. Create a key on your map for the salinities of river water (0 - 3 ppt), estuarine water (0 – 30 ppt) and ocean water (32 - 37 ppt), assigning a different color to each.
3. Color each of the three bodies of water with the matching salinity color from the key.

Outline map of the state of New Jersey

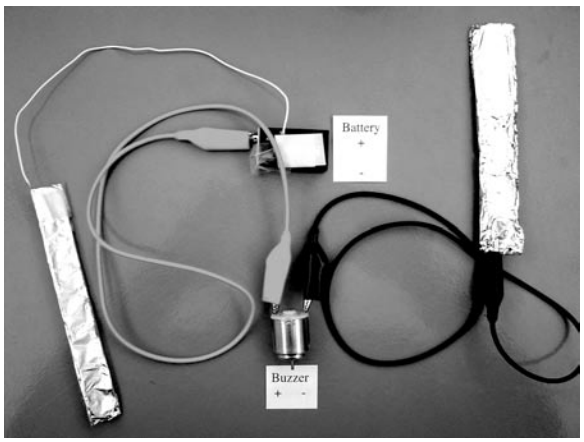
Part 2: Conductivity

GET READY!

You will now create an electrical circuit, a device that creates a path for electricity to follow. You will test each water sample to see if any of the samples can complete the electrical circuit by lighting the bulb or ringing the buzzer.

PROCEDURE

1. Wrap the popsicle sticks in aluminum foil.
2. Next, tape or clip the red wire of the light bulb or buzzer to the positive end of the battery (on a 9-volt battery the positive and negative symbols can be found on the sides).
3. Tape or clip one foil-covered popsicle stick to the black wire of the bulb or buzzer.
4. Tape the other foil-covered popsicle stick to one end of the 12-inch length of insulated wire.
5. Next, tape the end of the other 12-inch length of wire to the negative end of the battery. (It can also be clipped directly to the battery.)
6. See if the circuit is complete by touching the foil-wrapped popsicle sticks together. (If the circuit is complete, the bulb will light or the buzzer will ring.)
7. Half-fill each separate plastic cup with the water samples, and label the cups #1, #2, and #3.



conductivity set-up

PREDICT

Do you think any of the solutions will conduct electricity? Why do you think so?

OBSERVE

- Now, place the ends of the popsicle sticks into the first water sample, keeping the sticks apart in the water. Record your observations.

- Repeat these steps with the two remaining water samples recording your observations.

TIP
Dry the popsicle sticks between each test.
Make sure your circuits still work between each test by touching the sticks together.

Part 3: Evaporation

GET READY!

You will now conduct additional experiments in your attempt to determine the identity of each water sample.

BRAINSTORM

- What happens when we leave water out in the open over time?
- How does this relate to the water cycle?

PROCEDURE

1. Fill three separate cups with 60 mL (1/4 cup) of each of the three water samples.
2. Mark the water level on each cup with a marker.
3. Label the three cups #1, #2, and #3 to match the water samples.
4. Place the cups on a sunny windowsill.

PREDICT

What will happen to the water in the containers if you leave them out overnight?

OBSERVE

Check the water samples after 24 hours, 48 hours, and daily if possible for 1 week. Mark the water level on your cup each time you check the sample. Record your observations.

- How much water evaporated after each time interval? Draw what you see in the Data Recording Table.
- Which sample(s) do you think were freshwater? Which were saltwater?

NOTE: You will continue this investigation in Water Detectives II.

Water Detectives I Data Recording Table

Test	Sample #1	Sample #2	Sample #3
Conductivity Test • Did the buzzer ring / bulb light?			
Evaporation Test • Describe and draw what you observed in each cup, and the date you made the observation.			

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Word Play

If we don't conserve water we could go from one ex-stream to another.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Try painting with colored saltwater and colored freshwater with a paintbrush on two different pieces of construction paper. Observe your results after the water has evaporated.
- Take a field trip and collect real river, ocean and estuary water samples. Compare your results with this lesson.

Water Body Salinities II

Investigation: Water Detectives II

OBJECTIVE
In this investigation, you will continue to conduct additional experiments to determine the identity of each water sample.

Part 1: Make a Hydrometer

GET READY!
In this experiment, you are going to make hydrometers. Hydrometers measure the density of a liquid.

BRAINSTORM
Brainstorm what you know about density and salinity.

PREDICT
Based on the previous tests, can you predict which water sample will have the greatest density? The least? Why do you think so? Record your predictions.

PROCEDURE
1. Press a small ball of clay the size of a marble into one end of a straw to form a plug.
2. Starting at the top of the straw, draw horizontal lines with a permanent marker down the length of the straw at 1 cm intervals.
3. Half-fill one of the cups with tap water.
4. Put the straw hydrometer clay-end down into the tap water.
5. Remove or add clay until the hydrometer floats without touching the bottom of the cup.
6. Using your hydrometer, test each of the water samples in the cups.
7. For each sample, count the number of markings below the surface of the water and record the number in the Data Recording Table.

hydrometer set-up

OBSERVE
Make and record your observations in the Data Recording Table.
Which water sample had the greatest density? The least?

Part 2: Freezing Point

GET READY!

BRAINSTORM
What happens to water when it gets cold?

PROCEDURE

1. Label three sections of a plastic ice cube tray: #1, #2 and #3.
2. Fill each section of the tray with the matching water sample.
3. Place the trays in the freezer.

OBSERVE

Make observations and record the temperature of each water sample after 1 hour, 24 hours and 48 hours in the Data Recording Table.

Water Detectives II Data Recording Table

Test	Sample #1	Sample #2	Sample #3
Hydrometer/Density Test • How many marks on the hydrometer are below the surface of the water in each sample? • Describe and draw what you observed.			
Freezing Test Describe and draw what you observed in each section of the ice cube tray.			

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Words of Wisdom!

Where water is the boss, there must the land obey.
-- African Proverb

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Try painting with colored saltwater and colored freshwater with a paintbrush on two different pieces of construction paper. Observe your results the next day after the water has evaporated.
- Take pictures of the tests for each sample and make a book or showcase them on the Internet.
- Take a field trip and collect real river, ocean and estuary water samples. Compare your results with the results from today's investigation.

Science @ Home!

Salty Water

All water, even rain water, contains dissolved salts. But not all water tastes salty. Water tastes fresh or salty according to each individual. Your taste buds determine what is fresh and what is salty to you. Try this simple experiment.

Materials

- Measuring teaspoon
- Salt
- Tap water

Procedure

1. Fill three glasses with water from the kitchen faucet.
2. Drink from one and it tastes fresh even though some dissolved salts are naturally present.
3. Add a pinch of table salt to the second, and the water may taste fresh or slightly salty depending on a personal taste threshold and on the amount of salt held in a "pinch."
4. Add a teaspoon of salt to the third cup. This cup of salt water represents seawater. This water is too salty to drink, and will not be appealing to your taste buds.

TIP
It is not healthy to drink salty water because it can cause dehydration.

Explanation

The ocean contains very high amounts of dissolved salt, making the water too salty for human consumption. Oceanographers (scientists who study oceans and marine organisms) are very interested in salinity levels. Salinity describes the amount of salt found in water. Salinity is often expressed as "parts per thousand" (ppt). The average salinity level of the ocean is 35 parts per thousand, which means that about 35 pounds of salt is found in every 1,000 pounds of marine water. Ocean salinity can range from approximately 32 – 37 ppt.

References: U.S. Geological Survey & NASA (Goddard) Space Center

Investigation: Exploring Estuaries

OBJECTIVE
In these investigations you will learn what an estuary is and explain its important role in the environment.

Part 1: Salt and Water

GET READY!
You will dissolve salt crystals in water to observe its effects on water. Document your predictions, observations and findings.

OBSERVE
Take a pinch of salt and examine it using the magnifying lens or microscope. Share your observations with your partner or group. Sketch what you see in the space below:

PROCEDURE
1. Fill the cup with 100mL (about 3½ oz) of water.
2. Next, pour 1 tablespoon of salt into the cup and stir the solution until all of the salt dissolves.
3. Using the eyedropper, place one drop of the saltwater solution on a microscope slide or onto the clear plate.
4. Use the magnifying lenses or microscopes to examine a drop of the saltwater solution.

OBSERVE
Share your observations of the saltwater solution with your partner or group.
How would you describe what you see?

Part 2: Making a Salt Wedge

You will now make a model of a salt-wedge estuary. Salt wedge estuaries occur when the mouth of a river flows directly into seawater.

PROCEDURE
1. Place a small wooden block or book securely under one end of the baking dish, raising it approximately one inch from the table.
2. Next, make several tiny holes in the bottom of the cup using the tip of a pencil or a pair of scissors.
3. Drop marbles, small stones or pebbles in the cup and place the cup into the lower end of the baking dish.
4. Now, pour a liter of the room temperature tap water into the pan until it is about ½ inch from the top of the pan.
5. Allow the water to settle.
6. Add several drops of food coloring to the ½ liter saltwater solution, making it a dark-colored solution.

PREDICT
Before you add the saltwater solution to the tap water in the pan, make a prediction about what will happen when you pour the saltwater solution into the freshwater. Record your prediction.

OBSERVE
Now, slowly pour the saltwater solution into the cup of marbles, being careful not to overfill the cup. Make observations as the water settles in the baking dish. Look at the pan from the side at the table level & diagram what you see.

Part 3: Plant Dehydration

You will now investigate the effects of saltwater on freshwater aquatic plants. Hypothesize why some organisms are salt-tolerant while others are not.

PROCEDURE
1. Fill each graduated cylinder or soda bottle with 1000 mL (about 4 cups) of water and label the containers #1, #2, #3 and #4 using the masking tape and marker.
2. Measure 1 tablespoon of salt and pour the salt into container #1.
3. Next, measure 2 tablespoons of salt and pour the salt into container #2.
4. Measure 3 tablespoons of salt and pour the salt into container #3. No salt will be added to container #4.
5. Use a long-handled spoon or stirrer to dissolve the salt in each container of water.

OBSERVE
Examine the freshwater plants and share the following observations with your partner or group. What is the color of the plants? The texture? Shape?

PREDICT
Predict what will happen to freshwater plants when they are added to the containers of water/salt. Document your predictions.

Place one plant into each of the containers labeled #1, #2, #3 and #4. Observe the plants over the next several days and document your observations in the chart provided.

Freshwater Plant Observations

	Day 1	Day __	Day __	Day __
1 Tbsp salt				
2 Tbsp salt				
3 Tbsp salt				
water, no salt				

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Repeat the salt-wedge experiment using smaller amounts of salt. What is the smallest amount of salt that will form a wedge?
- List some of the ways that humans rely on estuaries.
- Research and compare plants from saltwater and freshwater environments. How are they similar? Different? Cut open the stems and leaves of the plants and examine them using a microscope or magnifying lens.
- Research estuarine organisms. Write a "name poem" using the names of plants and animals that live in the estuary. Each letter of an organism's name serves as the first letter for each line of the poem; for example, C - R - A - B:

  Can walk sideways
  Really small
  Algae it eats
  Bottom dweller

Science @ Home!

Soil Salination

Soil salination occurs when high levels of salts build up near the surface of soil. Salts are deposited in soil as groundwater flows through soil.

Materials

- 2 plastic or paper cups
- Cotton balls
- 10 bean seeds
- Salt
- Clear plastic wrap (optional)

Procedure

1. Cover the bottom of two cups with cotton balls.
2. Sprinkle some salt over the bottom of one cup. Label this cup “salt added”.
3. Place five seeds in each cup. It helps if you place the seeds with their grooved side upwards.
4. Wet the cotton balls in both cups and put in a light place.
5. Keep the seeds moist - you can cover the cups with clear plastic wrap to prevent the seeds from drying out.
6. Within four or five days, the seeds should begin to grow. Which seeds begin to grow first - the seeds with or without salt?
7. Observe the seeds growing for a few more days. What difference do you see?

Explanation

When it rains or snows, water flows into underground sources of water called aquifers. The uppermost layer of water in an aquifer is called the water table. Groundwater naturally contains small amounts of salts and minerals. As groundwater from the water table reaches the surface of the soil, it deposits salts and minerals into the soil. When water evaporates (changes from a liquid to a gas) from soil, it leaves behind a higher concentration of salts in the surface of the soil. Large amounts of salt in the soil (salination) cause major environmental problems, especially when farmers use groundwater to irrigate (water) their crops. High levels of salt are toxic to plants and other organisms that absorb nutrients from soil. When salt levels become too high, plants begin to die. To reduce the impact of soil salination, farmers plant trees and other salt-tolerant crops that help lower the water table.

Source: http://www.tryscience.org/experiments/experiments_saltsoilandseeds_athome.html

Wetlands

Investigation: Wetlands Discovery

OBJECTIVE
In this investigation you will learn what a wetland is and explain its important role in the environment.

Part 1: Build a Wetlands Model

GET READY!
You will create a model of a wetland to learn how it absorbs and filters water from the environment.

PROCEDURE
1. Measure the aluminum pan and divide the pan into three parts, identifying each part by making a line on the bottom of the pan with a permanent marker.
2. Next, flatten a piece of clay and use it to cover 1/3 of the aluminum pan, being sure to seal the clay along the edges of the pan.
3. Place the sponge firmly in the middle third of the pan. The sponge should fill the middle third of the pan and touch the edges of the pan.
4. Layer about 1 cm of potting soil onto the clay bottom. This represents land.
5. Add enough water to cover the final 1/3 of the pan.

OBSERVE
Record your observations. Which piece of this model do you think represents the wetlands?

PREDICT
You will make it "rain" on your wetland model. First, predict what will happen when it rains on the wetland. Record your prediction.

OBSERVE

- Using the ½ liter water bottle or spray bottle, slowly pour water onto the land. Discuss your observations with your partner or group.
- What happened as you poured water onto the wetland model?

- What would happen if you tried this experiment again without the sponge to act as a barrier? Try the experiment again without the sponge. Remove the sponge and observe what happens when you pour water onto the soil.

Part 2: Match-Making

PROCEDURE

You will now learn about plants and animals that make their homes in wetland habitats.

1. Look at pictures of different types of wetlands such as bogs, swamps and marshes.
2. Listen to the description of each wetland type.
3. Match the pictures with the descriptions.

OBSERVE

- What characteristics do you observe about the different wetlands in each picture?

- Look at the pictures of different types of plants and animals that live in or near wetlands. Try to match the plants and wildlife to each type of wetland. Make observations and record your matches in the space provided.

- What characteristics do you see in the plants? What about the animals?

- Can you match the proper wetland to each plant, bird, fish, amphibian, and mammal?

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Draw the plants and animals found in the wetlands.
- Use a Venn diagram to compare and contrast different types of wetlands. What plants and animals do they have in common? What are the differences?
- Write a magazine article about the importance of wetlands in your area.
- Do a mock interview of one of the wetland animals -- what does this animal have to say about what is happening in its habitat?
- Think of some of the ways that plants and animals would have to adapt in order to live in a wetland habitat. Adaptations can be physical (such as the size or shape of the teeth; the color, or the shape or type of the animal's body), or behavioral (activities that help an animal survive by avoiding predation or capturing prey). Make a list of your ideas.
- Participate in a community project that improves habitats located near water sources such as wetlands.
- Get the New Jersey freshwater wetlands map from the NJ Department of Environmental Protection's Maps and Publications Office at (609) 777-1038, or, check to see if your public library has a GIS (Geographic Information System) computer system to view the maps on its computer.

Purposes for Wetlands

Many people and organizations are spending much time and money to protect the remaining wetlands in the state of New Jersey. Adult helpers and students will explore the three main functions of a wetland and why wetlands are an important component in the ecosystem.

Materials

- Coffee filter
- Gravel
- Dirt
- Grass or pine needles
- 1 quart of water
- Strainer
- Sand
- Clear container
- Pitcher
- Wooden spoon

Procedure

1. Mix the gravel, sand, dirt, grass/pine needles and water in the pitcher stirring with the wooden spoon.
2. Place the coffee filter in the strainer and position the strainer on top of/over the clear container.
3. Slowly pour all contents of the pitcher into the strainer.
4. Make observations about what is happening in the pitcher.
5. Measure the amount of water in the clear container.

Explanation

Wetlands are more than just places with “wet land”. Wetlands provide a habitat for a variety of plants and animals, including food, water and shelter. The coffee filter removed the mud, grass, sand, and gravel from the water. Wetlands serve as filter for the environment, cleaning pollutants and debris from water. Wetlands also help control flooding. The tangled mass of plants, soil and roots help reduce the impacts of heavy storms and prevent soil erosion. Wetlands are a very important part of the ecosystem and it is important that we protect them.

Source: http://www.rockwood.k12.mo.us/ccl/mcclintock/Wetlands/wetland%20experiment2.pdf (modified)

LESSON 9

Water Quality and pH Levels in Aquatic Ecosystems

Investigation: Understanding pH

OBJECTIVE

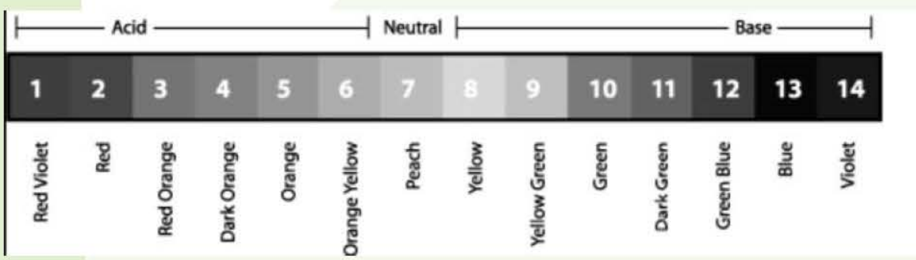
In this investigation you will examine how pH levels affect water quality in an aquatic ecosystem.

Part 1: Acid or Base?

GET READY!

You are going to test various liquid samples to determine their pH levels. The pH scale ranges from 0 to 14. A pH of 7 is considered to be neutral. pH levels from 1 - 6 are considered acidic. Solutions with pH levels from 8 - 14 are considered basic, or alkaline.

pH Color Chart



Source: National Aeronautics & Space Administration

OBSERVE

- Examine the physical properties of the liquids on the table and record your observations.
- Use the "wafting method" (move your hand back and forth over the top of the container) to determine how each liquid sample smells.
- Describe the color, viscosity (Is it runny or thick? How easily does it flow?), and other physical properties of the liquid samples.

Physical Properties of Liquids

	SMELL	COLOR	VISCOSITY	OTHER
Distilled water				
Lemon juice				
Vinegar				
Baking soda & water				

PREDICT

Predict the pH of each liquid sample. Is it an acid, a base (alkaline) or neutral? Record your predictions in the chart found in the PROCEDURE section.

PROCEDURE

1. Test each liquid sample by dropping one pH tablet into the test tube.
2. After the tablet has dissolved, compare the liquid sample in each test tube with the ph Color Chart above.
3. Record your observations on the chart below.

pH Levels

	pH Prediction *(write the number)*	**pH Results**	**Acid, Base or Neutral?**
Distilled water			
Lemon juice			
Vinegar			
Baking soda & water			

Part 2: pH and Plants

GET READY!

You will now place seeds in each solution to observe how pH levels affect seed germination (growth).

PREDICT

Predict what effect each solution will have on the seeds. Record your predictions.

Seed Growth Predictions

Solution	**Prediction**
Vinegar Water	
Baking Soda Water	
Plain Water	

PROCEDURE

You will place seeds in each solution to observe how pH levels affect germination (growth).

1. Label the plastic storage bags vinegar/water solution, baking soda/water solution, and plain tap water using the permanent marker.
2. Next, place a paper towel onto each of the three plates.
3. Count out eight seeds and place them on the paper towel in each of the plates.
4. Pour plain tap water onto one plate of seeds, filling the plate half-way.
5. Place the plate into the matching plastic storage bag and seal the bag securely.
6. Repeat the process, pouring the vinegar/water solution onto one plate of seeds, and the baking soda/ water solution onto the remaining plate of seeds. Save the remaining solutions in a sealed container.
7. Place each plate into the matching plastic storage bag and seal each bag securely.
8. Put the seed plates near, but not directly under, a light source.
9. Check the seeds in a few days to see if any of them are germinating (growing).
10. Check the seeds every week and measure the growth of any sprouts using a centimeter ruler.
11. Keep the paper towels moist by refilling the solutions as needed – don't let the seeds dry out.

OBSERVE

Record and share your observations with your partner or group.

Seed Germination

	Measure in centimeters (cm)	____ Days	____ Days	____ Days	____ Days
Vinegar/ water					
Baking soda/water					
Plain water					

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION
What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION
What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Word Pun

He studied water purification and had a great thirst for knowledge.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Repeat Part 1 of this investigation using other materials such as salt, milk, apple juice, hydrogen peroxide, shampoo, soda and soapy water. Record your results.
- Design an experiment to test the effects of other pollutants on aquatic ecosystems. What would happen if an ecosystem had too much salt, for example?
- Draw a diagram showing where acid rain and other pollutants travel through the environment.
- Collect water samples from an aquarium or from local bodies of water and test their pH levels. What can these levels tell you about the organisms living in these environments?
- Look at the shampoo bottles at home or in the store. Why does the pH level of shampoo or the pH level in a pool need to be a certain level?
- Plant the sprouted seeds from this investigation and chart their growth.

Science @ Home!

Make a Natural pH Indicator

The pH (potential hydrogen) level measures the strength of a chemical. pH is measured on a scale from 1 to 14 and tells how much hydrogen is found in a particular substance. Hydrogen is a naturally-occurring element and is one of the building blocks of Earth. You may remember that two hydrogen atoms combine with one oxygen atom to form a molecule of water. Hydrogen is found in all living things. The amount of hydrogen makes a solution acidic or basic. If you've ever used vinegar or baking soda, you're already familiar with acid-base chemistry. Ask an adult to help you make a natural pH indicator.

Materials

- Sliced red cabbage
- Stainless steel pan or microwave baking dish
- 1 quart water
- Stove, microwave, or hotplate
- White vinegar
- Baking soda
- Clear fruit juice or other beverage (non-carbonated)
- 3 clear cups or glasses
- Measuring spoons and measuring cups
- 4 teaspoons for stirring

Procedure

1. Boil the cabbage in a covered pan for 30 minutes or microwave in a bowl for 10 minutes.
   Note: Do not let the water boil away, or evaporate.
2. Let the cabbage cool before removing it.
3. Pour about ¼ cup of cabbage juice into each cup.
4. Add ½ teaspoon of baking soda to one cup and stir with a clean plastic spoon.
5. Add ½ teaspoon vinegar to second cup and stir with a clean spoon.
6. Add 1 teaspoon of clear non-carbonated beverage to the last cup and stir with a clean spoon.
7. Pour the contents of the vinegar cup into the baking soda cup.

Observe

- What color change took place when you added vinegar to the cabbage juice? Why?
- Did the baking soda turn the cabbage juice pH indicator red or blue? Why?
- What happens to the color if you pour the contents of the vinegar cup into the baking soda cup?
- If you were to gradually add vinegar to the cup containing the baking soda and cabbage juice, what do you think would happen to the color of the indicator? Try it, stirring constantly.
- Is the non-cola soft drink an acid or a base?

Explanation

The vinegar and cabbage juice mixture should change from deep purple to red, indicating that vinegar is an acid. The baking soda and cabbage juice mixture should change from deep purple to blue, because baking soda is a base which reacts chemically with the pH indicator, turning it blue. You should find that the acid and base are neutralized, changing the color from blue or red to purple -- the original color of the cabbage juice. As vinegar is added, the acid level increases, turning the cabbage juice pH indicator red.

Source: http://www.epa.gov/docs/acidrain/education/experiment3.html

Water Treatment

Investigation: To Drink or Not to Drink?

OBJECTIVE
In this investigation, you will work in groups to find a way to clean a polluted water sample.

Part 1: Pollution Solution
You can use any of the materials on the table to develop a method to remove the pollutants from your water sample.

OBSERVE
- Make observations about the dirty water sample. How does it look? Smell? Remember to use the wafting method to draw the odors towards your nose.
- Look at the materials that you can choose from to clean your water sample.

PREDICT
Will your group be able to clean the polluted water sample? Record your prediction.

PROCEDURE
Try to clean your dirty water sample. Share and document your group's methods. Which materials did you use to try to clean your water sample? How well did they work?

Part 2: Make it Clean, Make it Safe

GET READY!
In this part of the investigation, you will learn how water is cleaned at water treatment plants.

PROCEDURE
1. Set aside the dirty water sample from Part 1.
2. Using a funnel, pour half of the 2-liter dirty water sample into the 2-liter bottle with a cap.
3. Place the cap on the bottle and shake it for 30 seconds.
4. Next, pour the water into another 2 liter plastic bottle using the funnel, and pour the water back and forth between the bottles approximately 10 to 15 times.
5. Once the gases have escaped (the bubbles will stop forming), pour the water into the bottle with its top cut off.
6. Add two tablespoons of alum powder to the water and slowly stir the mixture.
7. Slowly stir the mixture for 3 - 5 minutes.

OBSERVE

Let the water sit undisturbed in the container for 5 minutes, then make observations about the water sample for the next 10 minutes. Record your observations every two minutes in the chart provided.

Observations of Dirty Water With Alum Added

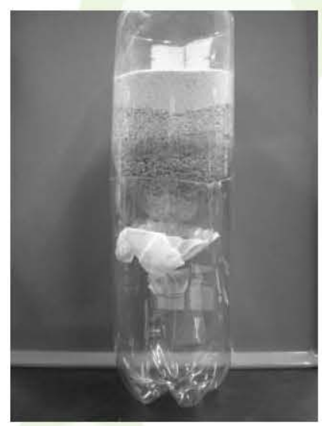
Intervals	Observations
2 minutes	
4 minutes	
6 minutes	
8 minutes	
10 minutes	

After ten minutes think abouth these two questions:
- How does the water sample look now?
- How do you think adding a substance such as alum makes it easier to purify (clean) dirty water?

Part 3: Make a Water Filter

In this part of the investigation, you will construct a filter using the bottle with no bottom.

PROCEDURE



1. Using a rubber band, attach the coffee filter to the outside neck of the bottle with the bottom cut off.
2. Place the bottle neck-side down into the cut-off bottom of a two liter bottle, which will serve to catch the filtered water.
3. Pour a layer of pebbles into the bottle with the bottom cut off. **NOTE: The coffee filter will prevent the pebbles from falling out of the neck of the bottle.**
4. Pour the coarse sand on top of the pebbles.
5. Pour the fine sand on top of the coarse sand.
6. Slowly and carefully pour 2 liters of clean tap water through the filter to rinse it. Try not to disturb the top layer of sand as you pour the water.
7. Discard the tap water that collects in the catcher after it has gone through the filter and then replace the catcher to its original position.
8. After a large amount of **sediment** has settled to the bottom of the dirty water sample to which the alum powder was added, carefully pour the cleaner top part of the dirty water sample (without the clumps) through the filter so that it collects in the catcher.
9. After the dirty water has gone through the filter completely, set aside the catcher containing the filtered water.
10. Also set aside the portion of the dirty water sample that was not poured through the filter, so that you can compare it to the filtered sample.

OBSERVE

Make observations about the filtered and unfiltered water samples. Share your observations with your partner or group.

- How has the filtration process changed your dirty water sample?

- Is your water sample safe for drinking? Bathing? Cooking?

SAFETY TIP

THE WATER THAT YOU JUST FILTERED IS NOT SAFE TO DRINK. Water treatment plants add disinfectants to the water to purify it and kill any organisms that may be harmful. Disinfectants are strong chemicals, so we are not using them in this investigation.

WRAP-UP

It is important to share results so that everyone has a clear picture of what happened. Scientists learn from each other through discussion and build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their investigations, we will now come together as a group to make conclusions in this wrap-up part of the lesson.

GROUP DISCUSSION

What did you learn from the group discussion? Did everyone have the same results? Did someone have a different opinion than you?

REFLECTION

What are your own ideas about this investigation? What new things did you learn? What surprised you? Record any thoughts that you might have.

Curriculum Match-Up

Here are some additional activities you can do to enhance what you learned in this investigation.

- Get a map of your state or town and chart the pollution in the area using colored pins.
- Find out which methods are used to clean the water in your area.
- Contact programs in your state that monitor and assess water quality. Visit http://yosemite.www.epa.gov/water to learn more.
- Adopt a watershed in your state to protect and restore rivers, estuaries and wetlands in your area.

Science @ Home!

Edible Aquifer

An aquifer is an underground source of water. When rain and other forms of precipitation fall to Earth, water soaks far into the ground and travels between the tiny particles of soil and rock underground. These tiny particles act as a filter, purifying water naturally.

Materials

- Blue or red food coloring
- Vanilla ice cream
- Clear soda
- Chocolate chips, multiple sizes
- Cake decoration sprinkles and sugars
- Drinking straws
- Spoons
- Clear cups

Procedure

1. Fill a small, clear cup about one-third of the way with chocolate chips. This represents all of the sand, gravel, and rocks in an underground aquifer.
2. Now, cover the “gravel, sand, and rock layer” with clear soda. This is the groundwater. Observe how the “water” fills in the spaces around the “gravel, sand, and rock”.
3. The next layer of the aquifer is called the confining layer, which is usually clay or dense rock. The water is cramped below this layer. Spread a layer of ice cream over the chips and soda to represent the confining layer. Now add another layer of “gravel and sand”, chocolate chips.
4. The next layer is the porous, spongy top layer of soil. Use decorating sprinkles and colored sugar to represent this layer.
5. Add a few drops of food coloring to a small amount of soda. The coloring represents pollution. Can you think of some pollutants that can affect groundwater?
6. Pour the soda over the layers of land. What do you observe?
7. Suck on the straw to pump the well and watch as the “water table” goes down.
8. Next, push the straw down toward the bottom of the cup into the center of your aquifer. This represents a drill trying to reach the water. Slowly begin to pump the well by sucking on the straw.
9. Make observations as the “water table” goes down. Are any contaminants seeping into the well area?
10. Recharge the aquifer by adding more soda. This represents “rain”.

Explanation

Many communities and homeowners must rely on wells that pump groundwater from aquifers. Unfortunately, groundwater can be contaminated by improper use or disposal of harmful chemicals, such as lawn fertilizers and household cleaners. These chemicals can percolate (seep into) down through the soil and rock into an aquifer and eventually be drawn into the wells. Water contamination poses a significant threat to human health.

Source: http://www.dnr.state.wi.us/org/caer/ce/eek/cool/ameliaedibleaquifer.htm (modified)

21st Century Community Learning Centers Programs

Soaring Beyond Expectations

NJDOE