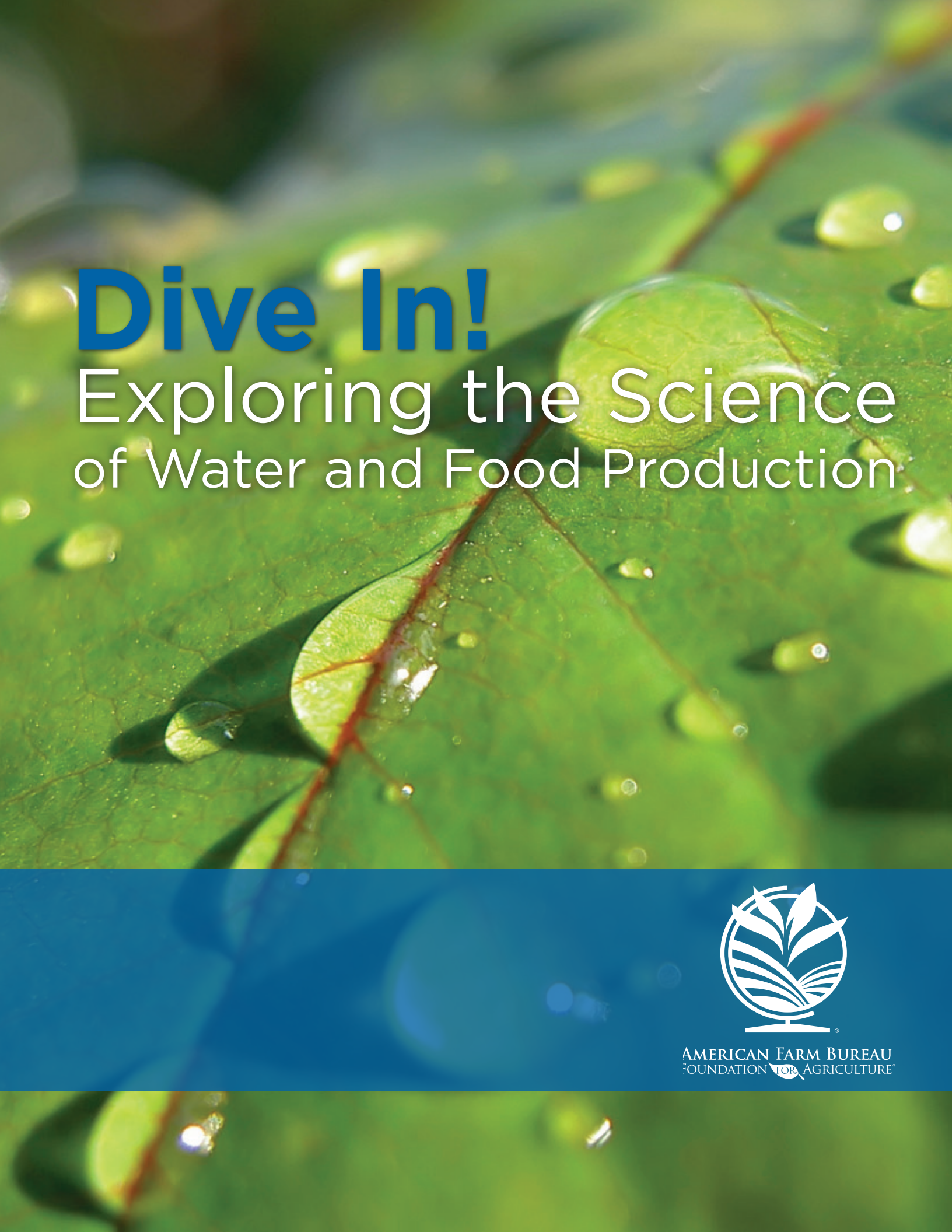

Dive In!

Exploring the Science of Water and Food Production

AMERICAN FARM BUREAU FOUNDATION FOR AGRICULTURE®

Welcome to *Dive In! Exploring the Science of Water and Food Production*, a water education resource for teachers and volunteer educators. This is a relevant, purposeful tool that will engage students in the science of water and food production. It is aligned to national learning standards for 6th-8th grade, but the interest level may be much broader.

The unit contains five sequential lesson plans which follow the Problem-Based Learning method. The unit focuses on **significant content**, derived from national learning standards and aligned to current issues. Students develop **21st century competencies** as they collaborate in learning groups, communicate key messages, and use innovation to develop new solutions. Each lesson is guided by a **driving question**, which frames the students' exploration and sets context for **in-depth inquiry**. Students apply new skills and use knowledge gained to create products and solutions. Students are allowed to **make choices** about products created and how they approach solutions. **Critique and revision** are embedded in the framework and the unit concludes with a **public audience presentation**.

If you are looking for additional information to support and extend learning about water and agriculture, we encourage you to explore the following resources:

- *Water: Sources, Use, Conservation* by Nancy Carlson. Available at http://www.agfoundation.org/
- Educator Guide for *Water: Sources, Use, Conservation* provided by Michigan Agriculture in the Classroom. Available at https://www.michfb.com/MI/4_6_Lesson_Plans/
- The USGS Water Science School http://water.usgs.gov/edu/wateruse.html
- Project Wet: Water Education for Teachers http://www.projectwet.org/
- World Water Monitoring Challenge http://www.monitorwater.org/

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The American Farm Bureau Foundation for Agriculture® is building awareness, understanding, and a positive public perception of agriculture through education.

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LESSON 1: OUTLINE

DRIVING QUESTION: WHY DO WE NEED WATER?

Lesson Time: 50-60 min.

Objectives: Students will be able to communicate that water is necessary for 1) life and 2) food production.

Standards:

Next Generation Science Standards

ESS3.A: Natural Resources. Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources.

Materials:

- Clear glass of water
- Lab sheets (1 per group of 2-3 students)
- Digital scales (1 per group of 2-3 students)
- 4-6 corresponding fresh and dried food samples. Examples below.
  - Fresh apricot half (pit removed), dried apricot half
  - Fresh plum (pit removed), dried prune
  - Fresh grape, dried raisin
  - Fresh apple slice, dried apple slice
  - Fresh pear half, dried pear half
  - Fresh tomato, dried tomato

Preparation: Purchase fresh and dried fruit samples. Set out food samples and scales. Place glass of water at the front of the room.

Activity Steps:

1. Hold up the glass of water. Ask students, "*Why do we need water?*" Listen for students to share that our body needs water.
   a. *According to the U.S. Geological Survey, the human body is made up of up to 60% water! Different parts of the body contain more water than others. More than 73% of the brain and heart are water. The lungs are about 83% water. Our skin is 64% water. Water is necessary for our body to survive.* [1]
2. Transition: Ask students to consider how we get water into our bodies. Listen for students to share examples beyond drinking water.
   a. *Thanks to nutrition labels, it's easy to find out what is in much of our food, but determining how much water is in our food can be tricky. We're going to take a look at how much water is in our food with a fun lab.*
3. Set context for the lab. Reference specific fresh and dried food samples available.
   a. *Through a process called dehydration, we are able to remove water from food items. By comparing the fresh weight (with water) to the dry weight (without water), we can learn about the amount of water in different food products.*
4. Divide students into lab teams of two to three and distribute lab sheets.
5. Have students review instructions and clarify questions. Students will weigh corresponding fresh and dry fruit samples to calculate water weight and percentage.
6. Monitor lab activity time.
7. Processing the learning by challenging students to analyze their findings.
   a. *Did all of the food have the same amount of water? Why or why not?*
   b. *How did the water get into the fruit initially? (Fruit gets water from the parent plant.)*
   c. *How did water get into the plant? (Rain or irrigation added water to soil which was drawn up by the parent plant.)*
8. Discuss the water content as shown below of several popular fruits and vegetables according to research conducted by the University of Kentucky. Ask students to compare and contrast the data they collected with the researched data provided.

(continued)

LESSON 1: OUTLINE (CONTINUED)

DRIVING QUESTION: WHY DO WE NEED WATER?

a. Fruits: Strawberries (92% water), Watermelon (92% water), Cantaloupe (90% water), Apricots (86% water) Plum (85% water), Grapes (81% water)

b. Vegetables: Lettuce (96% water), Cucumber (96% water), Radish (95% water), Zucchini (95% water), Celery (95% water)[2]

9. Conclusion: Review key concepts and challenge students to draw implications regarding the importance of water based on the lab. Elicit responses and preview the next lesson.

a. *Water is essential for life! Our body needs water to function. We get water by drinking and consuming foods containing water. Humans, plants, and animals all need water to survive. Just as we discovered that each fruit contains different amounts of water, each plant also needs a different amount of water to grow. Farmers must know exactly how much water a plant needs to grow in order to provide food for you and me. In our next lesson, we'll dive into the water cycle, who uses water, and how it gets to our homes and food.*

Note: This lab introduces the concept of fresh and dry weight comparison in a single class period. As a result, variations in food item size may impact accuracy of water percentage calculated. To enrich learning over time, you may wish to conduct an extension of this lab by weighing a single fresh food item, drying the item in a dehydrator, and comparing to the actual dry weight of that same item.

Names: _____ Date: _____ Class Period:_____

Lesson 1: Lab Sheet

How Much Water is in Our Food?

Materials:

- Fresh and dried food samples
- Scale (1 per group of 2-3 students)
- Lab sheet (1 per group of 2-3 students)

Directions:

Our food naturally contains water. Through a process called dehydration, water is removed from food. Today we will compare the weight of fresh and dried, or dehydrated, food items to determine the amount of water in each item.

Step 1: Zero out (tare) the scale.

Step 2: Carefully weigh each item and record the weight on the lab sheet below.

Step 3: Calculate the **difference** in weight by subtracting **dry weight** from **fresh weight**.

Step 4: Calculate the percentage of water by dividing the **difference** by the **fresh weight**.

Food Sample	Fresh Weight	Dry Weight	Difference	% Water
Ex: Apricot	35g	5.8g	29.2g	83.43%

LESSON 2: OUTLINE

DRIVING QUESTION: WHERE DOES WATER COME FROM?

Lesson Time: 50-60 min.

Objectives: Students will be able to 1) identify the steps in the water cycle, 2) identify who uses water, and 3) explain the general process of water distribution.

Standards:

Next Generation Science Standards

MS-ESS3-3: Earth and Human Activity. Apply scientific principles to design an object, tool, process, or system.

MS-ESS2-4: Earth's Systems. Develop a model to describe the cycling of water through Earth's systems driven by the sun and the force of gravity.

MS-ETS1-2: Engineering Design. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

English Language Arts

CCSS.ELA-LITERACY.W.6.2: Writing. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

Materials:

- Graphic of water cycle
- Computer with internet connection (1 per pair of students)
- Blue painter's tape (1 roll)
- Container of 30 ping pong or cotton balls
- Craft supplies (e.g., plastic spoons, pipe cleaners, paper, string, tape, etc.)
- Critique and Revision handout (1 per student)

Preparation: Using blue painter's tape, mark an area of the classroom floor that represents a mountain range. Across the room, mark an area of the floor that represents your town. Place the container of balls at the mountain location. Set out craft supplies. For more information on major divides and watersheds in the U.S., see *Water: Sources, Use, Conservation* by Nancy Carlson.

Activity Steps:

1. Review the water cycle. Ask students to recall what they remember about the water cycle. Capture key terms on the whiteboard as they are shared. After students have recalled concepts, display a graphic of the water cycle. Check out the graphic included in *Water: Sources, Use, Conservation* by Nancy Carlson.

2. Ask students to work in pairs to apply knowledge by writing a short descriptive passage in response to the following prompt:

   a. *If you were a raindrop, how would you get from a cloud to a home in our town?*

   b. Share responses.

3. As a class, ask students to brainstorm how we use water. Capture their list on the whiteboard.

4. Review current water use in the U.S. by having students visit the USGS Water Science School site at http://water.usgs.gov/edu/wateruse.html. Ask students to work in pairs to investigate the information provided and create a list of five to seven facts about water use. After working, have students share findings and update the previously brainstormed list as needed. (If computer access is not available, you may wish to print copies of the information found on the site listed above for group review.)

(continued)

LESSON 2: OUTLINE (CONTINUED)

DRIVING QUESTION: WHERE DOES WATER COME FROM?

5. Transition to water distribution.

    a. *Take a look at the water cycle. Do people only live near water sources? Historically, people had to live near fresh water sources. But thanks to advances in technology, we now store water in reservoirs and transport water. The challenge is determining the most efficient way to get water from there to here.*

6. Set context for the water distribution relay activity. Divide students into teams of three to five and reference the mountain and local town areas taped off in the room.

    a. *Your challenge is to work with your team to create a method for transporting water, represented by the white balls, from the mountains, where it is held as snowpack, to the city where we need to use it. When it is time to demonstrate, you'll have 60 seconds to transport as much water as possible, without allowing the water to touch your hands.*

7. Give teams a short amount of time to strategize and build prototypes. If teams are struggling, you may wish to give them an example (i.e., Students may create a large scoop using plastic spoons and paper to transport balls from the mountains to the city.).

8. Test prototypes, giving each team exactly 60 seconds.

9. Conclusion: Empower students to clean up work areas and distribute the *Critique and Revision: Water Transportation* student resource. Allow students to complete the resource in-class or as a take-home assignment. Discuss lessons learned and conclusions drawn. Share with students that, with every transportation method, there is an associated cost. Encourage continued exploration of water transportation methods used in your local area.

Names: _____ Date: _____ Class Period:_____

Lesson 2: Student Resource

Critique and Revision: Water Transportation

Describe what your team developed today.

_____

_____

_____

_____

What helped your team succeed?

_____

_____

_____

_____

How could your team work more effectively in the future?

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What challenges did you face in this activity?

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There are men and women developing new ways to transport water. What challenges do you think they face?

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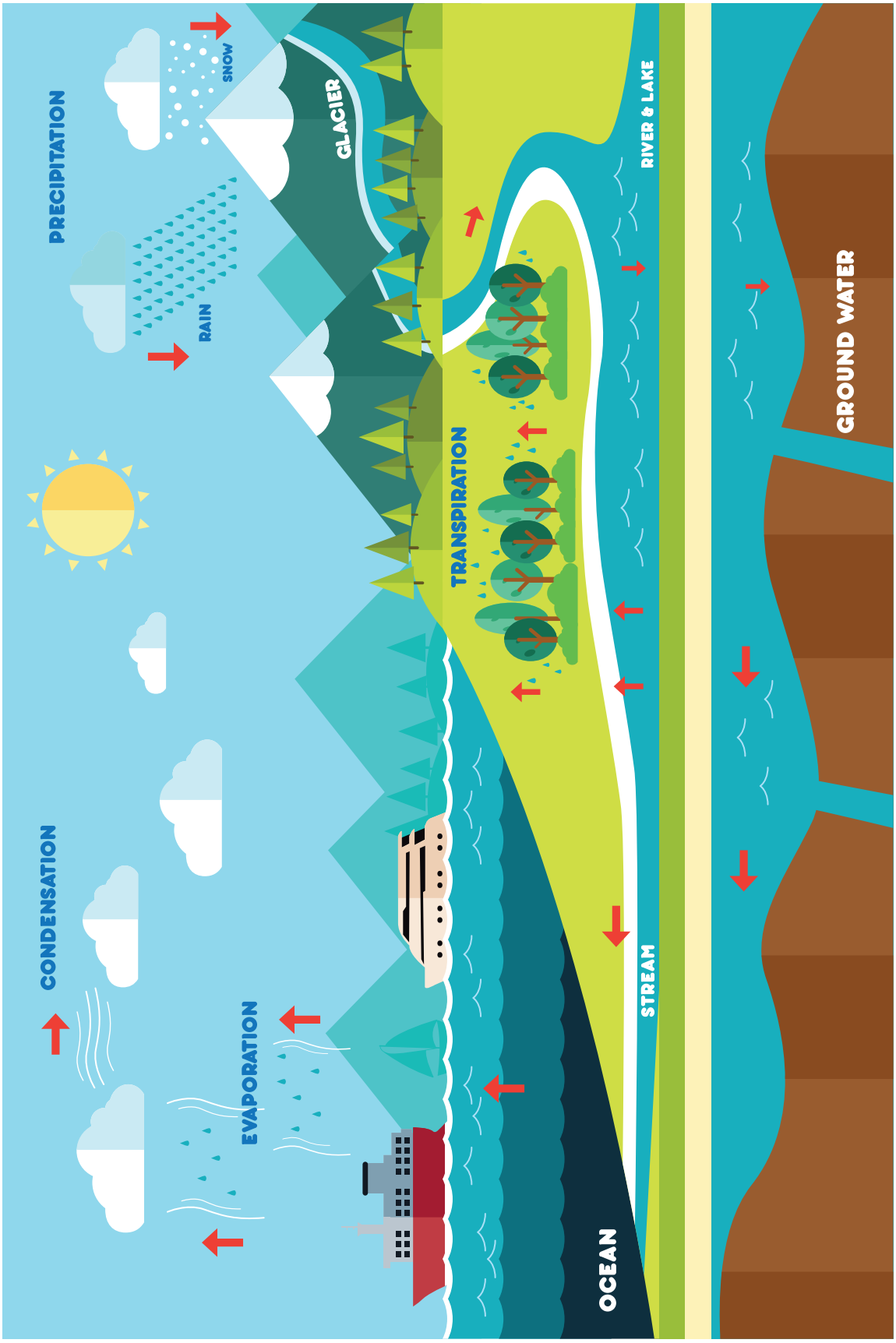
Lesson 2: Teaching Resource



LESSON 3: OUTLINE

DRIVING QUESTION: IS ALL WATER THE SAME?

Lesson Time: 50-60 min.

Objectives: Students will be able to communicate that water quality impacts 1) potability and 2) agricultural use.

Standards:

Next Generation Science Standards

MS-ESS3-3:	Earth and Human Activity. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Materials:

- Five water samples
  - (a) Purified drinking water
  - (b) Purified drinking water with food coloring added
  - (c) Acidic water
  - (d) Salt water
  - (e) Local stream/pond water
- Water test kits (e.g., First Alert Drinking Water Test Kit available at Wal-Mart and Amazon.com for $14) (1 per group of 2-3 students)
- Lab sheets (1 per group of 2-3 students)

Preparation: Create water samples and place in containers with letter labels only. For sample (b), add several drops of food coloring to purified drinking water. For sample (c), add vinegar to purified drinking water. Test sample prior to lab to ensure enough vinegar has been added to lower the pH. For sample (d), add salt to drinking water. Test sample prior to class to ensure enough salt has been added to register on nitrate/nitrate test. For sample (e), collect water from a local source, such as a stream, pond, or other area with potential bacterial contamination.

Activity Steps:

1. Review key information from previous lessons. Divide the class in half without moving students. Ask one half of the room to recall key information covered in Lesson 1. Ask the other half of the room to recall key information covered in Lesson 2. Have students share key messages using the popcorn method, bouncing back and forth from one group to the other for responses.

2. Set context for water quality testing by asking students, "*What makes water drinkable?*" Capture responses.

3. Reinforce key information as needed. Water quality is important for human health and agricultural production. *All water is not the same! Often water contaminants are not visible to the naked eye, so scientific testing is necessary. Drinking water kits commonly include tests for: bacteria, lead, nitrites/nitrites, chlorine, and pH (acidity) among other things.*

4. Introduce the selected water testing kit and key components. Address the purpose of each testing procedure.

5. Distribute lab sheets and discuss procedures.

6. Monitor completion of lab activity.

(continued)

LESSON 3: OUTLINE (CONTINUED)

DRIVING QUESTION: IS ALL WATER THE SAME?

7. Conclusion: Empower students to clean up the lab area and share results from the lab sheet. Connect this process to considerations farmers make when producing food.

   a. *Just as you have spent time testing water for drinking quality today, farmers must invest time and money to test water quality for food production. Think back to our first lesson and the amount of water in each food item. Plants and animals require water to grow! Quality water is necessary for food production. Contaminants, even naturally occurring contaminants like salt in soil and water, can negatively impact food production. In some cases, contaminated water can be treated for future use. Farmers also monitor water that leaves their farm to ensure that water returning to streams, reservoirs, and ground water is free from contaminants.*

   b. Optional: Share the YouTube video "Iowa Farmer, Jeff Pape, Protecting Water Quality" found at http://programs.iowafarmbureau.com/conservationcounts/doing.html

Names: _____ Date: _____ Class Period:_____

Lesson 3: Lab Sheet
Is all Water the Same?

Materials For Your Lab Group:

- Water samples
- Water testing kit
- Lab sheet

Directions: Familiarize yourself with the testing tools you have been provided. Begin lab exercise when instructed to do so by your teacher. Record data and observations below.

Sample **(A-E)**	**Observation** **What does the sample look/smell like?**	**Results From Test** **What does the test show?**	**Implication** **What does this mean?**

Make a Choice: Select three of the sample results above. Based on these results, how would you suggest these water types be used?

_____

_____

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LESSON 4: OUTLINE

DRIVING QUESTION: HOW CAN WE RESPONSIBLY USE WATER?

Lesson Time: 50-60 min.

Objectives: Students will be able to communicate that 1) different crops require varying amounts of water to be produced, 2) crops are affected if watered incorrectly, and 3) farmers use new technology to responsibly manage water.

Standards:

Next Generation Science Standards

MS-ESS3-1: Earth and Human Activity. Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

MS-ESS3-3: Earth and Human Activity. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-LS1-2: From Molecules to Organisms: Structures and Processes. Develop and use a model to describe the function of a cell as a whole and ways parts of a cell contribute to the function.

Materials:

- Crop Water Requirement Cards (1 per group of 2-3 students)
- Empty 1-gallon milk jugs (16 empty containers required if you wish to demonstrate all crop needs at the same time)
- Wilted plant
- Balloon
- 4" potted plant with soil (make sure pot has drainage holes)
- Gallon plastic bag
- Water

Preparation: Prepare one set of cutout Crop Water Requirement Cards for each group of two to three students. Place the plant, water, and plastic bag at the front of room.

Activity Steps:

1. Set context for lesson by asking students the following questions:

   a. *How do we conserve water? How do we use water responsibly? What is the difference? Listen for students to identify that conservation typically indicates using less water. Responsible use includes conservation, but also includes applying knowledge of water needs specific to each plant, soil, and environment.*

   b. *Why is responsible water use important to farmers and communities? Reinforce that farmers don't want to waste water! Water is expensive and irresponsible watering can negatively impact plant production. Communities must responsibly manage water so that there is enough available to maintain our food supply.*

2. Build on the concept of responsibility by introducing specific water needs by plant. Break the class into groups of two to three students. Give each group a cutout set of the Crop Water Requirement Cards. Challenge groups to correctly match the crop with the water required for production. The amount listed refers to the estimated number of gallons of water needed to bring a single crop item to full maturity in the U.S. using irrigated water.

   a. 1 head of broccoli (5.4 gallons), 1 head of lettuce (3.5 gallons), 1 almond (1.1 gallons), 1 strawberry (0.4 gallons)

(continued)

LESSON 4: OUTLINE (CONTINUED)

DRIVING QUESTION: HOW CAN WE RESPONSIBLY USE WATER?

3. Using empty gallon milk jugs, have a student volunteer demonstrate the amount of water used for each crop.

4. Ask student to consider what happens to plants if they are watered incorrectly.

5. Hold up the wilted plant. Ask students to hypothesize why plants wilt if they do not receive enough water. Demonstrate by holding up a deflated balloon.

    a. *Imagine this balloon is a vacuole within a plant cell. Without water, the vacuole cannot put pressure on the cell membrane and cell wall. The plant becomes limp.*

    a. *Inflate balloon with water or air. Imagine this balloon is a vacuole that has now filled with water. This puts pressure on the cell wall, enabling the plant to stand up.*

6. Now ask students to consider what happens if plants receive too much water.

7. Demonstrate water waste by holding up a 4" potted plant with holes in the bottom. Hold plant above a plastic bag or sink. Pour water in the soil until it drains out the bottom.

8. Next, demonstrate saturation by placing the same 4" potted plant in an empty gallon plastic bag, sitting upright. Add water to the soil, but allow the excess water to begin to fill up the bag and simulate soil saturation.

    a. *What is a potential benefit of overwatering?* Listen for students to share that it has the potential to replenish groundwater reserves, but only if soil allows water to drain.

    b. *Why wouldn't a farmer want to overwater?* Listen for students to share that water costs money, and excess water could harm the plant.

9. Supplement information as needed. Over watering actually kills more plants each year than under watering. Plants in overwatered soil die because their roots cannot get oxygen, and cannot go through a process of aerobic respiration. Aerobic respiration is what enables plants to convert organic compounds in the soil into energy.[3]

10. Farmers use advanced technology to responsibly use water. Ask students to share existing knowledge about irrigation technology. Distribute Lesson 4: Lab Sheet and guide students through completion.

11. Conclusion: Challenge students to become aware of water use in their life. Encourage students to look at water like a farmer. Farmers see water as a necessary, costly resource that must be managed responsibly.

Lesson 4: Student Resource

Crop Water Requirements Cards

How much irrigated water does it take to bring your favorite food to maturity?

	1.1 GALLONS OF WATER
	0.4 GALLONS OF WATER
	3.3 GALLONS OF WATER
	5.4 GALLONS OF WATER
	3.5 GALLONS OF WATER

Original Data Source: Mekonnen, M.M. and Hoekstra, A.Y., "Water footprints of derived crop products (1996-2005). This article is available for review at http://www.hydrol-earth-syst-sci.net/15/1577/2011/hess-15-1577-2011.html *Data interpreted by Huffington Post.*[4]

Names: _____ Date: _____ Class Period:_____

Lesson 4: Lab Sheet

How Do We Responsibly Use Water?

Farmers use advanced technology to responsibly use water. Check out the water management strategies described below.

☐ **Soil Moisture Meters** tell the farmer how dry the soil is. Meters can be placed at several locations in a farm or orchard. They transmit data back to a central computer that controls irrigation.

☐ **Variable Rate Irrigation** is a technology developed by the University of Georgia. It allows a farmer to turn off specific nozzles in a center pivot irrigation system as it moves. Only the areas that need water receive water.

☐ **Conservation Tillage** is a strategy farmers use to improve soil quality and keep soil moisture from evaporating. Farmers plant a cover crop to grow on the field when the regular crop is not growing. They also leave parts of harvested crops in the field.[5]

Task: Imagine that you have just become the owner of a large farm. You want to produce good food and care for the environment. Your budget only allows you to select one of the responsible water strategies above. Select one strategy and defend your choice.

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LESSON 5: OUTLINE

DRIVING QUESTION: HOW CAN I BE INVOLVED WITH WATER?

Lesson Time: 50-60 min. plus presentation time

Objectives: Students will be able to 1) explore careers related to water, 2) identify requirements for a career of interest, and 3) present their work to other people beyond their classmates and teacher.

Standards:

English Language Arts

CCSS.ELA-LITERACY.WHST.6-8.2: Writing. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.WHST.6-8.7: Writing. Conduct short research projects to answer a question, drawing on several sources and generating additional related focused questions that allow for multiple avenues of exploration.

CCSS.ELA-LITERACY.SL.6-8.4: Speaking & Listening. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes.

Materials:

- Computer lab with internet access
- Water careers presentation rubric (1 per student)
- Small water bottles (1 per student)

Preparation: preview *Dive into Water Careers!*, an online learning tool available at www.agfoundation.org. Reach out to administration, agriculture industry representatives, and community members who would be willing to evaluate student presentation. Write the titles of the four previous water-related lessons on the whiteboard.

Activity Steps:

1. Refer to the previous lesson titles displayed on the whiteboard. Ask students to recall one fact they learned from each lesson. As they recall each fact, they are to raise one finger. When they have four fingers extended, ask students to hold up their hand. Elicit responses and capture key discoveries on the whiteboard.
2. Ask students to consider the qualities they would like in their ideal job. Have volunteers share.
3. Tell students that there are vast opportunities for careers connected to water.
4. Set context for activity.
   a. Students will review 10 water-related careers.
   b. Students will select one career and use the online tool to research key information.
   c. Students will create a presentation about their selected career that includes key information from the learning tool as well as current job opportunities in that field.
   d. Students will deliver their presentations to other people beyond their classmates and teacher.
5. Distribute the presentation rubric and clarify expectations.
6. Monitor student work time. You may elect to have students finish presentation preparation outside of class time.
7. Facilitate presentations and celebrate success.
8. Conclusion: Give each student a small water bottle. Review information from unit through facilitated discussion.
   a. *Why do we need water?* Listen for examples of related to body function and food production.
   b. *Where does water come from?* Listen for major steps in the water cycle and information about water distribution.
   c. *Is all water the same?* Listen for factors affecting water quality for drinking and food production.
   d. *How can we responsibly use water?* Listen for information about giving each plant the exact water it needs, as well as technology used by farmers.

Names: _____ Date: _____ Class Period: _____

Lesson 5: Student Resource

Water Careers Presentation Rubric

	Advanced	**Proficient**	**Novice**
Description of Selected Career	Career is clearly and accurately described. The student understands the roles and responsibilities associated with the career.	Description of career is missing one or more key components.	No clear description of the selected career is given.
Education/Training Required	Education and/or training required for the job are clearly communicated. The student includes information regarding where he/she could obtain schooling or training for the job.	Description of education and/or training required is missing one or more key components.	No clear description of education and/or training required is given.
Annual Salary Range	Annual salary range is clearly communicated.	Annual salary wage is missing key information.	No clear annual salary range is given.
Current Job Opportunities	One or more current job opportunities related to the selected career are identified. The student identifies where the job is and what he/she would need to do to apply for the job.	Description of current job opportunities is missing one or more key components.	No description of current job opportunities is given.

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