

TTCD Lesson Plan (6): What is Hydroponics?

Unit: Hydroponics	Grade(s): All	Class Size: 1-30	Lesson Duration: 45 minutes	Location: Classroom or Garden
Topic(s):	Plant life cycle			
Student Prerequisites:	Students should understand that soil contains most of the basic ingredients of life for plants: water, air, nutrients, and minerals.			
Essential Questions:	How do plants get the things they need to grow <i>without</i> soil? Why is hydroponics useful in Alaska and other northern climates?			
Student Objectives:	Students will develop a working model of a wicking hydroponic system. Students will understand that hydroponics is an alternative growing method that does not depend on soil for plant nutrients. Students will make connections between their mini wicking hydroponics systems and their school's hydroponics system.			
Standards:	Supports NGS Standards: 5-PS3-1: Use models to describe phenomena. 5-LS2-1: Develop a model to describe phenomena. 5-LS1-1: Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.] Cultural Standards: B.4: Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life by: identify[ing] appropriate forms of technology and anticipat[ing] the consequences of their use for improving the quality of life in the community.			
Local Context:	How is this place-based?			
Vocabulary:	Hydroponics, growing medium, reservoir, wick, growing tray, nutrients			
Dena'ina language words:	<i>Added by TTCD or community partners</i>			
Materials:	● 2-liter plastic soda bottles, one per group ● Permanent marker ● Scissors or utility knife ● Thick cotton or felt strips (2), about 2 by 20 cm. Strips of an old towel work well. ● Growing medium, like coconut coir OR hydroponics clay pebbles + rapid rooter			

	plugs • A large bin to hold growing medium and a scoop for students to use • Seeds or a small plant. Start with a green leafy plant like spinach or lettuce, or herbs like oregano or basil. • Purified or filtered water • Quart-size container for measuring water, such as a yogurt tupperware • Plant nutrients/fertilizer for green leafy plants • Disposable gloves • Measuring spoon • Aluminum foil • Area that receives plenty of light to store the container • pH control kit (optional)
Instructor Prep:	Use a marker to draw a line around the bottle just below where the cylinder starts to curve in toward the cap. Cut the bottle along the line with scissors or a utility knife. <i>You may do this step with the students or ahead of time, depending on the needs of the class.</i> Rehydrate growing medium per package instructions, if necessary. 
Introduction:	Ask the class: What are some of the things that plants need to grow? Make a list on the board. Which of these things are found in soil? Have students tell you which items to circle: water, air, minerals, and nutrients. Then ask students: In our community, what are some of the challenges of growing plants in soil? (Possible answers: frozen ground, hard to procure ideal soil for planting) Today, we are going to learn about hydroponics, which is a method of growing plants that does not use soil. We are going to figure out how to give the plant all of these circled items <i>without</i> using soil.
Activity:	1. If more than 10 students are present, divide students into groups of 2-4. 2. Pass around some of the growing medium. Explain that a growing medium, such as coconut coir fiber, can sometimes look like soil but doesn't contain all of those ingredients (organic materials/dead stuff, minerals, air, water) that are in soil. Instead, the growing medium in hydroponics provides structure and retains moisture for the growing plant. This means that we will have to add nutrients (organic material and minerals) to our system. 3. We will start by creating a hydroponics container from our clean, empty, and pre-cut soda bottle. You could make this at home! 4. Pass out top and bottom bottle parts to each student, pair, or group.

Demonstrate how to flip the top of the bottle upside down and rest it in the lower half of the bottle. You will grow your plant in the upside-down top part, and the bottom part of the bottle serves as a **reservoir** to hold the water.



5. Pass out two cotton strips to each student or pair, and demonstrate how to tie the two ends together to make a wick. A **wick** transfers the water (plus our added nutrients!) from the reservoir to the roots of the plant.
6. Push the loose ends through the bottle top so they hang down into the reservoir. The knot should stop the wick from going all the way through. If students' knots fall through, help them retie a larger knot.
7. Demonstrate how to place the top with the wick back into the reservoir.
8. Have students fill their **growing tray** with the growing medium. Remind students: a growing medium in hydroponics does not contain nutrients, like soil does. So, we have to pull the wick up about 2/3 of the way into the growing medium to be sure that the water and nutrients stored in the reservoir reach the plant's roots.
9. Have students measure one quart of purified water to add to the bottom part of their systems.
10. Have one student look at the label of the liquid nutrients bottle to find out how much of the solution we need to add to a quart of water in the growing phase of the plant. Go around to each group and have students mix this amount into their water.
11. Optional: Have students test and adjust the acidity of their water using the pH control kit.
12. Planting: If you are starting from seeds and using coconut coir, place three seeds in the coconut coir just above the knot in the wick. If you are starting from seeds and using pebbles, pass out a soil plug along with seeds to each student group. Explain that while some species of plant seeds need light to germinate, most will do better in the dark. Cover the seeds with some of the growing medium and gently pat down.
13. If you are starting with a small plant, plant it directly into the growing medium, making sure the roots get close to the knot in the wick. Explain to students that the roots of a growing plant are very delicate, and do not like to be disturbed. We must handle them very gently!
14. Have students pour more water over the growing medium. It will seep into the reservoir. Keep pouring until the reservoir is about 1/2 to 2/3 full. The water should never reach the spout of the bottle. Make sure that the area around the seeds or tiny plant gets wet as you pour the water.



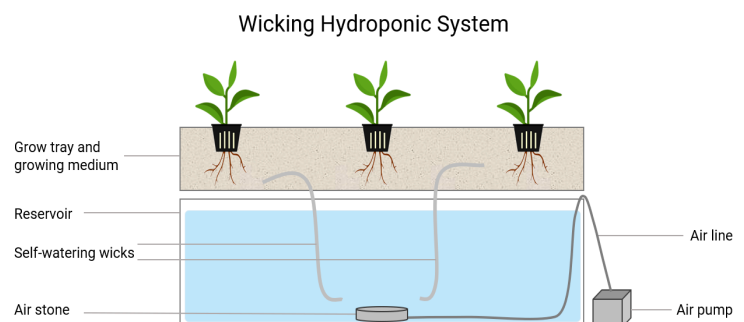
15. Wrap the whole container with aluminum foil to prevent sunlight from reaching the water. It is okay to leave the container uncovered, but algae may develop.
16. Place the mini hydroponics systems near a window or under grow lights.
17. Students should check their containers every day for a couple of weeks to make sure the area around the seed or tiny plant is moist. Explain that students should take turns caring for the plants in the classroom. They can be individually responsible for their plants, **OR** take turns to care for all of the plants at once. If they want to try this second method, make an ordered list of students who are interested in helping care for the plants (call on raised hands or use popsicle sticks to generate the list randomly). Post a calendar on the board or on a clipboard so that everyone knows whose turn it is to check the plants.
18. After two weeks, add a little water only when needed. As the plant grows, its roots will extend deeper and get better access to the water and nutrients sucked up by the wick.
19. Once the plant is established, check the water level in the reservoir weekly. Make a new batch of nutrient-enriched water when you start to run low, and add it when the water level gets low. Check the directions that come with the nutrients; you will probably need to add more nutrients for the same amount of water once the plant is well-established.

Wrap Up:

Quick Review: Since we added nutrients to the water, why do we still need the growing medium? Why do you think you need to keep the area around the seedling or tiny plant moist when it is small, but no longer need to once the plant is larger and established?

Check for Understanding:

Draw a simple model of the school's hydroponics system on the whiteboard, and ask students to guess, based on what we learned today, what the different parts of systems are called.



Evidence of Learning:

Have students work in pairs or small groups to draw a draft of their own design for a hydroponics system that could be used in the school, at home, or in a community building. Evidence of learning in these designs is usually demonstrated by including components that serve as the growing medium, growing tray, reservoir, wick, and nutrients. Alternatively, if students do design a hydroponics system without one of these components they can still demonstrate learning by including a written or verbal explanation of how their system functions without that component.

Closing Question: Why is hydroponics useful in Alaska and other northern

	climates?
Lesson Adaptations:	• Have older students cut bottles and set up their mini hydroponics frames along with you • Have students test and adjust the acidity of their water with the pH control kit. Explain that plants absorb nutrients from water best if it is slightly acidic (below a pH of 7). Since there are no soil nutrients in a hydroponics system, adjusting the pH can make a big difference for our growing plants! • For younger students, connect the wick to your bottle top ahead of time. • Have students draw and label their mini hydroponics system in their TTCD journals, or have them draw the one you labeled together on the board.
Extensions:	• Deepen the place-based nature of the “evidence of learning” outlined above by asking students to create a design for a hydroponics system using materials that are abundant in the local natural environment or items that are common in the community and could be repurposed/reused. • Build upon the “evidence of learning” outlined above and have students present their designs to the class. Provide time for constructive critique and have each student-pair make adjustments to their design based on this feedback. Then work as a class to build one - or more - of the designs! • Plant some of the same seeds you used for your hydroponics models in the school greenhouse on the same day. Compare how fast the plants grow in each of these conditions. Once the herb or vegetable is mature, compare their tastes as well! • Make a few “control” hydroponics containers with just water (no added nutrients). Make a hypothesis as a class: Do you think the plants getting nutrient-rich water will grow faster, grow bigger leaves, or look healthier? Why? • Can you give plants too many nutrients? Double the amount of nutrients added to one or more containers, and observe what happens as they grow.
Reflections:	How did it go? What did students understand most/least? What could change about instruction or lesson plan?
Resources Used	Science Buddies Hydroponics Activity Alutiiq Grown