

Green Our Planet's Hydroponic STEM Curriculum K-5

Hands-On STEM Teaching Curriculum, K-5

Fourth Grade Lessons (First Edition)



**VIDEO LESSONS
MATCHING OUR
CURRICULUM ARE IN OUR
VIRTUAL ACADEMY AT:
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GREEN OUR PLANET'S

K-5 HYDROPONIC STEM CURRICULUM

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Green Our Planet is a nonprofit, 501(c)(3) conservation organization established in 2013 and that runs the largest and one of the most comprehensive STEAM (science, technology, engineering, arts, and math) school garden programs in the United States. The organization's mission is to increase student academic performance in STEAM subjects as well as to conserve and protect the environment through project-based STEAM education, which includes nutrition, financial literacy, and conservation education in PreK-12 schools. In 2013, Green Our Planet launched its Outdoor Garden Classroom Program in Las Vegas, Nevada, which is designed to help schools fund and use outdoor vegetable gardens as "hands-on" classrooms. In 2018, Green Our Planet launched its K-5 STEM Hydroponics Program, which allows for hands-on STEM education using hydroponic systems. Green Our Planet published Nevada's first K-5 STEM hydroponics curriculum (this one!) in 2019. For more information on Green Our Planet and its programs, or to view Green Our Planet's hydroponic video tutorials, please visit www.greenourplanet.org.

TEACHER FEEDBACK—LET US HEAR FROM YOU!

Teacher feedback is welcome—we want to hear from you about your experiences using this curriculum so that the lessons can be continually improved! Please send your feedback to: feedback@greenourplanet.org

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IN Fourth Grade,



Students will apply scientific ideas to design, engineer, and test a hydroponic system that converts energy from one form into another. The students will also gain an understanding that plants have internal and external structures that function to support survival, growth, behavior, and reproduction. Fourth graders will plan and carry out tests with controlled variables and failure points to identify aspects of a system model that can be improved. Students will use digital models to explore complex issues and systems. They will also create original digital works as a form of personal expression with minimal teacher input. Students will identify a simple design problem addressing a need or a want that has specified criteria for success.

Lessons:

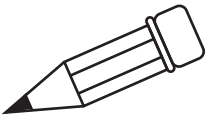
1. **Introduction to Hydroponics** - Students learn the external parts of a plant and how they function internally to support plant health. Students then investigate a hydroponics system and determine if it can meet plant needs.
2. **Maintaining a Hydroponic System** - A teacher led demonstration shows students how to complete a few simple tasks to maintain a hydroponic system through the grow cycle. Once students have a firm grasp of the process they can be divided into groups to check on the system periodically and maintain a hydroponic system through the grow cycle.
3. **Optimal Sprouting Conditions** (part 1) - Students will learn about optimal sprouting conditions for seeds and then set up several situations where they can control variables to begin an experiment that compares how the different conditions affect seed sprouting.
4. **Optimal Sprouting Conditions** (part 2) - Students will measure and construct a line plot for their portion of the experiment and collaborate with other groups to share information about each sprouting condition.
5. **Optimal Sprouting Conditions** (part 3) - Students will use the data collected in the previous lesson along with some independent research to develop an opinion writing piece about optimal sprouting conditions
6. **Optimal Sprouting Conditions** (part 4) - Students will find visual aides to support their writing from the previous lesson and present their finished project to the class.
7. **Transplanting Seedlings** - Students will use their knowledge about plant structures and functions along with some diagrams and videos to understand how to properly transplant seedlings into a hydroponics system.
8. **Building Plant Fractions** - Compare individual plants with the total number of planting sites in their hydroponic system to create and understand fractions. Students will construct sums of fractions and create a visual model to show where a fraction is derived from.
9. **Hydroponic Reading** - Students will read a hydroponic text, then summarize the reading by identifying the main idea and supporting details from the text.
10. **Making A Digital Model** - Students will research the various types of hydroponic systems and create a digital model describing the benefits and drawbacks for a hydroponic system of their choice.
- Env.11. **Exploring Renewable Energy** - Students will define renewable and nonrenewable energy sources. Students will explore if and how their hydroponic system could be connected to a renewable energy source.
- Env.12. **What is Biofuel?** -Students will identify biofuel as an alternative to fossil fuels for use on a daily basis. Students will research different sources of biofuels and determine the growing conditions necessary for growing them in a hydroponic system.
- H1. **Healthy Choices** - Students learn the components of a healthy eating plan which includes, but is not limited to; portion sizes, types of foods and food preparation.
- H2. **Spice It Up!** - Students investigate scents and flavors to identify herbs and spices. They learn how herbs and spices have helped cure illnesses throughout history and how herbs and spices are used today to help add flavor to food.



OVERVIEW



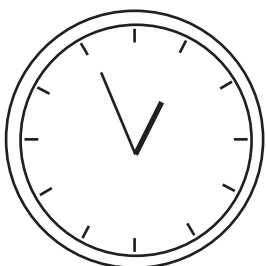
OBJECTIVE(S)



STANDARDS



TIME



Check for the matching curriculum at www.greenourplanet.org
<https://video.link/w/5UBrb>

Students will review and build on their understanding of how plants use their external and internal structures to grow. Through the lesson, students determine which variables provide an optimal environment for plant growth by testing and controlling different variables.

Question: What is an optimal water solution for basil to grow?

Students will:

- develop an experiment where one environmental factor is changed while the others are controlled.
- make a hypothesis of plant growth based on the environmental factors they test.

Nevada State Academic Content Standards:

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

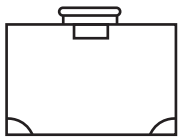
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

This lesson will take 30-40 minutes of instruction time to complete.

TEACHER BACKGROUND



MATERIALS



Different species of plants have different optimal pH levels. Basil grows best in a pH range of 5.5 to 6.5, which is slightly acidic. In this experiment, students will use lemon juice and baking soda to change the pH of the water solution. Basil usually takes 5-10 days to sprout. This lesson sets up following lessons. Students will organize data into line plots, construct an opinion writing based on the experiment and present their findings to the class.

- Zip bags, 5 for each group
- Rockwool growing cubes, 5 for each group
- Cups, 5 for each group
- Spoons, 2 for each group
- iPads for pictures (optional)
- Basil seeds
- Lemons
- Baking soda
- Water and plant nutrients
- Student notebook and marker
- pH test strips (optional)

PROCEDURES



1. Premix water and plant food based on the instructions provided with the plant food.
 - a. This will keep all plant food amounts the same in the experiment.
 - b. Each team will need access to the water solution, lemon juice, and baking soda.
 - c. It may help to have a materials station prepared.
2. Review what all plants need to live.
 - a. You may want to review through a class discussion, reading an informational text about plant growth, or watching a YouTube video.
 - b. Re-visit the class anchor chart from Lesson #1 to review the role of the roots as an external structure and how they function in absorbing nutrients and water.

3. Introduce the "Optimal Environment."
 - a. An "optimal environment" is the best suited environment for a living organism to grow and reproduce.
 - b. This lesson focuses on the optimal pH of water solution to promote early stages of plant growth.
4. Ask the focus question of the lesson: what is an optimal water solution for basil plants?
 - a. Have students write the focus question in their notebook.
5. Describe how nutrients are given to plants by making a water solution.
 - a. Different nutrients are best absorbed at different pH levels.
 - b. We can change the pH of our water solution by adding lemon juice to make the water more acidic and baking soda to make it more basic.
6. Set up the experiment.
 - a. Allow students to take pictures of the experiment if available or create a diagram of the experiment with labels.
 - Students will need to have a visual aid when presenting in Part 4 (Lesson 6).
 - b. Give each group 5 bags, 5 cups, 5 growing cubes, 2 spoons, and 10 seeds.
 - c. Have the students label each of the bags and cups with their group number. Tell the students to label each bag and cup with one of the following:
 - 3 spoons lemon juice
 - 1 spoon lemon juice
 - Regular water solution
 - 3 spoons baking soda
 - 1 spoon baking soda.
 - d. Have students fill each cup with the same amount of water to keep the ratio consistent across all groups. You may decide to pick a line on the cup or measure an exact amount each cup gets. You don't need much water. Use just enough to soak the sprouters to the concentrations of lemon juice and baking soda are stronger.
 - e. Have students add the amount of lemon juice and baking soda marked on the cups. If you have pH test strips, students can now test the pH of the water in the cups.
 - f. Soak 1 growing cube in each cup. When the growing cube is soaked, take it out and add 2 seeds to the cube. Put the cube face up in the correspondingly labeled zip bag and seal the zip bag. Do this for all 5 growing cubes.
7. Closure.
 - a. Follow up on diagrams made or pictures taken.
 - b. Make predictions.
 - Have students make a prediction in their science notebook about which of the 5 solutions will be optimal for plant growth.

c. Plan for collecting data.

- Ask students how they will observe and measure plant growth. Have students record their ideas in their science notebooks.

1. Depending on the amount of time you want to dedicate to the following lesson (Lesson 4: Optimal Sprouting Conditions: Part 2) will determine how you will measure growth of the seedlings.

2. If you decide to measure how quickly the seeds germinate, you will have to check on the seed bags daily. If you decide to measure the height of the plant or how many sprouted, you could pick a single day 5-10 days later to collect data.

d. Move zip bags to a warm area with light.

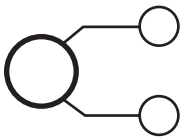
- Classroom temperature and light will work, but it may take longer to sprout.

ASSESSMENT



- Check student predictions and ideas for collecting data that they recorded in their science notebooks.

EXTENSIONS



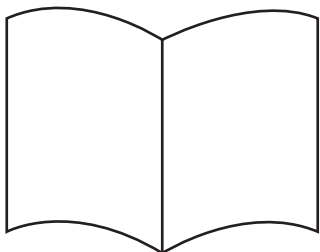
- Have students make predictions in science notebooks about what would happen if they used different juices in this experiment such as orange juice or apple juice. Would the results be similar or different from the lemon juice? What are some other liquids or juices that would be interesting to try?

Lesson 1

Exploring Renewable Energy



OVERVIEW



LESSON DESCRIPTION: Students will define renewable and nonrenewable energy sources. Students will explore if and how their hydroponic system could be connected to a renewable energy source.

PERFORMANCE EXPECTATION(S): 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

THREE DIMENSIONS OF SCIENCE LEARNING



SCIENCE & ENGINEERING PRACTICES:

Obtaining, Evaluating, and Communicating Information

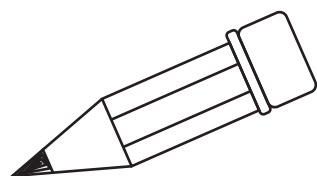
DISCIPLINARY CORE IDEAS:





ESS3.A: Natural Resources

CROSSCUTTING CONCEPTS:

Cause and Effect

SPECIFIC LEARNING OUTCOMES



-  Students will distinguish between renewable and nonrenewable energy sources.
-  Students will identify sources of renewable and nonrenewable energy.
-  Students will research and present information about renewable energy sources.
-  Students will use their knowledge to identify if and how their hydroponic system could be adapted to use renewable energy.

BACKGROUND INFORMATION



PRIOR STUDENT KNOWLEDGE:

Students should

- be familiar with the concept of energy and common types of energy sources
- understand the many ways we use energy

TEACHER BACKGROUND:

There are two types of energy sources: nonrenewable and renewable. Nonrenewable energy resources, like coal, nuclear, oil, and natural gas, are available in limited supplies. This is usually due to the long time it takes for them to be replenished. Renewable resources are replenished naturally and over relatively short periods of time. The five major renewable energy resources are

solar, wind, water (hydro), biomass, and geothermal.

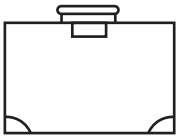
Since the dawn of humanity people have used renewable sources of energy to survive — wood for cooking and heating, wind and water for milling grain, and solar for lighting fires. A little more than 150 years ago people created the technology to extract energy from the ancient fossilized remains of plants and animals. These super-rich but limited sources of energy (coal, oil, and natural gas) quickly replaced wood, wind, solar, and water as the main sources of fuel.

From:

<https://ww2.kqed.org/quest/2014/02/13/nonrenewable-and-renewable-energy-resources-2/>

POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS: Students may not know the difference between renewable and nonrenewable energy sources. Students may not be aware of the environmental impacts of some popular energy sources.

MATERIALS



Science Notebook

Quantity: 1 per student

Pencils

Quantity: 1 per student

PROCEDURES



ENGAGE: OPENING ACTIVITY - PRIOR LEARNING & GENERATE QUESTIONS

Discuss behavior and learning expectations prior to going to the hydroponic system. Students will gather at the designated classroom.

1. Ask students: *What is energy? Where does energy come from?* Allow students time to think individually and then share with a partner.
2. Ask for volunteers to share ideas with the class. They may need guidance in pinpointing the exact energy source (ex. gas for cars comes from fossil fuels.)
3. Make a list of the different kinds of energy sources on the whiteboard or chart paper.
4. As a class, classify the energy sources as renewable or nonrenewable using the sites below or any books of your choice.

- Renewable Fuels:

<http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/renewable-fuels.htm>

- Fossil Fuels:

<http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/fossil-fuels>.

5. In their science notebooks, students should record renewable and nonrenewable energy sources and a definition of each in their own words.

Renewable Energy Sources <small>Define: can be used again and again.</small>	Nonrenewable Energy Sources <small>Define: limited supply</small>
wind	coal
solar	oil

6. Lead a discussion about the environmental impacts of fossil fuels (ex. pollutants, and the need to use more renewable energy



EXPLORE: LESSON DESCRIPTION - PROBING OR CLARIFYING QUESTIONS

1. Watch this video as an introduction to the different kinds of renewable energy: <https://www.youtube.com/watch?v=1kUE0BZfTRc>
2. Assign groups to research solar, wind, hydro, geothermal and biomass renewable energy sources.
3. Students should include the benefits, different types, and real world examples of the particular type of renewable energy.
4. Create a presentation of the teacher's choice.



EXPLAIN: CONCEPTS EXPLAINED & VOCABULARY DEFINED

1. Present findings to the class.
2. Record notes in science notebook about all types of renewable energy.
3. Write a brief paragraph explaining the different types of renewable energy and which type of energy they would like to see implemented in their community and why.

Vocabulary: energy-renewable, nonrenewable, solar, wind, hydro, geothermal, biomass



ELABORATE: APPLICATIONS & EXTENSIONS

1. Have students use their observation skills to identify what kind of energy is used to power their hydroponic system. (Your local energy supplier will likely have information about energy production in your area.)
2. Have students brainstorm ways that the unit could be connected to a renewable energy source. Possible guiding questions: Is there a window nearby to capture the sun's energy? Is there wind? Is there a water source they could connect it to?
3. Have students work in pairs or small groups to draw a prototype of their idea in their science notebooks.



EVALUATE: DISCUSSION & ASSESSMENT

1. Discussion Questions:
 - *What is energy? Where does energy come from?* (Students should be able to come up with different types of energy, but may need help identifying the origin (ex. gas for cars is a fossil fuel.)
2. Science Notebooks:
 - Record renewable and nonrenewable energy sources and a definition of each in their own words.
 - Record notes in about all types of renewable energy from the class presentations.
 - Write a brief paragraph explaining the different types of renewable energy and which type of energy they would like to see implemented in their community and why.
3. Presentation:
 - Students should include the benefits, different types, and real world examples of the particular type of renewable energy and present information to the class with their group.

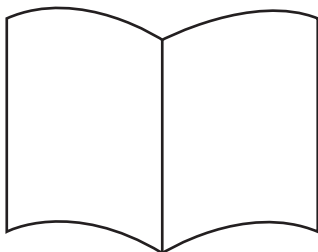
Health Lesson 1

Healthy Choices

Health



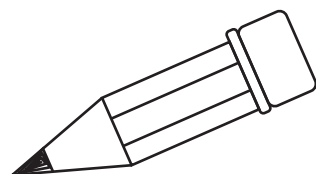
OVERVIEW



LESSON DESCRIPTION: Students will understand the components of a healthy eating plan which includes, but not limited to; portion sizing, types of foods and food preparation.

NATIONAL HEALTH EDUCATION STANDARDS: 5.5.5 Choose a healthy option when making a decision. 6.5.2 Identify resources to assist in achieving a personal health goal.

SPECIFIC LEARNING OUTCOMES



- Students will develop a plan that will incorporate others to make positive, healthy food choices.
- Students will create a design based on research that will help make a positive change for all students.

BACKGROUND INFORMATION



PRIOR STUDENT KNOWLEDGE:

Students should

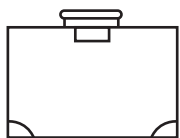
- be knowledgeable with the <https://www.choosemyplate.gov/>
- have knowledge of what is considered to be a healthy food option versus an unhealthy food option.

TEACHER BACKGROUND:

Teachers should preview the website <https://www.choosemyplate.gov/> before this lesson.

POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS: Students may feel that portion size is not important or does not matter when it comes to eating fruits and vegetables. Students may struggle with the concept of fresh food as outlined in school lunch versus fresh food from the hydroponic system. They may not feel that there is a difference. Students may have preconceived notions about what the definition of healthy truly is.

MATERIALS



iPad/Chromebook

Quantity: 1 per group

Pencils

Quantity: 1 per student

Pack of colored pencils or crayons

Quantity: 1 per student

PROCEDURES



ENGAGE: OPENING ACTIVITY - PRIOR LEARNING & GENERATE QUESTIONS

Discuss outdoor behavior and learning expectations prior to going to the hydroponic system. Students will gather at the designated classroom.

1. Ask students: *What are some of your favorite fruits? What are some of your favorite vegetables? Does anyone know what a lean protein is?*
2. Check for understanding and knowledge students have about fruits and vegetables.
3. Have students watch the following video about eating healthy and exercising:
<https://www.youtube.com/watch?v=fstlQDBaxV0&index=1&list=PL5SUN-qc7GC5sdNv50oeLnVmWnR-EXJDV>
4. While students are watching the video, they should look for answers to these questions and record in notebooks:
 - *What are the five food groups?*
 - *Do you have to give up your favorite foods and drinks?*
 - *How much exercise do kids need? What are some ways to stay active?*
 - *How can we learn about healthy eating on*
<https://www.choosemyplate.gov/> ?



EXPLORE: LESSON DESCRIPTION - PROBING OR CLARIFYING QUESTIONS

1. After the video, have students discuss what they learned in groups of four. Have each group choose a reporter.
2. Students can then add more notes to their notebooks after the group discussion.
3. Form a discussion circle and have the reporter from each group share the key points of their group's discussion. Teacher may chart key points on chart paper or a whiteboard.
4. If available, have students use a Chromebook or iPad and log on to:
<https://www.choosemyplate.gov/>

5. Have students explore each category and choose what they want to put on their plates.
6. Tell students: *Each group will use a large piece of posterboard to draw the plate and some portions of what students should be eating as a healthy plan for the day.*
7. Once the groups understand the criteria for creating and presenting their projects, have them present their posters to the class.



EXPLAIN: CONCEPTS EXPLAINED & VOCABULARY DEFINED

1. As students are sharing posters with class, ask students:
 - *Do you help plan the meals at your house?*
 - *How many fruits and vegetables should you eat each day?*
 - *What are some whole grains that you eat?*
 - *What kind of activities do you do to stay healthy?*

Vocabulary: healthy, portions, nutrition, food groups



ELABORATE: APPLICATIONS & EXTENSIONS

1. Ask students:
 - *What kinds of fruit are we growing that would be good for your plates?*
 - *What kind of vegetables do we have that we could add to your plates?*
 - *Are we growing any whole grains?*
2. Have the students gather in a discussion circle. Let the students know that this time is to be used to share ideas for feedback, ask questions if they are struggling with where to start, or just in general and to clarify questions. The teachers should prompt the discussion, but the students should be the ones sharing with one another. Teacher can encourage and interject as needed if students are a little apprehensive to share. You may need to remind them that even though they are working in groups, an idea that they feel makes sense to them may not once presented and it is always good to elicit outside feedback.
3. Return to the indoor classroom and if time allows, have the students time to play the games: <https://www.choosemyplate.gov/>



EVALUATE: DISCUSSION & ASSESSMENT

1. Discussion Questions:

- *What makes a meal healthy?*
- *What should be the largest items on your plate?*
- *How do you make a healthy meal?*

2. Poster Presentation - Teacher is checking for:

- half the plate is fruits and vegetables
- looking for low fat or fat-free dairy
- whole grains
- limited amounts of sugar
- oversized portions
- make sure they include activity somewhere
- drinking water instead of sugary drinks

SAMPLE