Green Our Planet's Hydroponic STEM Curriculum K-5

Hands-On STEM Teaching Curriculum, K-5

Second Grade Lessons

(First Edition)

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

IN Second Grade,

Students will participate in lessons and experiments with hydroponics that allow them to describe and classify different materials by their observable properties and to analyze data to determine which materials are best suited for an intended purpose. Students conduct investigations to determine that plants need water and sunlight to grow as well as run experiments to determine how a plant's survival is affected when deprived of specific needs. Additionally, students will learn about pollination by manually pollinating hydroponically-grown plants with a simple model that mimics the way plants and animals pollinate plants in nature. Throughout the lessons, second grade students will make observations and gather information about solving the problem of growing plants without soil. The lessons conclude with students designing and engineering a hydroponic system that can be used to solve the problem of growing plants without soil by developing a new or improved tool.

Lessons:

1. **What Does A Plant Need?** - Students will identify the four major elements plants need to survive: water, light, nutrients, and air. Students will be divided into 4 groups and each assigned one of the 4 elements. The groups will then design an experiment to prevent the plant from getting their assigned element and record what happens.
2. **Introduction to Hydroponic Systems** - Students will investigate Deep Water Culture hydroponics systems, draw diagrams, label parts, and brainstorm ideas about materials the class could use to construct their own DWC hydroponics system.
3. **Hydroponics: Past, Present, and Future** - Students learn about the ancient origins of hydroponic growing methods, learn about hydroponic businesses of today, and explore the idea of hydroponics in the future, such as space travel, and the possibility of farms in deserts or frozen environments.
4. **Diving Into Deep Water Culture** - In this lesson students investigate different types of hydroponic systems. They then find out that the class will be engineering a Deep Water Culture System. Students will draw a diagram of the system and begin brainstorming ideas for the project.
5. **Sink or Float?** - In preparation of creating a Deep Water Culture Hydroponics System students will make predictions then test a variety of materials to determine if they sink or float to determine what types of materials would be best suited for constructing a floating hydroponic plant raft.
6. **Building a Hydroponic System** - Students will work together either in groups or as a class to build a Deep Water Culture System. This can be one larger system for the whole class, or several smaller ones for each group to manage.

Env.7. **Hydroponic Redesign -** Students will learn about how materials are recycled and reused and how best to recycle in their area. Students will identify a container that they can reuse as a hydroponic system. Students will design and build the hydroponic system, using the container.

.. **Transplanting** - Students will learn how to transplant seedlings or purchased plants into the DWC hydroponic system that their class engineered in the previous lesson

9. **Indoor vs Outdoor Habitats** - Students examine the roles that insects play in a garden habitat. Students then compare indoor hydroponic gardens and traditional outdoor gardens to discuss and compare the benefits and drawbacks of each situation.
10. **Pollinating Plants** - students will further learn about the importance of pollinator insects. They will solve the problem of how to pollinate plants in an indoor hydroponic system where insects are absent.
11. **Graphing Growth** - Beginning in lesson 7 students started collecting data on plant growth after transplanting plants into the classroom system. Graphing Growth has the students review the data the was collected and create picture graphs to show how their plant grew over time.

Env.12. **Resource Rescue -** Students will learn how we use natural resources such as water, land, air, plants and animals. They will explore how a hydroponic system conserves natural resources while producing food and allowing us to explore STEM.

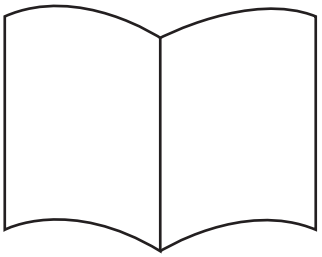
H1. **Nutrition** - Students learn about the nutritional value of different vegetables and fruits found in the hydroponic system.

H2. **Making Healthy Choices** - Students design and create a game to review healthy and unhealthy lifestyle choices.

2nd Lesson 1
Hydroponic Redesign

Environmental Awareness

OVERVIEW



LESSON DESCRIPTION: Students will learn about how materials are recycled and reused and how best to recycle in their area. Students will identify a container that they can reuse as a hydroponic system. Students will design and build the hydroponic system, using the container.

PERFORMANCE EXPECTATION(S): 2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for the intended purpose. K-2-ETS1-3 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

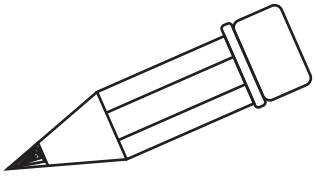
THREE DIMENSIONS OF SCIENCE LEARNING

SCIENCE & ENGINEERING PRACTICES: *Planning and carrying out investigations*

DISCIPLINARY CORE IDEAS: *Structures and properties of matter*

CROSSCUTTING CONCEPTS: *Structure and Function*

SPECIFIC LEARNING OUTCOMES



- Students will describe how some materials are recycled.
- Students will analyze the properties of different containers to determine their suitability for building a hydroponic system.
- Students will analyze the success of their design and suggest changes.

BACKGROUND INFORMATION

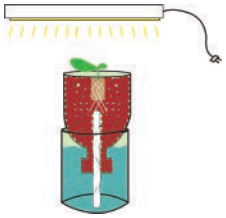
PRIOR STUDENT KNOWLEDGE:

Students should

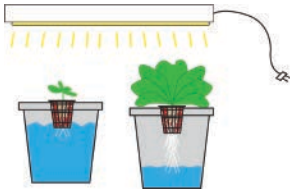
- Have basic knowledge that recycling means that the trash doesn't go to the landfill, but is reused in some way.
- Have some knowledge of hydroponics.

TEACHER BACKGROUND:

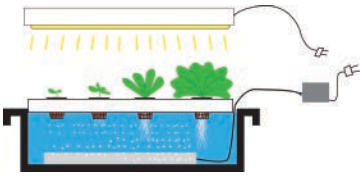
Reduce, reuse, and recycle has long been the rallying cry of the environmental movement, and many people try to work these ideas into their daily lives. Recently, we have come to realize that recycling has some limitations. To do it best we need to understand what is truly recyclable and how best to do it in our communities for maximum effect. For example, not all plastics are recyclable, even if they have the chasing arrows symbol on them, and they are certainly not recyclable if they are soiled or contain left-over product. The markets for all recycled materials change constantly. Different communities have different recycling capabilities.



Kratky



Wicking



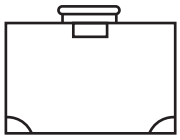
D.W.C.

Students can benefit from exploring the properties of materials to better understand their suitability for use or reuse in projects. For example, plastic and metal containers are great for holding liquids, whereas cardboard boxes are not. However, a milk carton is a paper container that has been modified to hold liquid.

Simple hydroponic systems can be built out of a multitude of different containers, including yogurt and cottage cheese containers, drink bottles, milk cartons, tin cans, and more. Kratky systems consist of a container with one or more holes to hold a small plant contained in a planting pod. Wicking systems add a wick that brings the water up to the plant. A small pump with an air stone can be added to create a deep water culture system (DWC).

POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS: Students may not know what materials are truly recyclable. Students may initially have the wrong definition of "property" in mind.

MATERIALS



- Science Notebook
  Quantity: 1 per student
- Pencils
  Quantity: 1 per student
- Device to show videos in lesson
  Quantity: Enough per class

PROCEDURES

ENGAGE: OPENING ACTIVITY - PRIOR LEARNING & GENERATE QUESTIONS

1. Tell students: *Today we are going to explore what it means to recycle or reuse something. First let's think about recycling.* Have students think, pair, and share with a partner their ideas about recycling.

2. Lead a class discussion. Ask students: *Do you know how things like paper and plastic bottles are recycled? What do you think is made out of recycled materials?* Present info about how common items are recycled by using information from this website https://www.eschooltoday.com/waste-recycling/what-is-recycling.html or video resources like these:
   - Aluminum cans: https://youtu.be/t4PLxg06HBU or https://youtu.be/KmMP67eC2tg
   - Paper: https://youtu.be/jAqVxsEgWIM or https://youtu.be/2c8YxMb0tlk
   - Glass: https://youtu.be/p47YlUUXuJE
   - Plastic: https://www.recyclenow.com/recycling-knowledge/how-is-it-recycled/plastics
   - Overview of metal, plastic and paper: https://youtu.be/VlRVPum9cp4

3. Lead a discussion with students. Ask students: *What do you understand about recycling?* Make an anchor chart to show student ideas. Then ask students: *What if we can't recycle something? Is there another way to keep it out of the landfill?* Allow students time to respond.

4. Tell students: *Let's think about the idea of reuse. You may have heard of the 3 R's—reduce, reuse and recycle. One of the things we know is that when we reuse something we are helping to conserve natural resources. We also know that growing plants using hydroponics helps conserve natural resources like water, energy and space.*

5. Ask students: *What if we combined those two ideas?* Allow students time to respond. Tell students: *Let's think of ways to reuse some materials to make a hydroponic system.*

LESSON DESCRIPTION - PROBING OR CLARIFYING QUESTIONS

1. Remind students of their food waste study or when they have noticed food packaging lying around on the ground, in the trash, or even in the recycling bin.

2. Ask students: *Could any of those packages have been reused to make a hydroponic system? What do you need for a hydroponic system?* Allow students time to respond.

3. Tell students: *All you need is a container for some water and a way to put the plant roots in contact with the water.*

4. Show students some examples of recycled material or DIY hydroponic systems.

5. Have students work with partners or small groups to make short lists of materials they see in the examples. Have students record their lists in their science notebooks.

6. Ask students: *Have you seen materials like these being wasted?* Allow students time to respond.

7. Tell students: *Let's work as engineers to try to reuse some of the materials to build hydroponic systems.*

EXPLAIN: CONCEPTS EXPLAINED & VOCABULARY DEFINED

1. Allow students to work individually, with a partner or in a small group to design a hydroponic system using reused materials. You could have some materials on hand to serve as inspiration or ask students to bring items to class.

2. Allow students time to draw detailed diagrams of their proposed systems in their notebooks. Have them label the parts and write a short narrative of how the system will work as well as why the materials they used are well-suited for their purpose. (Ex. Plastic is good because it holds water. The metal can is good because it already had a hole in the top. ect.) Establish criteria with students. (Ex. Must hold water, must allow plant roots to come in contact with water, must hold ___ number of plants, must fit in ____ space, etc.)

3. Schedule time for students to present their ideas to others either in a whole group or gallery walk setting. Students could leave feedback for the engineers using sticky notes.

4. Have students write a narrative in their notebooks, explaining how reusing their materials differs from recycling the material. Possible questions to answer: *Would it have even been possible to recycle the materials you used? How could you improve your design? What other materials would be well-suited to your design? Why?*

Vocabulary: hydroponic system, design, proposal, diagram

ELABORATE: APPLICATIONS & EXTENSIONS

1. Create a system for students to rate the proposals. For example: Best use of materials, most plants grown, simplest to build, etc.

2. Have students build their systems and test them.

3. Have students create a live or recorded commercial for their systems.

EVALUATE: DISCUSSION & ASSESSMENT

1. Discussion Questions:

- *What does it mean to recycle something?* (Students should be able to explain that to recycle something means to melt it down and turn it into something else.)
- *How are various materials recycled?* (Students should be able to describe the different processes of recycling for ex. paper, metal, plastic, aluminium, ect.)
- *What if we can't recycle something?* (Students should be able to explain what happens when a material cannot be recycled. Ex either thrown away or reused.)
- *What kinds of reused material would work well in a hydroponic system?* (Students should be able to list materials that can be made into a hydroponic system such as yogurt and cottage cheese containers, drink bottles, milk cartons, tin cans, ect.)
- *What are the criteria for building a successful hydroponic system?* (Students should be able to explain that a successful hydroponic system holds water and the plant roots are in contact with the water.)

2. Science Notebooks:

- Students drawing or diagram of their hydroponic system should include labels and explanations of their systems.
- Students should write a narrative explaining how reusing is different than recycling.
- Students should also write an analysis of their design in their narrative.

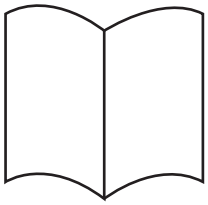
2nd

Lesson 10
Pollinating Plants

VIDEO LESSONS

Check for the matching curriculum at www.greenourplanet.org
https://video.link/w/JTBrb

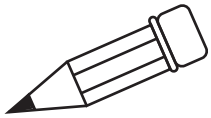
OVERVIEW



Students will learn about the importance of pollination and the role that beneficial insects play in the process. Students will solve the problem of how to pollinate plants in a hydroponic system when insects are absent from the process.

Question: How do plants get pollinated in an indoor hydroponic system where pollinator insects are not present?

OBJECTIVE(S)



Students will:

- learn that plants depend on animals for pollination.
- understand that the structure of animal helps plants disperse seeds or pollinate.
- develop a simple model to mimic an animal dispersing seeds or pollinating plants.

STANDARDS

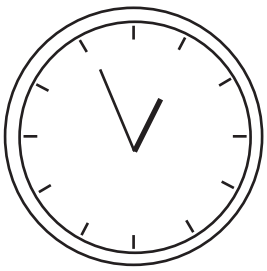
Nevada State Academic Content Standards:

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

LS2.A. Plants depend on animals for pollination or to move their seeds around.

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

TIME



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

TEACHER BACKGROUND

Many plant species rely on insect or animal pollinators, such as bees, which carry pollen from one plant to another or facilitate self-pollination as they buzz around inside a flower. In greenhouses or indoor hydroponics, these natural processes may still occur to some degree from air movement, vibration, or shaking as plants are trained and pruned—all of which can help release pollen. However, many crops benefit from a helping hand as large amounts of pollen transfer, which helps ensure improved fruit size, shape, and uniformity.

Hand pollination is the most common method used for indoor fruiting plants. It is cheap, flexible, and if carried out correctly, highly efficient. The main consideration with hand pollination is timing. Pollen is only viable for a short period, and flowers open quickly under good growing conditions, so there is a short window of opportunity to get the job done. For self-pollinating plants like tomatoes and peppers, hand pollination simply involves tapping, shaking, or flicking the stem behind the flower itself or the flowering truss.

The gentle but rapid movement of the flower releases pollen from the anthers inside the plant—one can see this as a cloud of yellow dust billowing from the flower. Once released, the pollen falls on the stigma and rapidly begins to germinate. The resulting pollen tube then grows down the style, and the process of fertilization then occurs within a few hours. Fertilization of the flower results in the formation of seeds. In fruits such as tomatoes and peppers, the number of seed and the growth hormone these release determines final fruit size.

Crops, such as strawberries, are largely self-pollinating; however, they benefit from assistance to help release the pollen inside the flower. This can be achieved by hand pollination using a cotton swab or paintbrush.

MATERIALS

- Pollination video: Mission Pollination
  https://pollinatorlive.pwnet.org/teacher/bug_chicks.php?movie_file=BugChicks5.flv
- Chart paper
- Cotton swabs or small, unused paint brushes
- Science notebooks

PROCEDURES

1. Gather students in an area in front of the Smartboard or viewing area. Review with the students the necessary steps for plants to produce fruits and vegetables (pollination). Have a brief discussion about pollination. Depending on the students' level of understanding, you may need to read From Seed to Plant by Gail Gibbons to review the process of pollination.

2. Watch the video "Mission Pollination," and review the students' findings from Lesson 8.

3. Group students and discuss how the plants in the indoor hydroponic system can be pollinated without insects.

4. Tell students that they have a challenge: they are now the pollinators. How will they pollinate their plants? Let them discuss for a few minutes, and then introduce the cotton swabs or unused small paint brushes that they will use to pollinate the plants.

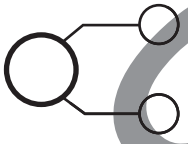
5. Model the process of pollinating by hand. Then allow pairs of students to gently pollinate the hydroponic plants using cotton swabs or clean paint brushes.
    a. (You will want to have flowering plants such as peppers, strawberries, or some other flowering plant present in the hydroponic system for this step. Bare root strawberries are a fairly common and good plant to put in hydroponics for this lesson)

6. Have students record what they learned about pollination in a hydroponics system in their science notebooks. Have students explain the strategy they used to solve the problem of not having insects to pollinate the hydroponic plants.

ASSESSMENT

- Science notebook recordings explaining the needs for self pollination in a hydroponic system
- Observation and class discussion

EXTENSIONS

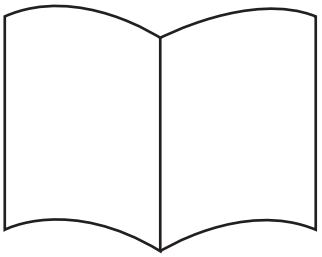


- Have students discuss the process of pollination by writing a brief story about pollination from the point of view of a bee and its journey to the center of a flower.

2nd Health Lesson 1 Nutrition

Health

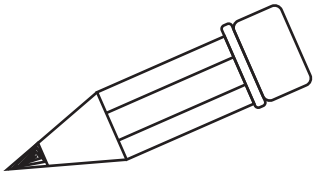
OVERVIEW



LESSON DESCRIPTION: Students will learn about the nutritional value of different fruits and vegetables in the hydroponic system.

NATIONAL HEALTH EDUCATION STANDARDS: 1.2.1 Identify that healthy behaviors impact personal health.

SPECIFIC LEARNING OUTCOMES



- Students will discover the benefits from eating a variety of fruits and vegetables.
- Students will learn that eating a variety of foods has a positive effect on personal health.
- Students will learn how to classify fruits and vegetables in the hydroponic system.

BACKGROUND INFORMATION

PRIOR STUDENT KNOWLEDGE:
Students should
- have some knowledge of the basic food groups: fruits, vegetables, dairy, protein, and grains.
- be able to name a few examples of foods from each food group.
- know that we need food to give us energy, vitamins and nutrients.

TEACHER BACKGROUND:
People who eat a diet rich in fruits and vegetables are less likely to develop certain health conditions like heart disease, stroke, diabetes, and even certain types of cancer. Most fruits and vegetables are naturally low in fat, sodium, and calories. Different types of fruits and vegetables give us different nutrients such as potassium, dietary fiber, vitamins A & C, and folic acid. Potassium is found in bananas, prunes, peaches, dried apricots, cantaloupe, honeydew, spinach, sweet potatoes, tomatoes, and lentils. Raspberries, mangoes, apples, bananas, oranges, strawberries, carrots, beets, broccoli, and artichokes are all good sources of fiber.

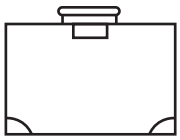
SPROUTS HEALTHY COMMUNITIES FOUNDATION

Citrus fruits such as oranges, lemons, kiwi, grapefruit, chili peppers, spinach, kale, and broccoli are good sources of both vitamin C and folic acid. Children ages 4-8 should have 1-1 ½ cups each of fruits and vegetables each day.

*This lesson would work best if taught in conjunction with a fruit/vegetable harvest from your hydroponic system, but it is not necessary. If you do not have fruits/vegetables (especially tomatoes) planted in your school gardens - you will need to modify parts of this lesson.

POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS: Students know they are supposed to eat fruits and vegetables to stay healthy, but many young children are picky eaters and will only eat a few of each of these types of foods. Students may not realize that a variety of fruits and vegetables also means a variety of vitamins and nutrients. Students may not fully understand what defines a fruit or vegetable.

MATERIALS



- Science Notebook
  - Quantity: 1 per student
- Pencils
  - Quantity: 1 per student
- Variety of fruits and vegetables and disposable plates
  - Quantity: Enough for class/per student group

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 is your favorite fruit? Vegetable?* Give students a few minutes to write down their own ideas in their science notebooks. You could provide the sentence stem: My favorite fruit is _____, because _____.

2. Next, have students turn to a partner to share their completed sentence. Allow several students to share their favorite fruits and vegetables until you get a variety of ideas.

3. Ask students: *How many fruits and vegetables should you eat in a day?* Discuss as a whole group and tell students they should have a cup and a half of each everyday.

EXPLORE: LESSON DESCRIPTION - PROBING OR CLARIFYING QUESTIONS

1. Gather materials to visit the hydroponic system to observe any fruits and vegetables growing. Students will need their science notebook and a pencil to record observations.

2. Give students time to explore your hydroponic system looking for any fruits or vegetables. They should draw and write observations about anything they find.

3. Gather students around the plants to share observations. They should share the name of the item and if they think it is a fruit or vegetable. Allow other students to share if they agree or disagree with the fruit and vegetable classifications by asking for "thumbs up" or "thumbs down."

EXPLAIN: CONCEPTS EXPLAINED & VOCABULARY DEFINED

1. Once you have returned to the classroom, show the students this video from the *SciShow* explaining how to tell fruits and vegetables apart. Is it a fruit or vegetable?: https://www.youtube.com/watch?v=DTK-uWx_VQo Through watching the video students will learn that some types of produce are considered a fruit according to botanists because of the way they grow.
2. Ask students: *Why is it important to eat fruits and vegetables each day?* Discuss whole group. Students should have some ideas about fruits and vegetables giving us vitamins and nutrients.

3. Ask students: *Do you think it is okay to eat the same fruits and vegetables everyday?* Discuss whole group. At the end of the discussion, students should understand that it is important to eat different fruits and vegetables each way because they give us different nutrients.

4. Have students make a list of as many fruits and vegetables as they can think of. You can make this a contest between groups of students and give them a time limit, you can brainstorm ideas whole group, or you can project the below linked fruit and vegetable quizzes, which I like to use so students can see pictures of the different foods you are discussing. The whole idea is to get a list of many different fruits and vegetables. Fruit Quiz: https://www.listchallenges.com/how-many-of-these-fruits-have-you-eaten & Vegetable Quiz: https://www.buzzfeed.com/natalyalobanova/youve-not-really-lived-if-you-havent-eaten-at-least-50-of

5. Next, have students work with a partner or a group of three to research one fruit and one vegetable from the list. You can have students choose their foods to research or you can assign them. It is important to make sure there are a variety of fruits and vegetables being researched and make sure to include the items growing in your hydroponic system.

Vocabulary: vitamins, nutrients

ELABORATE: APPLICATIONS & EXTENSIONS

1. Students can use technology to research their fruit and vegetables. They should record the following information in their science notebooks:
    - Name of fruit/vegetable
    - Drawing
    - Nutrients/Vitamins
    - How much is one serving?
    - Recipe Ideas
    - Could we grow this fruit/vegetable in our hydroponic system? Why or why not?

2. Once students have completed their research, host a "Fruit and Vegetable Tasting" where students will share their information and bring in samples of the food they researched from home. You can also do this in conjunction with a fruit/vegetable harvest in your hydroponic system, or ask for donations from your local supermarket depending on your class' family involvement. Make sure to check for student allergies ahead of time. You can also have students share their research without the tasting.

Possible Extensions:

- Students could write a journal entry from the point of view of a food they researched.
- Students could practice measuring different amounts of fruits and vegetables.
- Students could write a journal describing any new fruits and vegetables they tried during the lesson.

EVALUATE: DISCUSSION & ASSESSMENT

1. Discussion Questions:

- *How many fruits and vegetables should you eat in a day?* (Students should understand that they need to have a cup and a half of each everyday.)
- *Why is it important to eat fruits and vegetables each day?* (Students should have some ideas about fruits and vegetables giving us vitamins and nutrients.)
- *Do you think it is okay to eat the same fruits and vegetables everyday?* (Students should understand that it is important to eat different fruits and vegetables each day because they give us different nutrients.)

2. Science Notebooks:

- Students should include the following information in their fruit or vegetable research:
  - Name of fruit/vegetable
  - Drawing
  - Nutrients/Vitamins
  - How much is one serving?
  - Recipe Ideas
  - Could we grow this fruit/vegetable in our hydroponic system? Why or why not?