Hydroponic Nutrient Solution

A Carolina Essentials™ Investigation

Overview

This student-designed investigation is an extension for the Visual Desktop Hydroponics Kit. In this kit, students investigate the phenomena of plant growth, from seed to mature plant, using a hydroponic growing system. After a structured investigation of a hydroponic technology, students will design an experiment to test different nutrient solutions. Class data is compiled and analyzed to obtain results. Any hydroponic growing system can be used to complete the investigation. Students should be familiar with hydroponics before beginning the investigation.

Life Sciences
Grades: 9–12

Essential Question

What nutrients are necessary for plant growth?

Investigation Objectives

Design and carry out an investigation to test the quality of hydroponic nutrient solutions.

Next Generation Science Standards* (NGSS)

HS-LS1-6. Construct and revise an explanation based on valid and reliable evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Design an investigation to compare hydroponic nutrient solutions.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	**Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

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TIME REQUIREMENTS

PREP	ACTIVITY
30 min	See below

Teacher Prep: 30 min (if using the Visual Desktop Hydroponics Kit)

Student Activity:

Experimental Design: 1 class period plus the evening

Experiment Setup: 30 min on day 2

Daily Experimental Measurements and Observations: 10 min (duration to be set by teacher)

Concluding Results and Class Discussion: 45 min

SAFETY REQUIREMENTS

MATERIALS (PER GROUP)

2 or 3 Visual Desktop Hydroponics Kits or other hydroponics kit

Water-soluble fertilizer such as Miracle-Gro, 4–5 L

Aqua Vega A and Aqua Vega B, 4–5 L (equal volumes mixed per directions)

1 light bank for each kit used

1 bucket

1000-mL graduated cylinder

10-mL graduated cylinder

1 thermometer per group

Baking soda, 20–40 g

Lemon juice, 20–40 mL

Distilled or deionized water, 1 gal

Scissors

HELPFUL LINKS

Carolina™ CareSheet: Germinating Seeds

Hydroponics Center

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Safety Procedures and Precautions

Use this kit only in accordance with established laboratory safety practices, including appropriate personal protective equipment (PPE) such as gloves, chemical splash goggles, and lab coats or aprons. Ensure that students understand and adhere to these practices. Know and follow all federal, state, and local regulations as well as school district guidelines for the disposal of laboratory wastes. Students should not eat, drink, or chew gum in the lab and should wash their hands upon entering and before exiting the lab.

The rock wool used in the Visual Desktop Hydroponics Kit is made from rock and potash. It can be a skin, eye, and respiratory irritant. When handling rock wool, avoid getting the material near the face. Use gloves to avoid potential skin irritation, and wash hands thoroughlyafter handling the material.

Teacher Preparation and Disposal

1. Set up the Visual Desktop Hydroponic Kits or other hydroponics kits as directed.
2. Place each hydroponics unit under a light bank.
3. Do NOT fill the units with nutrient solution until students have had a chance to design their experiment and have it approved. Students cannot test more nutrient solutions than there are hydroponic units.
4. Remind students to consider a control solution. Distilled or deionized water can serve as a control nutrient solution. Tap water, bottled water, or well water may contain minerals

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REFERENCE KITS

Carolina STEM Challenge®: Hydroponics Kit

Student Hydroponics Kit

Visual Desktop Hydroponics Kit

Hydro-Tube Gardening Kit

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Activity Procedures

Student Procedure

1. Brainstorm ideas for a testable question to investigate the effect of a hydroponic nutrient solution on plant growth. Write the ideas down.
2. Complete background research on hydroponic nutrient solutions and water-soluble fertilizers. Attach the research notes to the lab report.
3. Select the idea to test and rewrite the idea in question format. The question should include the topic and variables to be tested.
4. Identify the variables: independent (include a control group), dependent, and controlled. You are limited by the number of available hydroponic kits.
5. Write a step-by-step procedure.
6. Make a materials list.
7. Create a data table.
8. Describe how you will analyze the data.
9. Get approval from the teacher. Teacher initials _____
10. Conduct the experiment.
11. Analyze the data.
12. Make an evidence-based claim.
13. Write a formal lab report.
14. Share the results with the class.

Teacher Tips

1. Brainstorming can be done as a class or group discussion. You may want to limit the possible ideas to a few choices based on the available materials.

2. You may decide on 1 or 2 questions for the entire class to investigate so there is ample data to analyze.

3. Remind students that they need a control group.

4. Check this carefully to make sure the procedure is doable.

5. Make sure all materials are readily available.

6. Check and initial each student, group, or class design.

7. Individuals, groups, or the class may analyze data. Analysis should include group averages and graphing at minimum. If the sample size is large enough, descriptive statistics can be added. If the whole class is contributing data, keep a digital spread sheet and complete the analysis together.

8. After students share results, hold a class discussion addressing the results, problems with the experimental design, and any changes that should be made.

Data and Observations

Students may choose to measure variables like plant height, root length, mass of the plant with the pot after draining for a period of time, number of leaves, or days to sprout. Emphasize consistency in measurement and always use the same tool. All data should be in table format with variable names and units of measure included.

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Analysis and Discussion

Students may choose to measure variables like plant height, root length, mass of the plant with the pot after draining for a period of time, number of leaves, or days to sprout. Emphasize consistency in measurement and always use the same tool. All data should be in table format with variable names and units of measure included.

At a minimum, students should graph the data and calculate averages for each group. Additional statistical analysis should be directed by the teacher.

For reference:

Aqua Vega NPK = 5-3-10

Trace elements include calcium (Ca), manganese (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), boron (B), copper (Cu), and molybdenum (Mo).

Miracle-Gro NPK = 24-8-16

Trace elements include boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn).

TEACHER NOTES