

# SCIENCE FAIR CENTRAL

## Maker Corner Activity



## FARMING FOR THE FUTURE

Grades 9-12

# MAKE. CREATE. EXPLORE.

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**Hydroponic farming could provide fresh food for an exploding population.**

## Overview

**Student groups will build a hydroponic growing system using simple materials.** They will explore how hydroponic farming may have potential as a future way of providing fresh food for an exploding population and growing urbanization. They will learn about the importance of proper nutrients for plant growth and look at the potential advantages of plants that are grown in a hydroponic system.

## Have you ever wondered . . .

**With an increasing population and shrinking land and water availability, what does farming look like in the future - can we feed people without traditional methods of farming?** As the global population is expected to continue to rise rapidly, how are we going to feed everyone? People need fresh produce in their diet and for many people it is becoming increasingly more difficult and more expensive to get it. In rural areas, people are often able to grow their own garden in their backyard and go to local farmers markets to find fresh and healthy foods, yet many people living in cities have found themselves stranded in food deserts. A food desert is defined as an area where people do not regularly have access to foods that aren't fast food or heavily processed, nutrient poor foods.

This activity focuses on the **Defining the Problem, Designing Solutions, and Creating or Prototyping** stages of the Engineering Design Cycle.

### Engineering Design Cycle

- **Defining the Problem**
- **Designing Solutions**
- **Creating or Prototyping**
- Refining or Improving
- Communicating Results

## Objectives

**Students will be able to:**

**Examine** some of the issues surrounding how people grow and get their food and the lack of access to fresh food for many people in the U.S. and around the world.

**Discover** how the field of hydroponics and vertical gardening could help to solve some of the issues facing the agriculture industry in the future.

**Construct** a hydroponic growing system and evaluate the effectiveness of using this method to grow produce.



**Hydroponic farming requires no soil or land and uses less water.**

## Materials

- (1) package of Net pots
- (6) Storage totes (10-20 gal)
- Inorganic grow medium for the plants.  
This may include:
  - Viagrow 10 l Viastone Hydroponic Gardening Grow Rock Medium
  - Clay pellets - Hydro Crunch Expanded Clay Growing Media
  - Hydroponic 50 Liter 8 mm Aggregate Pebbles Pellets
  - Perlite grow medium - Miracle-Gro 8 qt. Perlite
- (6) Air pumps
- (2) packages of Air stones
- (1) 128 oz. Black Magic Base Nutrient A
- (1) 128 oz. Black Magic Base Nutrient B
- (1) 8 oz. Black Magic pH Down
- (1) 8 oz. Black Magic pH Up
- (1) Aquatest TruTest strips
- (1) pack Plant starter plugs
- (1) Seed tray with a heat mat
- Seeds (suggested seeds to start with include lettuce varieties such as romaine or spinach, or herbs such a basil)

Hydroponics is an innovative way of growing food that may help solve many of the problems that the agriculture industry faces today because it requires no soil or land, reduces the amount of water used to grow food, and could potentially produce a greater yield per area than traditional farming practices.



**As the global population is expected to continue to rise rapidly,  
how are we going to feed everyone?**



# Make connections!

## How does this connect to students?

Did you know that you can grow plants, such as lettuce, tomatoes, and strawberries without a garden or even without any soil? With so many people today living in urban areas that lack yard space to have a garden, growing produce with nutrient-rich water systems in their own homes is an option that can help ensure that people will always have access to the important nutrients that fresh fruits and vegetables give us.

## How does this connect to careers?

### **Horticulturalist—**

Horticulturalists work with plants, applying their knowledge to fruits, vegetables, ornamentals, and non-food crops to maximize their health or growth.

### **Agricultural Engineer—**

Agricultural engineers integrate technology with farming. For example, they design new and improved farming equipment that may work more efficiently or perform new tasks.

### **Hydroponics Grower—**

Hydroponics growers choose plants for each growing season. They develop a hydroponic system and time schedule for planting vegetables, herbs, and other plants. They also oversee the maintenance of hydroponic equipment, the greenhouse, and ordering of necessary equipment.

## How does this connect to our world?

Hydroponics and vertical farming are innovative ways that people in the agricultural industry are looking to help feed a growing global population that is faced with shrinking land available for farming. Giving people the tools and skills to easily grow fresh produce in urban areas where there is little space for a traditional garden can help maximize food production, while cutting down on food waste, water use, and eliminating food deserts in cities.



# Blueprint for Discovery

## Prior to the Class Arriving:

- Roughly 3-5 days before this activity, the instructor should start the plants that will be grown in the hydroponic gardens. This can be done by using a seed tray with a heat mat, plant starter plugs, and the seeds of your choice. Begin by soaking the plant starter plugs in water. Place 1 starter plug into each section on your seed tray, and place a few seeds into the middle hole in each plant starter plug. Plug in the heat source and make sure that there is light available for the plants (either natural light or a grow light will work.) This will give the plants a chance to germinate before being moved to the hydroponic garden, accelerating the growth of the plants.
- Organize the materials that students will use to construct their hydroponic garden. This includes filling each plastic tub with 6-8 net pots, a bag of substrate for their pots (clay pellets, perlite, etc.), an air pump with tubing, an air stone, and seeds.
- Depending on time and materials available, instructors may want to use a hole saw or knife to pre-cut 6-8 net pot holes in the lid of the plastic bin for students. (These holes should be slightly smaller than the 2" diameter of the pots)

## Whole Group Activity:

**1. Ask students to brainstorm** about what the future of farming and agriculture will look like. What do they think are some of the challenges that the agriculture industry will face?

**2. Ask students to share their ideas** with the class. As groups share, the teacher should display a list of these agricultural challenges on the board or overhead projector.

**3. Explain to students** that some of the challenges that the food production industry faces in the future can fall into the following 4 categories:

- a) a lack of land for farming
- b) the growing global population
- c) availability of fresh water for farming
- d) urbanization - an increase of people living in urban areas rather than rural ones

Ask students to categorize their ideas and the ideas of others in their DESIGN JOURNAL for this lesson.

**4. Ask students if they have ever heard of the term "hydroponic,"** and if so, what do they think it is. Explain to students that the Greek word "hydro" means water and the word "ponos" means work.



In a hydroponics growing system, it is the water that is doing all the work - not the soil, in fact there is no soil needed to grow plants!

**5. Show students the following video** that introduce them to hydroponics and how it is helping solve problems in food production: <https://www.youtube.com/watch?v=FecuxU0tMmE>

**6. Ask students to write down the advantages** of hydroponics that they discuss in the video in their DESIGN JOURNAL. Students should share the advantages with the class and add to their list as others share.

### **Small Group Activity:**

**7. Now explain to students** that they will be getting into groups to construct their own hydroponic growing system.

**8. In their DESIGN JOURNAL, ask students to write down the things that they think are essential for plants to grow successfully in a hydroponic garden.** If students have devices, they can go to the following link: <https://www.brainpop.com/games/whatplantsneed/> In this simulation, students will explore the conditions plants need to thrive and grow. They should also think about the video and what conditions they had to provide to plants in their underground hydroponics operation.

**9. Next, give each student group a plastic bin** that has been filled with the materials that they will need to build their hydroponic garden.

**10. Ask to students to examine all of the materials** they have been supplied with and discuss within their group what they think each of the materials would be used for in their garden - in what ways does this meet the plant's needs? They should complete the chart in their DESIGN JOURNAL by describing the importance of each part of their hydroponic garden in helping the plants to grow.

**11. Finally, before they begin construction, students should create a sketch** of how they will build their hydroponic growing system using the provided materials. The teacher should approve the sketch before allowing groups to build.

**12. While groups should be able to construct most of the hydroponic system themselves, the teacher may need to give them guidance along the way.**

**13. Once students have set up their system properly, they can monitor growth** and hopefully even have some fresh produce to eat in the coming weeks!



## Teacher Guidelines:

Students may wish to design their own hydroponic system and develop a plan to monitor their system. Listed below are directions for one method students could use to set up a hydroponic growing system:

1. Students should **open their plastic bin and get out their air pump** with tubing and their air stone.
2. The **air stone should be connected** to their air pump with tubing and the air stone should be placed in the bottom of their plastic bin.
3. **Set 1 net pot in down into each of the holes** that have been cut in the lid of the plastic bin.
4. **Run the tubing** connecting the air pump and air stone out through one hole that does not have a net pot in it.
5. **Use a hose to fill the plastic bin.** There should be enough water so that each of the net pots is filled with roughly  $\frac{1}{2}$ " of water so that the water will reach the plant's roots.
6. Now **add nutrients to the water.** Follow the instructions on whatever liquid plant nutrients are being used, such as Black Magic A and B base nutrients.
7. **Conduct a pH test** using a pH test such as the ones used to test pools and hot tubs. The optimal pH for the water in the hydroponic system should be between 5.8-6.2. If the pH is too high or too low, add a product such as Black Magic pH UP or pH DOWN to adjust it. (Follow the instructions on the containers.
8. **Rinse the growing medium with water** to make sure it is clean (clay pellets, viastone, etc.) and fill each of the net pots with the growing medium and one of the plant starts that has been grown by the teacher.
9. **Plug in and turn on your air pump** and make sure that the hydroponic system has been setup somewhere with an adequate source of light - in a school greenhouse or under artificial grow lights.

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## Take Action

Now that students have learned about hydroponics, they may want to explore the related fields of aquaponics and aeroponics! Students can compare and contrast these modern farming techniques. Here are a couple of videos about these additional ways of creating food with limited space:



- Aquaponic farming saves water, but can it feed the country?  
<https://www.youtube.com/watch?v=pqjHT8MFSow>
- This Farm of the Future Uses No Soil and 95% Less Water  
[https://www.youtube.com/watch?v=-\\_tvJtUHnmU&t=54s](https://www.youtube.com/watch?v=-_tvJtUHnmU&t=54s)

**Want another way of gardening with little space or no place to have an actual garden?** Students can go to the following link to learn how to create a vertical garden at home with their families!  
[https://www.homedepot.com/c/Build\\_a\\_Vertical\\_Herb\\_Garden\\_Project\\_Guide](https://www.homedepot.com/c/Build_a_Vertical_Herb_Garden_Project_Guide)

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## National Standards

### Science

#### Next Generation Science Standards

##### **HS-LS1-5 From Molecules to Organisms: Structures and Processes**

Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

##### **HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics**

Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.\*

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### Technology Education

#### Next Generation Science Standards and International Technology and Engineering Educators Association

**Students will develop an understanding of Technology and Society.** This includes learning about:

- The cultural, social, economic, and political effects of technology.
- The effects of technology on the environment.
- The role of society in the development and use of technology.
- The influence of technology on history.

**Students will develop an understanding of the Designed World.** This includes selecting and using:

- Agricultural and related biotechnologies
  - Energy and power technologies.
  - Manufacturing technologies.
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**Mathematical**    **Common Core**  
**Practice**

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**English**            **Common Core**  
**Language Arts**

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## References and Helpful Links

- <https://www.cdc.gov/features/fooddeserts/index.html>
- <https://www.environmentalscience.org>
- <https://www.agcareers.com>
- <http://www.conference.ifas.ufl.edu/aitc/presentations/Session%204/Hydroponics%20in%20the%20Classroom/Hydroponics%20in%20the%20Classroom%20PowerPoint%20Presentation.pdf>
- <http://www.growthtechnology.com/growtorial/what-is-the-ph-value/>



# Farming for the Future Design Journal

## Part 1: Identifying the Problem

**Brainstorm:** What are some of the challenges that the agriculture industry will face in the future? Write down your initial ideas here.

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Now place your ideas and the ideas that others have shared about the future of farming into the following categories:

Land Issues	Population Issues	Water Issues	Urbanization



## Part 2: Background Information/Research

### Research: What do plants need to grow?

You have learned that hydroponics involves growing plants without soil - something you have probably always learned that plants need!

Do some research to determine the things that plants need to grow. These are things that your hydroponic garden must be able to provide!

List the things that plants need to successfully grow here:

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Now, take a look at the materials that your group has been provided with to create your hydroponic garden. In the chart below, list what each of these materials will provide for your hydroponic plants:

<b>Storage tote w/ holes in the lid</b>	
<b>Net pots</b>	
<b>Grow medium (clay, rock, perlite)</b>	
<b>Air pump w/ tubing</b>	
<b>Air stone</b>	
<b>Black magic A &amp; B Base Nutrient solutions</b>	
<b>Black magic pH Up &amp; Down solution</b>	
<b>Aquatest TruTest strips</b>	



### Part 3: Design Sketch

In the space below, create a sketch of how you will assemble your hydroponic garden using the materials provided. Make sure to label each part of your garden!

