LESSON PLAN: No Soil? No Problem!

Understanding what plants need for growth

Description: During this science focused unit, students will argue what plants need for growth: nutrients and water through their roots and CO_2 from the air. To support their understanding of what plants need for growth, students will work in teams to solve the problem of designing and building a device to grow a bean plant without soil. NOTE: This unit doesn't specifically require any water or growing plants. However, the devices that teams build could be adapted for use in a class hydroponics system. See Appendix A.	
Grade Levels: 4-MS	**Objectives:** Students will: • Design a device to support plant growth that does not use soil. • Support the argument that plants need chiefly water and air, using evidence discovered through research. • Work as a team to create and present a project.
Duration: Three to Five 60-Minute Sessions	**Standards Connections:** ***NGSS Performance Expectations (PE)*** 5-LS1-1 • **Support an argument that plants get the materials they need for growth chiefly from air and water.** **NGSS Science and Engineering Practices (SEP)** 7, 3-5 Engaging in Argument from Evidence • **Construct and/or support an argument with evidence, data,** and/or a model. ***NGSS Cross Cutting Concepts (CCC)*** 5, 3-5 Energy and Matter: • Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. **Matter is transported into, out of, and within systems.** See Appendix A: Grade Level Modifications for 4th and MS standard connections and extensions

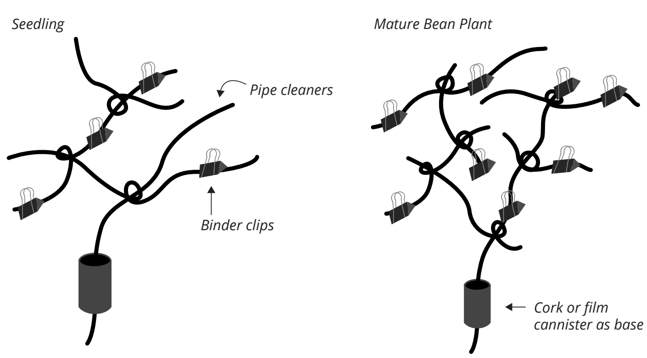
Materials:
Below there are categories of materials for students to build with that include suggestions for types of items. Look around your classroom, school, or ask students to bring in the materials you all can use during the design challenge. Material quantities are for a class of 32 students.

Filler	Connectors (100-200 total)
• 1 bag of Easter grass • Coffee filters • Tissue paper • 4 in x 4 in Fabric squares • 4 in x 4 in Burlap squares • Marbles • Plastic grocery bags • Soil (small quantity) *We recommend against using sand, pebbles or other soil analogy to prevent misconceptions about nutrient transfer from these "natural" materials	• Chenille stems (pipe cleaners) • 4-8 rolls of string or twine • Binder clips • Clothes pins • Paper clips
All Purpose Materials (100 total)	**Supports (100 total)**
• Straws • Plastic disc shapes • CDs • Toothpicks	• Popsicle sticks • Cake pop or lolipop sticks • Rulers • Paint stir sticks

Test Rig:
- Pre-made seeding and mature plants (see Set-up and prep).
- 1 fan for simulating wind.
- (Optional) Make a class hydroponics rig for authentic testing (see Appendix A).

Prep:

- Students will need rulers or tape measures to measure their device against the 5cm height criteria, or use popsicle sticks marked with a 5 cm line.
- Before the lesson, make two types of model plants (4 of each type of plant is recommended), using pipe-cleaners and binder clips to simulate vine and bean weight.
  - Seedling - use 2 pipe cleaners and 4-6 paper or lightweight foam leaves.
  - Mature bean plant - combine 2-3 seedlings, add binder clips or clothes pins to increase the weight of the plant and simulate bean pods
- Print handouts needed during unit: Evidence Notes, Data Collection sheet, and final assessments handouts. See Appendix D: Lesson Handouts.
- Preparing for content in Section C:
  - It is a commonly held misconception that the mass of a plant could come from the soil. If you look at a diagram of the process for photosynthesis you can see that the mass of a plant comes primarily from CO2 (from the air) and H20. If you are unsure of these concepts yourself, view the resources in Appendix C: Argument Learning Materials, before this session.
  - The Appendix C: Argument Learning Materials can also be used as sources for the student worksheet in Appendix D: Evidence Notes.



Test Rig example: Blue water line is 5cm high.

Tech Tips:

These one-page guides provide tips and best practices for facilitating design challenges

- Facilitating Brainstorming
- What is Engineering?
- Defining Criteria & Constraints
- Managing Materials
- Collecting Data
- Fostering Engineering Mindsets
- Sharing Solutions
- Innovation Design Process
- Assessing Design Challenge Learning
- The Language of Engineering

Lesson

A. Introduction (20-30 Minutes)

1. Help students build a context around food and access to introduce the unit:
    a. *Raise your hand if you have ever been to a farmer's market or picked your own fruit or vegetables in a garden or at a farm.*
    b. *(If students raise their hands, ask for their stories)*
    c. *What is your favorite fruit or vegetable?*
    d. *What would you do if the only way to get that food would be to walk five miles? Would you do that?*

2. Introduce the real-world problem with a discussion and brainstorm. Brainstorming with students allows them to use their prior knowledge to build understanding of a new topic or idea. To see options for conducting a brainstorm, see Tech Tip: Facilitating Brainstorming:
    a. *There are some places where people cannot get fresh food called **food deserts**. In cities and **urban** areas, the definition of a food desert can mean having to walk over 10 minutes to be able to access **produce**.*
    b. *Who might have a problem getting fresh fruits and vegetables if they have to walk over 10 minutes?* (Possible answers include: people with limited mobility, who have limited access to transportation, who have limited time.)
    c. *More than 23 million Americans live farther than one mile from a grocery store, which as we discussed, can make it very difficult to access fresh **produce**.* (For more information on this topic see, Appendix C: Resources - Food Deserts.)
    "Food Desert Statistics." Teaching Tolerance: A Project of the Southern Poverty Law Center, www.tolerance.org/. Web. 7 August 2018. https://www.tolerance.org/sites/default/files/general/desert%20stats.pdf
    d. *What are things we could do to increase access to **produce** in cities where people are not close to a grocery store?* (Possible answers include: open more grocery stores, send **produce**, open a farmer's market, grow food in the city.)
    e. *There are a lot of possible solutions for giving people access to **produce** in **urban** areas, in this unit we are going to focus on one specific option, which is growing food in a **food desert**.*

3. Introduce the real-world scenario for the assessment:
    a. *As a class we are going to focus on how we can grow food in **urban** areas to reduce the distance between people and the **produce** we need.*
    b. *Introduce the scenario.*

> *During this unit, we will be engineers. Our city has been looking into new ways to provide fresh **produce** for people in the community who live in **food deserts**. Your engineering firm (your team) has been given a grant by the city to spearhead the development of a device that will help people grow beans anywhere. After developing your device, your team will pitch your solution to the city council.*

    c. The reason we are going to design a device for beans is because they are a good source of nutrients people need to be healthy including, protein and fiber.

B. Engineering Challenge (60 Minutes)

1. Lead a discussion to introduce the concept of engineering. Tech Tip: What is Engineering? is a resource that can help guide the conversation with ideas on vocabulary and language use that can support students develop their fluency in engineering.

During this unit, we will be engineers. Our city has been looking into new ways to provide fresh ***produce*** *for people in the community who live in* ***food deserts****. Your engineering firm (your team) has been given a grant by the city to spearhead the development of a device that will help people grow beans anywhere. After developing your device, your team will pitch your solution to the city council.*

2. Give students an opportunity to think about what it looks like for a bean plant to grow, so they can think about what they will need to design.
    a. Show students visuals of what it looks like for a bean plant to grow. We recommend a timelapse video. "Bean Time-Lapse - 25 Days | Soil Cross Section." YouTube, GPhase, 7 March 2018. Web. 28 July 2018. www.youtube.com/watch?v=w77zPAtVTuI
    b. Ask facilitative questions to help students make meaning from the video.
        i. *What did you observe in the video?*
        ii. *How was the plant supported so it could grow taller?*
        iii. *What types of things do you think we need to build so that bean plants can grow in a city?* (Confirm that all students understand that air and water are things the plant will need.)
        iv. *Where will plants grow? Where won't plants grow?*

3. Create a context for students as to why they may not be able to grow beans in soil in **urban** areas to solve their engineering problem.
    a. *For our engineering challenge we are going to grow beans in* ***urban****/city areas which are sometimes called 'concrete jungles' because they often have little to no ground space for growing plants. In fact, even when there is soil it is often contaminated with pollution, which makes it a poor choice for growing* ***produce****. The cost of removing and replacing the contaminated soil can be too high for communities to afford.* (For more resources on soil contamination see, Appendix C: Resources - Soil Contamination.)
    b. *How much space do you think a bean plant will need to grow? What do you remember from the video?*
    c. *In what do you think we could grow a plant, if soil was polluted?* (Possible answers include: gel, something that can compact but move easily for the roots, "good" soil is also an acceptable answer at this time.)
    d. *What criteria and constraints do you think we should consider as we take on this challenge?* (The criteria and constraints provided in the Engineering Design Challenge should be up for discussion and incorporated as the educator sees as appropriate. Tech Tip: Defining Criteria & Constraints provides facilitation tips for guiding the understanding of and collaborative development of criteria and constraints.)

4. Introduce the engineering design challenge.

Design Problem: Design and build a device that will allow a seed to germinate and support a growing plant in the limited space available in **urban** environments.

Criteria* (Design Requirements/Desired Features): • Seed has access to air and water (at a height of 5cm). • Materials allow for downward root base below 5 cm line. • Vines are supported above the 5 cm line. • All team members must contribute to the design and building and take notes of their prototypes and changes on their data sheets.
Constraints* (Design Limitations): • **Budget:** a. Use only materials provided. b. Soil can only be used with two additional materials (see rationale below). • Device must have footprint of no more that 12 cm x 12 cm. *suggested sizes based on using strawberry baskets and gutter to build a "system". See Appendix A: Grade Level Modifications - Hydroponics Extension. • Schedule: You have 15 minutes to complete this challenge.
Testing: • Devices will be tested on whether they meet all 3 of the following: c. The seed rests at the 5 cm mark where it can access water and air. d. Their device holds up the "plant" with roots below the 5 cm mark and all leaves above it. e. The device can withstand a strong wind (by use of fan). • Test your device frequently and often at the testing station with optimal seed height scale and model bean plant! Can you help grow fresh food in food deserts? Give students a ruler to check for footprint size and seed height as they build.

5. Showcase available materials to teams. For facilitation tips on introducing and managing materials, see Tech Tip: Managing Materials.
    a. Inform teams that the cost of checking, cleaning or replacing soil in an **urban** garden can be very expensive. Therefore, if they choose to use soil in their design, they may only use two other items (i.e. two paper clips or two rubber bands).
    b. Encourage students to think of ways to "grow" their bean plant without soil.
    c. Discuss challenges a bean plant might face in an **urban** environment including increased winds from the tall buildings pushing air through like a wind tunnel.

6. Discuss with students how they will test their devices and how they will collect data to inform future designs. Tech Tip: Collecting Data provides facilitation tips for guiding this process.
    a. Provide students with the data collection handout (see Appendix D: Handouts - No Soil! No Problem! Data Collection Part B).
    b. Each team will be responsible for completing data collection for their design.
    c. Explain that teams will use the handout to create a labeled diagram of their prototype and record its performance during testing, including making note of **failure points.**

7. Form teams of 3-4 students. Give the teams 15 minutes to collect materials, build, and test at testing station.
    a. While students are working, walk around and ask questions to inspire creativity and perseverance. Tech Tip: Fostering Engineering Mindsets provides short descriptions of five critical mindsets that characterize successful innovators and tools students can use to reflect on their development of these mindsets.
    b. Some suggested facilitative questions are:
        i. *What criteria constraints are you finding the easiest to meet? The most difficult?*
        ii. *What parts of your device will support a growing plants? Roots? Leaves?*
        iii. *What have you tried so far?*

   c. For student teams that need an additional challenge:
      i. *What can you do to make your design work on extremely windy days?*
      ii. *How small can you make your prototype and still support the plant?*
8. Have teams share their solutions with the class. For ideas on facilitating a share out, see Tech Tip: Sharing Solutions.
   a. Ask questions to help each team communicate their ideas and reflect on their design.
   b. Possible questions include:
      i. *How will your device hold a full-grown plant?*
      ii. *How did the "cost" of soil affect your design?*
      iii. *Where are there **failure points** in your design? What changes will you make to try to resolve them?*
      iv. *How did your team persevere during this challenge?*
9. Engage students in a reflective discussion around their design challenge.
   a. Consider discussing the Engineering Design Process. Tech Tip: Innovation Design Process provides a graphic and description of this non-linear process.
   b. Reflect on the Engineering Mindsets with a focus on perseverance.

C. Content Learning (40-80 Minutes)

1. Teach students the structure of making an argument.
   a. *To convince the city that they will want to fund our project we will need to make a compelling **argument**. What do you think we would want to tell the city that might convince them to give us money to make our ideas a reality?* (Possible answers could include: We could ask for the money, we could show them how it will work, we could prove that our idea is the best.)
   b. Use the student answers to explain that an **argument** is a statement that can be supported by sufficient and relevant evidence.

2. Introduce the **argument** that they will need to make to convince the city to fund their project.
   a. *During our first challenge, we had a budget constraint on soil because of the cost involved with testing, cleaning or replacing polluted soil. To address a budget-focused government we need to research and prove we can grow the beans without the use of soil.*
   b. Explain that we, as a group will examine different sources to gather sufficient and relevant evidence to develop an **argument** that, "plants get the materials they need for growth chiefly from air and water."
   c. Provide and explain to students how to use the evidence handout (see Appendix D: Handouts - Evidence Notes).

3. Give students time to research the topic and gather evidence to support their argument for the discussion.
   a. Suggestions for learning materials are provided in Appendix C: Resources - Argument Learning Materials.
   b. Student understanding of the following key concepts are important to verify during this section:
      i. Plants get their **matter** from air and water (not soil).
      ii. **Matter** is a physical substance that occupies space (even air is made of matter).
      iii. Plants get their energy from sunlight (they do not "eat" soil).
   c. Facilitative questions to support the NGSS PE and CCC include:
      i. *What is* **matter***? (Matter is anything that takes up space.)*
      ii. *How does the weight of a plant change over time? Why? (A plant's weight increases as it grows and the amount of matter increases).*
      iii. *Where is **matter** coming into the plant system? Within? Out of? (Air and water go in and out of the plant system. Plants take in carbon dioxide and water and release oxygen.)*
      iv. *Why does your design not need soil? (Plants get energy from sunlight and matter from air and water, not soil.)*

4. Gather the class together to discuss what evidence they have found or heard to support the **argument** statement.
    a. *Raise your hand if you think you can give evidence that proves the statement, "plants get the materials they need for growth chiefly from air and water." What is the evidence? Where did it come from?*
    b. *(Use this method to gauge student confidence. Record student answers in a central location.)*
    c. *How could we draw a model to show others how a plant gets its matter from air and water?*
    d. *We will need to be able to draw a diagram of the bean plant in our prototype to show how it will work to allow the plant to grow.*
    e. Complete a drawing, as a class, to illustrate the argument they have supported with evidence. Encourage students to draw a sketch in their notes to help them with the assessment for this unit.
        i. Here is an example of how to draw a diagram of photosynthesis.
        KidsArtFun. "How to Draw and Color Photosynthesis - Labeled Science Diagrams." YouTube, 31 December 2017, Web. 7 August 2018. www.youtube.com/watch?v=dgaT2J6cfzk

D. Iterate Solution (30-40 Minutes)

1. Introduce the second design challenge.
    a. *As we learned while gathering evidence, plants gain mass over time and your plant has grown from the first challenge now: it is twice as big! You are going to have the chance to iterate your device as you consider:*
        i. *All the information you got from the first test about how your device met the criteria and constraints*
        ii. *Incorporate our understandings of what a bean plant needs to thrive.*
    b. Incorporate any criteria and constraints that your class decided on during the first design challenge or agree to for the second design challenge.

2. Explain the second design challenge to the students.

Design Problem: Design and build a device that will allow a seed to germinate and support a growing plant in the limited space available of urban environments.

Criteria (Design Requirements/Desired Features):
• Device must support a plant that has grown and is twice as heavy and twice as tall as the seedling
• Build a device that will provide a bean plant with the materials it needs to grow from seed to vine.
    a. Allow downward root growth.
    b. Allow upward vine growth with support.
• All team members must contribute to the design and building and take notes of their prototypes and changes on their data sheets.

Constraints (Design Limitations): • No soil will be used since it is not necessary and allows for a more inexpensive solution. • Device must have footprint of no more that 12 cm x 12 cm. *suggested size based on using strawberry baskets and gutter to build a "system" • **Budget**:   c. Use only materials provided. • Schedule: 15 minutes to complete this challenge (suggested).

Testing:
• Devices will be tested on whether they meet all of the following:
    d. Does the seed rest at the 5 cm mark where it can access water and air?
    e. Can your device hold up the "plant" with roots below the 5 cm mark and all leaves above it?
• Test your device frequently and often at the testing station with optimal seed height scale and model bean plant!

3. Give students 15 minutes to gather materials, build and test.
    a. Have students take notes, collect data on their prototypes as they build using a new copy of the "No Soil? No Problem! Data Collection" handout in Appendix D.
    b. While students are working, walk around and ask facilitative questions.
        i. *How is your device going to support the increased weight of the growing plant?*
        ii. *How is your plant getting the nutrients it needs to grow while in your device?*
        iii. *Which criteria and constraints are you meeting?*
        iv. *Which criteria and constraints are you not yet meeting?*

4. Share out on iteration.
    a. Emphasize improvements they made, why they made those improvements, what was their inspiration (maybe other team's designs).
    b. Make sure teams use their data from their data collection sheet to support their explanations.
    c. Possible facilitative questions include:
        i. *Can you show how plants get the necessary nutrients while growing in your device?*
        ii. *What are some solutions you saw other teams use that you would want to incorporate into your design?*
    d. Extension/bigger picture questions:
        i. *How could you design your device to support more plants?*
        ii. *How could you alter your device to work with less water?*
        iii. *How could you adapt your device to hold a smaller seed?*
        iv. *How would we test these ideas?*

E. Evaluation (120 Minutes)

1. Introduce and explain that the assessment for this unit has three parts. Explain what is expected of the students by going over the rubric and the assessment. (Appendix D: Handouts - Rubric and Final Assessment.)

2. Make the assessment as authentic as possible, try to invite the school principal and/or community members to attend the presentations and ask questions about the student's designs. For additional guidance on facilitating authentic assessment, see Tech Tip: Assessing Design Challenge Learning.
3. Give students 40-80 minutes to review their work from the unit, prepare a visual aid, and to practice their presentation with their team members.
4. When groups present, provide the audience (peers, administrators, community members) with a format for giving feedback, such as sticky notes to record "I like" and "I wonder" statements and including time for questions at the end of each presentation.
5. After the group presentations, provide students with the Individual Assessment for Learning handout to complete on their own. Use the rubric provided to help students evaluate their learning.

Appendix A – Grade Level Modifications

Grade	Standard	Modifications
4th	NGSS 4-LS-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	Students argue that plants have structures to support growth.
MS	NGSS MS-L-1-6 Construct a scientific explanation based on valid and reliable evidence that the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	Modify content in Section C: Content Learning to help students to understand the full role of photosynthesis in the cycling of matter by: • Students add evidence of the role of photosynthesis in cycling matter. • Students draw more specific model of how matter moves through the carbon system, photosynthesis, or with chemical formula.
Any		**Hydroponics Extension** Educator and students can build a hydroponics system to authentically test student devices. The system can be as simple as a length of gutter with end caps attached to a small fountain pump in a bucket to circulate the water. t40404. "DIY Hydroponics Using PVC Gutter (prototype): 11 steps." Instructables. Web. 23 August 2018. https://www.instructables.com/id/DIY-Hydroponics-using-PVC-gutter-prototype/

Appendix B – Vocabulary

The following is the start of a suggested list of words to discuss as you progress through this unit with students. For more in depth information about vocabulary and teaching information, visit Tech Tip: The Language of Engineering.

Term	Student-friendly definition
argument	An argument is a statement that can be proved and backed up by sufficient and relevant evidence.
food desert	A food desert is where families and/or neighborhoods do not have access to fresh food close by their homes.
matter	Matter is a physical substance that occupies space.
produce	Edible plant matter like fruits and vegetables.
urban	Urban is city living.

Appendix C - Resources

Argument Learning Materials

Explore Hydroponics	"The Future of Farming?" Scholastic Kids Press Corps, Scholastic. Web. 28 July 2018. http://kpcnotebook.scholastic.com/post/future-farming
Jan Baptist Van Helmont's experiments on photosynthesis	LSGScience. "Changing Ideas about Plants and Photosynthesis." YouTube, LSGScience, 25 April 2013. Web. 28 July 2018. https://www.youtube.com/watch?v=Ud-4tskogLA
Experiments to show conservation of matter	Thompson, Stephen and Christine Lotter. "Conservation of Matter in the Life Sciences." Scince Scope, NSTA. Web. 20 July 2018. http://digital.nsta.org/publication/?i=224549&article_id=1807144&view=articleBrowser&ver=html5#%7B%22issue_id%22:224549,%22view%22:%22articleBrowser%22,%22article_id%22:%221807144%22
Experiment to show air has weight	Funsciencedemos. "Balancing Balloons - Air Has Weight." YouTube, 30 September 2013. Web. 7 August 2018. https://www.youtube.com/watch?v=o5LT_wfl98w

Food Deserts

Map of food deserts in the U.S.A.	"Food Access Research Atlas." USDA ERS - United States Department of Agriculture Economic Research Service, 18 May 2017. Web. 28 July 2018. https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas/
News story about a food desert	PBSNewsHour. "Building an Oasis in a Philadelphia Food Desert." YouTube, 6 Aug. 2015. Web. 20 July 2018. https://www.youtube.com/watch?v=tayxf5q5y8c

Soil Contamination

Cleaning Soil Process	"Going for Green - Soil Cleaning in the Olympic Park." YouTube, Foreign & Commonwealth Office, 10 November 2010. Web. 28 July 2018. https://www.youtube.com/watch?v=l7y8kfX04gg
Article on contamination in community garden soil	Folstad, John, Sharon C. Long, Doug Soldat, and Geoff Siemering. "Soil Contaminants in Community Gardens." Web. 20 July 2018. https://learningstore.uwex.edu/Assets/pdfs/A3905-03.pdf

Appendix D - Lesson Handouts

Name:____ **Date:**_____________ **Class:**_________________________

No Soil? No Problem! Data Collection | Part B

Draw a diagram of your **device**. Include labels for:

- Seed germination site.
- Vine support.
- All materials.
- Any **failure points** observed during testing.

Date:	Prototype #:	Name:
Germination _______ Vine Support_______ Wind Test____		
Criteria and constraints this solution DOES meet:	Criteria and constraints this solution DOES NOT meet:	

Due to the high cost of soil we decided to: ____

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In our next design, we would: ____

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Our design supports plant growth because: ______________________________________

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Name:____ **Date:**_____________ **Class:**_________________________

No Soil? No Problem! Data Collection | Part D

Draw a diagram of your **device**. Include labels for:

- Seed germination site.
- Vine support.
- All materials.
- Any **failure points** observed during testing.

Date:	Prototype #:	Name:
Germination _______ Vine Support_______ Wind Test____		
Criteria and constraints this solution DOES meet:	Criteria and constraints this solution DOES NOT meet:	

To improve on our prototype and meet the new criteria of a heavier plant, some improvements we can make are:

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Describe how your new device supports the idea that plants get most of the material they need to grow from air and water.

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Name:____ **Date:**_____________ **Class:**_________________________

Evidence Notes

Directions: Read the following argument statement. Use different sources or activities to gather evidence to support the statement.

Argument: Plants get the materials they need for growth chiefly from air and water.

Source: **Notes and or Diagrams:**	**Source:** **Notes and or Diagrams:**
Source: **Notes and or Diagrams:**	**Source:** **Draw a diagram of how plants get their matter:**

Summarize what you have learned about plants from the information you gathered.

- How does the weight of a plant change over time?
- How do we know a plant can survive without soil?
- What **matter** enters the plant system?
- What **matter** becomes part of the plant?

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Name:____ **Date:**_____________ **Class:**__________________________

Final Assessment

City Council - Town Hall Proposal

Our local community has areas where people can't access fresh **produce**. You and your team have come up with a way for us to grow healthy fruits and vegetables without any soil. Now it is time to share your idea with everyone at city hall.

Design a presentation by any method your team prefers:

- Poster.
- Slideshow.
- Video.
- Storyboard.

Presentation should include:

- A detailed, labeled image of your device demonstrating how a plant obtains needed resources and support to grow.
- Make a persuasive **argument** on how a plant gets its matter without soil.
- Provide 1 example from your Evidence Notes handout.
- Provide 1 example of plants not needing soil to grow.
- Explain how your device meets the criteria and constraints of the challenge.
- Include a an explanation of how your device supports a plant's needs for growth.
- Support your work with evidence from your data collection or Evidence Notes research.
- Each team member should share some portion of the presentation.
- Presentations should be between 5-10 minutes.

Each student will also complete the individual assessment of learning.

Name:______________________________ **Date:**__________ **Class:**____________________

Individual Assessment of Learning

Draw a model of a plant growing in your device and label how **matter** flows in and out of the plant as it grows.

- How does air move into and out of the plant system?
- How does water move into and out of the plant system?

Explain how your device allows for the plant to continue to grow.

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RUBRIC: No Soil? No Problem!

	Below Standard	Approaching Standard	Meeting Standard	Above Standard
NGSS Life Sciences (PE) 5-LS1-1 **Support an argument that plants get the materials they need for growth chiefly from air and water**.	• Explanation of materials plants need for growth and where plants get those materials is missing or inaccurate. *Areas that individual students may need one-on-one support with:* • Understanding what a plant needs for growth. • Preparing for presentations. • Presentations in front of audiences.	• Explanation of materials plants need for growth is mostly accurate but does not include that air and water are the main materials. • Student explains that plants need air, soil, and water OR air and soil only.	In Team presentation: • Student cites an example of plants not needing soil to grow. • Student's argument explains that plants need air and water to grow	*Areas where students may exceed:* • Student's" presentation argument explains and demonstrates how plants get the materials to grow chiefly from air and water, but goes into the chemistry or discussion of nitrates. • Presentation is highly detailed and/or presentation is extremely easy to follow. Extra visual aids might be included. *Ideas for next steps for growth:* • Encourage students to research nutrients needed in water of hydroponic system. • Challenge students to research if and how air quality affects plant growth.
NGSS Engaging in Argument from Evidence on Earth and Human Activity (SEP 7, 3-5) **Construct and/or support an argument with evidence, data,** and/or a model.	• Diagram of device shows misunderstanding of the criteria and constraints or diagram is missing. *Areas that individual students may need one-on-one support with:* • Using the data collection form. • Getting evidence from sources.	• Mostly accurate labeled image that include some of the following: sunlight, water, air, and support. • Explanation lacks addresses some of how the device met or did not meet the criteria and constraints of the design challenge.	Final Presentation includes • A labeled image of the proposed device demonstrates how the plant needs access to sunlight, water, air and support as it grows. • An explanation of how the team met or did not meet all of the criteria and constraints of the design challenge	*Areas where students may exceed:* • Thorough, detailed, and nuanced explanation of how device meets the criteria and constraints. • Student conducts extra research to find evidence or explores a subtopic further. *Ideas for next steps for growth:* • Encourage students create and install a working prototype at school or at home. • Encourage students to grow a bean plant and document what they learn.
Energy and Matter (CCC 5, 3-5) Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. **Matter is transported into, out of,** and within **systems.**	• Diagram has no labels. • No explanation is provided. *Areas that individual students may need one-on-one support with:* • Thinking about what matter plants use to grow and where that matter can enter a plant system. • Practice drawing and labeling a scientific diagram.	• Diagram shows matter transported into **OR** out of the system through photosynthesis. • Limited explanation on how the device will support or allow for the bean plant's growth.	• Each student creates an individual assessment of learning that clearly and accurately labels the movement of air **and** water moving into and out of a plant.	*Areas where students may exceed:* • Thorough and detailed explanation of the transport of matter (e.g. Carbon in plants come from CO2) and energy in plant and device adding on the role of photosynthesis. • Goes into detailed analysis of other systems involved, including: carbon, water, decomposers, etc. *Ideas for next steps for growth:* • Have students to research the Law of Conservation of Mass and how hydroponics system demonstrates this. Let the student choose how they will demonstrate this understanding.