

**Grade Level:** 8-12

**Essential Understanding(s):**

- Hydroponics is a system to grow plants without soil, using a minimal amount of space.
- Hydroponics impacts humans and the larger environment.
- Plants influence and are influenced by biotic and abiotic factors.
- Scientific skills are applied to grow food.

**Learning Outcomes:**

- Students will be able to identify the growth cycle of plants.
- Students will be able to identify key structures and processes within a plant.
- Students will be able to describe the needs of plants.

**New York State Science Standards:**

Chemistry

Unit 1 – The Physical Nature of Matter

Effect of solute on solvent

- 3.4f – The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.

Unit 8 – Acids and Bases

Acids and bases

- 3.1t – On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.

Earth Science

Unit 4 – Landscapes

Water cycle

- 1.2g – Earth has continuously been recycling water since the outgassing of water early in its history. This constant recirculation of water at and near Earth's surface is described by the hydrologic (water) cycle.

Living Environment

Unit 1 – Scientific Inquiry

The role of scientific inquiry in studying biology

- 2.3a – Hypotheses are predications based upon both research and observation.



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- 2.3b – Hypothesis are widely used in science for determining what data to collect and as a guide for interpreting the data.
- 2.3c – Development of a research plan for testing a hypothesis requires planning to avoid bias.

### Unit 4 – Organization and Patterns in Life

#### Photosynthesis

- 5.1a – The energy for life comes primarily from the Sun. Photosynthesis provides a vital connection between the Sun and the energy needs of living systems.
- 5.1b – Plant cells and some one-celled organisms contain chloroplasts, the site of photosynthesis. The process of photosynthesis uses solar energy to combine the inorganic molecules carbon dioxide and water into energy-rich organic compounds and release oxygen to the environment.

### Unit 9 – Human influences on the environment

#### Decision making

- 7.3c – Human beings are part of the Earth’s ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems. Humans modify ecosystems as a result of population growth, consumption, and technology. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems may be irreversibly affected.

## Common Core Learning Standards:

### Anchor Standards

- R.2 Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
- R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.
- R.10 Read and comprehend complex literary and informational texts independently and proficiently.
- W.7 Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
- SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.



**Empire State Information Fluency Continuum Skills:**

Grades 9-12

- Shares ideas, asks questions, and makes references to print, non-print and electronic resources.
- Uses multiple sources for research projects.
- Uses skim/scan to locate main ideas and supporting evidence.
- Challenges ideas in text and makes note of questions to pursue in additional sources.
- Relates new information to prior knowledge and real-world experiences.
- Revises own point of view and preconceptions as new information is gained.
- Determines the significance of information to the specific research question.
- Evaluates, paraphrases, summarizes, and interprets information that answers research questions and gives an accurate picture of the research topic.
- Takes notes using one or more of a variety of note taking strategies, including reflecting on the information (e.g., graphic organizers, two-column notes).
- Takes notes by paraphrasing, summarizing, or selecting short segments to quote.

Stripling Model of Inquiry	Learning/Teaching Activities	Resources
Connect	<p>Pre- assessment: Instruct students to take a blank a sheet of paper and fold it in half. On the left side of the paper, the students will draw a plant. Give no further instructions. Allow approximately three minutes then instruct students to put the drawing aside for later. Students will return to these pictures in the post assessment.</p> <p>Each student receives a double-sided question/observation sheet.</p> <p>Show students a picture of a traditional farm. Students will generate observations, inferences and questions then record them on their 'Creating Questions from Observations' graphic organizer. Allow students one minute to share observations and questions with a partner. Pairs share out their best question/ observation.</p>	<p>Observation organizer. Print chart on BOTH sides of paper.</p> <p>Mini hydroponic system</p> <p>Overhead of Venn diagram</p>

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	<p>Show students the mini hydroponic system. Students will complete the graphic organizer. Allow students one minute to share observations and questions with their partner. Pairs share out their best question/ observation.</p> <p>The whole class will work together to complete the Venn diagram to identify similarities and differences between a hydroponic system and a traditional farm.</p>	
<p>Part 1: Wonder</p>	<p>This lesson involves the use of a Sunburst Model text set. All students read and analyze the same core text, then explore multimodal supplemental texts related to a specific aspect of plant biology in a jigsaw in Part 2. Students will demonstrate their basic understanding of plant biology in the post assessment by modifying their pre-assessment plant diagram.</p> <p><b>Group Annotation</b></p> <p>Arrange students in groups of four. Each student engages in a different task with the text:</p> <p>Student 1: Reads text, circles difficult vocabulary and writes a simple definition using their own words above each vocabulary word.        Student 2: Reads text, underlines the single most important thought in each paragraph.        Student 3: Reads text, shrinks the paragraph into a single short sentence (see side note.)        Student 4: Reads text, asks a question about what he/she reads in each paragraph. (see side note)</p> <p>When complete, each student will pass their page to the next student in their group. They will each complete the same task on the new student's sheet. The pages will be passed four times, until each student has written on all four sheets.</p>	<p>Class set of Plant Biology core text        - core text (L1180)        - core text (L780)        One dictionary or textbook glossary per group</p> <p>See notes below on guiding students through tasks:</p> <p><u>Summarizing (student 3)</u>= paragraph shrinking: If students struggle, have them answer the following 2 questions:        Who or what is this paragraph about? What is the most important thing I learned about that person or thing?</p> <p><u>Questioning (student 4)</u>= If they are struggling, offer these sentence starters:        What is the main idea of...?</p>

	<p>As a result, each student will have a sheet annotated by a total of four students.</p>	<p>What if...?          How does...affect...?          What is a new example of...?          Explain why...?          Explain how...?          How does this relate to what I've learned before?          What conclusions can I draw about...?          What is the difference between... and...?          How are...and...similar?          How would I use...to...?          What are the strengths and weaknesses of...? What is the best...and why?</p>
<p>Part 2:          Wonder</p>	<p>Jigsaw activity on four topics within plant biology:</p> <ol style="list-style-type: none"> <li>a. <b>Plant growth cycle</b></li> <li>b. <b>Photosynthesis</b></li> <li>c. <b>Elemental needs of plants</b></li> <li>d. <b>Plant anatomy</b></li> </ol> <p>Choose from below two to three resources on each topic that are appropriate for your students. Distribute the reflective note taking graphic organizer. Instruct students which text sets they will use and distribute the appropriate materials.</p> <p>Students will use the text sets to answer the guiding question, and record evidence/facts that support their answer. Students reflect on the reading to record opinions, questions and surprises.</p> <p>Guiding question for <b>Plant Growth</b>:</p>	<p>Plant biology graphic organizer          Reflective notetaking graphic organizer</p>

What are the stages in the life cycle of plants?

- [Life Cycle of a Seed Plant](#) (interactive activity)
- [From Seed to Flower](#) (video)
- [How Do Plants Grow? A 7-Stage Explanation of What Makes Plants Grow](#) (online article)
- [Basic Plant Life Cycle And The Life Cycle Of A Flowering Plant](#) (online article)
- Galbraith, Kathryn Osebold, and Wendy Anderson Halperin. *Planting the Wild Garden*. Atlanta, GA: Peachtree, 2011. Print. (physical book)

Guiding question for **Photosynthesis**:

Describe the process of photosynthesis.

- Bang, Molly, and Penny Chisholm. *Living Sunlight: How Plants Bring the Earth to Life*. New York: Blue Sky, 2009. Print. (physical book)
- [Photosynthesis and Respiration](#) (eBook)
- [How Do Plants Get Food?](#) (eBook)
- [Ethnobotany](#) (eBook)
- [NOVA | Photosynthesis](#) (video)

Guiding question for **Elemental Needs**:

What nutrients do plants need to grow and how do these nutrients affect the plants?

- [Plant Mineral Nutrition](#) (online simulation)
- [Plant Nutrients: Macro and Micro](#) (online article)

Guiding question for **Plant Anatomy**:

How do the structures of plants support their function?

- Aston, Dianna Hutts, and Sylvia Long. *A Seed Is Sleepy*. San Francisco: Chronicle, 2007. Print. (physical book)
- Macken, JoAnn Early, and Pamela Papparone. *Flip, Float, Fly*:

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	<p>Seeds on the Move. New York: Holiday House, 2008. Print. (physical book)</p> <ul style="list-style-type: none"> <li>• <a href="#">Plant Parts</a> (website)</li> <li>• <a href="#">The Great Plant Escape</a> (online game)</li> <li>• <a href="#">Biologycorner Plant Part Worksheet</a> (online worksheet)</li> </ul> <p>Students present their findings and collaborate to fill in notes on 'Plant Biology: the Complete Picture'.</p>	
Investigation	Visit the Environmental Study Center	
Construct/Express	<p>Facilitate a class discussion to reflect and share on their hydroponics learning experience during the pre-activity and field visit to ESC. What stayed with them? What are they still wondering about? What surprised them? What prior understandings were confirmed? Ask students to record their ideas and questions on the investigating ideas graphic organizer, IFC 12.2.</p> <p>Introduce <a href="#">instaGrok</a> to students. instaGrok is a digital tool that allows students to present research as well as gather information. Show students sample presentations. Explain that they are going to use their completed graphic organizer to shape their instaGrok presentations. Model delving into connected topics, switching between media types, and adding notes. Recommended research questions include:</p> <ul style="list-style-type: none"> <li>• How can hydroponic technology be used commercially?</li> <li>• What are the advantages and disadvantages of hydroponic farming?</li> <li>• How might hydroponic technology alleviate world hunger?</li> <li>• Is hydroponically grown produce as nutritious and flavorful as conventionally grown produce?</li> <li>• How could a hydroponic system be incorporated into your home or school?</li> <li>• What variables could be manipulated to increase growth or production of hydroponically grown produce?</li> </ul>	<p><a href="#">instaGrok</a> requires the use of computers and an internet connection.</p> <p>IFC 12.2  <a href="#">Project ECS@ESC Libguide</a></p>

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	<p>Students can use the ebooks on the <a href="#">Project ECS@ESC Libguide</a> to gather more information for their presentation.</p> <p>In groups or independently, students will build an instaGrok demonstrating their knowledge of hydroponics. They should include information on plant biology, methods of hydroponics, and real-world applications of this technology. Students may present their instaGroks to their classmates.</p>	
<p>Reflect</p>	<p>Have students return to the plant diagram they created in the pre-activity. Ask students if their original drawing was correct. Did they show the needs of the plants being met? Instruct students to draw a new diagram of a plant on the right side of their paper. If time allows, have your students write a paragraph describing the processes occurring within and around plants.</p>	