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California Foundation for Agriculture in the Classroom

SUSTAINABLE HORTICULTURE

A Six-Lesson Curriculum Unit
Grades 9-12

SUSTAINABLE HORTICULTURE

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Vision: An appreciation of agriculture by all.

Mission: To increase the awareness and understanding of agriculture among California's educators and students.

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A Note for Teachers

The California Foundation for Agriculture in the Classroom provides a wide range of resources designed to help students explore the many ways agriculture connects to their everyday lives. This curriculum unit builds on those efforts by engaging students in hands-on, inquiry-based activities that emphasize the importance of environmental stewardship, resource management, and sustainable practices. These lessons are designed to help students build the knowledge and skills needed to make informed decisions, whether pursuing a career in horticulture or managing landscapes as future homeowners.

The lessons included in this unit are aligned with California's Career Technical Education (CTE) Agriculture and Natural Resources Standards, the Next Generation Science Standards (NGSS), and Common Core State Standards to support meaningful, cross-disciplinary learning.

The content in this guide was developed to complement the *Retail Garden Center Manual* (Publication 3492) from the University of California Agriculture and Natural Resources (UC ANR), a comprehensive training resource for nursery professionals and staff. Much of the material included here is built upon the foundational concepts presented in that guide and is adapted for use in secondary classrooms.

For additional resources, lesson materials, and information, visit *www.learnaboutag.org.*

Acknowledgements

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CALIFORNIA ASSOCIATION OF NURSERIES

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We extend our sincere appreciation to everyone who contributed to the creation, writing, revision, and pilot testing of this unit. Your insights and feedback were invaluable to the development of this resource.

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WHAT IS SUSTAINABLE HORTICULTURE?

Grade Level: 9-12

DURATION: 90 minutes, over two class periods or one block

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Lesson Objectives:

1. Students will distinguish between sustainable and non-sustainable horticulture practices.
2. Students will investigate and identify sustainable practices used in horticulture businesses.
3. Students will explain the benefits of implementing sustainable horticulture practices.

STANDARDS ADDRESSED: CTE Agriculture and Natural Resource Standards C2.1, G9.2; NGSS: HS-ESS3-3, HS-LS2-7

Please use the scoring guide below to evaluate student learning for the lesson.

Assessment Scoring Guide (6 points total)

Review the student responses and assign points based on the criteria below.

- ___ Identified a specific area on campus for improvement (1 pt)
- ___ Proposed a sustainable change appropriate for the selected area (e.g., mulch, native plants, reduced water use) (2 pts)
- ___ Explained why the proposed change would have a positive impact on the environment, plant health, or resource use (2 pts)
- ___ Responses are clear, complete, and use appropriate vocabulary (1 pt)

TOTAL POINTS: ____ / 6

ENGAGEMENT ACTIVITY

SUSTAINABLE VS NON-SUSTAINABLE PRACTICES

10 MIN

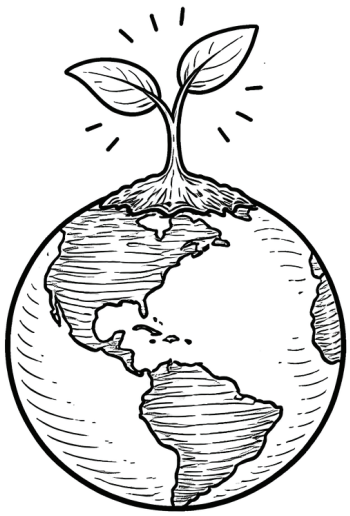
MATERIALS

- *What is Sustainable Horticulture? Slide Deck* (slides 2-12)

Google PDF

Introduce the topic:

"Every day, we make choices that impact ourselves, others, and the environment we live in. Some of these choices are sustainable, meaning they support long-term balance and health, while others are not."



Procedure:

1. Explain the concepts of sustainable and non-sustainable practices, using a few relatable examples to set the context (for example, cramming for a test versus studying a little each day, or using reusable containers instead of single-use packaging). Then, show the video "What is Sustainability" from the slide deck (slide 2) to reinforce these ideas and set the context for the lesson.
2. After the video, continue with the remaining slides (slides 3-12). Display each image one at a time. Ask students to observe the image and consider whether the practice shown is sustainable or not.
3. Encourage students to share their answers aloud or use a show of hands to indicate their opinion. Alternatively, use digital polling tools for more interaction.
4. After each image, briefly explain the correct classification (sustainable or non-sustainable) and the reasoning behind it.
5. Conclude the activity with a discussion about how understanding these practices can guide better decision-making in horticulture.

EXPLORE

SUSTAINABLE HORTICULTURE BUSINESSES CASE STUDIES

30 MIN

MATERIALS

- Laptop or tablet
- *Sustainable Horticulture Case Study Worksheet* (pages 8-9)
- *Horticulture Businesses For Case Study Research* (page 10)

Guiding Questions:

1. What does sustainability mean in the context of horticulture?
2. How do horticulturists produce plants and products in a way that is sustainable for the environment?

Introduce the activity:

"Today we're going to take a closer look at real horticulture businesses and how they use sustainable practices in their daily operations. Each student (or group) will be assigned a specific business to research. Your job is to explore their website and any other online sources to find out what steps they're taking to care for the environment while running a successful business."

Procedure:

1. Assign each student or group a specific horticulture business to research (page 10).
2. Instruct students to use the internet to explore the business's website to gather information about the sustainable practices they use.
3. Have students answer the questions and complete the prompts listed on the *Sustainable Horticulture Case Study Worksheet* (pages 8-9) based on their findings.
4. After the activity, facilitate a brief class discussion where students share their findings, including the sustainable practices they discovered.

EXPLAIN

WHAT IS SUSTAINABLE HORTICULTURE? PRESENTATION

35 MIN

MATERIALS

- *What is Sustainable Horticulture? Slide Deck* — Google, PDF
- *What is Sustainable Horticulture? Guided Notes* (pages 11-12)
- *What is Sustainable Horticulture? Guided Notes Answer Key* — PDF

Procedure:

1. Begin by reviewing the slide deck and ensuring familiarity with the content. Hand out the guided notes to each student.
2. As you present each slide, pause periodically to allow students to fill in their guided notes. Highlight key points, provide additional context, and encourage student interaction by asking questions or prompting discussion.
3. At the end of the slide deck, review the key concepts covered in the presentation. Go over the notes with the class, ensuring that students have accurately filled in their guided notes.

EVALUATE

SPOT SUSTAINABLE CHANGE

15 MIN

Introduce the task:

"Let's take a few minutes to think like sustainable horticulturists. Look around campus—where do you see an opportunity to care for the environment better through plants, soil, or water use? Is there an area that could be more resource-efficient, healthier for plants, or better for the environment?"

ASSESSMENT SCORING GUIDE: SEE PAGE 4

Procedure:

1. Ask students to choose one location and consider:
   - What's happening in that space now?
   - What sustainable practice could help?
   - Why would that change be good for the environment, plant health, or resource use?
2. Give students time to go outside and observe. Encourage them to take notes or photos if helpful.
3. After returning to the classroom, students can share their ideas through a group discussion or by writing a brief reflection summarizing their observations and explaining why the sustainable change they propose would be helpful.

Name: _____

Class Period: _____

Date: _____

SUSTAINABLE HORTICULTURE CASE STUDY

Instructions

Your teacher will assign you a horticulture business to research. Use the internet to explore their website. Identify the sustainable practices they use, then answer the questions and complete the activities below.

Business Name & Location

Name of Business: _____

Location (City/State): _____

Sustainable Practices

List three sustainable practices this business uses.

Practice 1: _____

Impact: _____

Practice 2: _____

Impact: _____

Practice 3: _____

Impact: _____

Critical Thinking Questions

1. How do you think these sustainable practices benefit the environment?

2. How might these sustainable practices impact the local community?

3. Do you think this business could expand its sustainable practices? If so, how?

Final Reflection

Based on your research, do you think more businesses in the horticulture industry should adopt sustainable practices? Why or why not?

HORTICULTURE BUSINESSES FOR CASE STUDY RESEARCH

Instructions

Make enough copies for the entire class. Cut apart the horticulture business names and websites, then distribute them to the students for their case studies.

Loma Vista Nursery
lomavistanursery.com

Pierson Nurseries
piersonnurseries.com

Olive Hill Greenhouses
olivehill.net

Frantz Nursery
frantznursery.com

Altman Plants
altmanplants.com

In Harmony Sustainable Landscapes
inharmony.com

Monrovia
monrovia.com/environment

Green Abundance By Design
greenabundancebydesign.com

Willoway
willowaynurseries.com

California Native Horticultural Foundation
calnativehort.org

Name: _____

Class Period: _____

Date: _____

GUIDED NOTES

WHAT IS SUSTAINABLE HORTICULTURE?

1 What is Horticulture?

- Horticulture is the _____ and _____ of cultivating plants to improve human _____, quality of life, and the _____.
- We interact with plants every day. We grow them on our _____, in our _____, and in our _____.

2 What is Sustainable Horticulture?

Sustainable horticulture is the practice of growing plants in a way that is:

_____ responsible _____ viable _____ equitable

3 Areas of Sustainable Horticulture

- Sustainable Gardening - Growing _____, _____, herbs, and _____ for personal or community use.
- Sustainable Landscaping - Creating environments that use fewer _____ like water, fertilizer, and pesticides.
- Sustainable Nursery Production - Propagating and growing _____-quality plants with minimal _____ impact.

4 Principles of Sustainable Horticulture

Write a brief summary of each principle and draw a symbol that represents it.

Environmentally Responsible	Economically Viable	Socially Equitable
_____	_____	_____
_____	_____	_____
_____	_____	_____

5 Examples of Sustainable Practices

Check the box on the examples below you think are most important:

- ☐ Efficient use of space
- ☐ Fair labor practices
- ☐ Creating pollinator habitats
- ☐ Urban farms in underserved areas
- ☐ Renewable energy use
- ☐ Efficient irrigation
- ☐ Sustainable packaging
- ☐ Organic fertilizers
- ☐ Locally sourced materials
- ☐ Rainwater harvesting
- ☐ Integrated pest management (IPM)

Reflection

Which practice is most important to you? Why?

_____

6 Benefits of Sustainable Horticulture

1. Reduced Environmental Impact - Minimizing _____ use, conserving _____, and reducing _____ emissions.
2. Improved Soil Health - Adding _____ matter, composting, crop _____ practices.
3. Increased Biodiversity - Creating habitats for _____, beneficial _____, and wildlife.
4. Thriving Landscapes - Using plants adapted to local _____.
5. Stronger Communities - Supporting _____ economies and fostering food _____.

Wrap-Up

Review and Reflect

One new thing I learned today:

_____

One question I still have:

_____

Something I can do to help plants and people:

_____

WHAT IS INTEGRATED PEST MANAGEMENT (IPM)?

Grade Level: 9-12

DURATION: 100 minutes, over two to three class periods

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Lesson Objectives:

1. Students will evaluate the impacts of insects on plant health and justify whether they are beneficial, harmful, or context-dependent using evidence from research.
2. Students will identify a pest on campus, determine its impact, and create a plan using IPM strategies to manage it.
3. Students will explain how IPM practices promote sustainable horticulture by protecting beneficial organisms, minimizing harm to the environment, and supporting healthy plant growth.

STANDARDS ADDRESSED: CTE Agriculture and Natural Resource Standards C2.1, C12.2, C12.3, F4.4, G5.4; NGSS: HS-LS2-6, HS-LS2-8; CC ELA: WHST.9-12.7

Please use the scoring guide below to evaluate student learning for the lesson.

Assessment Scoring Guide (10 points total)

Review the student responses and assign points based on the criteria below.

- ___ Identified and documented a specific pest issue on campus (location, pest, and evidence of damage) (2 pts)
- ___ Accurately identified and categorized the pest as beneficial, harmful, or neutral (2 pts)
- ___ Described key features or characteristics of the pest using research-based evidence (2 pts)
- ___ Developed an appropriate IPM-based treatment plan using one or more control strategies (2 pts)
- ___ Clearly justified chosen strategies and explained how they support prevention and management (1 pt)
- ___ Presentation or video is clear, complete, and uses appropriate vocabulary (1 pt)

TOTAL POINTS: ____ / 10

ENGAGEMENT ACTIVITY

PLANT PROBLEMS

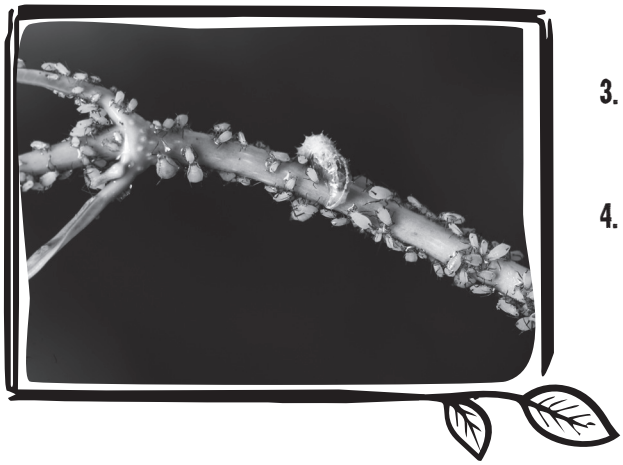
15 MIN

MATERIALS

- A real plant with a visible problem (if available)
- **Alternative:** High-quality images of the plant, its surroundings, and the issue (from multiple angles if possible)
- Access to the UC IPM website (optional for research)
- **Optional:** "Plant Problem Diagnosis Checklist" from the *Retail Garden Center Manual,* published by the University of California

Present the scenario:

"Imagine you're in the nursery and notice that all the plants in the back area have this issue. What do you do?"



Procedure:

1. Facilitate a discussion with the students, encouraging them to share their thoughts on what they think the problem might be and why it could pose an issue.
2. Introduce students to the UC IPM website and show them how to search for information related to plant problems. Highlight how to use the search engine, browse by plant type or pest, and find recommended management strategies.
3. Conclude the activity by discussing the students' findings and connecting their observations to potential solutions or management strategies.
4. **Optional:** Give students the "Plant Problem Diagnosis Checklist" (page 122 of the *Retail Garden Center Manual*) and demonstrate how to use the checklist to determine what might be wrong with a plant.

EXPLORE

PEST DETECTIVE CASE FILES

30 MIN

MATERIALS

- *Pest Detective Case File Photo Cards* PDF
- *Pest Detective Case File Worksheet* (page 18)
- Laptop or tablet
- Access to the UC IPM website or printed insect resources

Introduce the activity:

"There are many challenges that nursery professionals and homeowners face when growing plants, including insect pests. But not all insects are harmful, some actually play important roles in helping plants thrive. Today, you'll act as pest detectives. Your job is to investigate different insects and determine whether they are helpful, harmful, or both, using evidence to support your conclusions."

Guiding Questions:

1. What roles do insects play in an ecosystem?
2. How can an insect be helpful, harmful, or both?
3. What evidence can we use to determine an insect's impact?
4. Why might it be important not to eliminate all insects?

Procedure:

1. Divide students into small groups. Provide each group with two photo cards.
2. Distribute the *Pest Detective Case File Worksheet* (page 18). For each insect, students should:
   - Identify the insect
   - Describe what it does in the environment
   - Determine whether it is beneficial, harmful, or depends on the situation
   - Provide evidence to support their decision (from prior knowledge or resources like UC IPM)
3. As students work, circulate around the room to support discussion, ask probing questions, and encourage students to justify their thinking with evidence.
4. After about 15-20 minutes, bring the class together. Have each group share one insect and explain their "verdict," including the reasoning behind their decision.
5. Facilitate a brief discussion highlighting that some insects may fall into the "depends" category and introduce the idea that managing insects is about balance, not elimination.

EXPLAIN

WHAT IS INTEGRATED PEST MANAGEMENT (IPM)? PRESENTATION

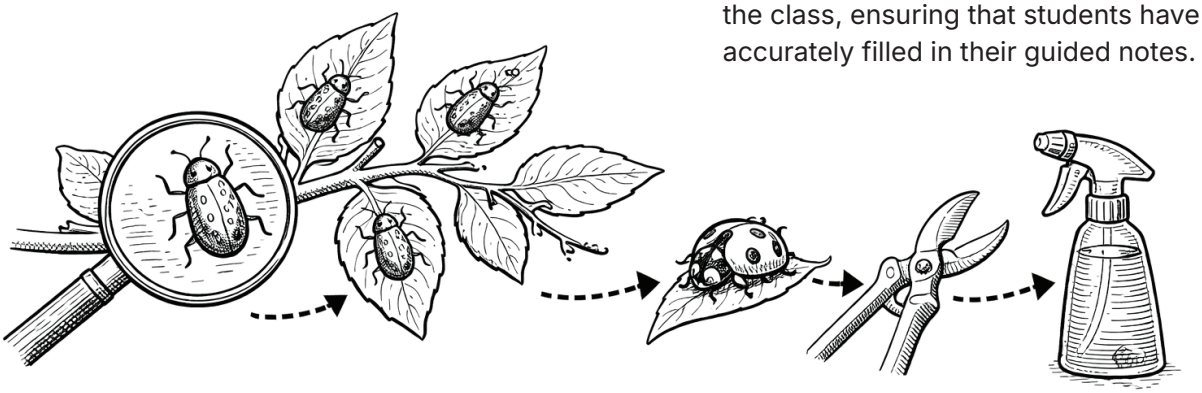
25 MIN

MATERIALS

- *What is Integrated Pest Management (IPM)? Slide Deck* — Google, PDF
- *What is Integrated Pest Management (IPM)? Guided Notes* (pages 19-21)
- *What is Integrated Pest Management (IPM)? Guided Notes Answer Key* — PDF

Procedure:

1. Begin by reviewing the slide deck and ensuring familiarity with the content. Hand out the guided notes to each student.
2. As you present each slide, pause periodically to allow students to fill in their guided notes. Highlight key points, provide additional context, and encourage student interaction by asking questions or prompting discussion.
3. At the end of the slide deck, review the key concepts covered in the presentation. Go over the notes with the class, ensuring that students have accurately filled in their guided notes.



EVALUATE

CAMPUS IPM CHALLENGE

MATERIALS

- Laptop or tablet
- Camera and presentation software, if students choose a presentation
- Video camera and video editing software, if students choose a video

Introduce the task:

"Today, you'll step into the role of IPM specialists. Instead of working with sample scenarios, you'll investigate real pest issues right here on campus. Your job is to identify the organism, determine whether it is beneficial, harmful, or context-dependent, and recommend solutions using integrated pest management practices. Just like nursery professionals, you'll use resources like the UC IPM website to research and support your recommendations. Your findings will be shared with our campus maintenance and landscaping team."

Procedure:

1. In pairs or small groups, students will:
   - Locate and document a pest problem on campus (location, pest, plant damage, etc.)
   - Research and identify the pest using the UC IPM website
   - Categorize the pest as beneficial, harmful, or neutral, and describe its key features
   - Develop an IPM-based treatment plan, justifying the use of biological, physical, cultural, or chemical control strategies for prevention and management
2. Students will then create a 60-second video or slide deck that clearly explains their findings and recommendations.
3. Share student videos with the campus maintenance team to highlight student thinking and promote real-world application of sustainable pest management practices.

ASSESSMENT SCORING GUIDE: SEE PAGE 13

Name: _____ Class Period: _____ Date: _____

PEST DETECTIVE CASE FILE

Insect Name: _____

What does this insect do? (What does it eat? How does it interact with plants?)

_____

Evidence (What source of information helped you investigate?)

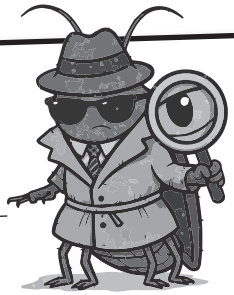
_____

Verdict (circle one)

BENEFICIAL HARMFUL DEPENDS

Explain your reasoning:

_____



Insect Name: _____

What does this insect do? (What does it eat? How does it interact with plants?)

_____

Evidence (What source of information helped you investigate?)

_____

Verdict (circle one)

BENEFICIAL HARMFUL DEPENDS

Explain your reasoning:

_____

Name: _____

Class Period: _____

Date: _____

GUIDED NOTES

WHAT IS INTEGRATED PEST MANAGEMENT?

1 What are pests?

- A garden or landscape includes many organisms, but only a small number are considered _____.
- Pests are organisms that negatively impact _____, _____, crops, structures, or possessions.

2 Examples of horticultural pests:

- **Insects:** Bugs that _____ plants like _____, whiteflies, or spider mites.
- **Weeds:** Unwanted _____ that compete with wanted plants for nutrients and space.
- **Rodents:** Mice and rats that can _____ gardens and spread _____.
- **Pathogens:** _____, _____, and viruses that infect plants.

Draw a simple picture of a plant pest:

3 What Is Pest Management?

- Pest management is the process of _____ or _____ pests to protect plants, animals, people, and property.
- The goal isn't always to eliminate all pests, but to keep their numbers _____ enough to avoid serious damage.

4 History of Pest Management

- **2500 B.C.** - Ancient Sumerians used _____ compounds
- **300 B.C.** - Chinese used _____ enemies (e.g., ants on citrus)
- **1600s** - Tobacco _____ _____, herbs, and arsenic are used for insect pest control
- **Late 1800s-Early 1900s** - Development of _____ _____ equipment
- **1939-1945** - DDT used during WWII to control malaria and typhus
- **1950s-60s** - The _____ Revolution, pesticides thought to be the answer to world hunger
- **1962** - Rachel Carson's book "_____ _____" brings the issue of pesticide safety to the attention of the public
- **1970s** - Universities and agencies focus research on _____ approaches

5 What is IPM?

- Integrated Pest Management (IPM) uses knowledge about how the _____ ecosystem works to solve pest problems.
- The goal is _____ _____ prevention of pests or damage using a variety of techniques.

6 Pest Management Method #1 Pest-Resistant Plants

- Choose plant species and varieties that have few _____ problems.
- Some plants are bred to be _____ to or strongly _____ to common pests.

7 Pest Management Method #2 Biological Control

- Biological control involves using one _____ to control another.
- Examples include insects and mites that _____ on other insects and mites.
- While you can buy these helpful bugs, most of the time they already live in the _____ and do the job naturally.

8 Pest Management Method #3 Cultural Controls

- Cultural controls include changing how we _____ _____ _____ the landscape to reduce pest _____, reproduction, dispersal, and survival.

Examples:

- Irrigation practices
- Removing infested material
- Using fertilizer
- _____ or harvest timing

9 Pest Management Method #4 Mechanical and Physical Controls

- Mechanical and physical controls _____ a pest directly, _____ pests out, or make the environment _____ for it.

Examples:

- _____ weeds
- Mowing
- Applying _____
- Trapping pests

10 Pest Management Method #5 Chemical Controls

- Chemical control is the use of _____.
- In IPM, pesticides are used ONLY when _____ and in combination with other approaches for more effective, long-term control.
- Pesticides are selected and applied in a way that _____ their possible harm to people, helpful _____, and the environment.

Pest Examples

Label each method as biological (B), cultural (C), or mechanical (M)

Pest	When to Control	Control Methods
11 Aphids 		• Release predators like lacewings, or parasites like Aphidius spp. _____ • Weed the area frequently _____ • Cover openings to the greenhouse _____ • Use sticky cards _____
12 Spider Mites 		• Release predatory mites _____ • Remove infected plants _____ • Pull weeds regularly _____
13 Whiteflies 		• Remove infected plants _____ • Pull weeds regularly _____ • Mulch with silver plastic _____ • Use sticky cards _____ • Release predatory wasps _____

Wrap-Up Review and Reflect

One new thing I learned today:

_____

One question I still have:

_____

WHAT MAKES A HEALTHY SOIL?

Grade Level: 9-12

DURATION: 120 minutes, over two class periods

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NOTE TO THE TEACHER: *This lesson extends beyond the traditional soil texture "shake test" by incorporating three soil evaluation tests, including infiltration, to provide students with a more complete picture of soil health. Students use test results to analyze soil conditions and connect their findings to realistic management practices that improve soil quality.*

Lesson Objectives:

1. Students will observe and describe differences between natural soil and growing media used in horticulture, and discuss when each is appropriate.
2. Students will conduct basic hands-on tests (e.g., jar test, pH test, infiltration test) to assess soil.
3. Students will describe how practices like proper mulching, compost incorporation, and minimal compaction improve soil function in landscapes.

STANDARDS ADDRESSED: CTE Agriculture and Natural Resource Standards C2.1, C10.1; NGSS: HS-ETS1-3, HS-ESS2-5; CC ELA: RST.11-12.3

Please use the scoring guide below to evaluate student learning for the lesson.

Assessment Scoring Guide (6 points total)

Review the student responses and assign points based on the criteria below.

- ___ Completed "If...Then..." statements for soil texture, pH, and infiltration with appropriate improvement strategies (3 pts)
- ___ Improvement strategies are accurate and match the observed soil conditions (1 pt)
- ___ Recommendation paragraph uses evidence from at least two soil tests (1 pt)
- ___ Responses are clear, complete, and use appropriate vocabulary (e.g., infiltration, organic matter, pH, drainage) (1 pt)

TOTAL POINTS: ____ / 6

ENGAGEMENT ACTIVITY

COMPARING SOIL AND GROWING MEDIA

15 MIN

MATERIALS

- Quart-size sealable bags (one per student)
- Several types of growing media (approximately 1 cup of each)
- Several soil samples for students who don't bring samples from home
- Paper plates (one per student, plus a few extras)
- Magnifying glasses (optional)
- Gloves (optional)

Preparation:

Prior to the lesson, distribute a sealable bag to each student with the following written instructions:

Return this bag with approximately three cups of soil found near your home or at school. The soil must be collected from 3-4 inches below the soil surface. This will require you to dig down deep to collect a soil sample. Return the soil to (TEACHER'S NAME) classroom by (DATE).

Introduce the topic:

"The material we grow plants in can affect everything—from how roots grow to how much water or fertilizer is needed. Today, you'll examine different samples to figure out what they're made of and where they might be best used. As you explore, try to decide: What looks like soil? What might not be? And why would we use one over the other?"

Procedure:

1. Instruct students to open their sealable bag and pour one cup of their soil sample onto a paper plate. Provide several types of growing media, also on paper plates. Place all plates on a central table or around the room as observation stations. Allow time for students to walk around, observe, and compare. Encourage them to touch the samples (gloves optional) and look closely with magnifying glasses (optional).
2. Lead a group discussion about their observations. Hold up samples as you discuss. Possible guiding questions:
   - What differences did you notice between the samples?
   - Which samples appear more natural, and which seem manufactured or mixed?
   - Which samples do you think would best support plant growth? What makes you say that?
3. After students share their thinking, share these definitions:
   a. **Soil:** The natural medium on the surface of the earth composed of minerals, organic matter, water, air, and various organisms, in which plants typically grow.
   b. **Growing media:** A manufactured mix used in horticulture, especially in containers. Often made from materials like peat moss, perlite, coconut coir, or bark.
4. Revisit the samples and identify together which were soil and which were growing media.

EXPLORE

SOIL TESTS

Instructors may select from the soil tests below to examine different aspects of soil health. For the most accurate and meaningful results, students should use soil from the same school location for all tests.

Texture Test

Guiding Questions:

1. How do we assess soil texture?
2. Why is soil texture important?

Introduce the activity:

"Today we're going to test the soil samples you collected earlier to find out what type of soil we're working with. By using a simple jar test, we'll observe how much sand, silt, and clay is in each sample and learn how that affects plant growth."

MATERIALS

- Hand trowel
- Soil samples (one per group)
- Clear pint-sized jar with lid, twist-top gelato containers are a great option (one per group)
- Water
- *Soil Exploration Lab Worksheet* (pages 28-30)

Procedure:

1. Using school-sourced soil samples from the engagement activity, instruct students to fill a jar halfway with their soil sample, then add water until the jar is nearly full. Seal the jar and shake it well to break apart clumps.
2. Leave the jar undisturbed for 24 hours to allow the layers to fully settle. After 24 hours, have students observe and measure each layer in centimeters: Sand will be at the bottom, silt in the middle, and clay at the top. Record observations on the *Soil Exploration Worksheet*.
3. Ask students to identify which soil type is most dominant and discuss what that tells them about their sample.
4. Conclude with a class discussion where students share their findings and reflect on how soil texture may impact plant growth and inform sustainable practices.

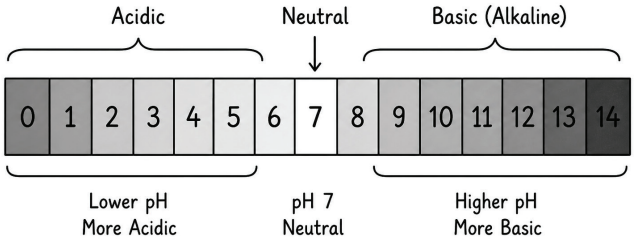
pH Test

MATERIALS

- Soil samples (one per group)
- pH test strips (one per group)
- Clear plastic cups (one per group)
- Stir stick or spoon (one per group)
- Distilled water
- *Soil Exploration Lab Worksheet* (pages 28-30)

Introduce the activity:

"Today we're going to test the pH level of different soil samples to learn how soil chemistry affects plant health. Each group will use their sample from the previous activity to determine if their soil is more acidic, neutral, or basic—and what that means for growing different types of plants."



Guiding Questions:

1. How do we measure pH?
2. How does pH affect plant growth?

Procedure:

1. Place approximately ½ cup of soil in a clear plastic cup. Add enough distilled water to cover the soil, about equal parts soil and water. Stir the mixture thoroughly and let it sit for 5-10 minutes to allow solid particles to settle.
2. Insert a pH test strip into the water, then remove and compare it to the color chart. Record the pH result on your lab worksheet.
3. Compare and analyze as a class: Which sample was most acidic? Which was most basic?
4. Conclude with a class discussion about how soil pH affects plant health. Discuss how pH levels can be altered using soil amendments (like lime to raise pH or sulfur to lower pH). Share how different plants prefer different pH levels—for example, blueberries thrive in acidic soils, while most vegetables prefer a neutral range. Ask students how knowing the soil pH might influence plant selection, fertilizer choices, or other gardening decisions.
5. **Optional:** Test the pH of the growing media to compare the chemical differences between soil and growing media.

Infiltration Test

MATERIALS

- Large metal can with both ends removed, check with your foodservice team (one per group)
- Ruler or measuring tape (one per group)
- Rubber mallet (one for class)
- Stopwatch or timer (one per group)
- Water, enough to fill the can about halfway
- *Soil Exploration Lab Worksheet* (pages 28-30)

Introduce the activity:

"Today we're going to investigate how quickly water soaks into different soils, a property called infiltration. This helps us understand how soil texture and health affect how water moves through the ground."

Guiding Questions:

1. How do we measure soil infiltration?
2. What does soil infiltration tell us about soil health?

Procedure:

1. Have students take their infiltration cylinder to the location where their soil sample was collected. Guide them to gently press the can straight down into the soil. If needed, carefully use a mallet or block of wood to tap the can until it's inserted about 1-2 inches deep.
2. Add enough water to fill the can up to half its depth (For example, if the can is 6 inches tall, add 3 inches of water). Start the stopwatch as soon as the water is added.
3. Observe how quickly the water soaks into the soil. Record the time it takes for the water to completely soak in.
4. After the experiment, compare the results as a class. Which sites had faster or slower infiltration? What does this tell us about the soil at those locations? Encourage a class discussion about the possible reasons behind the infiltration rates. For example, soils near trees or under plants might have more organic matter, which can improve infiltration. Similarly, compacted soil in high-traffic areas may have slower infiltration.
5. **Optional:** Test the infiltration of water into the growing media to compare the physical differences between soil and growing media.

EXPLAIN

WHAT MAKES A HEALTHY SOIL?

30 MIN

Procedure:

1. Begin by reviewing the slide deck and ensuring familiarity with the content. Hand out the guided notes to each student.
2. As you present each slide, pause periodically to allow students to fill in their guided notes. Highlight key points, provide additional context, and encourage student interaction by asking questions or prompting discussion.
3. At the end of the slide deck, review the key concepts covered in the presentation. Go over the notes with the class, ensuring that students have accurately filled in their guided notes.

MATERIALS

- *What Makes A Healthy Soil? Slide Deck* — Google, PDF
- *What Makes A Healthy Soil? Guided Notes* (pages 31-33)
- *What Makes A Healthy Soil? Guided Notes Answer Key*

EVALUATE

IF...THEN...SOIL HEALTH

20 MIN

MATERIALS

- *If...Then...Soil Health Graphic Organizer* (pages 34-35)

Introduce the assessment:

"You've now tested your soil's texture, pH, and infiltration rate. Use the graphic organizer to reflect on what results tell you about soil health, and think about what could be done to improve it. For each 'If' statement, write a 'Then' statement suggesting a specific way to improve soil health. Imagine you are advising a homeowner on how to make their soil better for plants."

Procedure:

1. Have students complete the *If... Then...Soil Health Graphic Organizer,* connecting each soil property to potential effects on plant growth and identifying practical improvements.
2. After finishing the chart, students should write a 3-5 sentence recommendation summarizing how to improve the health or performance of their soil sample. Remind them to reference evidence from their soil tests and to include at least one practical soil management technique, such as adding organic matter, adjusting pH, mulching, or improving drainage. Circulate to ensure responses are logical, evidence-based, and clearly explained.

ASSESSMENT SCORING GUIDE: SEE PAGE 22

Lab Group Members: _____

_____

_____

Class Period: _____

Date: _____

SOIL EXPLORATION LAB WORKSHEET

Instructions: Use each soil test below to examine different aspects of soil health. For the most accurate and meaningful results, you should collect soil from the same plot of land for all tests. Use a hand trowel to collect soil 3-4 inches below the soil surface.

Texture Test

Purpose: To determine the relative amounts of sand, silt, and clay in a soil sample and understand how texture influences soil health and plant growth.

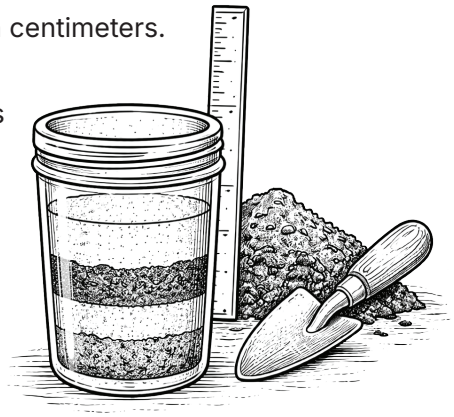
MATERIALS

- Soil sample
- Clear pint-sized jar with lid
- Water

Layer	Thickness (cm)
Sand (bottom)	
Silt (middle)	
Clay (top)	

Procedure:

1. Fill the jar halfway with your soil sample.
2. Add water until the jar is nearly full.
3. Seal the jar and shake it well to break apart clumps.
4. Let the jar sit undisturbed for 24 hours.
5. Observe and measure each settled layer in centimeters.
6. Record your measurements in the table to the left.



Questions:

1. Which soil type is most dominant?

_____

2. How would you describe your soil?

_____

3. Why would it be important to know the soil texture?

_____

pH Test

Purpose: To measure the acidity or alkalinity of soil and determine how it may influence nutrient availability and plant health.

MATERIALS

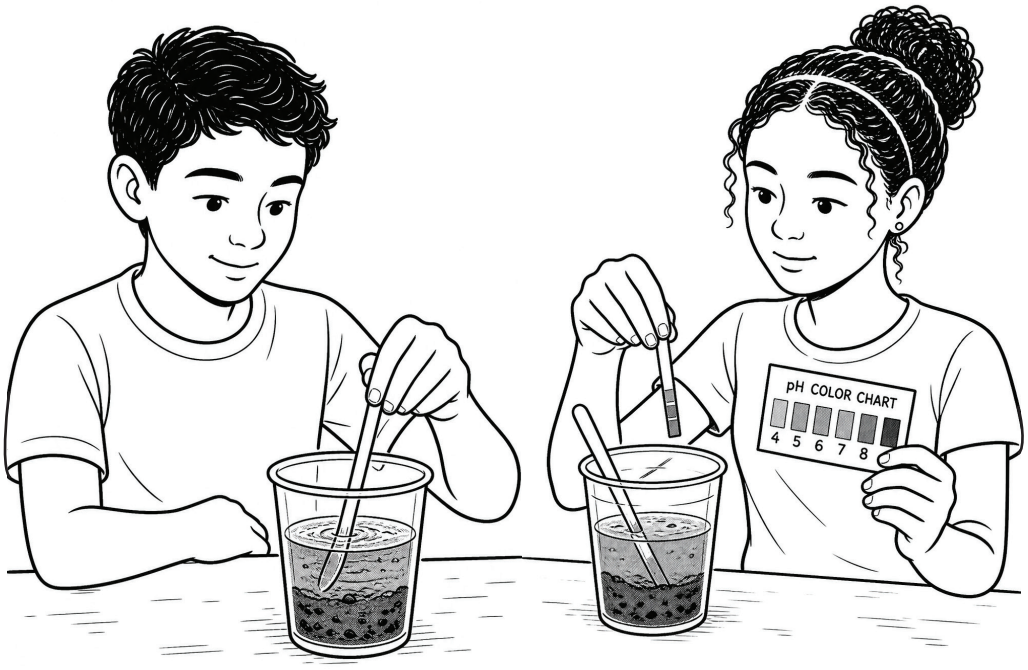
- Soil sample
- pH test strips
- Clear plastic cup
- Distilled water
- Stir stick or spoon

Procedure:

1. Place about ½ cup of soil into the plastic cup.
2. Add an equal amount of distilled water.
3. Stir thoroughly and let sit for 5-10 minutes.
4. Dip a pH test strip into the water. Remove and compare it to the color chart.

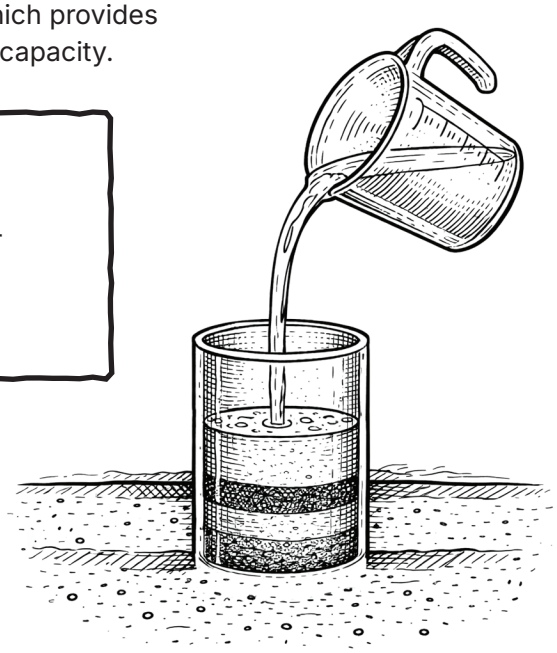
Questions:

1. What is the pH of your soil? _____
2. Was your sample acidic, neutral, or basic? _____
3. How might this pH affect plant health or fertilizer choices?



Infiltration Test

Purpose: To evaluate how quickly water enters the soil, which provides insights into soil structure, compaction, and water-holding capacity.



MATERIALS

- Large metal can with both ends removed
- Ruler or measuring tape
- Stopwatch or timer
- Water
- Rubber mallet

Procedure:

1. Insert the can 1-2 inches into the soil at your test site.
2. Pour water into the can until it reaches halfway up.
3. Start the stopwatch as soon as you add water.

Questions:

1. How long did it take for the water to fully soak in? _____ seconds
2. Was the infiltration rate compared to other groups?

_____

3. What might explain the infiltration rate you observed?

_____

4. What does this tell you about your soil's ability to support plant life?

_____

_____

Final Reflection

In your own words, why is it important to understand the physical and chemical properties of soil before planting?

_____

_____

Name: _____

Class Period: _____

Date: _____

GUIDED NOTES

WHAT MAKES A HEALTHY SOIL?

1 What is Soil?

- Soil is the natural _____ on the surface of the earth composed of _____, _____ matter, _____, _____, and various organisms, in which plants typically grow.

2 What is Growing Media?

- A manufactured mix used in _____, especially in _____.
- Often made from materials like peat _____, _____, coconut coir, or _____.
- Growing media is NOT _____

3 Signs of Healthy Soil

- _____ smell
- _____, loose structure
- Good water _____ and drainage
- _____ and other soil life visible
- Even plant growth with _____ color

4 Signs of Unhealthy Soil

- Hard, _____ surface
- Poor drainage or _____ water
- Cracks when dry, _____ when wet
- Few or no visible _____
- Plants show signs of _____

5 Soil Biodiversity

Healthy soil is _____!

- _____ and _____ help break down organic matter and cycle nutrients.
- _____ and _____ aerate soil and improve structure.
- _____ fungi help plants absorb nutrients.
- Loss of biodiversity = loss of _____.

6 Soil Texture — The Soil Triangle

Texture is the proportion of _____, _____, and _____.

- Clay soil: holds _____, can become _____
- Silty soil: holds _____ well, but can compact easily and drain _____
- Sandy soil: drains _____, low in _____

7 Why is Soil Texture Important?

It affects:

- Drainage - how fast _____ moves through soil
- Airflow - how well _____ can breathe
- Nutrient holding - how well soil holds _____
- Root growth - some soils are harder for _____ to grow in

Ideal texture for most plants: _____ (a balanced mix of sand, silt, clay)

8 What is Soil Infiltration?

Infiltration is how _____ moves from the surface into the soil.

What infiltration rate tells us:

- Soil texture: _____ soils absorb water quickly; _____ soils are slower.
- Soil health: Healthy soils with _____ matter and structure absorb water evenly and prevent _____.

9 How to Improve Soil Texture

You can't change your soil's natural texture, but you can improve how it:

- Holds _____
- _____ properly
- Supports _____ growth

10 How to Improve Soil Texture

- Add _____ matter
- Use _____
- Avoid over-_____
- Limit _____
- Improving soil texture takes _____.

11 Soil Nutrients

There are 17 essential nutrients for plant growth and development.

- Macronutrients: _____ (N), _____ (P), _____ (K)
- Micronutrients: Iron, manganese, zinc, copper, boron, etc.

Nutrient imbalances can lead to:

- _____ leaves (chlorosis)
- Poor _____ or _____
- Weak or _____ growth

12 How to Improve Soil Nutrition

- Natural organic fertilizer: compost, _____, and plant-based materials

→ Supports biodiversity and improves long-term soil _____

- Commercial fertilizers: fast-acting blends of N, P, and K

→ Useful for specific nutrient _____

13 Soil pH

Soil pH measures how _____ or _____ the soil is (scale 0-14). Most California soils range from _____ to _____.

Why it's important:

- pH affects _____ reactions in the soil.
- Controls how easily plants can absorb _____.
- Soil with a pH that's too high or too low can cause _____ problems.

14 How to Improve Soil pH

Signs of pH problems:

- _____ leaves
- Poor _____ despite fertilizing

Tips to adjust soil pH:

- To raise pH: add _____ or _____ _____
- To lower pH: add _____

It is best to adjust pH before _____!

15 When to Use Growing Media

- Ideal for _____ starting, _____ plants, and _____ plants
- Excellent _____ and consistent _____
- Free from _____, _____, and many soil-borne _____

Remember: You must add _____! Growing media usually contains few or none.

Wrap-Up Reflection

One thing I learned about healthy soil:

_____

One thing I can do to improve soil where I live:

_____

Name:

Class Period:

Date:

IF...THEN...SOIL HEALTH

You've now tested your soil's texture, pH, and infiltration rate. Use the charts below to reflect on what the results tell you about soil health and what could be done to improve it. For each "If" statement, write a "Then" statement that suggests a specific way to improve soil health.

Soil Texture

If... (observed result)	Then... (a specific way to improve soil texture)
The sample is mostly sand	
The sample is mostly silt	
The sample is mostly clay	

Soil pH

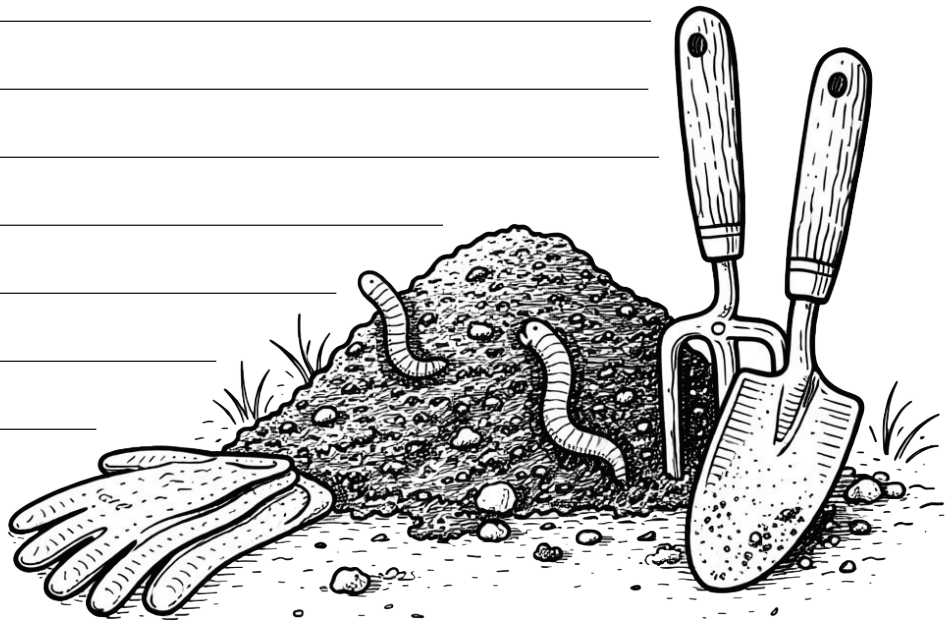
If... (observed result)	Then... (a specific way to improve pH)
The pH is below 6.0 (acidic)	
The pH is between 6.0 and 7.5 (neutral)	
The pH is above 7.5 (alkaline)	

Soil Infiltration

If... (observed result)	Then... (a specific way to improve infiltration)
Water soaked in quickly (less than 2 minutes)	
Water took several minutes to soak in (2-5 minutes)	
Water pooled on the surface and took a long time to soak in	

SHOW WHAT YOU KNOW

Based on your test results, write a brief recommendation (3-5 sentences) for how to improve the specific soil you tested. Use information from at least two of the tests above.



HOW CAN WE MAKE EVERY DROP COUNT?

Grade Level: 9-12

DURATION: 90-120 minutes, over two class periods

Lesson Objectives:

1. Students will observe and compare the water distribution and flow rates of various irrigation methods used in horticulture.
2. Students will measure and calculate flow rates to evaluate the water efficiency of drip irrigation, hand watering, and sprinkler systems.
3. Students will evaluate the sustainability of different irrigation methods and recommend appropriate systems based on efficiency, plant needs, and environmental impact.

STANDARDS ADDRESSED: CTE Agriculture and Natural Resource Standards C2.1, D1.4, F2.1, F2.4, F5.1; CC ELA: W.9-12.4, W.9-12.9; NGSS: HS-ESS2-5

Please use the scoring guide below to evaluate student learning for the lesson.

Assessment Scoring Guide (8 points total)

Review the student responses and assign points based on the criteria below.

- ___ Data table is complete with recorded volumes and calculated flow rates for all irrigation methods (3 pts)
- ___ Correctly identifies the most water-efficient method using quantitative evidence (flow rate, total water used) (1 pt)
- ___ Analysis reflects understanding of how irrigation methods perform in real-world conditions (1 pt)
- ___ Recommendation is clearly stated and supported with data from the lab (1 pt)
- ___ Includes at least one water-saving practice from the slide presentation (1 pt)
- ___ Responses are clear, complete, and use appropriate vocabulary (e.g., flow rate, efficiency, runoff, evapotranspiration) (1 pt)

TOTAL POINTS: ____ / 8

ENGAGEMENT ACTIVITY

IRRIGATION METHODS

15 MIN

MATERIALS

- *How Can We Make Every Drop Count? Slide Deck* (slides 2-4)

Google PDF

Begin by asking:

"If you had to water 100 plants wasting as little water as possible, how would you do it?"

Procedure:

1. Let a few students share ideas. Explain that today's focus is on how different irrigation methods impact water use. Emphasize that horticulturists make decisions about watering systems not just based on convenience, but also on factors like water efficiency and long-term sustainability.
2. Show students the slides featuring different irrigation methods. For each method, ask:

What do you notice about how this method applies water?

Would you label this as efficient, wasteful, or does it depend? (Students can respond by raising their hands, moving to different sides of the room, or using digital polls.)

Why might someone still choose this method?

3. After each image, briefly share one advantage and one disadvantage of the method. For example, "Drip irrigation uses less water but can be expensive to install." Have students predict which system will use the least amount of water and why. They can revisit their predictions later in the lesson.

EXPLORE

IRRIGATION COMPARISON

Instructors may choose to divide the class into three groups, assigning each group a different irrigation method to test and collect data. Alternatively, the entire class can work together to set up and evaluate each method sequentially, or the class can be divided into smaller groups that test each method concurrently. The materials listed below are for one group; adjust quantities as needed based on the number of groups. Each student will need a copy of the *Irrigation Comparison Lab Worksheet* (pages 41-43).

Guiding Questions:

1. How does flow rate vary between different irrigation methods?
2. Which irrigation method appears to be the most water-wise and efficient based on our data?
3. How can understanding flow rate help us make sustainable irrigation choices?

Drip Irrigation

MATERIALS

- 4 feet of polyethylene drip tube
- Drip emitters (0.5 GPH, 1 GPH, 2 GPH)
- Female hose thread compression fitting
- Figure 8 hose end closure
- Drip punch tool
- Garden hose
- Plastic cups, 12- to 16-ounce
- Beaker or liquid measuring cup
- Towels or trays (to manage spills)
- Timer or clock

Procedure:

1. Ensure the group has all materials and understands how to safely use the punch tool.
2. Students assemble their drip lines:
   - Cut a 4-foot length of polyethylene tubing.
   - Attach the female hose thread fitting to one end and close the other with the figure 8 end closure.
   - Use the punch tool to insert an emitter approximately every foot, starting with 0.5 GPH, then 1 GPH, and ending with 2 GPH at the end.
   - Check emitter placement and connections.
3. Students place a plastic cup under each emitter. Each cup should be held in place by a student to prevent tipping and spills.
4. Run the test:
   - Connect the drip line to the hose.
   - Start the water and timer simultaneously. Let run for 10 minutes (0.17 hours).
   - Watch for disconnected emitters or leaks. Encourage groups to observe if any emitter is dripping faster or slower than expected.
5. After 10 minutes, instruct students to measure the water collected in each cup by carefully pouring each amount into their measuring device (beaker or liquid measuring cup). Record all three measurements (in gallons) on the data sheet.

Hand Watering

MATERIALS

- Garden hose nozzle
- Garden hose
- Four 5-gallon buckets (marked with gallon levels)
- Towels or trays (to manage spills)
- Timer or clock

Procedure:

1. Gather and prepare supplies. Ensure the group has all materials and understands how to operate the hose nozzle attachment.
2. Set up the garden hose nozzle test:
   - Attach the nozzle to the garden hose.
   - Place the 5-gallon buckets in a location where they can be easily filled and measured without spilling.
3. Run the test with the garden hose nozzle set to "jet" or something similar.
   - Start the water and timer simultaneously.
   - Run the jet setting for 5 minutes, filling the bucket. Only begin filling the next bucket once the first bucket is completely filled. Monitor carefully to avoid overflow or spills.
   - At the end of 5 minutes, measure and record the amount of water collected in the buckets (in gallons) on the data sheet. Use the bucket markings for measurement.
4. Set the garden hose nozzle to "shower" or something similar. Empty the buckets and repeat the test. Measure and record the water collected (in gallons) on the data sheet.

Sprinkler Watering

MATERIALS

- Pop up spray head (10′ radius)
- Impact sprinkler (10′ radius)
- Rotor sprinkler (10′ radius)
- Sprinkler manifold system (pre-assembled, see page 45)
- Garden hose
- Nine 5-gallon buckets (marked with gallon levels)
- Tape measure
- Towels or trays (to manage spills)
- Timer or clock

Procedure:

1. Gather and prepare supplies. Ensure the group has all materials and understands how to safely attach and operate the manifold and sprinkler heads.
2. Set up sprinkler system:
   - Attach the pop up spray head, impact sprinkler, and rotor sprinkler to the manifold system, one on each riser.
   - Connect the manifold to the garden hose.
   - Using the tape measure, place the 5-gallon buckets at 1 foot, 5 feet, and 10 feet distances from each sprinkler head, on either side of the sprinkler line.
3. Run the test:
   - Turn on the water and start the timer simultaneously.
   - Let the sprinklers run for 5 minutes.
4. After five minutes, combine the three buckets at each sprinkler head. Measure the total amount of water collected from each sprinkler using the gallon markings. Record the water collected (in gallons) on the data sheet.

EXPLAIN

HOW CAN WE MAKE EVERY DROP COUNT?

30 MIN

MATERIALS

- *How Can We Make Every Drop Count? Slide Deck* (Google / PDF)
- *How Can We Make Every Drop Count? Guided Notes* (pages 46-49)
- *How Can We Make Every Drop Count? Guided Notes Answer Key*

Procedure:

1. Begin by reviewing the slide deck and ensuring familiarity with the content. Hand out the guided notes to each student.
2. As you present each slide, pause periodically to allow students to fill in their guided notes. Highlight key points, provide additional context, and encourage student interaction by asking questions or prompting discussion.
3. At the end of the slide deck, review the key concepts covered in the presentation. Go over the notes with the class, ensuring that students have accurately filled in their guided notes.

EVALUATE

WATER EFFICIENCY REPORT

MATERIALS

- *Irrigation Comparison Lab Analysis* (page 44)

15 MIN

Introduce the task:

"Now that you've learned about water conservation methods and collected data from different irrigation systems, it's time to analyze what your results mean. We are going to return to our lab worksheet and look closely at our findings."

Procedure:

1. Have students complete the analysis questions, using the data they collected during the lab and information from the slide presentation to summarize their findings and form recommendations. Circulate to check for understanding and to support student success.

ASSESSMENT SCORING GUIDE: SEE PAGE 36

Lab Group Members: _____

_____

_____

Class Period: _____

Date: _____

IRRIGATION COMPARISON LAB WORKSHEET

Instructions: In this lab, you will measure and compare how much water is used by three different irrigation methods: drip irrigation, hand watering, and sprinkler irrigation. You will work with your group to:

1. Set up and test your assigned irrigation method.
2. Measure how much water is used during the test.
3. Record your data carefully.
4. Share your results with the class so everyone has complete data for all methods.

PRE LAB QUESTION: Based on what you observed in the irrigation system photos, which system do you think delivers water to plants most effectively with the least waste?

Method 1: Drip Irrigation

MATERIALS

- 4 feet of polyethylene drip tube
- Drip emitters (0.5 GPH, 1 GPH, 2 GPH)
- Female hose thread compression fitting
- Figure 8 hose end closure
- Drip punch tool
- Garden hose
- Plastic cups, 12- to 16-ounce
- Beaker or liquid measuring cup
- Timer or clock

Procedure:

1. Gather supplies and pre-check. Make sure you have all materials and know how to safely use the punch tool.
2. Assemble a drip line:
   - Cut a 4-foot length of polyethylene tubing.
   - Attach the female hose thread fitting to one end and close the other with the figure 8 end closure.
   - Use the punch tool to insert an emitter approximately every foot, starting with 0.5 GPH, then 1 GPH, and ending with 2 GPH at the end.
3. Place a plastic cup under each emitter. Each cup should be held in place to prevent tipping and spills.
4. Run the test:
   - Connect the drip line to the hose.
   - Start the water and timer simultaneously. Let run for 10 minutes (0.17 hours).
   - Watch for disconnected emitters or leaks.
5. After 10 minutes, measure the water collected in each cup by carefully pouring each amount into the measuring device (beaker or liquid measuring cup). Record all three measurements (in gallons) on the data sheet.

Method 2: Hand Watering

MATERIALS

- Garden hose nozzle
- Garden hose
- Four 5-gallon buckets (marked with gallon levels)
- Timer or clock

Procedure:

1. Gather and prepare supplies. Make sure you have all materials and know how to operate the hose nozzle attachment.
2. Set up the garden hose nozzle test:
   - Attach the nozzle to the garden hose.
   - Place the 5-gallon buckets in a location where they can be easily filled and measured without spilling.
3. Run the test with the garden hose nozzle set to "jet" or something similar.
   - Start the water and timer simultaneously.
   - Run the jet setting for 5 minutes, filling the bucket. Only begin filling the next bucket once the first bucket is completely filled. Monitor carefully to avoid overflow or spills.
   - At the end of 5 minutes, measure and record the amount of water collected in the buckets (in gallons) on the data sheet. Use the bucket markings for measurement.
4. Set the garden hose nozzle to "shower" or something similar. Empty the buckets and repeat the test. Measure and record the water collected (in gallons) on the data sheet.

Method 3: Sprinkler Watering

MATERIALS

- Pop up spray head (10' radius)
- Impact sprinkler (10' radius)
- Rotor sprinkler (10' radius)
- Sprinkler manifold system (pre-assembled, see note*)
- Garden hose
- Nine 5-gallon buckets (marked with gallon levels)
- Tape measure
- Timer or clock

Procedure:

1. Gather and prepare supplies. Make sure you have all materials and understand how to safely attach and operate the manifold and sprinkler heads.
2. Set up sprinkler system:
   - Attach the pop up spray head, impact sprinkler, and rotor sprinkler to the manifold system, one on each riser.
   - Connect the manifold to the garden hose.
   - Using the tape measure, place the 5-gallon buckets at 1 foot, 5 feet, and 10 feet distances from each sprinkler head, on either side of the sprinkler line.
3. Run the test:
   - Turn on the water and start the timer simultaneously.
   - Let the sprinklers run for 5 minutes.
4. After five minutes, combine the three buckets at each sprinkler head. Measure the total amount of water collected from each sprinkler using the gallon markings. Record the water collected (in gallons) on the data sheet.

DATA SHEET

Irrigation Method	Time System Ran in hours (t)	Volume of Water Used In Gallons (v)	Flow Rate (Q) in Gallons per hour
Drip System, 0.5 GPH	0.17 Hours		
Drip System, 1 GPH	0.17 Hours		
Drip System, 2 GPH	0.17 Hours		
Hand Watering, Jet Setting	0.08 Hours		
Hand Watering, Shower Setting	0.08 Hours		
Sprinkler Irrigation, Pop Up Spray Head	0.08 Hours		
Sprinkler Irrigation, Impact Sprinkler	0.08 Hours		
Sprinkler Irrigation, Rotor Sprinkler	0.08 Hours		

Conversion of fluid ounces to gallons: 1 gallon = 128 fluid ounces

USE THIS EQUATION TO NOW CALCULATE FLOW RATE:

$$\text{Flow Rate (Q)} = \frac{\text{Volume of Water (v)}}{\text{Time (t)}}$$

Name: _____

Class Period: _____

Date: _____

IRRIGATION COMPARISON LAB ANALYSIS

Homeowners often want to save water without sacrificing plant health. Based on your lab results, determine which irrigation system would be the best choice for a homeowner. Use lab data and water-saving strategies from the slides to support your answer.

1. Which method was most efficient? What evidence supports your answer?

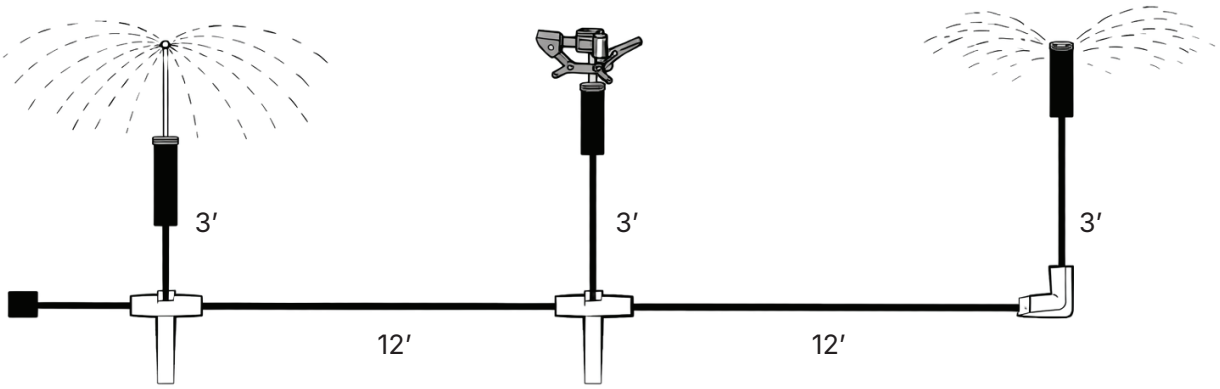
2. Do you think your data accurately reflects how these systems would perform in a real landscape setting? Why or why not?

3. Based on your data, which irrigation system would you recommend for a homeowner and why?

4. How could someone make any irrigation system more water efficient?

5. Write a 3-5 sentence irrigation recommendation for homeowners that summarizes your findings. Support your recommendation with data from your tests and include at least one water-saving practice discussed in the slide presentation.

SPRINKLER IRRIGATION MANIFOLD SYSTEM DIAGRAM



Pop Up Spray Head **Impact Sprinkler** **Rotor Sprinkler**

- Distance between risers is 12 feet.
- One end needs a female hose attachment fitting.
- Pipe is made of PVC.
- Risers should come up 3 feet.
- 39′ of ¾″ PVC Pipe is needed along with 2 tees and 1 elbow fitting.
- The system should be primed and glued before students complete the lab.

Name: _____

Class Period: _____

Date: _____

GUIDED NOTES

HOW CAN WE MAKE EVERY DROP COUNT?

1 Plants Need Water

- Water is a valuable yet limited resource that is essential for _____.
- About _____% of most plants are made up of water!
- Plants need water for _____ and other important processes.

Draw or describe one place you see plants being watered (home, school, park, etc.):

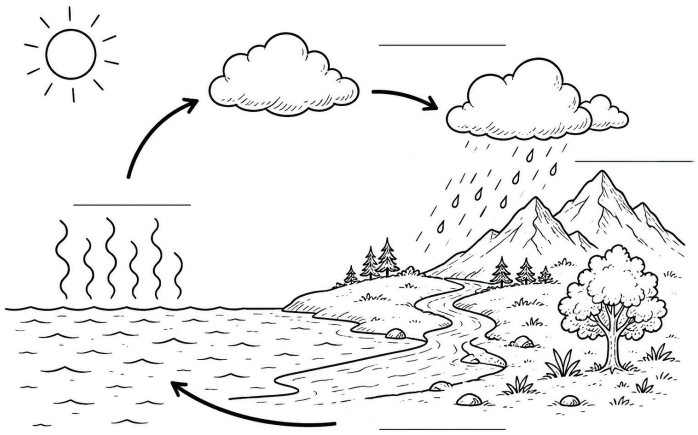
2 Water Is a Limited Resource

- Water is limited, but _____ keeps growing.
- Drought and _____ _____ make water supplies less reliable.
- Careful management helps save water and keeps _____ healthy.

3 The Water Cycle

Label the diagram with the numbers below to describe what happens to water as it:

1. Evaporates from oceans and soil
2. Condenses into clouds
3. Falls as _____
4. Returns to rivers, lakes, and plants



4 Evapotranspiration

- Plants lose water through _____ (from soil and surfaces) and _____ (from leaves).
- This combined process is called _____.
- Temperature, humidity, _____, and wind affect how fast water is lost.
- All lost water must be replaced for plants to grow and stay healthy.

5 Why Timing Matters

- Watering during the _____ part of the day increases evaporation and wastes water.
- Water early in the _____ or late in the _____ to reduce water loss.
- **Tip:** _____ and _____ can help soil stay moist longer.

Best Management Practices for Irrigation

6 Create Hydrozones

- Group plants with similar _____ needs together.
- This allows you to water each group with the right _____ at the right _____.
- **Result:** Healthier plants and less _____ water.

Sketch or list two types of plants that might belong in the same hydrozone:

7 Apply the Right Amount of Water

- Overwatering is more common than _____, especially in clay soils.
- Check your irrigation system regularly and adjust schedules to match _____.
- Conduct an annual "can test" to check sprinkler _____ and ensure even watering.

8 Water Deeply and Infrequently

- Allowing soil to dry between waterings helps prevent _____.
- Watering plants as deeply as their _____ grow makes the water more accessible.
  - Vegetables/bedding plants → ____ inches to ____ foot
  - Shrubs, cool-season grass, tomatoes → ____ to ____ feet
  - Trees, warm-season grass, large shrubs → ____ to ____ feet

9 Water Early in the Morning

- It is usually cooler and less _____ in the early morning.
- These conditions reduce _____ water loss.
- Automated systems that _____ before people are awake should be checked regularly.

10 Avoid Deep Percolation

- Deep percolation happens when water _____ into the soil too quickly and goes _____ than the plant roots can reach.
- Common in _____ soils, where water drains fast.
- **Fix:** Water for _____ periods of time so the soil absorbs what plants can use.

11 Avoid Runoff

- Runoff happens when water can't soak into the soil, so it _____ across the surface instead.
- Common in _____ soils, which absorb water slowly.
- **Fix:** Use _____ _____. Break one long irrigation into two or more shorter cycles.

12 Check Irrigation Systems Regularly

- If there are brown spots or wilted plants, there might be a problem.
- **Common issues:**
  - ☐ _____ sprinklers
  - ☐ Sunken _____
  - ☐ _____ blocking sprinklers
  - ☐ Broken sprinklers
  - ☐ Dirt or debris _____ nozzles

Write one way you can spot a problem early:

_____

13 Mulching Matters

- Add _____ inches of organic mulch on top of the soil.
- Why mulch?
  - Keeps _____ in the soil
  - Cuts down on _____
  - Builds healthier _____ over time
- **Tip:** Don't stack mulch against _____ trunks. It can cause damage.

14 Organic Matter + Soil = Better Water Use

- Organic matter comes from once-living things like _____, leaves, or manure.
- In clay soils, it helps water _____ in and move through faster.
- In sandy soils, it helps soil _____ onto water longer.

Draw or write two items of food waste that can be used to create compost:

15 Save Water, Grow Better

- By adopting smart irrigation practices, we can:
  - Save _____ on water bills
  - Conserve a valuable natural _____
  - Keep plants _____ by avoiding overwatering

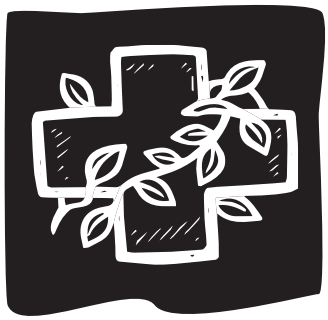
Wrap-Up Reflection

How could smart irrigation practices make a difference at your home, school, or community?

_____

_____

_____



WHAT NUTRIENTS DO PLANTS NEED?

Grade Level: 9-12

DURATION: 80 minutes

Lesson Objectives:

1. Students will explain how fertilizers impact the environment and why overuse can be harmful.
2. Students will identify essential nutrients for plant growth and recognize signs of nutrient deficiencies.
3. Students will compare different types of fertilizers and their uses.
4. Students will recommend appropriate fertilizers to address specific soil nutrient deficiencies.

STANDARDS ADDRESSED: CTE Agriculture and Natural Resource Standards C2.1, C10.4, F2.4, F6.1, F6.2, F6.3, G6.2

Please use the scoring guide below to evaluate student learning for the lesson.

Assessment Scoring Guide (8 points total)

Review the student responses and assign points based on the criteria below.

- ___ Identified nutrient deficiency or toxicity based on soil test results (1 pt)
- ___ Linked soil data to at least one correct plant symptom (1 pt)
- ___ Recommended one appropriate organic fertilizer based on soil needs (1 pt)
- ___ Recommended one appropriate inorganic fertilizer based on soil needs (1 pt)
- ___ Explained the impact of overfertilization (e.g., leaching, runoff, plant damage) (2 pts)
- ___ Responses are clear, complete, and use appropriate vocabulary (e.g., nutrients, deficiency, toxicity, leaching, runoff) (2 pts)

TOTAL POINTS: ____ / 8

ENGAGEMENT ACTIVITY

HUNGER SIGNS IN PLANTS

10 MIN

MATERIALS

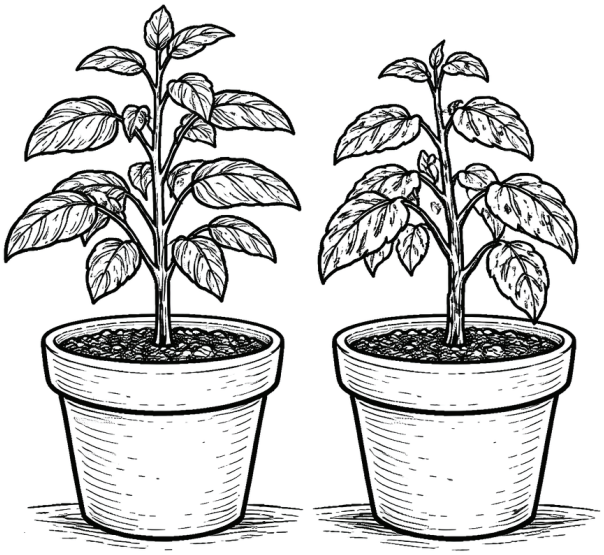
- *Hunger Signs in Plants Slide Deck*
- *Hunger Signs in Plants Worksheet* (page 54)
- **Optional Video:** youtube.com/watch?app=desktop&v=pgF7dVmqVL4

Google PDF

Video

Introduce the topic:

"Since ancient times, people have used plant appearance to understand plant health. Plants communicate through distress signals, and today we're going to be plant detectives to learn what those signals can tell us."



Procedure:

1. Explain that plants can show symptoms for many reasons, including water, light, temperature, and nutrient issues. Briefly introduce nutrient deficiencies and toxicities as possible causes.
2. Display each plant image from the slide deck, one at a time. Ask students to carefully observe the leaves of hungry and healthy plants, and record visual observations on the *Hunger Signs in Plants Worksheet.* Encourage them to think about what might be causing the problem without needing to make a final diagnosis.
3. Facilitate discussion using guiding questions:
   - What clues do the leaves give about this plant's health?
   - Which environmental factors (like light, water, or temperature) might be causing these symptoms?
   - How could we test whether the problem is due to a nutrient deficiency or something else? What would you do next?
4. Conclude the activity by emphasizing that careful observation helps identify plant needs and lays the foundation for better decision-making in horticulture.

EXPLORE

SOIL NUTRIENT TEST

MATERIALS

- Soil samples
- Growing media (optional)
- Soil nutrient test kit (e.g., Luster Leaf Rapitest Kit)
- *What Nutrients Do Plants Need? Lab Worksheet* (pages 55-57)

20 MIN

Guiding Questions:

1. How do nutrients in soil affect plant growth?
2. What happens when soil lacks key nutrients?

Introduce the activity:

"Today we're going to test soil to see which nutrients it has and which it may be missing. By the end, you'll understand more about your soil's health and how that affects plant growth."

Procedure:

1. Divide the class into groups of three and provide each group with a soil sample and nutrient test kit. Have them prepare their sample by mixing soil with water, then use the kit to test for nitrogen (N), phosphorus (P), and potassium (K). If time allows, have one group test the growing media as well for comparison. Students should follow the kit instructions carefully, compare their results to the color chart, and record the data on their *What Nutrients Do Plants Need? Lab Worksheet.*
2. After testing, students will describe their soil sample, identify which nutrients are sufficient or lacking, and consider how that might affect plant growth.
3. Wrap up with a class discussion where groups share results and reflect on which elements are needed to improve their soil.

EXPLAIN

WHAT NUTRIENTS DO PLANTS NEED? PRESENTATION

30 MIN

MATERIALS

- *What Nutrients Do Plants Need? Slide Deck* (Google, PDF)
- *What Nutrients Do Plants Need? Guided Notes* (pages 55-57)
- *What Nutrients Do Plants Need? Guided Notes Answer Key*

Procedure:

1. Begin by reviewing the slide deck and ensuring familiarity with the content. Hand out the guided notes to each student.
2. As you present each slide, pause periodically to allow students to fill in their guided notes. Highlight key points, provide additional context, and encourage student interaction by asking questions or prompting discussion.
3. At the end of the slide deck, review the key concepts covered in the presentation. Go over the notes with the class, ensuring that students have accurately filled in their guided notes.

EVALUATE

SOLVING NUTRIENT PROBLEMS

20 MIN

Introduce the task:

"Now that you've tested your soil, it's time to use your results to make a recommendation. Imagine you're advising a homeowner on how to fix a nutrient problem. Which fertilizer would you suggest?"

Procedure:

1. Ask students to review their soil test data and identify whether their sample shows a deficiency or toxicity. Have students predict the plant symptoms that would appear if the deficiency or toxicity were left uncorrected.
2. Instruct students to research and identify one organic and one inorganic fertilizer that could address the issue. Remind students to check the nutrient content of each fertilizer and avoid recommending products that add nutrients already abundant in their soil.
3. Ask students to consider sustainability: What could happen if these fertilizers were over-applied, and how might that affect the soil or environment over time?
4. Have students record their recommendations in the "Assessment" section on page 57 of the *What Nutrients Do Plants Need? Lab Worksheet* and provide a written explanation connecting their soil test results to their fertilizer choices.

ASSESSMENT SCORING GUIDE: SEE PAGE 50

Name: _____

Class Period: _____

Date: _____

HUNGER SIGNS IN PLANTS

Record the visual observations you make when comparing hungry and healthy plants.

IMAGE	HUNGRY	HEALTHY
1		
2		
3		
4		
5		
6		
7		

Name: _____

Class Period: _____

Date: _____

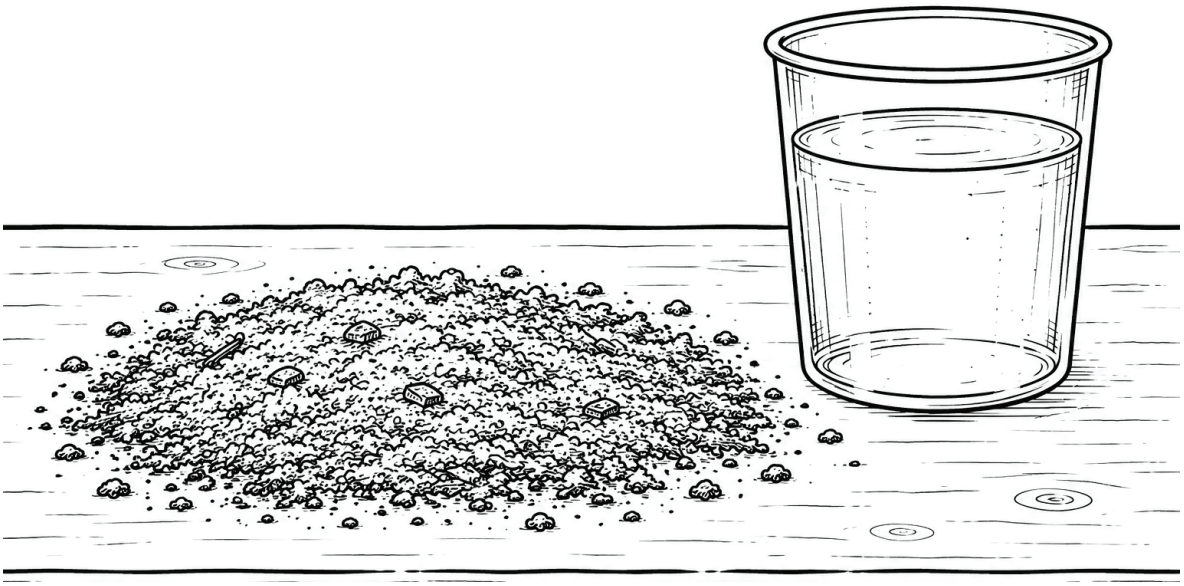
LAB WORKSHEET

WHAT NUTRIENTS DO PLANTS NEED?

Purpose: To test soil samples for the three primary plant nutrients, nitrogen (N), phosphorus (P), and potassium (K), and decide which fertilizer (if any) would best support healthy plant growth.

Directions

1. Form a team of 3 students.
2. Collect a soil sample (either from campus or from home).
3. Spread out your soil on the table and gently crumble it into smaller pieces. Record visual observations.
4. Fill a clean container with 1 cup of soil and 5 cups of water. Shake well for at least 1 minute, then let the mixture settle for 10 minutes.
5. Use the clear liquid (not the sediment) for your nutrient tests.



NUTRIENT TESTS

Test 1 - Nitrogen (PURPLE chamber)

1. Fill the reference chamber with liquid from your soil mixture (avoid sediment).
2. Open the purple capsule and add the powder to the test chamber.
3. Cap tightly, shake thoroughly, and let sit for 10 minutes.
4. Compare the solution color to the chart (using daylight, not direct sunlight).
5. Record your results.

Why it matters: Nitrogen helps plants grow strong leaves and stems. Too little causes yellow, stunted plants. Too much can run off into rivers, harming fish and water quality.

Test 2 - Phosphorus (BLUE chamber)

1. Repeat the same steps using the blue capsule.
2. Shake thoroughly and let sit for 10 minutes.
3. Compare the color to the chart.
4. Record your results.

Why it matters: Phosphorus supports root growth, flowers, and fruit. Without enough, plants grow slowly. However, using too much phosphorus can lead to leaching or runoff, which pollutes waterways and disrupts aquatic ecosystems.

Test 3 - Potassium (ORANGE chamber)

1. Repeat the same steps using the orange capsule.
2. Shake thoroughly and let sit for 10 minutes.
3. Compare the color to the chart.
4. Record your results.

Why it matters: Potassium improves plant health, helping plants resist drought and disease. Balanced potassium makes crops more resilient and reduces the need for chemical treatments.

Soil Observations and Test Results

Soil Location: _____

Soil Visual Description: _____

Soil Test	Results
Nitrogen (N)	
Phosphorus (P)	
Potassium (K)	

STOP HERE

Assessment

Task: Now that you've tested your soil, it's time to use your results to make a recommendation. Imagine you're advising a homeowner on how to fix a nutrient problem. Which fertilizer would you suggest?

Identify the Problem

1. Which nutrient(s) were most lacking (or too high) in your soil sample?

2. What plant symptoms might appear if this issue is not corrected?

Fertilizer Recommendations

Organic Option:

What is it? Why did you choose it?

Inorganic Option:

What is it? Why did you choose it?

3. How do your fertilizer choices match the nutrient problem in your soil?

4. What could happen if too much of either fertilizer was applied?

5. How might this affect soil, water, or the environment?

Name: _____

Class Period: _____

Date: _____

GUIDED NOTES

WHAT NUTRIENTS DO PLANTS NEED?

Helpful Definitions

Nutrient Deficiency - When a plant doesn't have enough of an essential _____

Nutrient Toxicity - Too _____ of a nutrient that can damage plants

Chlorosis - Yellowing of leaves caused by a lack of _____

Necrosis - Brown or dead _____ on leaves due to tissue death

Stunting - Slowed or reduced _____, often a general symptom of multiple deficiencies.

1 17 Essential Nutrients for Plant Growth

- Plants need 17 essential elements to grow and stay healthy.
- Carbon, hydrogen, and oxygen come from the _____ and _____.
- The other 14 are absorbed from the _____ through the roots.
- Primary nutrients: _____, _____, _____
- Secondary nutrients: _____, _____, _____
- Micronutrients: boron, chlorine, copper, iron, nickel, zinc, manganese, molybdenum

2 How Plants Absorb Nutrients

- Roots absorb nutrients dissolved in _____ from the soil.
- Dead plants and leaves recycle nutrients back into the _____.
- Fertilizers add nutrients when nutrient levels are low.
- Soil _____ can make it easier or harder for roots to take up nutrients.

Think & Write

Why might two gardens growing the same plant need different fertilizers?

3 pH and Plant Nutrients

- Soil pH affects nutrient availability.
- Too acidic (low pH) → some nutrients become _____
- Too alkaline (high pH) → others "_____ up" in the soil
- Most plants grow best at pH _____ to _____.

4 Deficiency Symptoms

- Nutrients may be _____ _____ by soil pH
- Or nutrients may be _____ _____ over time
- Either way, plants show visible _____.

5 Nitrogen (N) Deficiency Symptoms

- General chlorosis that begins as light green and turns _____.
- Chlorosis starts in _____ leaves and spreads.
- _____ deficiency can cause the entire plant to show chlorosis.
- Growth becomes _____, plants look _____ and weak, and older leaves may _____.

6 Phosphorus (P) Deficiency Symptoms

- Leaves may appear _____ and turn dark green, blue-green, or red-_____.
- Purpling often shows on the _____ of leaves, especially along the midrib and veins.
- _____ may also turn purple.
- Growth becomes _____.

7 Potassium (K) Deficiency Symptoms

- Leaf margins may turn brown, appear _____, or develop necrotic spots.
- Leaf edges can _____ downward.
- Growth becomes stunted, and _____ may occur.
- Mild symptoms often appear first on _____ matured leaves.

8 Fertilization of Garden Soils

- Garden soils rarely have enough nutrients on their own.
- It's important to only add nutrients that are _____ in your particular soil.
- Most homeowners _____ fertilize or _____ fertilize.

9 Types of Fertilizers

- Inorganic Fertilizers - Fast-acting, precise nutrient content
- **Examples:** _____(N), triple superphosphate (P), potassium chloride (K)
- Organic Fertilizers - Slow-release, improve soil structure, almost always complete
- **Examples:** _____, _____, bone meal, fish emulsion

10 Reading Fertilizer Labels

A complete fertilizer contains all three macronutrients:

N = _____ P = _____ K = _____

The numbers on the bag show the % of each nutrient, always in this order.

SHOW WHAT YOU KNOW:

Example: 32-0-5 → ____% nitrogen, ____% phosphorous, ____% potassium

Example: 21-8-11 → ____% phosphorus, ____% nitrogen, ____% potassium

11 Fertilizer Application Rate

- Rate = how much fertilizer is applied per _____ of soil.
- Too little → plants don't get enough nutrients → _____ growth
- Too much → _____, and can harm plants and the _____

12 Too Little Fertilizer

When plants don't get enough nutrients, they show signs like:

- _____ growth
- _____ leaves
- _____ yield or poor harvest
- Are _____ to pests and disease

13 Too Much Fertilizer

- Can be _____
- May _____ or damage plants
- Leaching: nutrients move deep into soil, _____ from roots
- Runoff: nutrients _____ into rivers, lakes, or streams
- May _____ the environment

14 Fertilization and Sustainability

- Apply fertilizer at the right _____ for the crop
- Use _____-release or organic fertilizers
- Fertilize when plants can use nutrients _____
- Avoid fertilizing before heavy _____
- Use cover crops or _____ to hold soil in place

Reflection

Describe one mistake homeowners often make when fertilizing plants. How could they change their routine to fertilize more sustainably?

WHAT MAKES A LANDSCAPE FIRE RESISTANT?

Grade Level: 9-12

DURATION: 90 minutes, over two class periods or one block

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Lesson Objectives:

1. Students will explain how the placement and management of vegetation and materials around a home influence wildfire risk.
2. Students will identify and analyze fuel sources in a landscape and describe how their location affects fire behavior near structures.
3. Students will apply firewise landscaping principles to design a residential landscape that reduces fuel sources near the main structure.
4. Students will justify their design choices using fire-safe landscaping principles.

STANDARDS ADDRESSED: CTE Agriculture and Natural Resource Standards C2.4, C2.5, E9.3, E9.4, F1.5, F10.3; NGSS: HS-ESS3-1, HS-ESS3-3

Please use the scoring guide below to evaluate student learning for the lesson.

Assessment Scoring Guide (14 points total)

Review the student responses and assign points based on the criteria below.

___ All required design elements are included (4 pts)

___ Defensible space zones are clearly marked and correctly applied (2 pts)

___ Plant and material placement demonstrates intentional fuel management (2 pts)

___ Reflection responses identify and explain fuel-related design decisions (4 pts)

___ Design balances fire safety with realistic landscape use (2 pts)

TOTAL POINTS: ____ / 14

ENGAGEMENT ACTIVITY

WHAT FUELS A FIRE?

20 MIN

MATERIALS

- *What Fuels A Fire? Slide Deck*
  Google PDF
- 3-5 plant samples (e.g., dry grass, woody shrub, succulent) or short video clips of plants burning

For additional guidance, including a plant list with fire-smart considerations, refer to pages 6-23 in the UC ANR resource, *Fire-Smart Landscaping in the Sierra Foothills*.

Introduce the topic:

"When a wildfire starts, it needs fuel to keep burning. In a landscape, that fuel often comes from plants and materials around a home. Today, we're going to explore how different types of plants and landscape choices can increase or reduce fire risk."

Procedure:

1. Explain that California, and much of the West, is prone to wildfire, and that fires can start from small sparks but spread quickly depending on the available fuel. Emphasize that plant type, moisture in the environment, and the landscape's design all influence how fire behaves.
2. If permitted by school safety guidelines, demonstrate how different plant materials burn using small samples in a controlled setting, ensuring students observe from a safe distance. Alternatively, show short video clips of these materials burning. Ask students to silently observe for 30-60 seconds, focusing on how each material burns.
3. Facilitate discussion using guiding questions:
   - Which plant material appeared to burn the fastest or most intensely?
   - What differences do you notice in moisture, structure, or density between the materials?
   - How might these differences affect how a fire spreads in a landscape?
4. Display the slides from the *What Fuels A Fire? Slide Deck*. Ask students to silently observe both images for about 30 seconds, focusing only on what they notice.
5. Continue with guiding questions:
   - Which home do you think is more likely to survive a wildfire?
   - What do you see that makes you think that?
   - Where do you see features that might help fire spread or help slow it down?
6. Conclude the activity by emphasizing that while many plants can burn under extreme conditions, thoughtful plant selection and placement can reduce fuel and slow fire spread. Transition to the next activity by explaining that students will now identify common fuel sources in a landscape and explore design techniques that can increase or reduce wildfire risk.

EXPLORE

WHERE IS THE FUEL?

20 MIN

MATERIALS

- Post-fire photo cards (three images per group)

PDF

- *Where is the Fuel? Analysis Worksheet* (pages 67-69)

Introduce the activity:

"Before we learn firewise landscaping practices, we're going to investigate real post-fire images to better understand what fuel sources look like around homes and how they may influence fire damage."

Guiding Questions:

1. What materials or features around a home can act as fuel during a wildfire?
2. How does the location of fuel sources affect fire behavior near a structure?

Procedure:

1. Divide the class into small groups of three to four students and provide each group with a set of three post-fire photo cards.
2. Have students begin with silent observation. Prompt students to imagine what the image would have looked like before a fire. For one minute, students will observe the first photo and individually record three things they notice, focusing only on what they can see rather than explanations.
3. Next, students will work with their group to look at the same photo and identify potential fuel sources and the location of the fuel sources. Students should list any items that appear to be easily flammable and dangerous to have near a structure.
4. As groups work, circulate to prompt deeper thinking with questions such as:
   - "What do you see that might help fire move toward the house?"
   - "Where is this fuel located in relation to the structure?"
5. Repeat with each photo. After groups complete their analysis, facilitate a brief whole-class discussion. Invite groups to share one image and the fuel source they identified. Record common fuel sources and patterns on the board. Wrap up the activity by asking students, *"What would you want to know before designing a landscape to make it more fire resistant?"*

EXPLAIN

WHAT MAKES A LANDSCAPE FIRE RESISTANT?

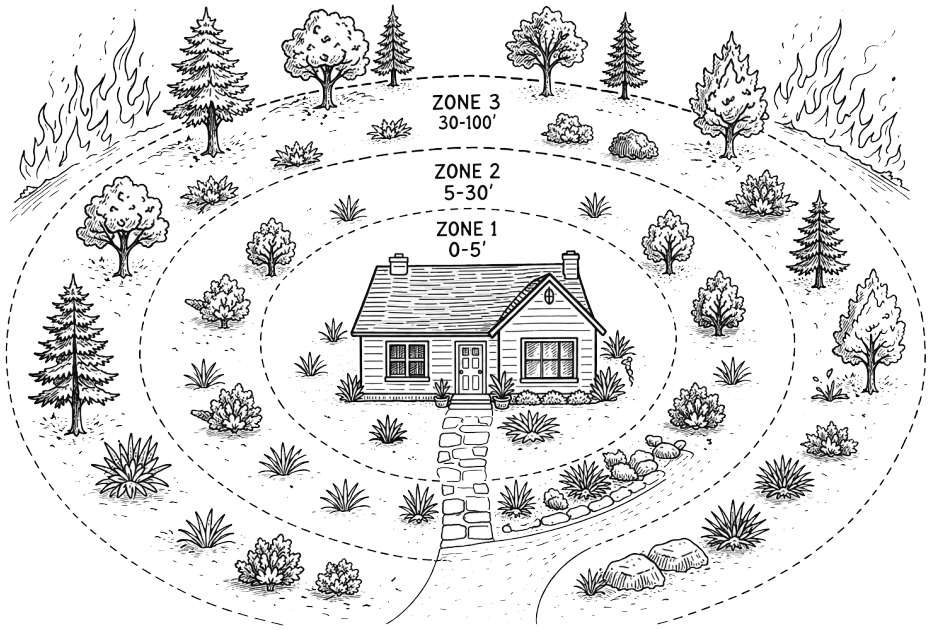
20 MIN

MATERIALS

- *What Makes A Landscape Fire Resistant? Slide Deck* Google PDF
- *What Makes A Landscape Fire Resistant? Guided Notes* (pages 72-75)
- *What Makes A Landscape Fire Resistant? Guided Notes Answer Key*

Procedure:

1. Begin by reviewing the slide deck and ensuring familiarity with the content. Hand out the guided notes to each student.
2. As you present each slide, pause periodically to allow students to fill in their guided notes. Highlight key points, provide additional context, and encourage student interaction by asking questions or prompting discussion.
3. At the end of the slide deck, review the key concepts covered in the presentation. Go over the notes with the class, ensuring that students have accurately filled in their guided notes.



EVALUATE

DESIGNING A FIRE RESISTANT LANDSCAPE

20-30 MIN

Introduce the task:

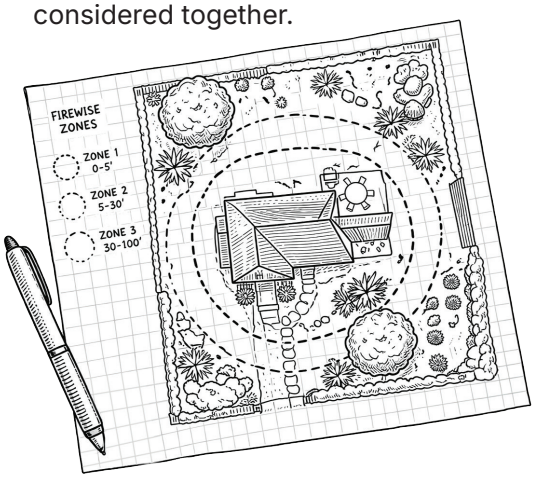
"Now that you've investigated fuel sources around homes and learned about firewise landscaping practices, it's time to apply that knowledge. Imagine you're advising a homeowner in a wildfire-prone area. Your goal is to design a landscape that reduces fire risk while still being functional and visually appealing."

MATERIALS

- 11×17 inch graph paper, with ¼-inch grid
- *Fire Resistant Landscape Design Challenge Worksheet* (pages 70-71)

Procedure:

1. Ask students to review the firewise zones and remind them that fire risk is influenced by where fuel sources are located and how close they are to structures.
2. Instruct students to use graph paper to design a scaled residential lot that includes a primary structure and required landscape elements. All requirements are outlined on the *Fire Resistant Landscape Design Challenge Worksheet.* Remind them to clearly mark firewise zones on their design and to intentionally place plants, hardscaping, and other features based on fuel considerations and defensible space principles.
3. As students work, prompt them to think critically about their choices:
   - Where are the highest-risk fuel sources located?
   - How does spacing or hardscaping reduce fire spread near the structure?
   - How can beauty, habitat value, and water conservation still be incorporated without increasing fire risk?
4. Students should also complete the written portion of the assessment, explaining how their design choices support fire resistance, aesthetics, and overall functionality.
5. Conclude by reminding students that this type of planning reflects real-world decision-making in landscaping, horticulture, and land management, where safety, sustainability, and aesthetics must all be considered together.



ASSESSMENT SCORING GUIDE: SEE PAGE 62

Name: _____

Class Period: _____

Date: _____

WHERE IS THE FUEL? ANALYSIS WORKSHEET

Purpose: Landscaping choices can influence how fire behaves near homes. In this activity, you will analyze real post-fire images to identify fuel* sources and consider how their placement may have affected fire damage.

What is fuel? Fuel can be any plant, material, or object that can burn and help fire spread toward or away from a structure.

PHOTO CARD NO. _____

OBSERVE

Examine the photo carefully. Record only what you can see:

_____

_____

_____

_____

_____

_____

_____

FUEL SOURCE

Identify materials or features that could act as fuel:

_____

_____

_____

_____

_____

_____

_____

LOCATION

Describe where the fuel is located in relation to the structure:

_____

_____

_____

PHOTO CARD NO. _____

OBSERVE

Examine the photo carefully. Record only what you can see:

FUEL SOURCE

Identify materials or features that could act as fuel:

LOCATION

Describe where the fuel is located in relation to the structure:

PHOTO CARD NO. _____

OBSERVE

Examine the photo carefully. Record only what you can see:

FUEL SOURCE

Identify materials or features that could act as fuel:

LOCATION

Describe where the fuel is located in relation to the structure:

Reflection

Answer the questions below using evidence from the images.

1. Which fuel sources appeared most often across the photos?

2. Why might the location of a fuel source matter more than the type of material alone?

3. Did you notice any areas where fire damage appeared reduced or stopped? What features might explain this?

Name: _____

Class Period: _____

Date: _____

FIRE RESISTANT LANDSCAPE DESIGN CHALLENGE

Wildfires spread based on the fuel available around homes and structures. Fuel includes any combustible material that can ignite and help fire spread.

In this activity, you will apply what you have learned to design a firewise landscape that reduces fuel near a structure while still allowing for functional and realistic outdoor space.

YOUR TASK

Using a separate piece of graph paper, design a firewise landscape around a structure. Your design should show how fuel placement, spacing, and material choices can reduce wildfire risk. You will label and explain your design choices using this worksheet.

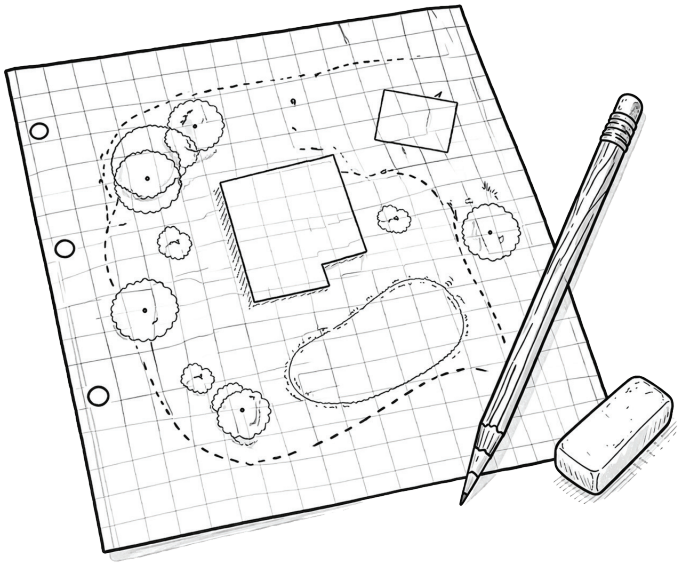
Required Elements in Your Design

Your design must include all of the following:

- ☐ One primary structure (home)
  - Minimum size: 1,200 square feet
- ☐ One secondary structure
  - Examples: detached garage, shed, chicken coop, or similar outbuilding
- ☐ Defensible space zones
  - Clearly marked and labeled on your design
- ☐ Vegetation, including:
  - At least three trees
  - At least five shrubs
  - One grass area
- ☐ Potted plants
- ☐ Mulch or ground cover
- ☐ One fence
- ☐ Labels or a key identifying:
  - Fuel sources
  - Fuel-free or reduced-fuel areas

Design Planning Questions

1. What scale will you use? How many square feet will be represented by one square?
2. What types of fuel are most dangerous when located close to a structure?
3. How can spacing and material choices reduce fire spread?
4. How can you arrange landscape elements to reduce fuel ladders?



Reflection

After completing your design, respond to the following questions using complete sentences.

1. Identify two fuel sources you intentionally reduced, moved, or removed in your design. Why?

2. Why might the location and condition or a fuel source matter more than the type of plant or material alone?

3. Choose one defensible space zone and explain how your design lowers wildfire risk in that zone.

4. How does your design balance fire safety with realistic land use (shade, access, appearance, or function)?

Name: _____

Class Period: _____

Date: _____

GUIDED NOTES

WHAT MAKES A LANDSCAPE FIRE RESISTANT?

1 Why Are We Talking About Wildfires?

- Wildfires are becoming more _____ and _____
- _____ fire seasons
- More people _____ near wildland areas
- Over the past ten years, more than 57,502 _____ have been destroyed in CA

2 Wildfires Aren't Just a Forest Problem

- Many homes lost in _____ and _____ areas
- _____ can travel far ahead of flames
- Landscaping can either _____ or _____ homes

3 What is a Fire-Resistant Landscape?

- Designed to slow fire, reduce _____, and limit spread
- Focuses on _____, maintenance, and materials
- Doesn't mean "_____ _____"

4 What Plants Should We Use?

No plant is truly "_____"

Higher-risk plant traits:

- Dense or _____ growth
- High _____ or oil content
- Large amounts of _____ material

Lower-risk plant traits:

- Higher _____ content
- _____, airy structure
- _____ plants

Think & Write:

Now that you know the traits, what is one example of a **low-risk** plant variety?

_____

_____

5 Placement Matters More than Plant Type

- How plants are placed and _____ matters most
- Continuous _____ that leads up to a _____ = higher risk
- Dry, _____ plants = higher risk

6 How Do Homes Catch Fire? Direct Flame

- Flames _____ plants or structures
- Often caused by _____ vegetation close to buildings
- Protect homes by creating a defensible space to interrupt fire _____

7 How Do Homes Catch Fire? Embers

- _____ _____ burning materials
- Can _____ mulch, planters, decks, roofs
- Travel miles ahead of the _____
- Protect homes with home hardening and defensible space

Think & Write:

What is one example of home hardening—updating a home with fire resistant materials?

_____

_____

8 How Do Homes Catch Fire? Radiant Heat

- Heat transfers without flames _____
- Can break _____ or ignite materials
- Worse when plants are _____ _____ together
- Protect homes with home hardening and _____ reduction

9 Reducing Fire Pathways

- _____ _____ continuous fuels
- Avoid "_____ _____" (ground → shrubs → trees)
- Use _____ and separation

10 Fire-resistant Landscaping Uses Zones

There are three primary defensible space zones to protect structures from wildfire.

Zones help manage vegetation from 0 to 100+ feet away.

These zones reduce fuel loads, preventing ember ignition and slowing flame spread.

11 Zone 0 (_____)

- Extends _____ around buildings, decks, and stairs
- Goal: prevent the structure from _____
- Reduces risk from:
  - Direct _____
  - Wind-blown _____
  - _____ heat
- Keep this zone _____ of combustible materials
- Use _____ surfaces (gravel, concrete, stone)

12 Zone 1

- Extends _____ from the structure
- Goal: slow fire and keep it from _____ the building
- Achieved by:
  - _____ plants and plant groups
  - _____ _____ continuous fuels
  - Reducing _____ and radiant heat exposure
- Vegetation should be low, irrigated, and _____
- Provides space for firefighters to _____ the structure

13 Zone 2

- Extends _____ from the structure
- Goal: reduce fire _____ before it reaches the home
- Actions focus on:
  - Removing _____ vegetation
  - Reducing _____ plant growth
  - Eliminating ladder _____
  - Increasing _____ between trees and shrubs
- Improves effectiveness of Zones 0 and 1

14 High Risk vs. Safer Alternatives

Wooden barrel → _____

Bark mulch → _____

Wooden fence → _____

Synthetic turf → _____

Dense plantings → _____

Trees close to home → _____

15 The Role of Mature Trees

- Mature trees can _____ fire risk:
  - Provide shade that lowers soil and surface _____
  - Increase soil _____
  - Reduce _____
- Must be properly maintained (_____, spacing)

16 How Fire-resistant Landscaping Becomes Standard Practice

- Fire-safe landscaping practices may be used in different ways:
  - Regulations: Required by _____ or building codes
  - Incentives: Rebates or programs that _____ safer choices
  - Insurance or Homeowner Choice: May be _____ by insurance or chosen by the homeowner
- All three help reduce wildfire risk in communities.

17 Key Takeaways

- Wildfire risk is _____ in communities
- Landscaping design can _____ risk
- Placement and maintenance > _____ _____
- Everyone can apply fire-resistant principles

Reflection

Describe a fire risk and provide a solution that would make a landscape more fire resistant.

_____

_____

Career Connection

CAREERS IN HORTICULTURE

Choose one career from the menu below to explore. Each job connects to what we've learned about sustainable horticulture.

WATER MANAGEMENT JOBS

Help plants get the right amount of water

Irrigation Designer or Technician

Designs, installs, repairs, and adjusts irrigation systems.

Water Conservation Specialist

Helps reduce water use while keeping plants healthy.

FIRE-SMART LANDSCAPE JOBS

Design and manage landscapes that reduce wildfire risk

Landscape Designer

Plans outdoor spaces that are attractive and fire resistant.

Defensible Space Inspector

Evaluates properties for wildfire hazards.

Arborist

Prunes and manages trees to improve health and safety.

Fire Ecologist

Studies how plants and ecosystems respond to wildfire.

SOIL & PLANT NUTRITION JOBS

Improve soil health and help plants grow

Soil Scientist

Studies soil texture, pH, and nutrient levels.

Compost Manager

Produces compost to improve soil structure and fertility.

Certified Crop Adviser (CCA)

Uses soil and plant data to guide nutrient decisions.

NURSERY & LANDSCAPE JOBS

Grow, install, and care for plants

Greenhouse Grower

Manages water, nutrients, and environmental conditions.

Landscape Contractor

Installs plants, irrigation systems, and hardscape.

Retail Nursery Specialist

Helps customers choose plants and solve gardening problems.

WANT TO LEARN MORE?

There's countless horticulture career resources available online. Here's a few ideas of where to start:

seedyourfuture.org/careers

agexplorer.ffa.org

thelandlovers.org

PEST MANAGEMENT JOBS

Protect plants using Integrated Pest Management (IPM)

Pest Control Adviser (PCA)

Diagnoses pest problems and recommends treatments.

Entomologist

Studies insects and helps identify both harmful and beneficial species.

UC Cooperative Extension Advisor

Researches pest issues and shares science-based solutions.

URBAN AGRICULTURE JOBS

Grow food and connect communities to local agriculture

Urban Farmer

Grows fruits, vegetables, and herbs in city gardens, rooftops, or small farms.

Hydroponics Technician

Manages systems that grow plants in water instead of soil.

Community Garden Coordinator

Organizes shared garden spaces and teaches people how to grow their own food.

WHAT'S NEXT?

Choose one job that sounds interesting to you.

☑ **RESEARCH**
Your chosen career.

☑ **COMPLETE**
The 'A Day in the Life' Career Worksheet.

☑ **OPTIONAL**
Create a business card for your role.

Name: _____

Class Period: _____

Date: _____

'A DAY IN THE LIFE' CAREER WORKSHEET

Career Snapshot

1. What career did you choose?

2. What does this person do? Describe the main responsibilities of this career.

3. Where does this person work?

4. Who or what does this person help?

Day in the Life

6. How might this person typically begin their day?

7. What are the most important tasks this person completes?

8. How does this person typically end their day?

Tools and Tech

9. What tools or technology does this person use?

Draw and label a tool or technology they use.

Why it Matters

10. How does this career support sustainability?

11. Why does this job matter?

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