

Blank Lesson Template

Yellow highlight = required component

Subject Area(s) (Select from [TE Subject Areas](#))

Associated Unit **Plants**

Lesson Title **PlantSpeak: How Plants Eavesdrop on Each Other**

Header Insert Image 1 here

<p>Image 1 Image file: ___? ADA Description: ___? Source/Rights: Copyright © ___? Caption: ___?</p>
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Grade Level ___ (10-12)

Lesson # ___ of ___

Lesson Dependency

Time Required **15-45 min, depending on the depth of presentation**

Summary

It is well known and documented that plants respond to herbivorous attacks in a number of ways as an attempt to make them more resistant to subsequent herbivores. When plant cells are alerted to attack, their immune systems can increase production of poisons, stenches, or flavors to fend off the attacker. In some instances, volatile organic compounds (VOCs) are released which alert other organisms to either stay away or increase their own defenses. This idea of one plant species alerting another plant species of attacks was disregarded in the scientific community until evidence in the early 2000s showed otherwise. Now, significant research is being performed on “volatile communication” between paired plant species (such as wild tobacco and sagebrush) in order to better understand the factors involved. It is believed that this may aid in synthetic pest control products that are safer for the environment.

Engineering Connection

Biomimicry is a useful concept for engineers to solve human problems using natural phenomena as a stepping-stone. In the case of volatile communication, evolution has had thousands of years to refine this type of chemical communication. With our current technological capabilities, the synthesis of re-engineered forms of communicative chemicals would be highly desirable. It is intriguing to ponder the possibilities of synthetic pest control that wouldn't pollute ground water and communities downwind.

Engineering Category = #1

Choose the category that best describes this lesson's amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering

Keywords

Plants, defense mechanisms, Biomimicry, volatile organic compounds (VOCs)

Educational Standards

Science: Texas, science, 2009, The Texas Essential Knowledge and Skills, Chapter 112

2B know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories

3D evaluate the impact of scientific research on society and the environment

10A describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness (in animals)

10B describe the interactions that occur among systems that perform the functions of transport, reproduction, and response in plants

11B investigate and analyze how organisms, populations, and communities respond to external factors

Pre-Requisite Knowledge

Learning Objectives

After this lesson, students should be able to:

- **Describe what volatile communication refers to and provide an example of its observed occurrence**
- **Relate their understanding of an organism's response to conventional factors (plants to sunlight) to an organism's response to factors we are just beginning to understand (plants to VOCs)**
- **Understand the concept of biomimicry and how it can be useful in solving human problems**

Introduction / Motivation

Pests such as insects and disease can be a major issue for farmers trying to grow fruits and vegetables, but pesticides produce their own problems as well. Pesticides can be transported either by groundwater systems or by air to receptors downstream/downwind. Pesticides are most often encountered on produce purchased at grocery stores. The exposure levels of most consumers to pesticides from produce are very low, however, chronic exposure may be linked to conditions such as fatigue and headache (NIH Health and Education – Pesticides). The goal for future pesticide production is to make pesticides that are safer for humans and the environment while retaining effectiveness against pests. Mother Nature may be able to help us out with that.

Recently, scientists at several universities have observed a phenomenon that was formerly dismissed. Some plants, like wild tobacco, can “eavesdrop” on their neighbors who are being attacked by herbivores. This eavesdropping, or sensitivity to emitted VOCs, enables the plants to only use precious energy for defenses when they’re needed, instead of all the time. Imagine the advantages to a natural pesticide that can be used only as needed.

Lesson Background & Concepts for Teachers

Volatile communication is a term used to describe the ability of a plant to change its phenotypic level of resistance based on reception and processing of airborne chemicals emitted by a neighboring plant. The original observations of this phenomenon were typically disregarded by the majority of scientists due to lack of controls, however, more recent laboratory studies have presented more quantitative evidence supporting the field observations.

Prof. Rick Karban from the University of California, Davis, studies the interactions of sagebrush and wild tobacco (<http://karban.wordpress.com/research/>). When the sagebrush is attacked by herbivores, the severed leaf cells emit the VOC methyl jasmonate (MeJA), which cues leaf cells on adjacent leaves, branches, and sagebrush plants to increase production of polyphenol oxidase (PPO, an antinutritive chemical that provides resistance to herbivores). Although of an entirely different species, wild tobacco was observed to respond to the same chemical indicator, MeJA, and increase production of PPO. Since then, Prof. Karban has conducted numerous studies testing the robustness of this theory in both field and laboratory experiments. More information on his work can be found in his publications and at his website (listed above).

Image Insert Image # or Figure # here [use Figure # if referenced in text]

<p>Figure 1 Image file: ___? ADA Description: ___? Source/Rights: Copyright © ___? Caption: Figure 1. ___?</p>

Vocabulary / Definitions

Word	Definition
Biomimicry	The process of examining natural mechanisms to solve human problems.
Volatile Organic Compounds	Organic chemicals that are emitted from liquids and solids at typical ambient temperatures and pressures.
Volatile Communication	The ability of certain plants to respond to gases emitted by a neighboring plant

Associated Activities

Lesson Closure

Assessment

Students are assessed throughout lesson on topics of covered previously (e.g. plant responses, roles of proteins in plant cells, etc.)

Lesson Extension Activities

Additional Multimedia Support

References

Attachments

Other

Redirect URL

Contributors

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Supporting Program

National Science Foundation GK-12 program, University of Houston, Department of Civil and Environmental Engineering