TOWER GARDEN BY JUICE PLUS+

PLANT LESSON

LEARNING ABOUT PARTS OF PLANTS

Grade 7 and up

Science

Plant Research

1 Purpose and Content of Lesson:

Crop plants have a long history of domestication, with scientific research continuing now and in the future. In this lesson, each student will do extensive internet research on one crop plant and prepare a report and presentation for the class. Each student will become an expert on his or her crop plant.

At the end of the presentation sequence, whereby students are exposed to detailed information on crop plants from their peers' reports, they will decide, as a class, which seeds would be best to plant in the Tower Garden® and why.

2 Next Generation Science Standards (NGSS):

http://www.nextgenscience.org/search-standards

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5) Middle School

LS4.B: Natural Selection

In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)

LS4.C: Adaptation

Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-6)

3 Common Misconceptions About Crop Plants:

Learners are mostly unaware of the long pre-historical journey of human domestication of plants and the immense amount of research that continues to give us a reliable food supply.

4 Lesson Objective:

Learners will be able to explain the botanical and geographical origin of the plants they choose to grow in the Tower Garden®, their medical and nutritional values, and current challenges to crop plants being researched in a written report citing reliable sources of information.

Developed by: Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

5 Lesson Procedure— THE LEARNING CYCLE: The Five Es

ENGAGE

Ask the class:

What did you eat today?

Students make a bulleted list of individual foods.

Then ask:

"Where did each of these foods come from?"

Ask students to write the answer next to the list of the foods they wrote down. If they list a meat product, ask them to write what that animal ate.

Example:

- Hamburger: cow that ate grass
- Bun: wheat

Key question:

Where does our food come from? (plants)

EXPLORE

Have students share foods on their list, and guide them as they come to the conclusion that plants provide all animals with food. They can trace their food from the market (to the factory) and back to the farm, with all the transport in between, and then jump back through history to the scene of crop domestication, to its wild ancestor, which may still be growing in the wild. The food has taken a journey of thousands of miles and thousands of years to arrive on our plates today.

EXPLAIN

This story is different for every crop. Wild ancestors of tomatoes and potatoes grew in South America. Corn's ancestor grew as a grain in Mexico, wheat came from the Middle East, apples from Central Asia, coffee originated in Ethiopia, oregano around the Mediterranean Sea, and squash in Central America. These foods are a gift of our ancestors, who, over generations, selected the best varieties each year as the seeds for the next year. Scientific research to improve crops continues at present and into the future. New varieties are bred to be resistant to diseases, produce tastier fruit, or be better adapted to grow in hot or dry conditions.

The Tower Garden® is a new way to grow plants. In this lesson, students carry out research about one of the plants they can grow in the Tower Garden and present their findings to the class in an informative presentation. (See the handout under **Appendices**.)

EXPAND

Students will listen to the research findings of their classmates and think about the history and current challenges of each of the plants presented. They will list a minimum of four essential facts about each plant in their notebooks as their peers present. They must include in their notes: **1) country of origin, 2) major nutrients, 3) important challenges,** and **4) other facts of interest.**

At the end of all the plant presentations, the class will decide what plants they would like to grow in the Tower Garden with rationales. Twenty (twenty-eight with an extension kit) plants can be grown, but only six to seven different seed packets will be purchased. Students must consider information learned in prior lessons about wavelengths and quantity of light for each plant; size of adult plants; if there are heavy fruits, vines, or large leaves that might block light from other plants; and time from seed to harvest. These are important characteristics to consider when grouping different plants to grow together in a vertical tower.

EVALUATE

Students write the answers to these questions at the conclusion of the research presentations:

1. *Where in the world is the origin of most of the plants your class researched?*
2. *What are the most important challenges facing agriculture today? Which challenge would you be interested in researching if you were a botanist?*
3. *What are the major nutrients in green leafy vegetables?*
4. *What are the best plants for our Tower Garden® and why?*

6 Web Resources

General information on crop plants:
http://plants.usda.gov/java/

New World Encyclopedia:
http://www.newworldencyclopedia.org/entry/Info:-Main_Page

Encyclopedia Britannica online:
http://www.britannica.com/

Wikipedia—The Free Encyclopedia:
https://en.wikipedia.org/wiki/Main_Page

7 Additional Applications

Make a chart with a photo of each crop being grown in the tower and its nutritional values. The photos can be taken by students as the plants grow.

8 Appendices

See research topics and report criteria below.

Domesticated Plants for Research and Reporting

Here is a list from which each person can choose a crop plant to research. These are plants that could be grown in the Tower Garden.® After researching reliable websites to respond to the questions below, plus any other interesting facts you may find, write a research report in an organized, typed narrative with all websites, quoted or paraphrased, cited as footnotes. Create a PowerPoint presentation that is a minimum of six slides containing images and key facts of interest about your crop plant to present to the class.

Tower Garden Crop Plants:

http://www.towergarden.com/content/towergarden/en-us/what-can-i-grow.html#.VY7pSHv0xv4

1. **Tomato**
2. **Cucumber**
3. **Strawberry**
4. **Cilantro (also coriander)**
5. **Sweet basil**
6. **Mint**
7. **Lettuce**
8. **Oregano**
9. **Thyme**
10. **Peas**
11. **Green beans**
12. **Kale**
13. **Arugula**
14. **Mustard greens**
15. **Swiss Chard**
16. **Tatsoi**
17. **Pakchoi**
18. **Spinach**
19. **Parsley**
20. **Catnip**

Research Guide for Crop Plant Report and Presentation

The following topics are to be used to guide your research. You can pose other questions that arise as you begin to do the research. Organize the information you find to write cohesive paragraphs.

1. **Find the scientific (Latin) name for the plant and the meaning of this Latin name.**

   For example, apples come from the tree Malus domestica. "Malus" is Latin for apple. Note that the first word of the scientific name is the genus, which is capitalized (Malus). The second word of the scientific name is the species of the plant; "domestica" means the apple tree that is not wild but grows edible apples. The species name is not capitalized. The scientific name is also called the binomial (two names). It is always italicized or underlined because it is in Latin, a foreign language.

   This system of naming was introduced by the Swedish botanist Linnaeus in the 17th century. Scientific names with "L" after the name indicates that this plant carries the name given to it by Linnaeus himself. An example is the Gingko tree, Gingko biloba L.

   The scientific name may also include a subspecies or a variety name. For example, many varieties of squash are called Cucurbita pepo. Each variety is designated with a third word. Zucchini squash is Cucurbita pepo zucchini.

2. **Where was this crop plant first domesticated?**

   Do scientists know this plant's wild ancestor? Does the wild ancestor still grow in the wild somewhere? For example, apples were domesticated in Central Asia, what is now Kazakhstan, Tajikistan, Kyrgyzstan and Xinjiang, China. The domestic apple tree's wild relative, Malus sieversii, still grows in the mountains on the border of Kazakhstan and China. Many times, the wild relative is hardier than the domestic species. Crossing or grafting the wild and the domestic species can improve the crop plants.

3. Find general information about the eating of this plant:

a. *Which part(s) of the plant are eaten? How has human activity and cuisine selected for different parts of the plant?*

For example, Brussels sprouts and broccoli are both varieties of cabbage.Cabbage is the leaves, broccoli is the flower buds, and Brussels sprouts are buds that grow along the stem next to each leaf.

b. *Are any plant parts poisonous?*

c. *What is the nutritional value of this plant? Is it more nutritional raw or cooked?*

d. Find and include two healthy recipes that you'd like to try using this plant.

4. What agricultural challenges are driving the research on your plant?

Are there GMO varieties of this plant? If so, tell what they are and for what purpose the GMOs were made? For example, purposes could include longer shelf life, different flavors or colors, disease resistance, or adaptation to use less water.

5. What are some of the important varieties of this crop, and how do they differ?

For example, most varieties of plum tomatoes are "determinate," meaning the plant grows to its full size, and then it produces a lot of tomatoes all at once. Other tomato plants are indeterminate, meaning they grow and develop fruit throughout the season.

Cucumbers come in varieties for pickling and other varieties for slicing into salads. There are many kinds of peppers: hot, sweet, and mild. Apple varieties have different flavors and colors.

6. What nutritional benefits or medical value does this plant provide?

Many herbs have oils with health benefits. What claims to better health can you find for eating this plant? (Find reputable sources, not advertisements.)

7. Find out how your plant is typically grown agriculturally — its needs for water, sunlight, optimum temperatures, soil type, nutrients, season of growth and harvest, and other interesting growing tips.

8. Find out what diseases or pests threaten the growth of your plant.

What measures are typically taken to prevent damage done by diseases or insects that attack your plant? What measures for prevention of damage would cause the least harm to the environment or animals, including people?

9. What are the benefits for growing your plant in a soil-free system? What are the challenges that you should prepare for?

Once you have answers to these questions, plus other facts of interest, write an organized, typed narrative using footnotes for your sources of information. Write a conclusion, summarizing what you have learned about your plant and its suitability for selection for our Tower Garden®.

Create a PowerPoint presentation of at least six slides, with images and an outline about your plant focusing on history, nutritional value, and growing challenges. Do not put large blocks of text in your PowerPoint slides; instead, create a presentation outline with interesting images.

TOWER GARDEN BY JUICE PLUS+

PLANT LESSON

LEARNING ABOUT PARTS OF PLANTS

Grade 7 and up

Science

Pigments

1 Purpose and Content of Lesson:

Plants use light to make food from the air, measure time, and respond to changes in their environment. Plants use pigments to capture light's energy. A plant makes many different pigments, and each pigment responds to light of a particular color. Chlorophyll and phytochrome are two important pigments.

2 Next Generation Science Standards (NGSS):

http://www.nextgenscience.org/search-standards

Disciplinary Core Ideas
LS1.C: Organization for Matter and Energy Flow in Organisms

The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.

Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (High School-LS1-5)

PS3.D: Energy in Chemical Processes

The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (High School LS 2-5)

3 Lesson Objective:

Learners will explain the importance of plant pigments in relation to light energy for the growth and development of plants.

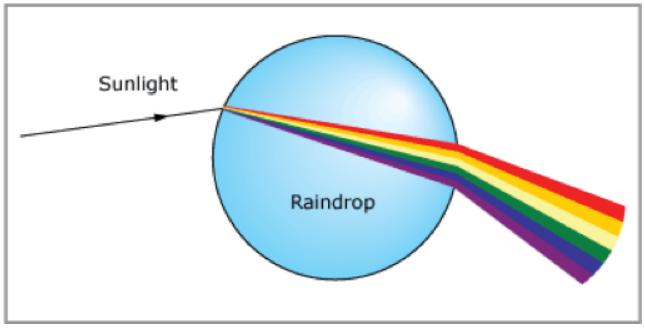
4 Lesson Procedure— THE LEARNING CYCLE: The Five Es

ENGAGE

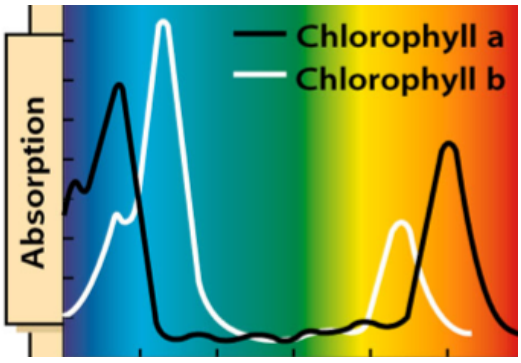
A PowerPoint presentation accompanies this lesson.

Key question: *What is it about sunlight that makes it so important to plants?*

Sunlight is composed of a spectrum of all the colors of the rainbow. A raindrop can spread out the sunbeam into a spectrum and make a rainbow. When all the colors are combined together, the spectrum appears colorless and is called "white light."



Plants make pigments, which are colored chemicals that absorb different colors of the spectrum. Chlorophyll is a green pigment that absorbs light in the blue and red parts of the spectrum. Chlorophyll comes in two forms, a and b. The chart below shows the amount of each color light that chlorophyll absorbs. It is called the absorption spectrum of chlorophyll.



Figure[1]

Developed by: Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

EXPLORE AND EXPLAIN

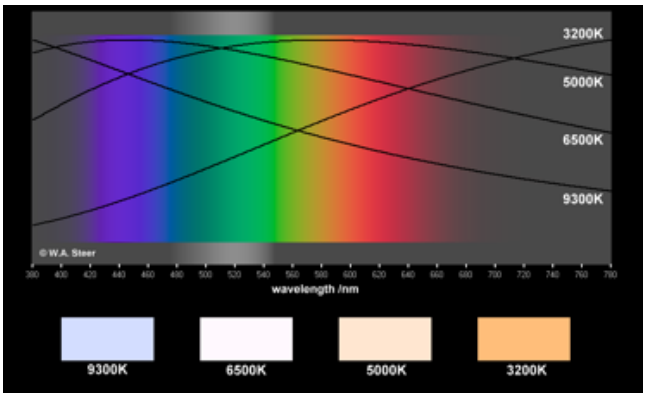
1. **Study figure 1 and describe the differences in the absorption spectrum of chlorophyll a and b.**
2. **Why do you think healthy leaves are green?**

Chlorophyll is a chemical that is energized when it absorbs light. Chlorophyll passes this energy to other chemicals that use it to make sugar from carbon dioxide and water. The plant uses sugar to make the chemical building blocks of the plant body.

When plants are grown indoors, they use artificial light which has a different mix of colors compared with sunlight. The overall color of the light is indicated on a Kelvin scale (K). Figure 2 shows the amount of each color of light produced by four types of light bulbs with different Kelvin numbers.

3. **Study figure 2 to choose the type of light bulb that would be best for activating chlorophyll.**

Explain your choice.



Figure[2]

EXPAND

Key questions:

How do plants adapt to changes in the seasons?

How can a plant keep track of the seasons?

Common misconceptions. People think of seasons in relation to temperature, but day length is a more reliable signal to measure the coming and going of a season. As the days get longer, spring is on the way, though the temperature may go up and down as the days get steadily longer.

Phytochrome is a plant pigment that plants use to measure the length of the day. Plants use day length to determine when to start making flowers. The temperature determines how quickly the flowers will be produced. Questions for group and/or whole class discussion:

1. **Why is it important for a plant to choose the right season to flower?**
2. **How might the plant become confused and flower too early or too late?**
3. **What might happen it a plant flowers too early? Too late?**

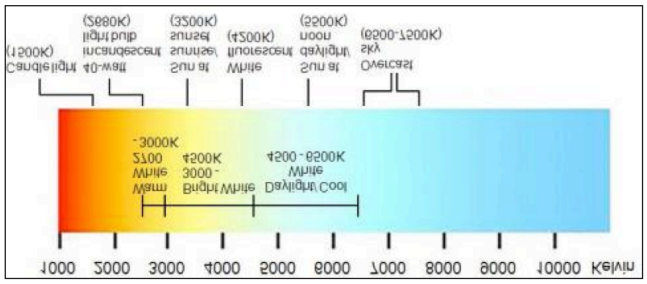
Phytochromes sense sunrise and sunset.

4. **How does the spectrum of sunlight at sunrise/sunset differ from the spectrum during bright daylight?**

   a. Use the figure 3 to find the Kelvin values for these two types of sunlight.

   b. Then use figure 2 to compare the intensity of the different colors of sunlight at sunrise/sunset and at daylight/noon.

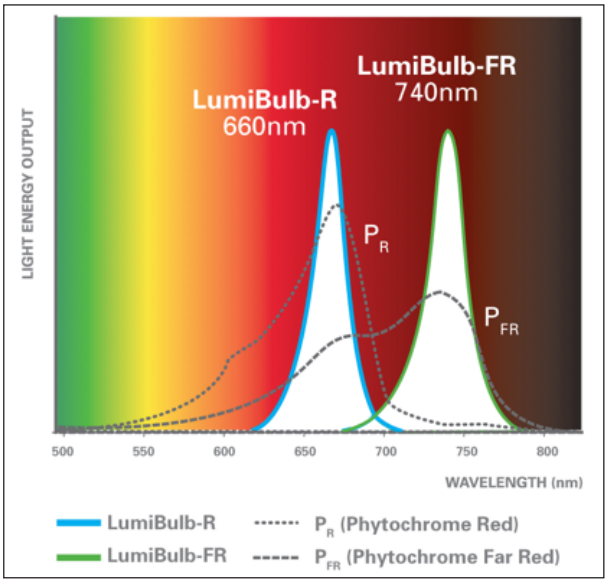
   c. What sort of pigment would be able to differentiate between sunrise/sunset and regular daylight?



Figure[3]

Figure 4 shows the absorption spectrum of two different phytochrome pigments produced by plants in comparison to the spectrum of artificial light in two commercial bulbs called LumiBulb –R and LumiBulb FR.

5. **How does the absorption spectrum of these phytochromes allow plants to sense sunrise and sunset?**
6. **Explain why the LumiBulb would be needed to grow plants such as tomatoes, cucumbers, or strawberries, but would not be needed for lettuce, kale, or parsley when they are growing indoors.**



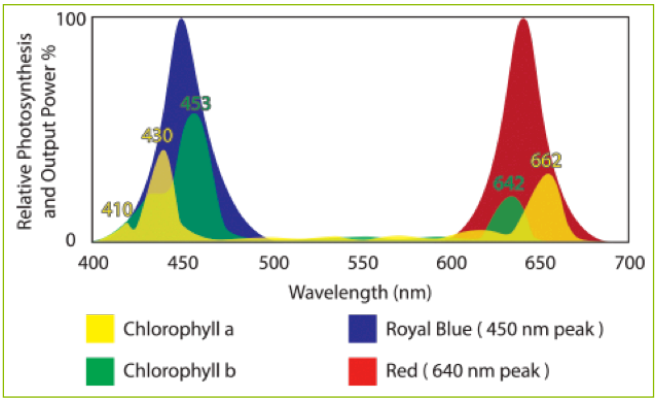
Figure[4]

There are a variety of other light-sensing pigments in plants. Many are also found in animals. Cryptochromes and phototropins sense blue light. UV-B resistance 8 senses UV-B light.

7. **What other aspects of plant behavior might be controlled by these pigments?**

   LED (light-emitting diode) light bulbs use a tiny fraction of the energy required by fluorescent light bulbs. LED bulbs are being developed to match the absorption spectra of plant pigments so plants can be grown indoors more efficiently.

8. **See Figure 5. Would the leaves of plants that are grown under LED lights look green? Explain.**



Figure[5]

EXPLAIN

1. **Imagine you are growing pepper plants in the Tower Garden indoors. The plants are growing, but they aren't producing any peppers, only heathy green leaves. Explain what you would do to get the plants to make peppers.**
2. **Imagine you are growing lettuce and you don't want it to "bolt" (shoot up a bitter stalk and make flowers.). Explain how you might keep the lettuce from bolting.**

6 Web Resources

Video that explains how a phytochrome controls germination of a seed

https://www.youtube.com/watch?v=oJCunDtSHE0

7 Appendices

All figures are shown larger on the following pages for reproduction.

[1] http://blog.captive-aquatics.com/.a/6a010535f11c3d970c015434697eb6970c-popup

[2] http://blog.captive-aquatics.com/.a/6a010535f11c3d970c015434697eb6970c-popup

[3] http://www.lumigrow.com/content/wp-content/themes/agivee/images/docs/LumiGrow_LumiBulb_SpecSheet.pdf

[4] http://globaltechled.com/wp-content/uploads/2015/01/Grow-Light-Spectrum.png

[5] http://globaltechled.com/wp-content/uploads/2015/01/Grow-Light-Spectrum.png

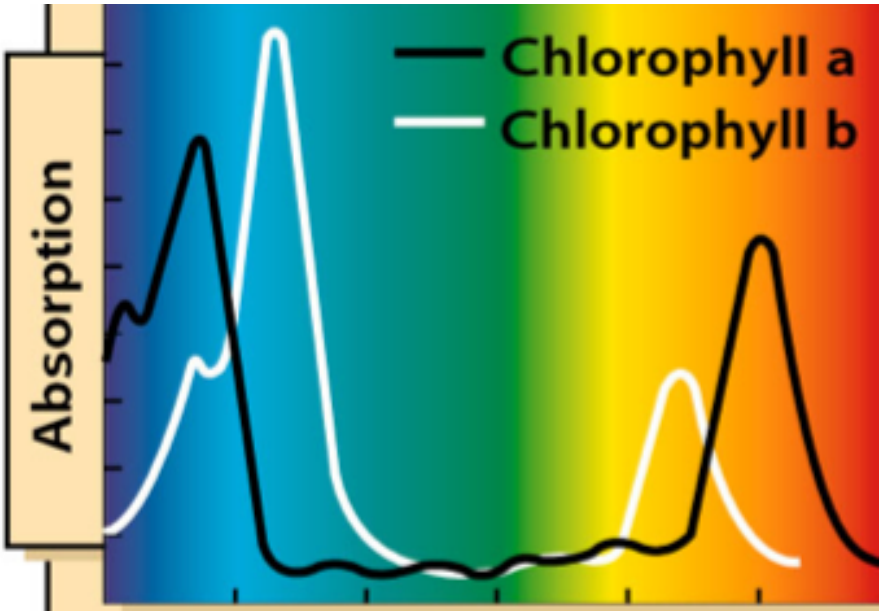


Figure 1

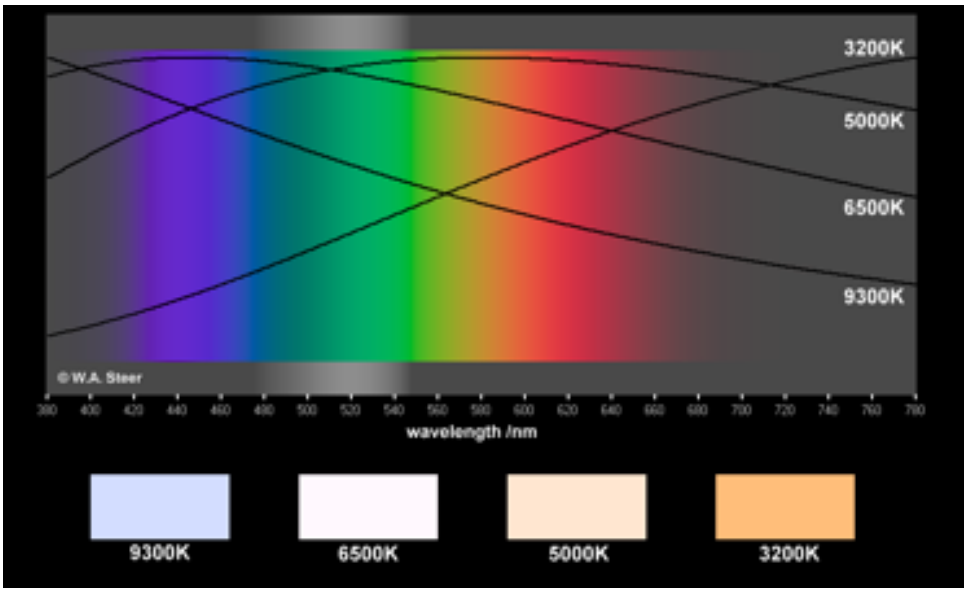


Figure 2

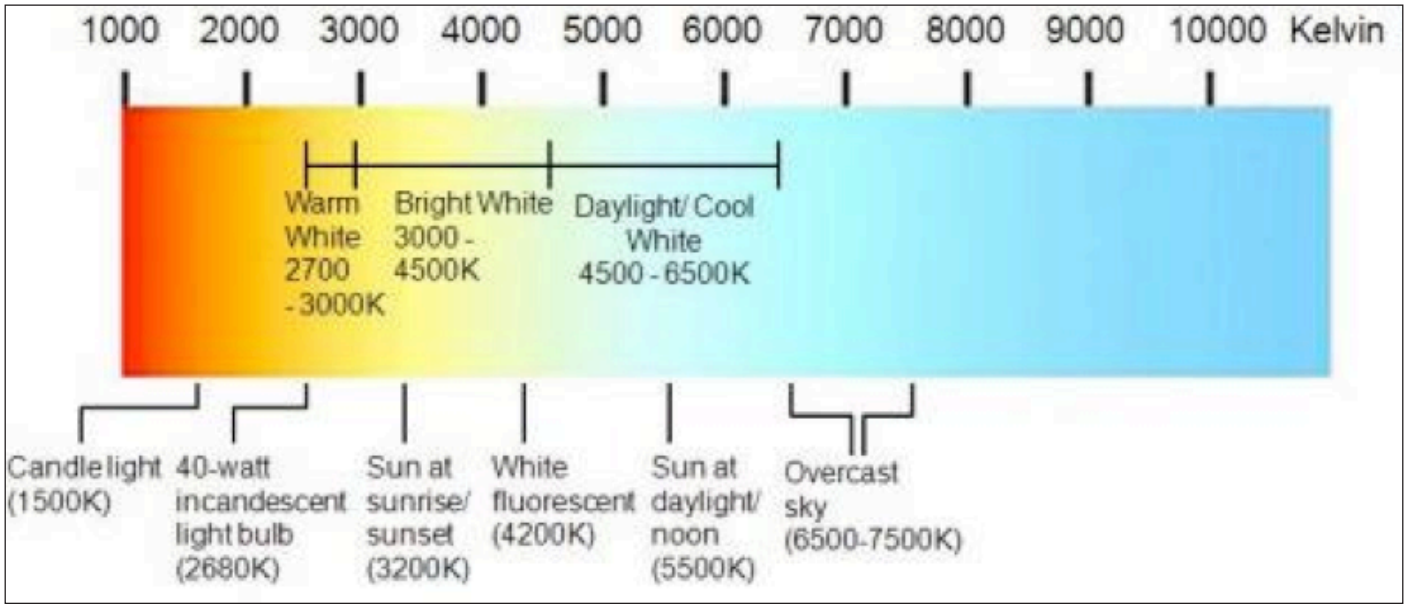


Figure 3

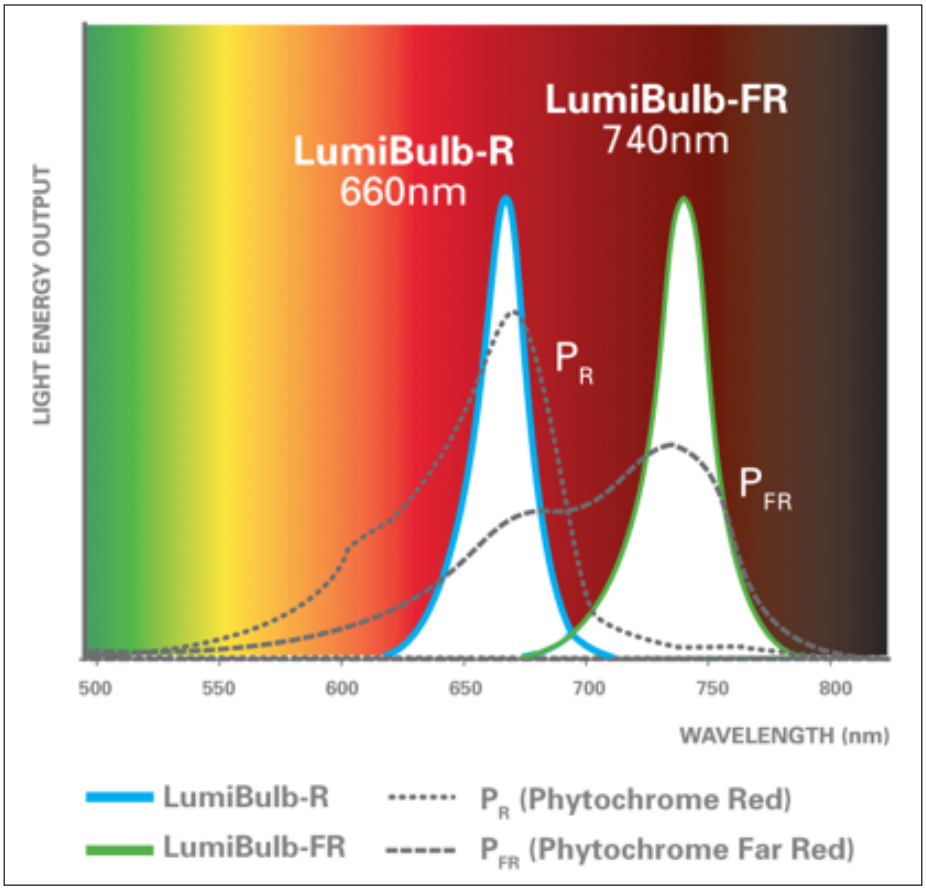


Figure 4

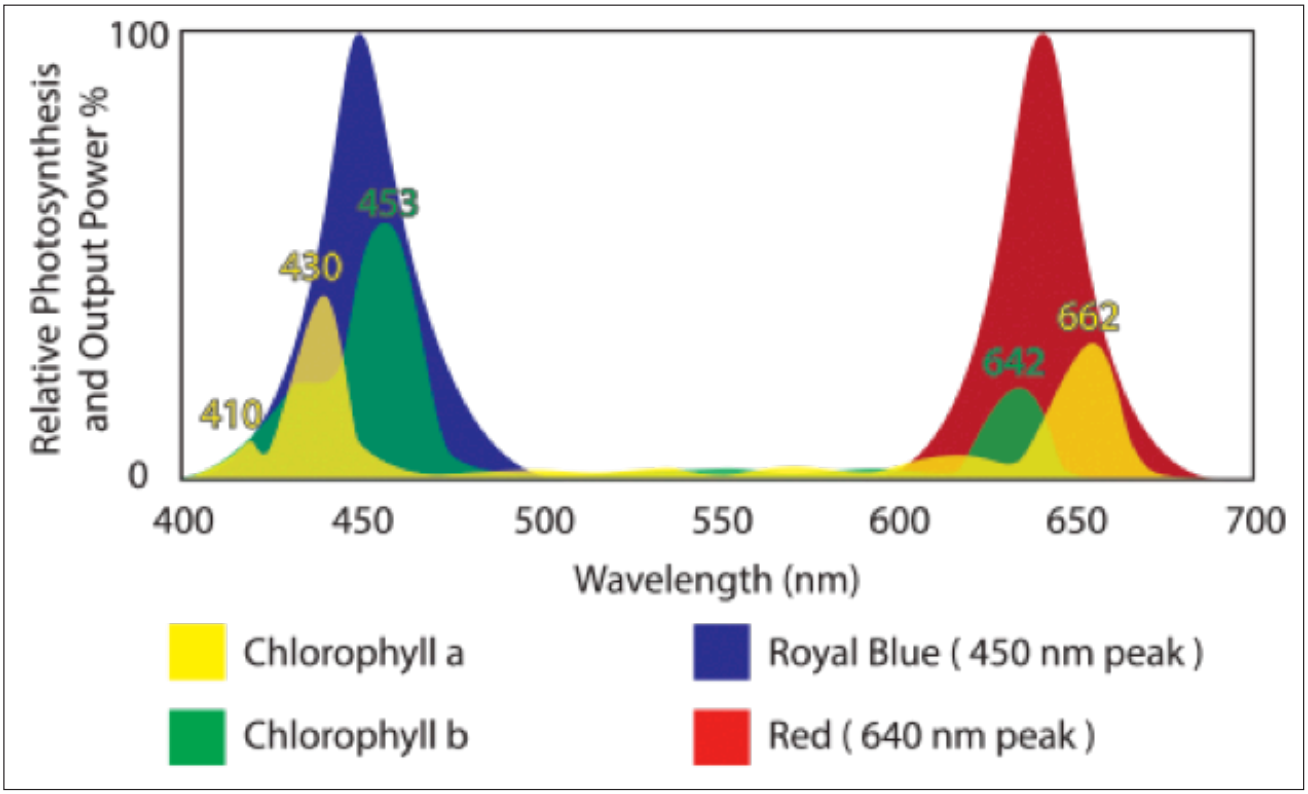

100
0
Relative Photosynthesis and Output Power %
453
430
410
662
642
400
450
500
550
600
650
700
Wavelength (nm)
Chlorophyll a
Chlorophyll b
Royal Blue (450 nm peak)
Red (640 nm peak)

Figure 5

Pigments

Pigments are colored chemicals that plants make to respond to light.

DEVELOPED BY:

Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and
Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

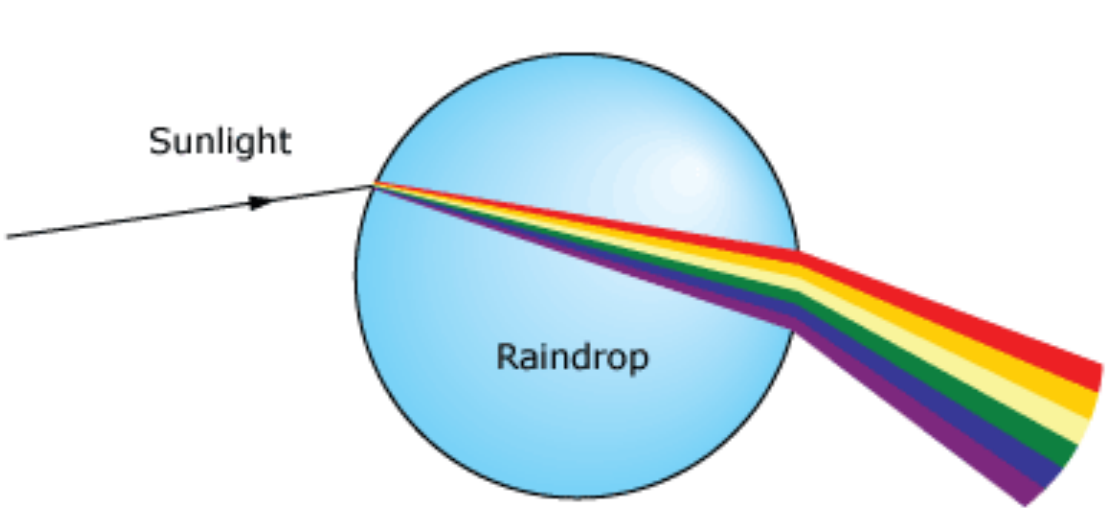
TOWER GARDEN BY JUICE PLUS+

Pigments

TOWER GARDEN BY JUICE PLUS+

Pigments

A raindrop separates the colors in a sunbeam to make a spectrum.

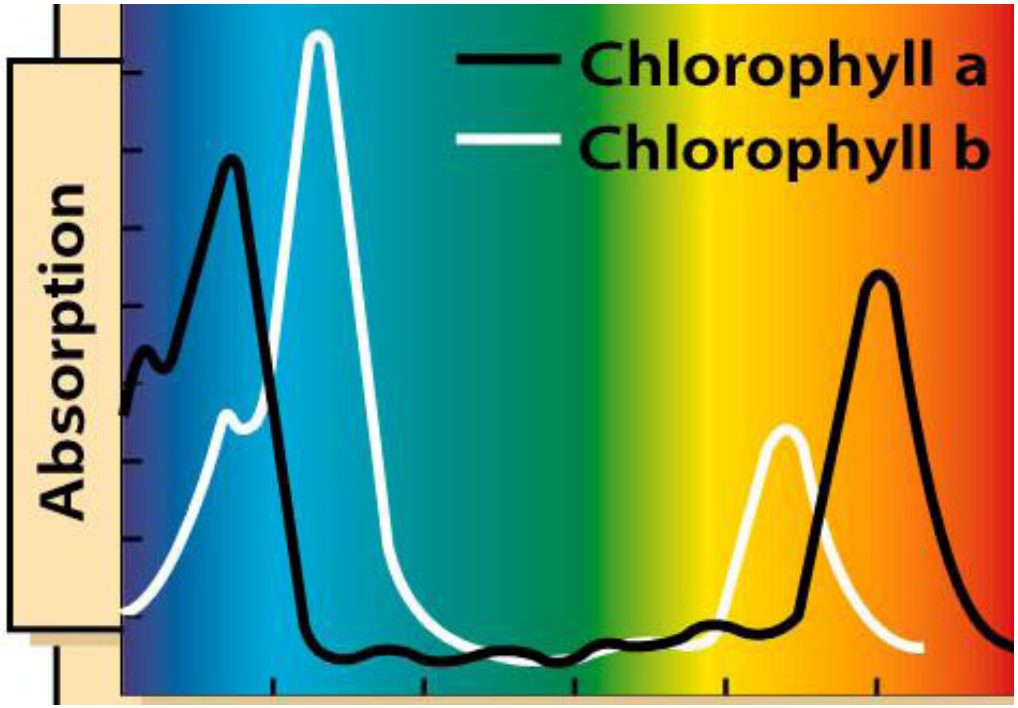


TOWER GARDEN BY JUICE PLUS+

Pigments

Absorption spectra of chlorophyll a and b:

1. Describe the differences in the absorption spectrum ofchlorophyll a and b.
2. Why do you think healthy leaves are green?



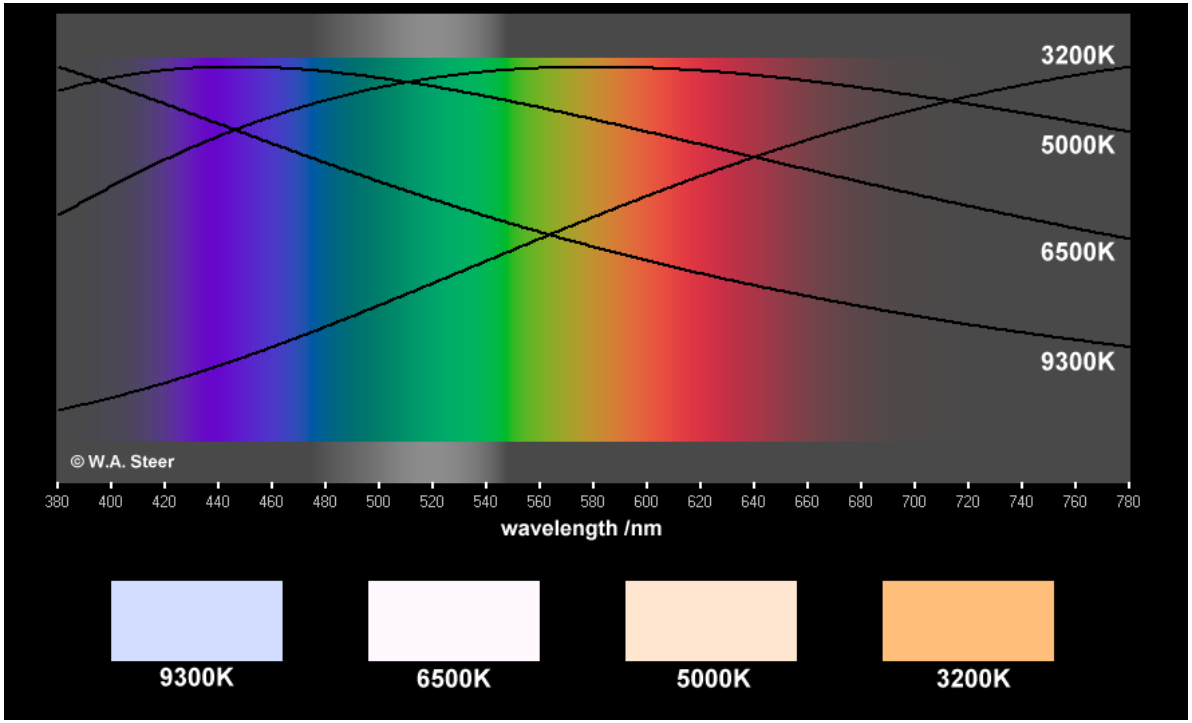
TOWER GARDEN BY JUICE PLUS+

Pigments

Spectral output of four types of light bulbs:

What light bulb would be best for activating chlorophyll?

Explain your choice.



TOWER GARDEN BY JUICE PLUS+

Pigments

Questions to think about:

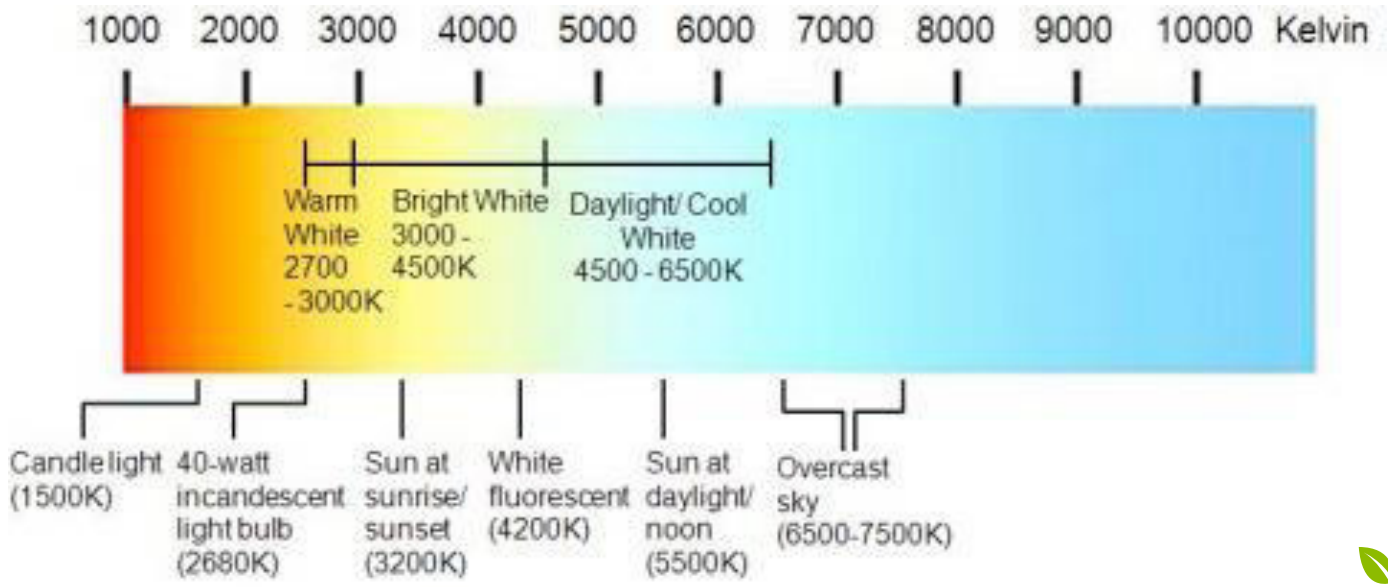
1. Sometimes leaves turn yellow. What is happening in the leaf?
2. How do plants adapt to changes in the seasons?
3. Why is it important for a plant to choose the right season to flower?
4. How might the plant become confused, and flower too early or too late?
5. What might happen if a plant flowers too early? Too late?
6. How can a plant keep track of the seasons?

TOWER GARDEN BY JUICE PLUS+

Pigments

Kelvin temperature of different kinds of light:

1. How does the spectrum of sunlight at sunrise/sunset differ from the spectrum during bright daylight?
2. What sort of pigment would be able to differentiate between sunrise/sunset and bright daylight?

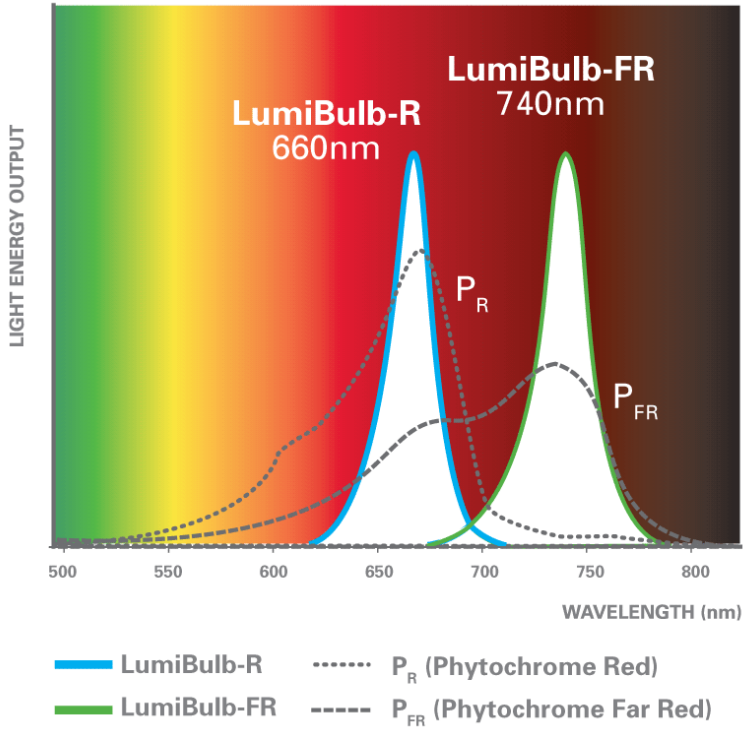


TOWER GARDEN BY JUICE PLUS+

Pigments

Absorption spectrum of two phytochromes:

1. How does the absorption spectrum of these phyto-chromes allow plants to sense sunrise and sunset?
2. How can this be used to measure the length of day?
3. Explain why a LumiBulb is needed to grow plants such as tomatoes, cucumbers, or strawberries indoors, (as in the Tower Garden) but it is not needed for lettuce, kale, or parsley. What do you think might be the benefit of antioxidants to the plants?



TOWER GARDEN BY JUICE PLUS+

Pigments

Extending your thinking:

There are a variety of other light-sensing pigments in plants. Many are also found in animals.

- Cryptochromes and phototropins sense blue light.
- UV-B resistance 8 senses UV-B light.

What aspects of plant behavior might be controlled by these pigments?

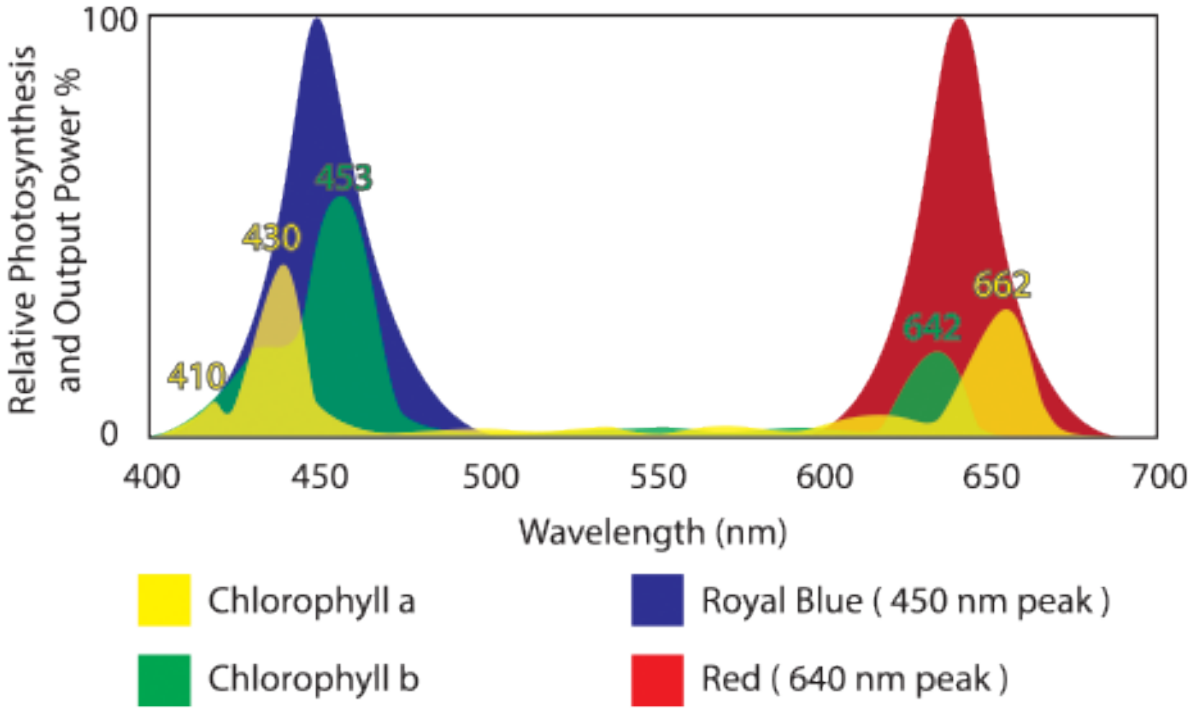
TOWER GARDEN BY JUICE PLUS+

Pigments

LED bulbs designed for indoor gardens:

Would the leaves of plants grown under LED lights look green?

Explain your hypothesis.



TOWER GARDEN BY JUICE PLUS+

Pigments

Additional research questions:

1. Imagine you are growing pepper plants in the Tower Garden indoors. The plants are growing, but they aren't producing any peppers, only heathy green leaves. Explain what you would do to get the plants to make peppers.
2. Imagine you are growing lettuce and you don't want it to "bolt" (shoot up a bitter stalk and make flowers.) Explain how you might keep the lettuce from bolting.

TOWER GARDEN BY JUICE PLUS+

TOWER GARDEN BY JUICE PLUS+

PLANT LESSON

LEARNING ABOUT PARTS OF PLANTS

Grade 7 and up

Science

Mineral Nutrition

1 Purpose and Content of Lesson:

Tower Tonic is a solution of minerals that plants absorb through their roots. These minerals combine with the sugar that plants make using air and light to form the building blocks of the plant body. Plants supply these minerals to animals and humans. The minerals needed by plants are similar but not identical to those needed by animals. Animals also require a source of carbohydrates, but plants use sunlight, water, and carbon dioxide in the air to make their carbohydrates.

The pH of the mineral solution is critical to efficient absorption of minerals.

Terms and concepts:

Mineral or inorganic nutrient: a nutrient that does not contain carbon and hydrogen

Organic nutrient: a nutrient made by a living organism

pH: a designation to express how acidic (acid) or alkaline (base) a solution is on a scale of 0 to 14. Less than 7 represents acidity, 7 neutrality, and more than 7 alkalinity.

2 Next Generation Science Standards (NGSS):

http://www.nextgenscience.org/search-standards

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (Middle School-LS2-1)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (Middle School-LS2-3)

ESS2.E Biogeology

The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual coevolution of Earth's surface and the life that exists on it. (High School-ESS2-7)

3 Common Misconceptions About Plant Nutrition:

Some learners will erroneously believe that the nutrients and water that come from the soil are the only "food" for the plant. Fertilizer is called "plant food" and we say that plants need water to grow. While this may be so, learners may have difficulty believing that leaves, together with the soil nutrients and water contribute to the making of the food the plant needs. They often hold to the idea that plants get food solely from water and nutrients in the soil.

4 Lesson Objective:

Learners will explain the importance of minerals for formation of the plant body and the role of plants in forming the animal body; this also includes the topic of human nutrition. They will be able to explain the importance of monitoring and regulating pH of the Tower Tonic nutrient solution.

Developed by: Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

5 Lesson Procedure— THE LEARNING CYCLE: The Five Es

ENGAGE

The PowerPoint slide show takes students through these learning sequences. Answers to the questions posed only appear in the lesson plan.

1. *What do plants need besides water, air, and sunlight?* (good soil)
2. *How can plants grow without soil?*

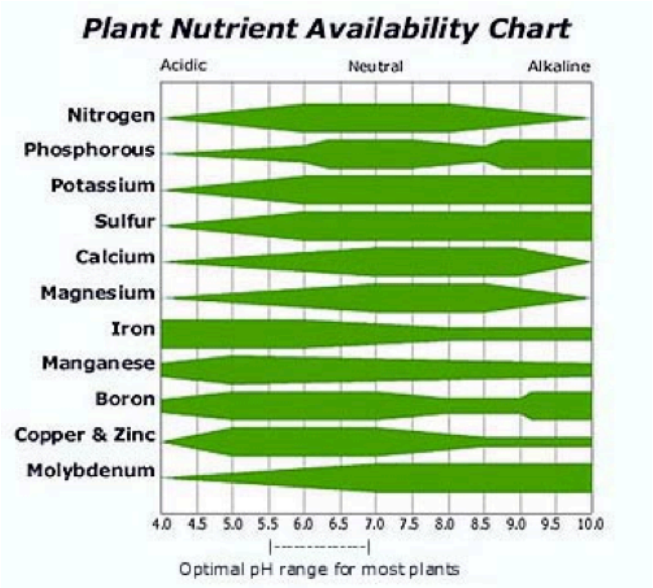
EXPLAIN

1. *What do roots do?*
2. *How do plants grow without soil?*

Roots do more than just anchor the plants. Microscopic root hairs take up water and minerals that plants need for healthy growth. They can take up these minerals from wet soil or from a mineral solution without soil.

Tower Tonic is formulated so roots can absorb the minerals efficiently. This involves maintaining a balanced pH. The PowerPoint presentation for this lesson explains pH.

3. **Explain the importance of maintaining a pH between 5.5 and 7 in the Tower Garden.** (Most plants absorb nutrients best in this range.)



About pH:

- *pH indicates how acidic or alkaline (basic) a solution is using a scale from 1 to 14.*
- *Water has a pH of 7, which is considered "neutral." Water can ionize, and it has the same number of acidic (H3O+) and basic (OH-) particles, as shown in this formula. H2O Đ H3O+ + OH-*
- *An excess of OH- makes the pH › 7, called alkaline or basic. An excess of H3O+ makes the pH ‹ 7, called acidic.*
- *Plants can grow well in pH 5.5 to 7.*
- *pH neutrality is a balance of H3O+ and OH-*
- *Electrical neutrality is a balance of + and – ions of any kind.*
- *Some positive ions are K+, Mg++, Mn++, Ca++*
- *Some negative ions are nitrate (NO3)- phosphate (PO4)- - -, sulfate (SO4)- -*

4. **Explain how to make calcium nitrate so it is electrically neutral.**

   Answer: Calcium has a charge of +2, which is balanced by the two nitrates, each with a charge of minus 1 (Ca++ and 2 (NO3)- makes Ca(NO3)2

5. **Explain how to make potassium sulfate so it is electrically neutral.**

   Answer: Two K+ are needed to balance the negative charge of minus 2 on sulfate. (2 K+ and SO4- - makes K2SO4)

   Plant roots must maintain electrical neutrality, which means they have the same number of + and – ions.

   Roots take up nutrients as ions, which can be positive or negative. When roots take in a nutrient that has a negative charge, such as phosphate, nitrate, or sulfate, they lose electric neutrality. They can regain neutrality by expelling OH- . But this raises the pH, which could lead to trouble. However, when roots take up a positive ion like Ca++, they expel H+, which lowers pH.

   Tower Tonic is formulated so roots take up a roughly even number of positive and negative nutrients; in turn, they maintain electric neutrality and don't change the pH by much.

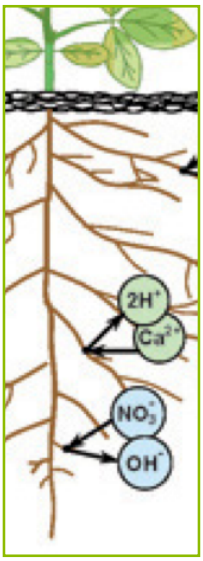
   On the chart IN THE , the nutrients highlighted in yellow contain a balance of positive and negative parts.

6. **Explain how the + and – balance of nutrients helps maintain a balanced pH in the solution around the roots.** (See above content.)

7. *What is one element that animals require but is rare in plants?* (Sodium [Na]) Most plants are not salty, probably so animals won't gobble them up.

   Tower Tonic does not contain **carbon**, which is a major element in all living organisms.

8. *Where, then, do plants get* **carbon***?* (Carbon comes from the air as carbon dioxide.)



EXPLORE

Students will do Internet research on mineral nutrients in Tower Tonic and complete the **Chart of Mineral Nutrients** in Plants and Humans (included under Appendices.) Students can be given printed copies or electronic versions. Have them share findings in a class discussion.

EXPLAIN

Plant nutrients are often called fertilizer. Fertilizers carry a three-number code that tells the concentration of the macro-nutrients: N (Nitrogen), P (Phosphorus), and K (Potassium). The other elements are called micronutrients (B, Cu, Mg, Mn, Mo, Na (Sodium), S, Zn).

These elements are present in the soil as minerals.

Tower Tonic supplies these minerals that plants would otherwise absorb from the soil.

9. How is plant fertilizer similar yet different from animal food?

Answer: Plants need only minerals, sunlight, and water to make their own food. This is called inorganic nutrition. Animals must consume organic food (made from living or dead plants or animals) such as carbohydrates, proteins, fats, and sugars.

Plants transport the minerals into their bodies, and they nourish us when we eat the plants.

Plants and animals require similar elements, but the sources of nutrients are fundamentally different for plants and animals. Plants "eat" simple inorganic minerals, whereas animals eat chemically complex organic food, which is then digested.

Plants make their own food from inorganic chemicals; animals consume organic food.

EXPAND

Dietary recommendations and human nutrition.

The *Dietary Guidelines for Americans* are jointly issued and updated every five years by the Department of Agriculture (USDA) and the Department of Health and Human Services (HHS). Recently, the concept of the Food Pyramid as a way to communicate a healthy diet was replaced by the image of a healthy serving of food, "Choose My Plate". **http://www.choosemyplate.gov/**

10. Compare and contrast the two concepts. Which image do you find more effective to educate people about healthy eating? Explain why.

11. Use the concept you find most useful to compose a healthy menu for a breakfast, school lunch, and dinner—something you would enjoy eating.

Goodbye Pyramid.....Hello My Plate

Breakfast

_____
_____
_____
_____

Lunch

_____
_____
_____
_____

Dinner

_____
_____
_____
_____

12. What plants would you choose to grow in the Tower Garden® to meet the dietary recommendations? http://www.towergarden.com/

EVALUATE

1. **Explain how plants in the Tower Garden® are able to grow without soil. Use facts from this lesson to support your answer.**
2. **What differences would you expect to find between plants grown in the tower and those grown outside in soil? List at least three.**
3. **How could growing plants in the Tower Garden lead you to healthier eating habits? List three ways.**

8 Appendices

The worksheet that includes all questions from the lesson plan, the chart of nutrients, and the assessment are attached for students to write or type responses. A PowerPoint presentation accompanies this lesson.

Useful References for the Chart:

1. **http://kidshealth.org/teen/misc/mineral_chart.html**
2. **http://www.nhs.uk/Conditions/vitamins-minerals/Pages/Other-vitamins-minerals.aspx**
3. **http://en.wikipedia.org/wiki/Dietary_element**

MINERAL NUTRIENTS IN PLANTS AND ANIMALS

Name_____

CONTENTS OF TOWER TONIC A

Mineral Forms	Major Function in Plant	Major Function in Human	References
Nitrogen (N) 2%	Ca++ and 2 NO_3-	proteins, DNA, RNA contain N	
Calcium (Ca) 1%	Calcium nitrate	Plant cell wall	
Iron (Fe) 0.5%	FeNa EDTA Chelated iron	Energy in cells	

CONTENTS OF TOWER TONIC B

Element %	Mineral Forms	Major Function in Plants	Major Function in Humans	References
Phosphorus (P) 1%	H_3PO_4 Phosphoric acid	DNA, RNA cell membrane energy (ATP) promotes roots, flowers, and fruits		
Potassium (K) 3%	2 K+ and SO_{4--} Potasium Sulfate	Cell sap, promotes vigor		
Sulfur (S) 3%	Potassium Sulfate	To make proteins defensive molecules		
Magnesium (Mg) 0.5%	Mg SO_4 Magnesium sulfate	Chlorophyll for photosynthesis		
Boron (B) 0.01%	H_3BO_3 Boric Acid	Cell wall		
Copper (Cu) 0.001%	Cu SO_4 Copper sulfate	Energy production		
Manganese (Mn) 0.01%	Mn SO_4 Manganese sulfate	Photosynthesis		
Molybdenum (Mo) 0.0005%	Na_2Mo_4 Sodium molybdate	To absorb N and P		
Zinc (Zn) 0.005%	Zn SO_4 Zinc sulfate	To make DNA		

MINERAL NUTRITION WORKSHEET

Name _____ **Date**_____

1. **What do plants need besides water, air, and sunlight?**
2. **How can plants grow without soil?**
3. **Explain the importance of maintaining a pH between 5.5 and 7 in the Tower Garden.**
4. **Explain how to make calcium nitrate so it is electrically neutral. Ca++ and 2 (NO3)- makes Ca(NO3)2**
5. **Explain how to make potassium sulfate so it is electrically neutral. 2 K+ and SO4- - makes K2SO4**
6. **In the chart, the nutrients highlighted in yellow contain a balance of positive and negative parts.**

   Explain how this helps maintain a balanced pH around the roots in the Tower Garden.
7. **What is one element that animals require, but is rare in plants?** _____
8. **Tower Tonic does not contain carbon, which is a major element in all living organisms.**

   Where, then, do plants get carbon?
9. **Use these references and others you may find to complete the chart on page 4, comparing the function of minerals in plants and animals. Be prepared to explain your findings to the class.**
10. **How is plant fertilizer similar yet different from animal food?**
11. **Compare and contrast the Food Pyramid and the My Plate concepts. Which image do you find more effective to educate people about healthy eating? Explain why.**

http://www.choosemyplate.gov/

12. **Use the concept you find most useful to compose a healthy menu for a breakfast, school lunch, and dinner. List foods you would enjoy eating and be sure to follow the guidelines.**

Food Pyramid or My Plate? _____

Breakfast

Lunch

Dinner

13. **What plants would you choose to grow in the Tower Garden to meet the dietary recommendations?**
    http://www.towergarden.com/

MINERAL NUTRITION ASSESSMENT

1. **Explain how plants in the Tower Garden are able to grow without soil? Use facts from this lesson to support your answer.**
2. **What differences would you expect to find between plants grown in the tower and those grown outside in soil? List at least three.**
3. **How could growing plants in the Tower Garden lead you to healthier eating habits? List three ways.**

Mineral Nutrition

How Plants Make Their Own Food from Minerals, Air and Sunlight

DEVELOPED BY:

Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and
Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

What do plants need to grow?

- air
- water
- sunlight
- _____ ?

TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

How can plants grow without soil?

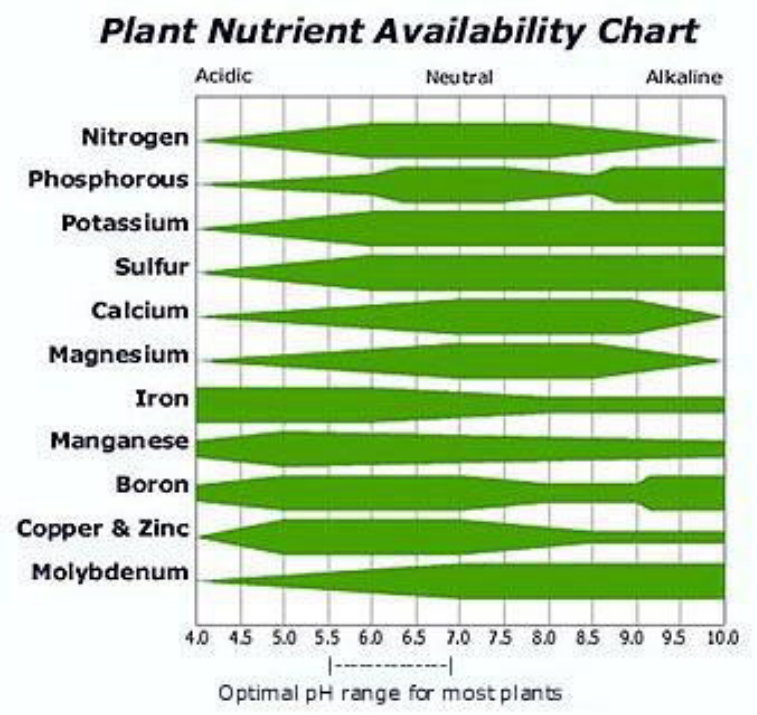
- Plant nutrients are often called “fertilizer”.
- Fertilizers carry a 3-number code that tells the concentration of the macro-nutrients: N, P, and K (chemical symbols for Nitrogen, Phosphorus, Potassium).
- Other elements needed by plants are called micro-nutrients (B, Cu, Mg, Mn, Mo, S, Zn) .
- These elements are present in the soil as minerals.
- Tower Tonic supplies the minerals that roots would otherwise absorb from the soil.
- Watch this video on how nutrients help the plants grow in the Tower Garden. (Vertical Aeroponic Technology)

TOWER GARDEN
BY JUICE PLUS+

Mineral Nutrition

pH affects the ability of plants to absorb minerals.

- pH indicates how acidic or alkaline a solution is.
- Pure water has pH=7 which is considered “neutral”.
- Most plants grow best in pH that is slightly acidic. What number might that be?

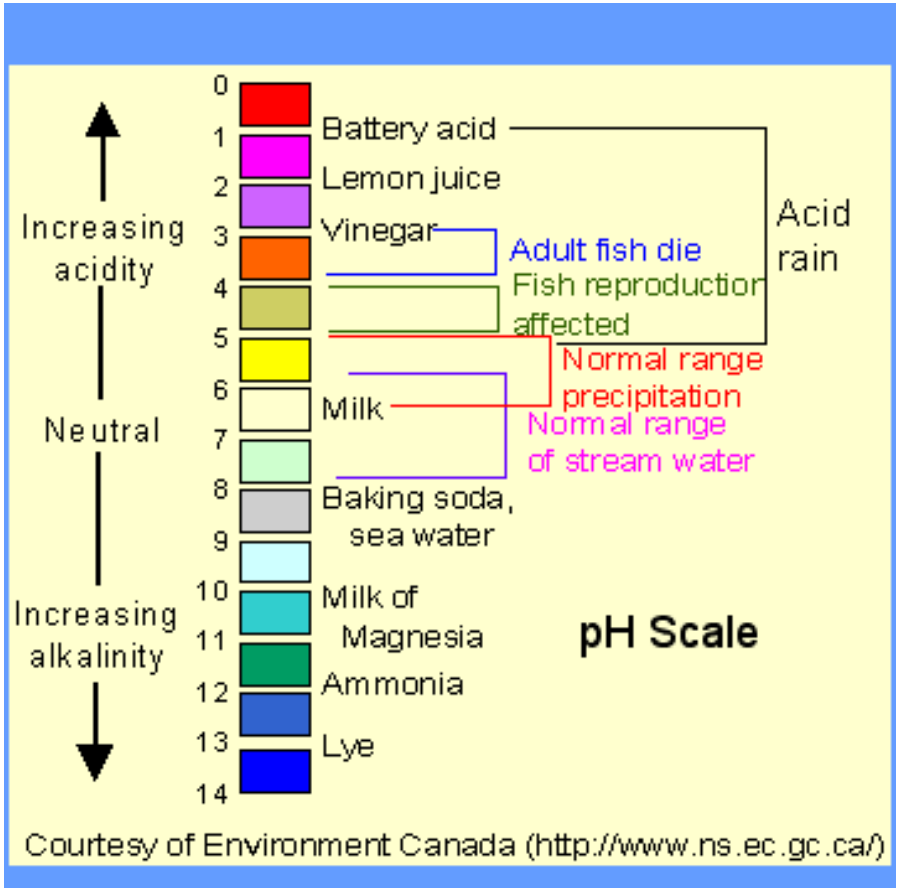


TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

A Primer About pH:

- pH indicates how acidic or alkaline (basic) a solution is using a scale from 1 to 14; water is pH 7 (neutral)
- Water can ionize which means it breaks into charged ions, like this:
  2 H_2O (yields) $H_3O^+ + OH^-$
- An excess of OH^- is called alkaline or basic, pH>7
- An excess of H_3O^+ is called acidic, pH < 7
- Why would pure water be considered "neutral pH"?



TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

Two kinds of neutrality:

- pH neutrality is having equal numbers of H_3O^+ and OH^-
- Electrical neutrality is having equal numbers of + and – charges.
- Some negative ions and their charges: nitrate (**NO_3**); phosphate (**PO_4**); sulfate (**SO_4**)
- Some positive ions and their charges: **K^+**, **Mg^{++}**, **Mn^{++}**, **Ca^{++}**

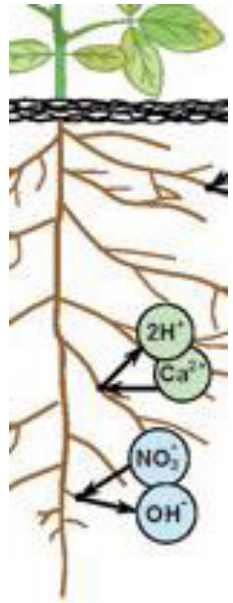
1. Explain how to make calcium nitrate so it is electrically neutral.
2. Explain how to make potassium sulfate so it is electrically neutral.

TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

Plant roots maintain electric neutrality.

This can affect the pH in the solution around the roots.



- Roots take in nutrients as positive or negative ions.
- When roots take in nitrate, they expel OH^- to regain electric neutrality.
- When roots take in Ca^{++} they regain neutrality by expelling $2H^+$
- Tower Tonic is formulated so roots take in roughly even positive and negative nutrients. This way, the roots maintain electric neutrality and don't change the pH in the solution.

TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

Nutrients in Tower Tonic A:

- The nutrients highlighted in yellow, contain a balance of positive and negative parts.
- Explain how this helps maintain a balanced pH in the solution around the roots.

Element %	Mineral Forms	Major function in Plant
Nitrogen (N) 2%	Ca++ and 2 NO3-	proteins, DNA, RNA contain N
Calcium (Ca) 1%	Calcium nitrate	Plant cell wall
Iron (Fe) 0.5%	FeNa EDTA Chelated iron	Energy in Cells

TOWER GARDEN BY JUICE PLUS+

Mineral Nutrition

Nutrition in Plants and Animals:

- Fill in the chart on your worksheet to explore how plant nutrients are used in humans.
- How is Tower Tonic similar and different from human food?

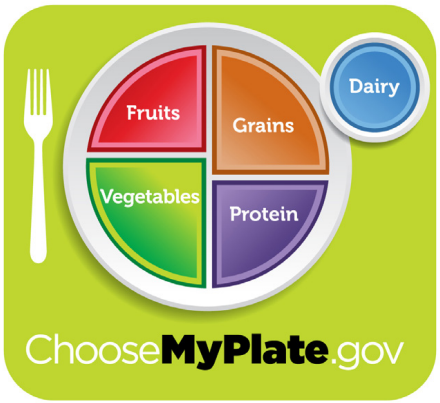
TOWER GARDEN
BY JUICE PLUS+

Mineral Nutrition

Dietary recommendations and human nutrition:

- Dietary Guidelines for Americans are issued by the Department of Agriculture (USDA) and the Department of Health and Human Services (HHS).
- Recently, the "Food Pyramid" was replaced by "Choose My Plate."
- Compare and contrast the two concepts for helping people understand good nutrition.

Goodbye Pyramid.....Hello My Plate



TOWER GARDEN BY JUICE PLUS+

TOWER GARDEN BY JUICE PLUS+

PLANT LESSON

LEARNING ABOUT PARTS OF PLANTS

Grade 7 and up

Science

Flavors and Phytochemicals

1 Purpose and Content of Lesson:

Fresh fruits and vegetables, herbs, and spices have a long history in medicine as well as in cuisine. Numerous epidemiological studies demonstrate that a diet rich in fruit and vegetables offers health benefits to humans, including a reduced risk of developing many forms of cancer (lung, prostate, pancreas, bladder, and breast) and a reduced risk of cardiovascular diseases.[1] Current research is focused on defining the physiological effects that explain the epidemiological evidence, with a focus on phytochemicals. Plants produce a large variety of chemicals that are not directly involved in primary metabolism like growth and reproduction. These phytochemicals, also called secondary metabolites, protect the plant against bacteria, fungi, viruses, and UV light, and deter herbivores. When we eat the plants, these chemicals may have health-promoting effects. Much research remains to be done to demonstrate the specific physiological effects of these phytochemicals in humans.[2]

Terms and definitions:

herbs: the dried, leafy parts of a plant

spice: pungent or aromatic part of a plant made by drying the bark, seed, fruit or root

antioxidant: chemical that protects against harmful oxidation reactions, often more potent when plant is cooked

phytochemical and secondary metabolite: both terms refer to an unusual chemical made by a plant that is not involved in the making of food, reproduction, or other primary processes.

- Phytochemical is used primarily for chemicals deemed to have a beneficial effect on human health.
- Secondary metabolite is used when referring to chemicals from the plant's point of view. Thus, chemicals that are beneficial to the plant may be harmful to those eating the plant, including chemicals that interfere with the nervous system, such as nicotine, caffeine, and pyrethrum, for example.

2 Next Generation Science Standards (NGSS):

http://www.nextgenscience.org/search-standards

Disciplinary Core Ideas
LS4.C: Adaptation

Natural selection leads to adaptation of a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (High School-LS4-3, 4)

LS1.B: Growth and Development of Organisms

Plants reproduce in a variety of ways, often depending on animal behavior and specialized features for reproduction. (MS-LS1-4)

Genetic factors as well as local conditions affect the growth of the adult plant. (Middle School-LS1-5)

3 Lesson Objective:

Students will hopefully become interested in sampling fresh fruits, greens, and other vegetables to experience the variety of flavors and health benefits they offer, especially from plants growing in the Tower Garden®.

Learners will conduct research to explain the relevance of flavors, colors, and phytochemicals to the survival of the plant species as well as their role in human health, medicine, and cuisine.

[1]http://www.ipfn.ie/introduction/phytochemicals.html
[2]http://lpi.oregonstate.edu/mic/dietary-factors/phytochemicals

Developed by: Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and
Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

4 Lesson Procedure— THE LEARNING CYCLE: The Five Es

ENGAGE

Distribute a variety of fresh herbs and other flavorful plants for students to smell and taste. *Be sure these foods have been thoroughly washed and that there are no food allergies to any of the samples.* This lesson is best taught when the plants growing in the Tower Garden® serve as samples. Examples may include fresh basil, cilantro, thyme, oregano, dill, mint, Swiss chard, spinach, mustard greens, strawberries, chives, pakchoi, endive, and kale.

List the names of each sample. After tasting, smelling and observing the color, each student rates each one:

1. like it, interesting, and would try it again

2. interesting, but wouldn't try it again

3. don't like it.

Compare the ratings and draw some conclusions about the nature of the flavors from the class results. Think about the possible physiological effects of these samples based on the experience of tasting them. Discuss cultural preferences and specific uses for certain foods, herbs, and spices as well as having "acquired tastes over time vs. having a new tasting experience."

EXPLORE

Begin the PowerPoint slideshow titled FLAVORS and PHYTOCHEMICALS.

1. **Why do plants make all these interesting flavors? Come up with as many ideas as possible, since scientists haven't pinned it down. Present reasons for your ideas.**
2. **What are some examples of plants or secondary metabolites that have physiological effects in humans, especially effects on the nervous system?**

(Some examples are: caffeine, nicotine, digitalis, and chemicals found in tea, coffee, tobacco, chocolate, nightshade, pokeweed, and many herbs. **https://faculty.unlv.edu/landau/psychoactiveplants.htm**)

EXPLAIN

Plant flavors are chemicals in a category called **secondary metabolites**. These are chemicals that are not involved in making food or reproduction or other primary processes. These secondary metabolites protect the plant against bacteria, fungi, viruses, and UV light, and deter herbivores. Some of these secondary metabolites, often called **phytochemicals** (phyto means "plant") may be responsible for the health-promoting effects that have been demonstrated when people eat more fresh fruits and vegetables.

Particular families of plants make particular kinds of chemicals (chemical families). For example, the mustard family, including cabbage and radishes, makes a chemical that irritates the tongue and sinuses; chili peppers sting; the onion family makes eyes tear; the citrus family and the mint family are both refreshing.

3. **How might these secondary metabolites be useful to the plant that makes them?** (They deter animals that try to eat the plant.)
4. **Examples of other secondary metabolites that taste bitter are found in coffee, tea, and tobacco. Of what use might these be to the plant? How is this consistent with their effects on humans?** (These are toxins to small mammals and insects but have a less toxic effect on humans. They affect the nervous system.)

Some of these secondary metabolites, often red or yellow in color, are antioxidants that scavenge highly reactive oxygen. They help the plant cope with the toxic effects of free oxygen that is a by-product of photosynthesis. **Antioxidants** are also considered helpful for human health by protecting against cancer. Antioxidant content in food is often increased by cooking. What do you think might be the benefit of antioxidants to the plants? (protect against oxygen made during photosynthesis)

Fruits and vegetables, especially leafy greens, are considered health promoting. Choose four such plants that you like, and research their medicinal or health-promoting characteristics.

EXPAND

5. **Compare the flavor and nutritional value of a particular vegetable that is raw vs cooked. Find out how heating (cooking) affects the nutritional value of this food.**
6. **What did you learn about the scientific basis for the dietary advice "Eat more fruits and veggies?"**

EVALUATE

Create grading criteria to evaluate research question responses.

5 Additional Applications

Create a FOOD FAIR as a class, incorporating real food samples and knowledge about nutritious foods and interesting flavors.

- Groups prepare a list of edible plants to bring in for a healthy-food tasting fair.
- Consider how the nutritional value of these foods is optimized, and wash, cut, cook (if needed), and display your selected foods in an appetizing and attractive manner for others to taste.
- Each group must present four foods in quantities large enough for everyone to have a small serving.
- Each dish will be accompanied by a one-page, typed report that relates the following information:

1. **Name of plant**
2. **Where it was grown and where it was obtained** (if bought)
3. **Health benefits and nutritional value**
4. **How it is best or typically served**
5. **Phytochemicals and antioxidants in this food and what you learned about them**
6. **Historical and cultural uses as food and/or medicine**
7. **How varieties of the plant have been developed and modified**

Food Fair Presentation:
On the day of the food fair, share what you learned about your plant and encourage others to taste it.

Be sure to tell them about the highlights of your research findings.

6 Resources

Phytochemicals http://lpi.oregonstate.edu/mic/dietary-factors/phytochemicals

Herbs and Spices http://blog.fooducate.com/2011/10/19/whats-the-difference-between-herbs-and-spices/

Secondary Metabolites http://www.biologyreference.com/Re-Se/Secondary-Metabolites-in-Plants.html

Micronutrients http://lpi.oregonstate.edu/mic/dietary-factors/phytochemicals

Herb flavor wheel http://www.tasteofherbs.com/fe/57799-flavor-wheel

Antioxidants http://www.preparedfoods.com/articles/108500-antioxidants-and-flavor-masking

Book: *Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet* / edited by Alan Crozier, Michael N. Clifford, Hiroshi Ashihara.

Scientific American **article by Ferris Jabr:** "Reclaiming the Lost Flavor of Heirloom Produce—without GMOs," 2014.

Making modern supermarket fruits and vegetables grow big and hardy drained a lot of their flavor. Scientists now have the technology to restore those flavors — and it doesn't involve genetic engineering.

http://www.scientificamerican.com/article/reclaiming-the-lost-flavor-of-heirloom-produce-mdash-without-gmos/

7 Appendix

Use the information in the references below to complete the table below them.

1. **Leafy Green Vegetables**
   http://www.joybauer.com/food-articles/leafy-green-vegetables.aspx
2. **Video**
   http://www.webmd.com/diet/how-to-eat-more-vegetables/keep-nutrients-in-vegetables
3. **Phytochemicals**
   http://lpi.oregonstate.edu/mic/dietary-factors/phytochemicals

Name of Plant	Health Benefits and Phytochemicals	How to Consume (raw, cooked, infusion, etc.)	References

8 Appendix

Worksheet for student responses to questions in lesson is attached (next page). Students will need access to the Internet in class. A Powerpoint presentation accompanies this lesson.

PLANT FLAVOR QUESTIONS **NAME**_____

1. **Why do plants make all these interesting flavors? Come up with as many ideas and reasons as possible.**

2. **What are some examples of plants or secondary metabolites that have physiological effects in humans, especially effects on the nervous system? (examples: cafffeine, tobacco)**

3. **How might these secondary metabolites be useful to the plant that makes them?**

4. **Examples of other secondary metabolites that taste bitter are found in coffee, tea, marijuana, poppy, and tobacco. Of what use might these secondary metabolites be to the plant?**

5. **Fruits and vegetables, especially leafy greens are considered health promoting. Choose four such plants that you like, and research their medicinal or health-promoting characteristics.**

6. **Compare the flavor and nutritional vae of a particular fruit and vegetable (from your chart) that is raw vs. cooked. Find out how heating (cooking) affects the nutritional value of this food, and write your findings.**

7. **What did you learn about the scientific basis for the dietary advice "Eat more fruits and vegetables?"**

Flavors and Phytochemicals

DEVELOPED BY:

Debra Zinicola, Ed.D., Seton Hall University, Chair, Department of Educational Studies, and
Marian Glenn, Ph.D., Seton Hall University, Professor, Department of Biological Sciences

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Some terms and definitions:

- **Herbs** – the leafy parts of a plant
- **Spice** – pungent or aromatic part of a plant made by drying the bark, seed, fruit or root
- **Antioxidant** – a chemical that protects against harmful oxidation reactions, often more potent when plant is cooked
- **Phytochemical and secondary metabolite** – both terms refer to an unusual chemical made by a plant, that is not involved in making food, or reproduction, or other primary processes.
- **Phytochemical** – a term used primarily for chemicals deemed to have a beneficial effect on human health.
- **Secondary metabolite** – expresses the plant's point of view. Chemicals that are beneficial to the plant may be harmful to those eating the plant, including chemicals that interfere with the nervous system, such as caffeine, opium, pyrethrum, for example.

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Thinking about plants as food:

Now that we have tasted and rated some of our Tower Garden plants, let's learn about why they may taste different, some more appealing than others.

Why do you think plants make all these interesting flavors?

Come up with as many ideas and rationales as possible.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

TOWER® GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Thinking about plants as food:

What are some examples of plants you know (or secondary metabolites) that have physiological effects in humans, especially effects on the nervous system?

Two examples are stimulants and tobacco.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Fruit and vegetables are good for you but why?

A diet rich in fruit and vegetables offers health benefits:

- reduced risk of cancer (lung, prostate, pancreas, bladder and breast)
- reduced risk of cardiovascular disease

Plants produce phytochemicals, also called secondary metabolites.

- These chemicals can protect the plant against bacteria, fungi, viruses, UV light, and deter herbivores.
- When we eat the plants, these chemicals may have health-benefits.

Much research is needed to demonstrate the specific physiological effects of phytochemicals in humans.

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Particular families of plants make particular kinds of chemicals.

- Mustard family, including cabbage and radishes, makes a chemical that irritates the tongue and sinuses.
- Chili peppers sting.
- Onion family makes eyes tear.
- Citrus family and the mint family are refreshing

How might these secondary metabolites be useful to the plant that makes them?

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Bitter tasting plants:

Secondary metabolites that taste bitter are found in:

- coffee
- marijuana
- poppy
- tobacco
- cacao

Of what benefit does having a bitter taste help the plant?

How is your answer consistent with their effects on humans?

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Antioxidants are phytochemicals.

Antioxidants:

- are often red or yellow.
- scavenge highly reactive oxygen produced by photosynthesis.
- are believed to protect people against cancer.
- have a presence in food that is often increased by cooking.

What do you think might be the benefit of antioxidants to the plants?

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Learn more about plants:

Fruits and vegetables, especially leafy greens are considered health-promoting.

Choose four such plants that appeal to you and research their medicinal or health-promoting characteristic for display in a chart. (*next slide*)

WebMD

Leafy greens

WebMD eat more veggies

Phytochemicals

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Plant chart:

Name of Plant	Health Benefits and Phytochemicals	How to Consume (raw, cooked, infusion, etc.)	References

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Additional research questions:

Compare the flavor and nutritional value of a particular vegetable that is raw vs. cooked. Find out how heating (cooking) affects the nutritional value of this food.

Phytochemicals and phytonutrients are marketed as health-promoting supplements, such as beta carotene, and phytoestrogens, especially as a substitute for eating vegetables.

Use this website or other sources to find information about one of the phytochemicals identified in your chart.

WebMD phytonutrients

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Additional questions:

Explain the pros and cons of taking a supplement
vs. eating the food itself.

What did you learn about the scientific basis for the dietary advice,
“Eat more fruits and veggies?”

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Food fair:

In your groups, prepare a list of some of the edible plants you researched (the legal ones) to bring in for a healthy food tasting fair.

- Consider how the nutritional value of these foods is optimized and wash, cut, cook (if needed) and prepare your selected foods in an appetizing and attractive manner for others to eat.
- Each group must present four foods in quantities large enough for everyone to have a small serving. Each dish will be accompanied by a one page sheet, typed, sources cited, that relates the following information: (*next slide*)

TOWER GARDEN BY JUICE PLUS+

Flavors and Phytochemicals

Food fair research:

- Name of plant;
- Where it was grown and where it was obtained (if bought);
- Health benefits and nutritional value;
- How it is best or typically served;
- Phytochemicals and antioxidants in this food and what you learned about them;
- Supplements sold to substitute for eating this food;
- Historical and cultural uses as food and/or medicine;
- How varieties of the plant has been developed and modified.

Food Fair Presentation:

You will talk about your plant and encourage others to try it. Be sure to tell them about the highlights of your research findings.

TOWER® GARDEN BY JUICE PLUS+