



Grade Level

7th - 12th Grade

Lesson Length

90-120 Minutes

STEM Careers

- Gardener/Horticulturalist
- NASA Scientist
- Plant Scientist
- Ag Technician

Life Skills

- Critical Thinking
- Decision Making
- Planning/Organizing

Related Activities

- Seed Dissection

Learn More

- Visit Raising Nebraska raisingnebraska.unl.edu
- Visit Hastings Museum hastingsmuseum.org

Virtual Fun

- <https://www.youtube.com/watch?v=GCRNHdGXTi4>

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PLANTS SEE THE LIGHT?

Plant Science

This grab and go lesson will focus on how gravity impacts a plant's growth.

LEARNING OBJECTIVES

By the end of the lesson, students should be able to:

- Become familiar with plant hormones and impact on plant development
- Explain how phototropism works
- Understand how different wavelengths activate the phototropins

EDUCATIONAL STANDARDS SUPPORTED

- NE 2010 8.3.1.e Describe how plants and animals respond to environmental stimuli
- NE 2010 12.3.1.d Describe how an organism senses changes in its internal or external environment and responds to ensure survival
- NGSS HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

MATERIALS LIST

- 3 Small Cups (15 small cups – optional activity)
- Potting Soil
- Tape
- Marker
- Sticky Notes
- Medium-sized Shoe Box (such as a shoebox or a storage cube) – (5 boxes – optional activity)
- 12 corn seeds (45 corn seeds – optional activity)
- Aluminum Foil
- Small Cookie Sheet that Fits Inside the Box (or another sheet of aluminum foil)
- 5 Drinking Straws
- Water
- Spray Bottle
- 13" x 3" piece of clear, red, green, and blue cellophane (Optional)

PREPARATION

- For larger groups or to save time, you can fill the small cups with the potting soil.



INTRODUCTION

Plants are able to sense the environment around them and respond accordingly. In fact, they are in constant motion as they develop, search for light and nutrients and reproduce. Plants have mechanisms that determine up from down to produce shoots and roots in the correct orientation and also have mechanisms to measure time to know when to produce flowers at the right time of the year, become seasonally dormant and even determine night from day. Light is an important environmental cue to which plants are especially sensitive. Different levels of light will stimulate dramatic differences in growth pattern, leaf size and shape.

Plants move through tropisms which are vital to plants' survival. In general, tropisms involve cell elongation on one side of a plant, causing the plant to grow in a particular direction.

Phototropism

Leaves and stems respond to solar light and grow toward the sunlight (example of phototropism). Phototropism occurs because of plant hormones, called auxins, react to sunlight. When light is shown on one side of a plant, the auxins will move to the dark side of the plant. The movement of the hormones stimulates those cells to elongate, while the cells on the light side of the plant remain the same. This elongation of cells on one side of the plant and staying the same on the other causes the plant to bend in the direction of the light. Some plant leaves will move so their leaves are perpendicular to the sun in order to maximize photosynthesis (example of solar tracking).

Gravity and Earth

Gravity can happen between any two objects that have mass. The reason it seems like gravity on Earth holds you down is because the Earth has a larger mass and therefore has a much stronger pull. Your gravitational pull is much too weak to fight the Earth in any way. The Earth's pull on the moon is what keeps the moon orbiting the Earth. The sun's pull on Earth is what keeps the Earth in orbit.

OPENING QUESTIONS

- How do plants know which direction the light is coming from?
- How do plants bend to the light?

Today we are going to be a plant scientist and explore how plants can find the light and respond to light in order to better understand the biology of plants. You will also be deciding if gravity impacts a plant's growth. Let's get started.....

Did You Know?

Isaac Newton was the first to truly study gravity in the 1680s. His theory stated that gravity is a force that acts on all matter on Earth. He also noted that the matter's mass and distance played a role in how gravity effected that object

Fun Fact

Phototropism comes from the word "photo" which means light and "tropism" which means a plant movement triggered by a stimulus.

Did You Know?

Charles Darwin and his son Francis were the first to discover that light was perceived at the coleoptile's tip in 1880.

Gravity Information

Things that effect gravity are the size of the objects involved and the distance between the two objects. More mass means more gravitational pull. The further away the two objects are, the less of a pull they have with each other.

ACTIVITY 1: CORN “SEEING” THE LIGHT

1. Plant four corn seeds in each of the soil cups. Make sure they are evenly spaced and plant them just a half inch under the soil surface.
2. Create the following labels and place onto a cup
 - Control
 - Tip
 - Base
3. Water the cups and dump out any excess water. Place the cups on the cookie sheet or aluminum foil. This will prevent moisture and dirt from soaking through the box.
4. Place the cups/cookie sheet setup inside the box. Make sure it is open on one side so that light is coming in from an angle. Place in a windowsill, with the open side facing the sun.
5. Make four of each type of light-exclusion device:
 - **Shoot Cap:** cut a small 2” x 3” square of aluminum foil. Wrap it around the tip of a straw to create a small, closed-ended metal cap and slide it off. This will be placed over the tip of the growing shoot to cover any light coming in to the tip.
 - **Base Sleeve:** cut a small ½” x 3” square of aluminum soil. Wrap it around the middle of a straw so it creates a small open-ended ½” tall tube, and slide it off. This will be placed around the growing shoot so that it can grow through it.
 - Check the cups each day. Once they send up a shoot about 1/2” high, place either a shoot cap (on Tip seedlings) or a base sleeve (on Base seedlings) around them, depending on which cup they’re in. The control cup will get neither of the light exclusion devices. The seedlings might grow at different rates, so be sure to check each day to put the caps/sleeves on as needed. They grow fast once they germinate! Have students hypothesis what will happen in plant growth for each treatment in the “Plant Investigation Journal”
6. Continue to water the seedlings as needed.
7. Check the seedling after a week. Record plant growth and development for each of the treatments in their Plant Investigation Journal.
 - Compare hypothesis to observed results for each treatment. Was the hypothesis correct?
 - Compare the caps and sleeves to the control. What occurred differently between the treatment and the control? Are any of the seedling growing in a certain direction?

Variation to activity:

You can add four more tests to this activity by preparing the seeds in the cups as described above, but placing the case as follows:

Place the cups/cookie sheet setup inside the box. Cut out a square out of the box. Place a piece of either clear, red, green or blue cellophane over

Terminology

Phototropism – occurs when plant stems grow towards light

Solar tracking or heliotropism – ability of a plant to track the movement of the sun

Phototropins – photoreceptor proteins that mediate phototropism response.

Auxins - plant hormones that in high concentrations stimulate growth and elongation of cells in stems, while slowing growth of root cells.

Mass - the quantity of matter in a body regardless of its volume or of any forces acting on it

Weight - Measurement of the gravitational force acting on an object

the opening of the additional 4 test subjects. Place the open side facing the sun.

What color wavelength will the plants receive with each of the cellophane panes? Do plants respond to different light wavelengths?

Follow the experiment the same as above starting at the light-exclusion devices.

Did the plants grow differently under different light wavelength exposure? How did plant growth differ with the light-exclusion devices? What color of light activates phototropins?



REFLECT

Let's review what we have learned so far...

What is the definition of phototropism?

- Leaves and stems respond to solar light and grow toward the sun-light

What happened to the “tip” test subject?

- The corn seedlings do not bend toward the light

What happened to the “base” test subject?

- The corn seedling continued growing upward until it reached the top of the “tube”. Upon growing through the tube, the seedling started to grow toward the light.

How do phototropins play a role in phototropism?

- Phototropins are the light-absorbing proteins found in the chromophore. These proteins absorb light in the blue range and become active upon exposure to light. Which in turn causes the transport of auxin (plant hormone) to the shady side of the plant.

What do impact do auxins have on cell development?

- Auxins promotes cell elongation on the shady side of the plant.

Can you visually see a plant move?

- Yes but it is slight movement. For an additional activity, the students could record the movement of a plant(s) during the day. Then manipulate the video to increase the time-lapse to visually see the movement of the plant(s).

Fact

Phototropins are made up a protein bound to a light-absorbing organic molecule, called chromophore. As phototropins absorb light in the blue range, they change shape, become active and can change the activity of other proteins in the cell. From this phototropin activation, auxin (plant hormone) is transported unequally down the two sides of the coleoptile. More auxin is transported down the shady side and less auxin is transported down the illuminated side. Auxin promotes cell elongation, causing the plant to grow more on the shady side and bend in the direction of the light source.



APPLY

Now that you have successfully observed how a plant grows toward the light. You are on track to being a great plant scientist – someone who studies plants or even an NASA scientist who studies plant interactions in space!

How do you prevent indoor plants from “bending”?

- Placing a light source directly above the plants will prevent the plants from bending toward the window. Or turning plants occasionally to encourage them to “bend” the opposite direction is also helpful.

Have you ever observed plants move during the day with the sunlight in nature?

- <https://www.youtube.com/watch?v=3MYJEm99MYQ> Video show phototropism (aka heliotropism) with a time-lapse video of arctic poppies tracking the sun in a continuous circle. The sun does not go down during the summer months.

Can plant ever be planted the wrong way from the sun?

- No – the plant will grow according to the light.

Who depends on plant research?

- NASA Astronauts, farmers, landscaping professionals, golf course managers, and all of us. Remember if you eat, it was impacted by plants!

What are other careers that relate to growing plants other than what we have discussed?

- Plant breeder, geneticist, nursery, soil scientist, agronomist, pathologist, entomologist, etc.

References

<http://www.untamedscience.com/biology/plants/phototropism/NASA> website at <https://www.nasa.gov/>

We want to hear from you!

Let us know what you thought of the lesson or send us a picture of youth participating in the lesson.

#NE4HSTEM #ECLIPSE2017

PHOTOTROPISM AT WORK

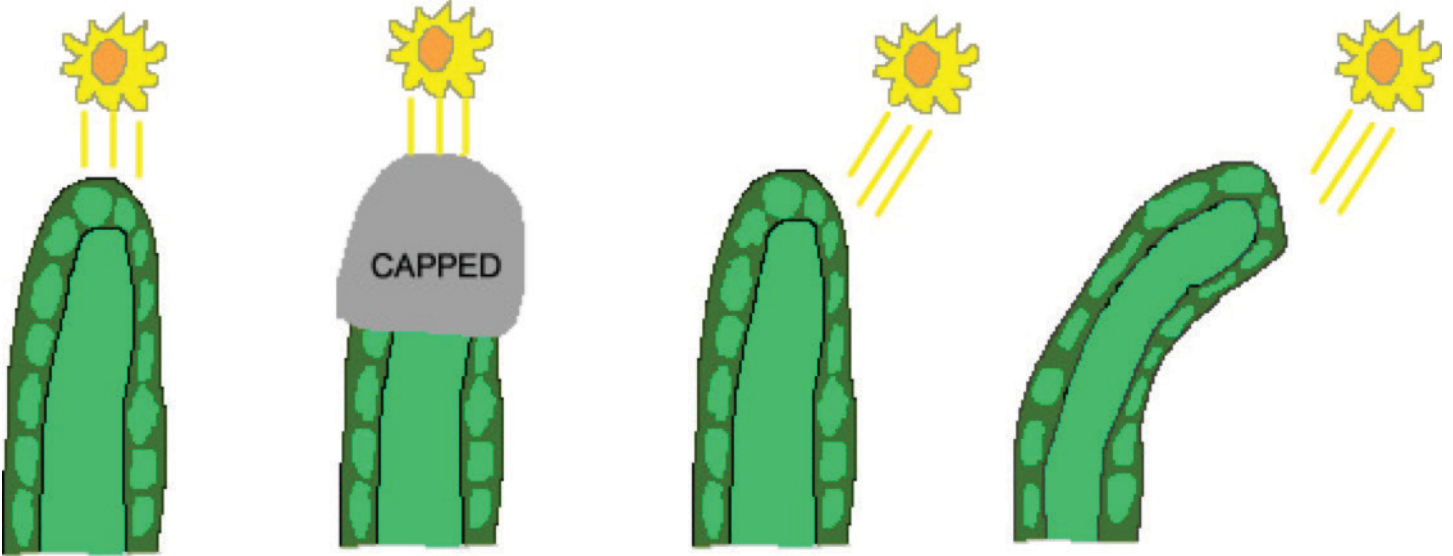
Plants See the Light

NAME

DATE

Explain how a plant “sees” light.

Draw with circles where the plant hormones are found in each drawing.



What is the plant hormone called?



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PHOTOTROPISM AT WORK

Plants See the Light

NAME

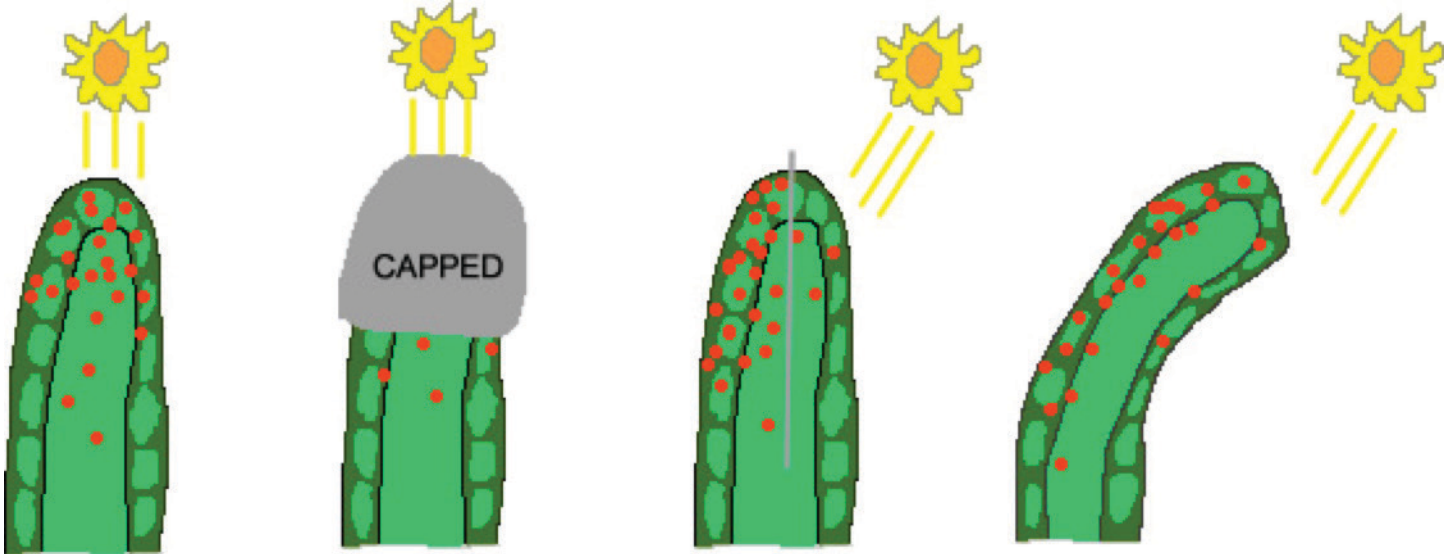
ANSWER KEY

DATE

Explain how a plant "sees" light.

Phototropism occurs because of plant hormones called auxins react to sunlight. When light is shown on one side of a plant, the auxins will move to the dark side of the plant. The movement of the hormones stimulates those cells to elongate, while the cells on the light side of the plant remain the same. This elongation of cells on one side of the plant and staying the same on the other causes the plant to bend in the direction of the light

Draw with circles where the plant hormones are found in each drawing.



What is the plant hormone called?

auxin



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Life up close.
HastingsMuseum

PLANT SCIENCE INVESTIGATION JOURNAL

Plants See the Light?

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Hypothesis for Control:

Actual Observation for Control:

Hypothesis for Tip:



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PLANT SCIENCE INVESTIGATION JOURNAL

Plants See the Light?

NAME

DATE

Actual Observation for Tip:

Hypothesis for Base:

Actual Observation for Base:

A spiral-bound notebook with a grey cover and lined pages. A vertical red margin line is on the left side. The notebook is open to a page with three sections: 'Actual Observation for Tip:', 'Hypothesis for Base:', and 'Actual Observation for Base:'. Each section has several horizontal blue lines for writing. The spiral binding is on the left side.

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