

## Lesson Title – How Does Phototropism Affect the Growth of Plants?

<b>Length</b> – 45 Minutes			
<b>PA Academic Standards and Anchors Addressed –</b>			
<u>Science Education</u>			
3.1.10.A9			
<ul style="list-style-type: none"> <li>• <b>Compare and contrast scientific theories.</b></li> <li>• <b>Know that both direct and indirect observations are used by scientists to study the natural world and universe.</b></li> <li>• <b>Identify questions and concepts that guide scientific investigations.</b></li> <li>• <b>Formulate and revise explanations and models using logic and evidence.</b></li> </ul>			
<u>Mathematics</u>			
A1.2.1.1.1 Analyze a set of data for the existence of a pattern and represent the pattern algebraically and/or graphically			
<b>PA Agriculture Standards and Benchmarks –</b>			
<u>Plant Science</u>			
Botany & Physiology			
4.7-Explain environmental factors that affect the growth and development of a plant			
4.8-Demonstrate the use and effects of plant regulators			
<b>Objectives:</b> <i>The student will be able to:</i>			
1. Design an experiment to evaluate the effect of phototropism to teacher satisfaction.			
2. Evaluate a peer’s experimental design to teacher satisfaction.			
3. Collect initial data from the experiment to teacher satisfaction.			
<b>Lesson Type -</b>	Informational	Operational	<b><u>Managerial</u></b>
<b>Modalities Addressed -</b>	<b><u>Visual</u></b>	<b><u>Auditory</u></b>	<b><u>Kinesthetic</u></b>
<b>Multiple Intelligences Addressed -</b>	Verbal-Linguistic	<b><u>Naturalist</u></b>	Musical      Visual-Spatial
	<b><u>Logical-Mathematical</u></b>	<b><u>Interpersonal</u></b>	<b><u>Intrapersonal</u></b> <b><u>Bodily-Kinesthetic</u></b>
<b>Essential Vocabulary</b> – “Tropism,” “Phototropism,” “Geotropism,” “Hypothesis”			

**Need of Lesson** – Many factors can affect plant growth. The purpose of this lesson is to allow students to design an experiment that will test the effects of light (or lack thereof) on plant growth. The lesson will draw on vocabulary from yesterday’s lesson and put this vocabulary into action as students investigate the effects of phototropism. The experiment that the students design during today’s class will turn into a 2-week long observation project. This lesson is designed for 20 students in a 9<sup>th</sup>-grade Intro. to Agriculture & Natural Resources course.

This lesson is modeled as **Inquiry-Based Instruction** in which students will develop a hypothesis, experimental procedure, and data collection method surrounding the topic of the long-term effects of phototropism.

**Materials –**

20 seedlings in pots

20 Popsicle sticks

Light Source

Rulers

Lab Log or Notebook

**Resources (Community, etc)**

CASE Agricultural Science—Plant (Curriculum for Agriculture Science Education). “*Bright Light*” activity guide. 2016.

**Pre-Class Set-Up –**

Have 20 seedlings potted and ready for class in the greenhouse (or laboratory setting). Bell Work should be displayed on Power Point or written on board. Objectives for the day are listed in the corner of the board.

**Bell Work** – *Answer the following in your notebook...*

1. What are 3 factors of light that affect plant growth? (Light quality, Light duration, Light intensity)
2. What happens to the photosynthetic rate when any of these factors are changed? (It changes; if more light exposure is given, photosynthetic rate will increase. If light is taken away, photosynthetic rate will decrease)

**Interest Approach** – (Show Power Point Slide with plants exhibiting phototropism)

Like we discussed yesterday, plants respond to the stimuli around them. Does anyone remember the word that describes a plant's response to stimuli? Yes. **Tropism** is a response to internal or external stimuli that have an effect on the growth of the plant. Do you think that tropism can be permanent and alter the growth rate of the plant in the future? Keep that thought in mind as we look at some photos. (Go through 3 slides of Power Point) What did all three of these plants have in common? Yes. They were growing towards a light source. If we remember our discussion yesterday, we coined this term **phototropism**. We also discussed when plants have a positive or negative growth pattern as a response to gravity (**geotropism**). So, after looking at these pictures, do you think that phototropism can have a permanent effect on plant growth?

**Transition** So, after looking at these pictures, do you think that phototropism can have a permanent effect on plant growth? That is our question for the day. Our objectives for the day are to design an experiment that can measure the effects of phototropism, evaluate the experimental design for your peers, and decide how we are going to collect data for the experiment.

### **Summary of Content and Teaching Strategies –**

#### Experimental Design (30 minutes)

As we begin our investigation, I want each of you to think of a question that you would like to answer about the long-term effects of phototropism in plants? Think about the 3 factors of light that you listed in your Bell Work and how they can relate to this experiment. Everyone grab a partner, start on a new page in your notebook, and write your question at the top of the page that you have regarding phototropism. Below the question, propose an answer to your question. This will be your **hypothesis** for the experiment. The hypothesis will also guide how you set up your experiment.

*(Allow students to create hypothesis while asking questions such as “What are the factors that affect plant growth,” “Why do you think that would happen,” “What does light do for a plant,” “Do all plants grow the same way,” etc. Play off of student's statements and turn their questions into another question that they can answer with prior knowledge and/or critical thinking).*

It looks like all groups have finished their hypotheses. But before we go any further, we need to develop a materials list for your experiment. In your group, develop a list of materials that you will need to conduct your experiment. I'll give each group 2 minutes to develop a list of items. Great! So what are some materials that you need for your experiment? [Have groups share out items.] It sounds like there are going to be a bunch of intense experiments going on. Well, the bad news is I couldn't read your minds as to what materials to buy, so here are the materials that we have available. [Show seedlings, plants, ruler, rubber bands, popsicle sticks.] With these materials, I'd like each group to create a new experimental design. Each group will have 2 plants to utilize. One person in your group needs to write out a procedure for your experiment. You will have the remaining 15 days of school to complete your observations, so be sure to include this in your experimental design and procedure. When your group has finished, I must approve your procedure. And remember, anyone should be able to pick up your procedure and follow the directions. What questions are there? Go!

*(Discuss positives and negatives of each experimental design. Use probing questions such as "how often will you measure, where will you measure, what will you measure with, what units will you measure in, to what will you compare your plant growth (i.e. is there an experimental control), will you have constant light, etc. Guide students to create a table/chart to collect their data as well).*

#### Data Discussion (10 minutes)

With the time remaining in class, I'd like to review some methods of expressing data. There are several charts commonly used to express data. What are a few examples that you may have seen before? [Students should respond with pie chart, bar graph, line graph, etc.] Let's take a line graph as our example. Can someone come to the board and draw a sample of a line graph? Great. [Lead a discussion on the positives and negatives of the graph drawn. Emphasize to students that a graph must have box axis labeled, a title, a legend, units, etc.] With that being said, take a look at your experimental design and brainstorm within your group how you will represent your data at the end of the project. This may change your experiment's design and/or procedure. With the time remaining, please decide on a way to record/represent your data. If your experiment has changed, I must approve it before you leave class. **Also, remember that**

**all experiments have beginning data. [This should make students think about taking Day 0 observations. If no one realizes it, ask students probing questions such as “How are you going to know where your plants were at the beginning of the experiment?”]**

(Review Objectives with students)

(Review Cognitive Connect with students)

Don't forget to write about today's lab in your record book journal!

**Learning Assessment-**

Students will be expected to keep a daily observation log of their plants for the next 15 days. At the conclusion of the experiment, students will have to present their data to the class and also prepare a lab report describing their experiment and data collected. This assignment is worth 100 points.

**Cognitive Connect –**

Yesterday – Factors that affect plant growth

Today – Effect of phototropism

Tomorrow – Plant Nutrients

**Adaptations/Accommodations for Special Needs** - Students with special needs will be accommodated based on their individual IEP. Guided notes, modified quizzes & tests, and other instructional aids will be available. Preferential seating will be available for students who need it. Various teaching methods and aids will be utilized to accommodate a wide variety of learners. I plan to work with the IEP teams as necessary to adapt to the learner's needs.

**Total Ag Program –**

Extended Classroom-Students may search for pictures of plants that have exhibited tropisms in magazines or on the internet. Students may also observe real-life examples of tropisms around their home or community.

FFA – Many skills gained in this unit could be transferred to several CDE events including Agronomy, Landscape and Nursery Management, Floriculture, or Ag Sales (depending upon product being sold).

SAE - Students with an interest in Plant & Soil Science may enjoy several SAE areas in both Entrepreneurship and Placement areas with skills gained through this lesson.

Students may begin growing their own plants and merchandising them during holiday sales, be employed at a local greenhouse or nursery business, work in Landscape Design or Turfgrass Management, or shadow a Botanist or Plant Geneticist. On the agronomy side, students may rent a plot of land to grow grain or forage crops, be employed on a commercial crop farm, or start their own custom crop business. Depending upon a student's SAE, they would be eligible for Proficiency Awards in the following areas:

Agriscience Research-Plant Science, Diversified Crop Production

Entrepreneurship/Placement, Diversified Horticulture Forage Production, Fruit

Production, Landscape Management, Nursery Operations, Specialty Crop Production,

Turfgrass Management, or Vegetable Production.

### Lesson Summary

*Which component(s) in your lesson plan are your “flex” item(s), i.e., can be lengthened or shortened to accommodate time? Explain how the component(s) can be “flexed”.*

**The flex item in this lesson is the revision of the student’s procedures. This portion can be lengthened if the students have completed other portions of the lesson quicker than anticipated. In addition, I could ask students to make an outline for their final lab report if they finish all assigned tasks.**

*Describe any adaptations and accommodations for learners with special needs that can be made in this lesson plan (see Methods chapter 12).*

**Students with special needs will be accommodated based on their individual IEP. Guided notes, modified quizzes & tests, and other instructional aids will be available. Preferential seating will be available for students who need it. Various teaching methods and aids will be utilized to accommodate a wide variety of learners. I plan to work with the IEP teams as necessary to adapt to the learner’s needs.**

*We learn in three modalities. Where in this lesson plan are your specific evidences of accommodating learners’ modalities?*

**Visual-Students can see plants that have exhibited phototropism and model their experiment off of the sample photos.**

**Auditory-Students will hear questions being posed to the instructor and take the answer into account when designing their own experiment.**

**Kinesthetic-Students will construct an experiment using live plants to test the effects of phototropism.**

*What is the highest level of cognition according to Bloom’s Taxonomy that students reach in this lesson plan? Describe this occurrence.*

**The highest level reached during this lesson is *Synthesis*. This occurs when students are designing their experiment and actually constructing the experiment in the greenhouse.**