Phototropism Lab- Part 1

Procedure

1. Collect 4 cardboard milk cartons per lab group
2. If all of your milk cartons have not been prepared then you will need to use one that has been as a template.
3. Once all of your milk cartons are ready take your first milk carton and tape a piece of red cellophane over the hole in the side of the box.

It is important the cellophane completely covers the hole and that no light can sneak into the box.

4. Take your second milk carton and tape blue cellophane over the hole
5. Take your third milk carton and tape green cellophane over the hole
6. Take your fourth milk carton and tape clear cellophane over the hole
7. Using the square flowerpots that fit inside the milk carton fill the flower pot with soil up to the inner rim. Water the soil until it runs out the bottom. Then plant 10 radish seeds in each pot, ½ inch below the surface.
8. Mark the FRONT of each flower pot with tape (your initials and period will do nicely)
9. Once all pots are labeled bring them out to the greenhouse and place the milk cartons over the flowerpots.

BE SURE you orientate the boxes so they all face the same way.

10. Return to your group and prepare a data table that includes cellophane color, average seeding height, direction of curving and amount of curving.
11. Make sure your lab area is clean and then individually answer the Prelab Questions:

Prelab Questions

1. What is phototropism and why do plants display it?
2. In which box do you think the strongest phototropism will bee seen? Why?
3. In which box the least? Why?
4. What is/are your control group(s)?
5. What is/are your experimental group(s)?
6. What environmental variables besides sunlight might have an impact on this experiment?

Phototropism Lab- Part 1

Plant growth and distribution are limited by the environment. If any one environmental factor is less than ideal it will become a limiting factor in plant growth. Limiting factors are also responsible for the geography of plant distribution. For example, only plants adapted to limited amounts of water can live in deserts. Most plant problems are caused by environmental stress, either directly or indirectly. Therefore, it is important to understand the environmental aspects that affect plant growth. These factors are light, temperature, water (humidity), and nutrition.

Your milk box lab tested the response of a plant to light a little something botany teachers like to call phototropism.

As you already know a tropism is a response (movement) by a plant that is determined by the direction of an environmental stimulus. Movement toward an environmental stimulus is called a positive tropism, and movement away from a stimulus is called a negative tropism. Each kind of tropism is named for its stimulus. For example, a plant movement in response to light coming from one particular direction is called phototropism. The shoot tips of a plant that grow toward the light source are positively phototropic.

Phototropism, as mentioned, is illustrated by the movement of sprouts in relation to light source direction. Light causes the hormone auxin to move to the shaded side of the shoot. The presence of auxin causes the cells on the shaded side to elongate more than the cells on the illuminated side. As a result, the shoot bends toward the light and exhibits positive phototropism. In some plant stems, phototropism is not caused by auxin presence or movement. In these instances, light causes the production of a growth inhibitor on the illuminated side of the shoot. Negative phototropism is sometimes seen in vines that climb on flat walls where coiling tendrils have nothing to coil around. These vines have stem tips that grow away from the light, or better put, toward the wall. This brings adventitious roots or adhesive discs in contact with the wall on which they can cling and climb.

Solar tracking is the motion of leaves or flowers as the follow the suns' movement across the sky. By continuously facing toward a light source, moving or not, the plant maximizes the light available for photosynthesis.

In order to understand the plant’s response to light you must first understand light itself.

Light has three principal characteristics that affect plant growth: quantity, quality, and duration.

Light quantity refers to the intensity or concentration of sunlight and varies with the season of the year. The maximum is present in the summer and the minimum in winter. The more sunlight a plant receives (up to a point), the better capacity it has to produce plant food through photosynthesis. As the sunlight quantity decreases the photosynthetic process decreases. Light quantity can be decreased in a garden or greenhouse by using shade-cloth or shading paint above the plants. It can be increased by surrounding plants with white or reflective material or supplemental lights.

Light quality refers to the color or wavelength reaching the plant surface. Sunlight can be broken up by a prism into respective colors of red, orange, yellow, green, blue, indigo, and violet. On a rainy day, raindrops act as tiny prisms and break the sunlight into these colors producing a rainbow. Red and blue light have the greatest effect on plant growth. Green light is least effective to plants as most plants reflect green light and absorb very little. It is this reflected light that makes them appear green. Blue light is primarily responsible for vegetative growth or leaf growth. Red light when combined with blue light, encourages flowering in plants. Fluorescent or cool-white light is high in the blue range of light quality and is used to encourage leafy growth. These lights are excellent for starting seedlings. Incandescent light is high in the red or orange range but generally produces too much heat to be a valuable light source. Fluorescent "grow" lights have a mixture of red and blue colors that attempts to imitate sunlight as closely as possible. They are costly and generally not of any greater value than regular fluorescent lights.

The third characteristic of light is: duration. **Photoperiod** refers to the amount of time that a plant is exposed to sunlight. When the concept of photoperiod was first recognized it was thought that the length of periods of light triggered flowering. The various categories of response were named according to the light length (i.e., short-day and long-day). It was then discovered that it is not the length of the light period but the length of uninterrupted dark periods that is critical to floral development. The ability of many plants to flower is controlled by photoperiod.

Plants can be classified into three categories, depending upon their flowering response to the duration of darkness. These are short-day, long-day, or day-neutral plants. Short-day, (long nights) plants form their flowers only when the day length is less than about 12 hours in duration. Short-day plants include many spring and fall flowering plants such as chrysanthemum and poinsettia. Long-day, (short nights) plants form flowers only when day lengths exceed 12 hours. They include almost all of the summer-flowering plants, as well as many vegetables including beet, radish, lettuce, spinach, and potato. Day-neutral plants form flowers regardless of day length. Some plants do not really fit into any category but may be responsive to combinations of day lengths. The petunia will flower regardless of day length, but flowers earlier and more profusely under long daylight. Since chrysanthemums flower under the short-day conditions of spring or fall the method for manipulating the plant into experiencing short days is very simple. If long days are predominant, a black plastic sheet is drawn over the chrysanthemum for 12 hours daily to block out light until flower buds are initiated. To bring a long-day plant into flower when sunlight is not present longer than 12 hours artificial light is added until flower buds are initiated.

After your group has collected its data you need to answer the following questions.

1. Which characteristic of light was the milk box lab testing? (What stimulus did the radish stems respond to?)

2. Construct a data table to organize your observations. Include details such as amount of bending, differences in growth.

3. In which flowerpot were the radish seedlings stems the least curved?

4. In which flowerpot were the radish seedlings stems the most curved? In what direction were the stems curved (towards or away from the light)?

5. Were the stems curved in any of the other pots? In what direction were they curved?

6. What effect if any did the red, blue, green, and clear cellophane have on the direction of growth?

7. Remembering your color spectrums (or looking at page 235 in your textbook) why are plants like radishes green? (your answer should include the words absorb and reflect)

8. Red light should have had a minimal phototrophic effect on your seedlings. If there was any significant curving what might be responsible for this error?

9. Write a conclusion for this lab. Under what light conditions did you observe the greatest phototrophic response?

PART TWO: The inquiry lab NAMES:

Using what you have learned from the first lab you will now construct a new experiment using radish seeds that will test one of the three characteristics of light. This new experiment must be significantly different from the original lab. You will have the standard planting materials available to you will have access to milk boxes and colored cellophane, outlet timers and light bulbs on moveable arms for your use. Use the spaces below to design your experiment.

Experiment name:

Hypothesis. In the space below, write a hypothesis for the problem stated above. Make sure that groups have decided on which factors they will investigate to avoid duplicate experiments. Be sure to write your hypothesis as an "If (independent variable) then (dependent variable)." statement. Be specific!!

List the environmental factors or variables that you will need to control. (Be thorough)

Name the independent variable:

Name the dependant variable:

Materials: Go to the supply table or review the list given to you by the teacher. Think about how you would design a controlled experiment to test your hypothesis using these materials. List the specific materials you will need (example: 4 flower pots, 40 radish seeds – 10 for each pot)

Procedure: Draw a sketch of how you will set up an experiment that will test your hypothesis, and label all of the parts of your experimental and control setups.

Procedure: In the space below, list the steps of the procedure you will follow. Be sure to include a control group in your experiment. Be specific enough that another lab group could follow your experimental design… not that I would ever make you switch procedures to prove a point…

In the space below, list the observations or the measurements you will make during the experiment.

Data: Make a table in the space below or on a separate sheet of graph paper. Make sure your table has descriptive headings. Use it to record your data.

5. Analysis:

1. Using graph paper, create a graph that properly displays all of your data. Be sure to include proper headings.

2. Which group(s) was considered your control group? Why?

3. Which group(s) was considered your experimental group? Why?

4. What experimental factor most influenced your results (what color, time etc.)

5. Which setup showed the strongest result related to the factor chosen above?

6. Which setup showed the weakest result to that same factor?

7. Is it possible that your results were influenced by a variable that you did not control for?

6. Conclusion. In the space below, state whether your data supports or refutes your hypothesis. Include any sources of error. Be sure to use data in your conclusion to support your conclusion.

7. Class Conclusions: Use the chart to discuss other factors affecting phototropism that were tested by other groups. List all that apply

	Hypothesis	**Result**
Group __		
Group __		
Group __		
Group __		
Group __		

Class Conclusion: From the information of the entire class, what would be the ideal conditions for maximum phototropic effect?

Based on the class results and the results of your own experiment, suggest a new problem that could be pursued as an extension of this investigation?

Final comments on the lab: How can I improve this for the next class?

PHOTOTROPISM LAB REPORT RUBRIC

Student Names:	Due Date:

This analytic rubric is used to verify specific tasks performed when producing a lab report. If the task has been completed, all points are awarded. If the task is incomplete half points may be awarded. No points are awarded if the task is not complete.

Category	**Scoring Criteria**	Points	Student Evaluation	Teacher Evaluation
Lab Introduction ***15 points***	The question to be answered during the lab is stated.	5		
	The hypothesis clearly shows it is based on facts.	5		
	A connection is made between the lab and the “real world” (how might data from this lab improve life?)	5		
Methods ***15 points***	Procedures are written during pre-lab preparation and clearly state what is planned. *(written as a paragraph not as list)*	10		
	There are no understood procedures or materials. *(Such as: plant seeds in potting mix and water.)*	3		
	A diagram of your experimental apparatus is shown at the end of your procedure. (include notes about color of cellophane, spacing of seeds etc)	2		
Results ***15 points***	Results of the procedure are clearly recorded. *(Usually presented in a data table)*	10		
	Measurements, when required, show proper units.	3		
	Calculations, when required, are clearly shown. *(Write these as observations on the lab report.)*	2		
Graph/Diagram 10 points	The graph\diagram properly displays all of your data	7		
	On paper, used ruler, proper units and headings	3		
Discussion ***35 points***	Summarize the essential lab data. (come to a conclusion)	10		
	Show how the essential data answers the lab question. Include the answers to the analysis questions.	20		
	Identify the one area of the lab most likely responsible for measurable experimental error. *(Think carefully.)*	5		
Presentation ***15 points***	Report is printed in black ink on white paper using 12 point Times New Roman or Arial font. Paragraphs are double spaced with 1 inch margins on all sides with no visible corrections (**Warning**: this is not Word’s default).	5		
	A diagram of the essential apparatus used in the experiment is drawn in the largest available white space on the front of the lab report (or cover).	5		
	Report is written in such a way that other students could accurately duplicate the experiment.	5		
Participation ***10 points***	No safety or participation violations.	10		
Score	Total Points	115		
Self-evaluation	If the difference between the student evaluation and the teacher evaluation is less than 5 points, 5 points will be added to the teacher's score when the grade is recorded.			
Deadline	Reports will be accepted after the beginning of class for 3/4 credit. Papers turned after that time will be mulched for use in the greenhouse and receive ¼ credit.			

Phototropism Lab Report Lab Report

Lab Reports should follow the following format.

1. **Introduction:** Include the essential question "**What impact does** (your characteristic of light) **have on phototropism?"** Your specific statement of the problem you investigated and why you choose that problem to work on, include the background information of the problem including an explanation of how the problem relates to you, and the world. Conclude this section with a brief summary statement of the general method of approach to the problem, your hypothesis and prediction.

2. **Methods and materials:** This section tells the reader how and with what "stuff" the work was done. You should try to strike a balance between an over-detailed description of even the most trivial items and a very sketchy statement that provides insufficient information. The important guideline is that another worker of similar training and ability, following your description, should get the same results. This section should be written as a description of what you did, not as a set of numbered instructions. Make sure you alert the reader to any dangerous substances or necessary safety procedures.

3. **Results:** Here is the real meat of a report. In this section you should **describe** the important qualitative and quantitative observations is your work. You are **not yet** drawing conclusions from you data. Data should be tabulated and/or graphed and described. One of the common errors in report writing is to say, "The data are plotted in Fig. 1" without saying something like, "As can be seen in the graph, the positive photrophic response over 5 days was slow for the first three days after which a sharp increase is noted." Be aware that tables and graphs are not self-explanatory, and must be summarized for the reader. All graphs and tables should be numbered and provided with a title. Any additional information that makes the data more comprehendible should be provided as needed.

4. **Discussion and conclusions:** This section serves two functions. First, it provides a place where the data may be fully discussed and interpreted (you answer all the WHYS and HOWS), and second, it allows the author to delve into the realms of speculation. Here one may address questions like "why did something unexpected happen?" or "what would happen if the light source was brighter?" or "why did the expected results not materialize?" In this section the author may (discretely) pat him- or her-self on the back, criticize other workers results, suggest improvements in methodology, etc. You should also find and explain one major source of experimental error. This could be as simple as "we did not measure accurately because..." To concepts as complicated as "auxin inhibition by long wavelength radiation."

5. **References:** Some papers have no references while others have 200 or more.

Required Diagrams

- A diagram of your pots with measurements before you began
- A diagram of your pots with measurements after your lab.

Be sure you address the following in your lab report:

- Experimental error (human or otherwise)
- Your conclusion for the effect of __your variable here__ on phototropism.
- A labeled graph or diagram of your results