

SCIENCE PROJECT PROPOSAL  
EFFECT OF LIGHT INTENSITY ON STEM ELONGATION  
Suggestions by Michael H. Renfroe, Ph.D.

Question: Does light intensity have an effect on stem elongation?

Background information for Mom:

When seeds are germinated in the dark, the stems that grow from the embryo are very elongated and white to light yellow in color. Stems in this condition are referred to as etiolated. Plants grown in dim light tend to be long and spindly, but stems that develop in bright light tend to be stout. Your daughter could examine the effects of light intensity on stem elongation. A possible set-up would be to use fluorescent lights which would avoid the heat problems associated with incandescent lights. You can get shop lights at a hardware or discount department store pretty inexpensively, if you don't have lights that will do.

You could help your daughter figure out the experimental design by asking her the following questions.

If you ask the question "does light intensity have an effect on stem elongation," how could you state that as a hypothesis?

Hint: Light intensity has an effect on the elongation of growing plant stems. Another way to state this is by using the null hypothesis which would be: differences in light intensity have no effect on the elongation of growing plant stems. Statistically, it is easier to test the null hypothesis, since statistically it is easier to reject a hypothesis than to prove a hypothesis. Therefore, if you state the null hypothesis and statistically can reject the null, it supports the hypothesis. That may seem backwards, but mathematically, it is so.

To test your hypothesis, how many seeds do you think you need to use?

Hint: The judges like to see that the student had enough samples to average out individual plant differences or variations. I would suggest that you have 12 plants for each level of light, but no less than six. That will let her calculate averages for each treatment and see if differences are present.

How can you control the light intensity for each group of seedlings?

Hint: You could plant seeds in potting soil in planting trays. You can use two six-slot trays per treatment and put the trays into a box under the lights. Use one box per treatment, and have one box open to receive full light intensity. Over another box, drape one layer of gauze (cheesecloth can be purchased in the hardware or paint or automotive section of Wal-Mart or K-Mart). Over another box, drape two or three layers of gauze. Over another box, drape five or six layers, or use a dark cloth like a sheet or something that will keep the light very low. If you can borrow a light meter from a local school or a photography studio and actually measure the light intensity and report what the plants are receiving, that would be best. If you can't measure the intensity,

you can at least report them in relative terms as brightest to darkest. If you use boxes to support the cloth, make sure that the boxes are deep enough to permit growth of the tallest seedlings without them hitting the top. How tall that needs to be will depend on how long you grow the seedlings.

How long do the seedlings need to grow?

Hint: This will depend upon what plant you select. If you select a plant that germinates pretty quickly and grows quickly, you might get results in a week or two. I don't think you would need to let them go more than two or three weeks in any event. The plants in the dimmest light will not do well if kept in the dark too long and might die. You might try bean plants (lima, navy, or pinto beans, perhaps) or some other plant that makes a single stem.

How will you measure the growth of the seedlings?

Hint: The simplest method would be to measure the length in centimeters from the soil surface to the tip of the stem (not including the length of the leaf at the tip if one is present). If you have some fine calipers, you might also measure the width of the stem at a given height above the soil (e.g. two or three cm above the soil surface) to get another aspect of the growth.

How will you tell if there are differences among the treatments?

Hint: The easiest way is to calculate the average stem length by adding all the lengths for a given treatment and dividing by the number of plants measured. A better way would be to test the means for statistical significance. Your daughter's math teacher might be able to suggest a simple statistical test (t-test or use of standard deviations or some other technique) for her to use. If not, let me know, and I will give her some information or someone to contact. The judges will look for the use of statistics. It is not mandatory at her age, but as a minimum they want to see that she understands the need for multiple samples and averaging. If she uses a statistical test, the judges will want to see that she understands what it means and what it does for analyzing the data.

How will you show the results to the judges?

Hint: Large simple graphs that the judges can quickly understand and evaluate are best. Make sure that the labels are clear and that the numbers on the axes are easy to read.

What kinds of questions do you think this study might lead to next?

Hint: One question that might come to mind is where is the plant measuring the light intensity? Does the plant measure the light by the stem, by the leaves, by the stem tip (growing point), or some other part? How could test your new hypothesis? The judges like to see that the student has put the present study in some larger context and is looking ahead to new questions and follow up studies or hypotheses.

Good luck with your project!