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Title: **Becoming a Plant**

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Appropriate Level: This lab is appropriate for Middle School, Honors, Regents, and basic level students.

Abstract: Students will plant seeds at various depths in the soil and make observations after seedlings emerge. Based on their observations, students will decide what measurements could be made. They will make these measurements and look for an explanation for differences in their measurements. They will write a hypothesis that describes how a specific variable affects their measured parameter and they will then design an experiment to test their hypothesis. In their experimental design, they will decide the type and number of seeds to plant, the conditions to germinate the seeds, and what measurements to make once the experiment is in progress or complete. Pairs of students will turn in a worksheet that describes their experiment and details what materials they will require. The teacher will comment on their experimental design before the experiment is initiated. After considering teacher input, the students will implement their experiment. Data will be collected and summarized in charts, tables, and/or graphs. Optional: Each student will write a two to four page lab report that summarizes their results.

Time Required: It will take 20 minutes to plant seeds at the onset of the experiment. One forty minute lab period (about one to two weeks later) should be devoted to seedling observation and a class discussion of experimental design, controls, data collection and analysis. As homework, pairs of students will develop a hypothesis and design an experiment to test their hypothesis. A second forty minute lab period will be required to set up the main experiment. Students will be required to water and tend to the plants as needed. Students should keep a running log during the seedling germination period. After about about two weeks, a third lab period will be needed to collect data and make observations. At least one lab period should be set aside

for a class discussion of the experimental designs, results, and interpretation.

Living Environment Standards:

STANDARD 1. Analysis, Inquiry, and Design. SCIENTIFIC INQUIRY.

Key idea 1. The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

S1.1. Formulate questions independently with the aid of references appropriate for guiding the search for explanations of everyday observations.

S1.1.a formulate questions about natural phenomena.

S1.1.c refine and clarify questions so that they are subject to scientific Investigation.

S1.2 Construct explanations independently for natural phenomena, especially by proposing preliminary visual models of phenomena.

S1.2 a independently formulate a hypothesis.

Key idea 2. Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

S2.2. Develop, present and defend formal research proposals for testing their own explanations of common phenomena, including ways of obtaining needed observations and ways of conducting simple controlled experiments.

S2.2c design a simple controlled experiment.

S2.2e choose an appropriate sample size and number of trials.

S2.3c collect quantitative and qualitative data.

Key idea 3. The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

S3.1 Design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research questions or hypothesis.

S3.1a organize results, using appropriate graphs, diagrams, data tables, and

other models to show relationships.

S3/2c evaluate the original hypothesis in light of the data.

S3.2d formulate and defend explanations and conclusions as they relate to scientific phenomena.

S3.2h use and interpret graph and data tables.

Living Environment Standards:

STANDARD #4. The Living Environment.

Key Idea 1: Living things are both similar to and different from each other and from non living things.

1.1f Many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.

Key Idea 4: The continuity of life is sustained through reproduction and development

4.3e Patterns of development vary among plants. In seed-bearing plants, seeds contain stored food for early development. Their later development into adulthood is characterized by varying patterns of growth from species to species.

Key Idea 5: Organisms maintain a dynamic equilibrium that sustains life.

5.1a Animals and plants have a great variety of body plans and internal structures that contribute to their ability to maintain a balanced condition.

5.1c All organisms require energy to survive. The amount of energy needed

and the method for obtaining this energy vary among cells. Some cells use oxygen to release the energy stored in food.

5.1d The methods of obtaining nutrients vary among organisms. Producers, such as green plants, use light energy to make their food.

Key Idea 6: Plants and animals depend on each other and their physical environment.

6.2a Photosynthesis is carried on by green plants and other organisms containing chlorophyll…..

Additional Teacher Information

Objectives:

1. Students will learn how to design an experiment.
2. Students will learn the value of "controls".
3. Students will learn how to make observations.
4. Students will learn how to summarize experimental results in the form of tables & graphs.
5. Students will learn how to analyze data and draw conclusions.

Materials

Preliminary Experiment

Per pair of students:

- 4 – Styrofoam or other drinking cups.
- cm rulers.
- 12 corn, sunflower seeds, garlic cloves or any other type of seed the teacher is familiar with
- Potting soil.
- Tape and markers.
- Plant lights or window.
- Newsprint to lay on benches to collect potting soil debris.

Student designed experiments [suggested experiments include a study of the effects of crowding, soil type, temperature, pH, salt concentration, amount of water (rainfall), light duration, wavelength, and/or intensity, detergents, roadside pollution (for example oil, etc)].

Per pair of students:

- 15 - 20 corn, sunflower seeds, garlic cloves or any other type of seed the teacher is familiar with
- 5 - 8 Styrofoam or other drinking cups.
- cm rulers.
- Potting soil.
- tape and markers.
- Newsprint to lay on benches to collect potting soil debris.
- Squirt bottles and beakers for rinsing seedling.
- Plant lights or window.

Some students may also request:

- string to measure the length of curved seedlings.
- graduated cylinder to measure the amount of water.
- Dark growing space.
- Plastic food storage bags.
- Growing space at different temperatures.
- Celsius thermometers.
- Other creative items detailed by students (for example filters for those who wish to monitor the effect of wavelength, or light intensity).

Background information

1. Students should be trained in experimental design and the importance of control in an experiment.
2. Students should be familiar with plant anatomy and physiology including photosynthesis, and reproduction and development in flowering plants.

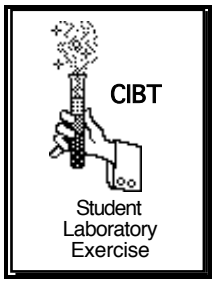
Approach

We recommend that you hand out the parts of this experiment in several phases. On the first day, hand out the first part (pages 1 and 2) detailing the seed planting procedure. Hand out the second part on the day that students are taking observations from their preliminary experiment. In this experiment, students will observe the seedlings to try to find differences that can be measured. They will then make these measurements during class time.

Data interpretation will, however, could be a homework assignment. For homework, pairs will also formulate a hypothesis and design an experiment to test their hypothesis. This, along with a materials list, will be turned in for teacher comments. You will critique their experimental designs and return them to the students before they set up their experiments, collect data, and tabulate results. At the completion of the experiment, each student (not pairs) will write a two to four page lab report to be turned in for evaluation.

Becoming a Plant

Part I: Planting the seeds



Name: _____

In the next few weeks, you will explore the world of plants. We will begin with seeds. A seed contains an embryo and stored nutrients packaged so that the embryo will be able to survive extremely cold or dry periods. When germination begins, the seed absorbs water and it swells, bursting the seed coat. The water activates enzymes that break starch into glucose (the glucose can be used as a source of energy) and the plant transports the glucose to the embryo. Cell division occurs in the embryo and the first root and the first shoot begin to grow. All the nutrients needed for this initial growth are supplied by food stored in the seed.

Although the plant will eventually produce food by capturing energy from the sun, until it has leaves, it must be able to grow even without photosynthesis. If leaves are produced too soon, they are likely to rot. If they take too long to develop, the stored supply of starch may run out! In this experiment, you will look at germinating seedlings. After identifying differences between different seedlings, you will write a hypothesis that explains why some seedlings have developed differently than others. You will then design an experiment to test the effect of some environmental factor on seedling development.

Part 1

Materials List

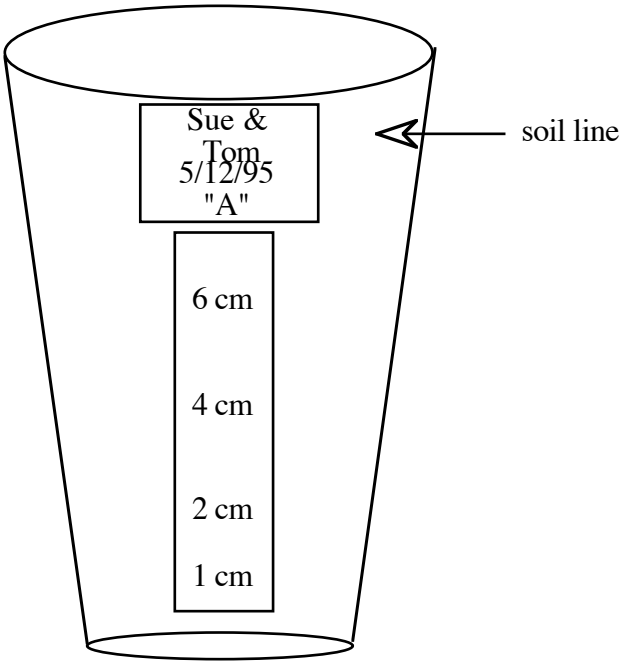
Per pair of students:

- 4 - Styrofoam drinking cups
- several sheets of newsprint
- metric rulers
- 12 - corn, sunflower or mustard seeds or cloves of garlic
- Potting soil
- Tape and permanent markers
- beaker
- paint brush
- squirt bottle

- Plant lights or window
- Piece of string
- balance

1) Make a tape label with your names and today's date for each of your four styrofoam cups. Label the cups “A”, “B”, “C” and “D”.

2) Make another tape label for each of the cups. Measure up 1 cm, 2 cm, 4 cm, and 6 cm from the bottom of the cup. Make a mark at each position as shown below (please note the example below is not drawn to scale).



3) Poke a 0.5 cm hole in the bottom of each of your cups using a sharpened pencil.

4) Add potting soil to each cup as described in the table below:

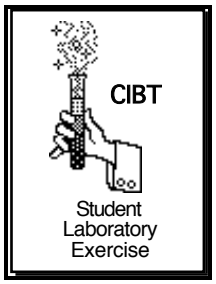
Cup Number	Add soil mix to line at:
A	1 cm
B	2 cm
C	4 cm
D	6 cm

5) Lay three seeds onto the surface of the soil in each of your cups. Add soil to fill them to the top. Make sure all cups are filled to the same level.

6) Place your cups in the sink and SLOWLY add water to each cup until it runs out the bottom of the cup. Place your cups on the tray in the windowsill or under the growth lights. Check the plants periodically and water carefully as needed. Also watch for seedlings to emerge!

Becoming a Plant

Part II: Measurements



Name: _____ Date: _____

1) What measurements could you make to show the differences between seeds planted at different depths?

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

2) Remove each of your four cups from the tray. Spread a piece of newspaper on your lab bench. Carefully turn each cup upside down and squeeze gently to remove the soil and seedlings. Use your pencil to gently remove the soil from each seedling. If needed, use a squirt bottle of water to rinse any remaining soil into a beaker. **Be sure to keep track of which seedling came from which pot!**

   Be careful because the roots may break off very easily! Use the pain brush if necessary.

3) Observe each seedling and make sketches in the table in the following page. What would be an appropriate name for such a table? Label the sketches according to seed planting depth. Then answer the questions below.

Table 1._____

Plant A. Depth of seed planting:_____cm.	**Plant B.** Depth of seed planting:_____cm
Plant C. Depth of seed planting:_____cm	**Plant D**. Depth of seed planting:_____cm

3a. Did all the seeds germinate? Suggest reasons why or why not.

3b. Describe any general differences you can see between the seedlings that were planted at different depths.

3c. What are some variables that might be responsible for these differences?

_____

_____

_____

_____

4) Choose one measurement that will show differences among the seedlings. Use the table below to organize your data allowing comparison of your measurements. Use the correct units.

Table 2._____

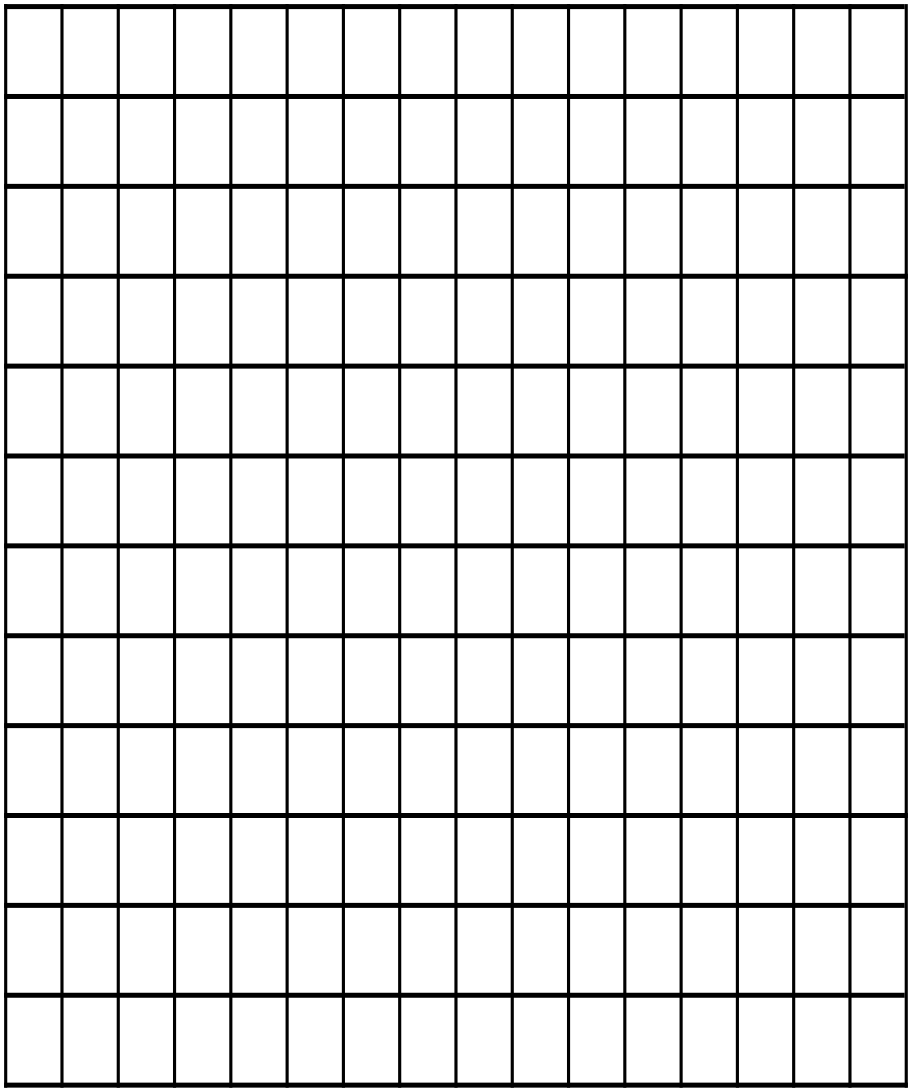
	Seed #1	Seed #2	Seed #3	Average:
CUP A. **Depth of seed planting:**_____				
CUP B. **Depth of seed planting:**_____				
CUP C. **Depth of seed planting:**_____				
CUP D. **Depth of seed planting:**_____				

5) Take the averages and construct a histogram of the results. **Be sure to give the graph a title, label the axes, and label the units on each axis**!

Cups will be on the____axis. The units will be_____.

The measurements you took will be on the_____axis. The units will be_____.

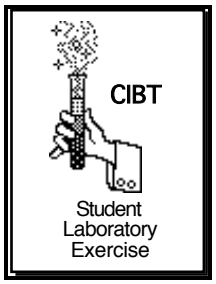
Graph 1._____



6) What conclusions can you draw based on your data?

Becoming a Plant

Part III: Design and experiment



Name: _____ Date: _____

Now you have a pretty clear idea of how the depth of planting affects seed development. Draw on your conclusions from Part II to design an experiment and test one other variable that might affect seed development.

Design an experiment to test one variable that appears to affect seedling development.

- What is your hypothesis?

- What will be your variable?

- How will you alter your variable in this experiment?

- What factors will you control? (What factors will you keep the same for all specimens?).

- How many seeds and or pots will you need to prepare?

- What measurements will you need to make?

- How often will you make these measurements?

- Is there more than one set of measurements that could be made to test your hypothesis? Explain.

- How will you present your data (histogram, graph, etc.)?
- In the space below, provide a list of all the materials that you will need to carry out this experiment. Be specific and thorough. Provide quantities when appropriate.

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Teacher Comment Section:

After you have been given the go ahead by your teacher, you may set up your experiment. Check your experimental design notes to see when you will need to begin collecting data. Also be sure to check your plants regularly and water them as needed. After your experiment has been completed, you will be required to write a formal two to four page lab report that describes:

- The original hypothesis (provide a rationale and support the rationale with background information.
- The experimental procedures carried out to test this hypothesis
- A log of your results.
- At least one data chart and one graph to summarize the results of your experiment.
- A conclusion that indicates whether or not your results support your hypothesis?
- A discussion including sources of error and ways to improve and/or expand the experiment.