Lesson Title: Potato Roots, Shoots, and Colored Containers!

Grade: 6-8

Duration of Lesson: 1 - 50 minute class and additional time for observation, twice weekly for 4 weeks

Brief: Students will understand that different color containers affect root formation on plants when plants are rooted.

Materials:

Several plastic containers in different semi-transparent colors, one for each student if possible. Large Rx bottles work well, so do water or soda containers which are colored and have had the top cut off. Colored glasses work well too, but are easier to break. Plastic glasses which are semi-transparent colors work well too. You will need at least one amber colored container and one clear container.

Toothpicks
1 small potato for each student
Water
Journals
Rulers

Key Terms

propagation, mass, control, prediction, hypothesis, variable, testable question, chitting, differentiation, tuber, root, shoot, and eye or bud.

Standards / Objectives

Montana State Standards:

Science: Science Content Standard 1. Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations. **Content Standard 2 -** Students, through the inquiry process,

demonstrate knowledge of properties, forms, changes and interactions of physical and chemical systems.
Math: Content Standard 1 – Number and Sense Operation

Understanding(s) /Big Ideas:	**Essential Question(s):**
Students will understand that different color containers affect root formation on plants when plants are rooted. Students will understand that potato buds form roots and shoots. Students will understand that high quality potatoes are grown in Montana, and are important to the State's economy.	How and where do roots and shoots form on a potato for propagation? Does the color of the rooting container affect the mass of roots and shoots when propagating potatoes?
Students will know: Students will know that many aspects of science deal with observation and experimentation. Students will know that changing variables in scientific experiments will change outcomes.	**Students will be able to:** Students will be able to determine the point of root and shoot formation on potatoes. Students will be able to identify forces of gravity on plant roots and shoots.

Performance / Observations

Performance Task(s):	**Other Evidence:**
Observe root and shoot growth on plants inquiring as to effects of growth in different colored containers. Journal the observations. Test hypothesis.	Measure the growth of roots and shoots. Estimate the mass of roots and shoots in each color of container. Journal the results.

Learning / Inquiry Activities

Learning Activities:

Potatoes are grown in Montana, as a matter of fact many of the seed potatoes used to plant fields of potatoes in Idaho and other states are grown right here in Montana and then shipped out to other states in the spring. Montana has an ideal climate for growing seed potatoes and our potato crops have been free of many of the diseases that are present in other states. Seed potatoes are actually just small potatoes that will be planted in order to start new potato plants that produce potatoes for us to eat or potatoes to be used for seed potatoes the following year.

Even though potatoes grow underground they are not roots, but rather tubers. A tuber is a modified underground stem, and is usually swollen. Each potato farm in Montana grows about 32,500 pounds of potatoes per acre. Each person in the U.S. eats on average 120 pounds of potatoes each year.

Potatoes are very colorful tubers which are indigenous to South America. Montana farmers grow white potatoes for baking and french fries called russets. Yellow, red, and purple, and white potatoes for all other uses are grown in Montana as well. Potatoes are high in fiber, and supply about 45% of the daily nutritional value of vitamin C in each 5 oz. potato!

Science Lesson Introduction

Inform students that they will be conducting a science experiment to see if the color of a

container affects the mass of roots and shoots when chitting potatoes. Chitting means forcing a potato or other tubers to form roots and shoots for planting, similar to pre-sprouting.

The key idea of this lesson is to predict, observe, and record any changes that are seen in the growth and mass of roots and shoots when a potato is chitted in different colored containers. Students should also notice that the roots and shoots form from the same bud, and that growth in the form of roots goes down, while the shoots form upward growth. These affects are due to geotropism.

Geotropism (also called *gravitropism*) *is the directional growth of an organism in response to gravity*. Roots display positive geotropism when they grow downward, while shoots display negative geotropism when they grow upward. Among the first scientists to study geotropism was Charles Darwin.

Geotropism provides several benefits that help plants to survive. Plants draw water from the soil with their roots and synthesize water, carbon dioxide, and sugar from sunlight in their leaves. This means roots must grow underground and leaves must have access to sunlight.

Geotropism exerts dramatic effects on plants, and there are other effects at work as well, like cell differentiation which determines if a cell will form a root or a shoot. In this experiment you will see that roots and shoots form from the same potato bud. Some cells form roots while others form shoots, and geotropism will affect which directions the cells grow.

Discuss with students any past experience in growing potatoes and if they know how to propagate potatoes. Ask students if they had ever considered what was happening to potatoes after they were planted.

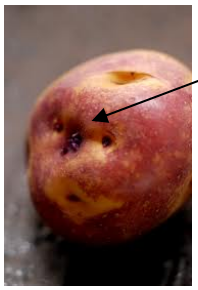
Following the discussion, let students know that they need to keep a journal of each step, and observe and record remarkable changes to the potatoes in the colored containers. One student will use a clear container, this will be the control.

1. Ask students to write a testable question in their journal.
2. Ask students to list the variables in the experiment in their journal.
3. Ask students if they can form a hypothesis, if so journal that as well.
4. Ask students to predict if there will be any difference in root/shoot growth in different colored containers and why?

Setting up the experiment – chitting potatoes

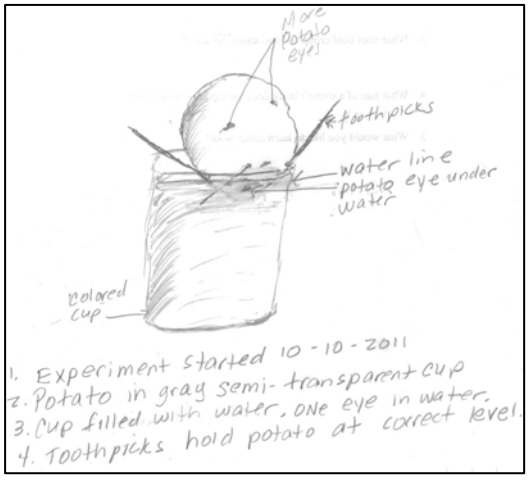
Provide each student a colored container, 3 toothpicks, and a potato. Inform them that they will be forcing potato tubers to form roots and shoots, or chitting.

Ask students to find the “eye” or bud on the potato, which will be placed down in the container. Potato "eyes" are buds that will start the growth of a new plant.



Note: If you leave a potato in a warm place for a few weeks you will see the new growth begin. Each section of potato with an eye will grow a new potato plant and form new potato tubers when planted.

Ask students to hold their potatoes with the eye down in the container so that the eye is about 1 inch below the rim of the container. Ask students to place toothpicks one at a time into the potato to hold it in place. Adjustments can be made by changing the angle of the toothpicks. Add water to the containers so that the portion of the potato with the eye in the container is sitting in about ½" to 1" of water. Ask students to sketch the experiment set up in their journal with the date. Example below:



Over the next few days ask students to check each container and see if there have been any changes to the eyes of the potato. Roots and shoots will form in a few days on the eye that is underwater. Ask students to observe any changes they see in the potatoes in each colored container, some changes may occur on the potato surface that is outside the water. At the end of each observation period take a few minutes to discuss the changes and have the students journal remarkable changes.

After several days it will become obvious that some container colors promote more root growth than others. At the same time, the shoots on the potatoes which developed more roots may be much smaller than the shoots in the colored containers which developed lesser root masses. Ask students, "how would you explain the reduced shoot growth on the potatoes which developed more root mass?" Students should think about the stored energy in the potato, and that the energy went to developing roots instead of shoots.

Ask students to observe which direction the roots grew and which direction the shoots grew. They both originated in the bud, how did they differentiate and grow different directions? Ask students "how would you explain the direction of root and shoot growth on the potatoes, and what force of nature could be determining this differentiation?" Discuss geotropism.

Ask students to line up the colored containers in the order which shows more root mass, starting with the greatest root mass. Journal the results in order. Repeat this step lining the colored containers up in order of most shoot growth.

Example: (results may vary)

Root development order, most to least: amber, orange, green, clear, blue, and purple.
Shoot development order, most to least: clear, blue, purple, green, orange, and amber.

Ask students if they can see any pattern when comparing the two orders.

Math Extensions: measure the shoot growth on each potato in both standard and metric measurements. Figure out which potato had the longest cumulative shoot growth. Which color of container was it? Does that correspond with the shoot development order above?

Provide opportunities to rethink and revise their understandings and work.

Ask students to refer back to the beginning 4 questions they wrote in their journal. Discuss each question and how they related to the experiment. Was the clear container a good control? Why or why not? Discuss other options of setting up a potato rooting experiment.

Planting Extension: If it is springtime potatoes can be planted outside. Prior to planting ask students to take the potatoes out of water and remove the toothpicks. Weigh all of the potato tubers now and then weigh the total amount of potato tubers that you dig in the fall to find out what your yield was.

Planting Instructions: Place each potato with roots down about 4 inches deep in well worked soil. If shoots are sticking out of the soil that is ok. Place plants 18" apart. Water and weed regularly. Dig plants in the fall in late September or early October.