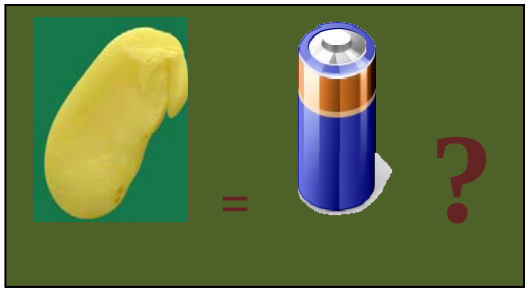


Lesson Title: Stored Seed Energy - Seed Planting Depth Inquiry!

Grade: 4-6

Duration of Lesson:
1 introductory lesson - 50 minute class
1 lab session – 50 minute class
7-10 days (15 minutes each day)
1 final 50 minute class

Brief: Students will investigate seed starch as an energy source for plants.

Materials:

- Seeds: bean seeds and pea seeds (legumes) are recommended for the first experiment, after that try other size seeds like radishes, carrots, and wheat berries.
- Ruler (for measuring seed size, plant growth, and planting depth)
- Clear plastic containers with 3-5 holes in the bottom for drainage (bottom half of empty 2 liter bottles work well, just remove the top half)
- Potting soil or sand
- Paper towels (do not use tissue paper or bath tissue as they are too thin and difficult to work with)
- Journal

Key Terms

- Germination
- Pulse crops
- Legume
- Roots
- Starch
- Leaves
- Depth
- Weight

Standards / Objectives	
Montana State Standards: **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 5 –** Students demonstrate understanding of measureable attributes and an ability to use measurement process. **Art: Content Standard 6 -** Students make connections among the Arts, other subject areas, life, and work.	
Understanding(s) /Big Ideas: Students will understand that planting depths affect the seeds due to the amount of energy stored in seeds.	**Essential Question(s):** Does it matter how deep seeds are planted? Does seed size correlate with planting depth?
Students will know: Students will know that seeds use starch in the embryo for food until the plant reaches the light and begins photosynthesis.	**Students will be able to:** Analyze the size of a seed and estimate the correct planting depth.
Performance/Observations	
Performance Task(s): Students will set up an inquiry based science experiment to determine if seeds have enough stored energy to complete the germination process if planted at varying depths.	**Other Evidence:** Students will chart the growth of seeds that were planted at different depths.
Learning / Inquiry Activities	

Pre-assessment questions:

Do seeds have the energy they need to grow? Where in the seed is the energy? What uses up the energy in the seeds? Do you eat legumes? What is a legume? Does it matter how deep you plant a seed if you want it to grow?

Introduction:

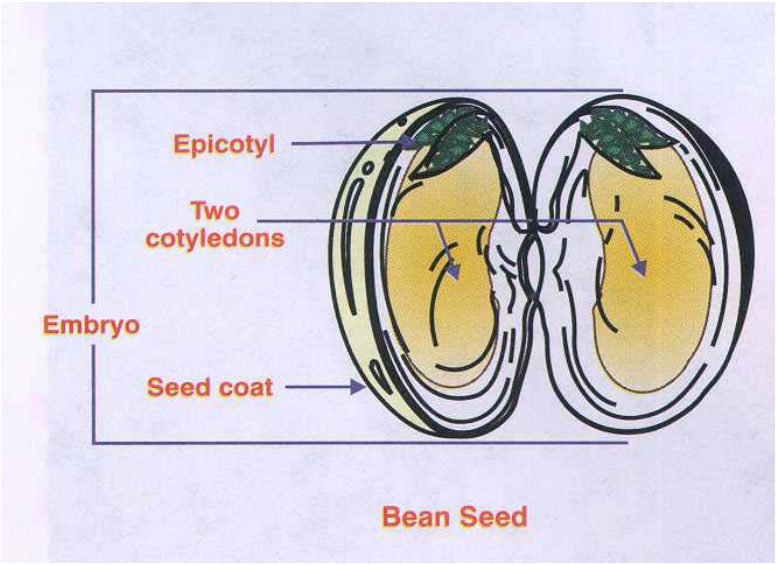
Distribute copies of *Pulse crops and Dry Edible Beans Ag Mag* to each student or group of students to read and complete.

http://www.ag.ndsu.edu/agmag/agmag_pulse-beans/agmag_pulse-beans.pdf

This easy to set up plant science experiment will give your students insight into what is happening when seeds germinate, how the seedling emerges from the seed, and how the roots

grow. The experiment also allows your students to both watch the growth of and care for bean plants.

You may think planting seeds is as simple as putting them in the ground and giving them water. Seeds have stored energy in the form of starch which feeds them until the leaves can begin the process of photosynthesis. In some ways they can be compared to batteries, holding energy until it is needed. Seed size and planting depth impact the process of germination because they affect the seeds energy stores. To understand the relationship between planting depth and seed size, you should have solid understanding of the parts of a seed and their function.



Seed parts illustration

When you look at a seed you are looking at the seed coat. As people wear coats for protection from foul weather, seed coats perform much the same function. They provide protection against entry of parasites, against mechanical injury and, in some seeds, against unfavorably high or low temperatures.

Inside the seed coat is the epicotyl-- they may be tiny but they are the beginnings of a plant. The seed's embryo leaves are called the "cotyledons." The seed is filled with "endosperm," food that will nourish the embryo during its early stages of development.

Germination is a fascinating process. The first sign of germination is the absorption of water -- lots of water. Soon the embryo becomes too large and the seed coat bursts open and the growing plant emerges. The tip of the root is the first thing to emerge and it’s first for good reason. It will anchor the seed in place and allow the embryo to absorb water and nutrients from the surrounding soil.

Some seeds need special treatment or conditions of light, temperature, moisture, etc. to germinate. Seed dormancy is very complex, but it protects that living plant material until conditions are right for it to emerge and grow.

Student Analyze, Observe, and Record:

Ask students to weigh and measure their seeds, and to sketch a seed in their journal that accurately represents the size of the seed they are working with.

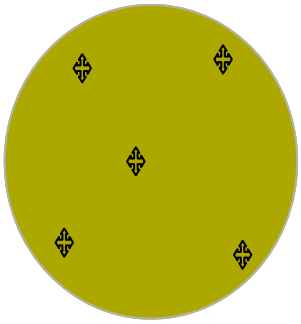
Learning Activities:
Hands on inquiry

Step 1: Cut the top off the 1.25 liter bottle so that it resembles a large drinking glass.

Step 2: Turn the bottle over and punch several holes in the bottom so that excess water can drain out.

Step 1

Step 2



Step 3: Fold the paper towels into a cylinder that fits snugly inside the plastic bottle. The cylinder needs to be placed firmly against the wall of the bottle.

Step 3

Steps 4 & 5: Push 4 bean seeds down the side of the bottle, evenly around the bottle, **between the bottle and the paper towel**. The seeds will be in plain view as you rotate the bottle. Fill the space inside the paper towel tube with potting soil or sand to 2" above the seeds. Place another layer of seeds evenly around the bottle, they will be about 2" above the first seed and add another 2" of potting soil or sand. Repeat until you have seeds within 1" of the top of the container. Leave ½ inch of room below the top of the soil and the bottom of the rim for watering area.

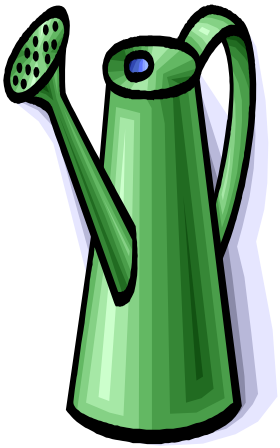
Place first four seeds and fill to this level with potting soil, repeat until planting is complete.

Step 4:

5. Completed planting with soil

Step 6: Water the container gently until a small amount of water drips from the holes in bottom of the container. The next step will be to observe the seeds in the container over the next 7-10 days.

Step 6



Note:

Knowledge for success:

1. Ineffective drainage holes from Step 2 may cause problems. Make sure these are open enough to allow excess water to drain away. If not, the water will build up in the container and may drown the bean seeds.

2. Using weak paper in Step 3 will make this very difficult. Paper such as toilet paper or tissues is not advised. First, it is not strong enough to trap the growing roots against the plastic and the roots will break through the paper into the potting soil or sand. Secondly these papers are thin and so the darkness of the soil makes seeing the growing bean roots difficult to see.

3. Dirt falling on top of the beans as they are pushed in during Step 5. This will obscure your child's view of the bean's growth.

Student Analyze, Observe, and Record:

Each day set aside 15 minutes for students to observe their seed plantings. . Have them predict which seeds will have enough energy to grow into plants and record their predictions. Ask students to sketch the container and seeds in actual size in their journal. Each day ask them to add to the drawing the changes they observe. This is best done with colored pencils, using a different color each day. Ask students to measure the growth of the roots and stem and to transfer that information onto their sketch accurately. Schedule a final class period to view and discuss what students have learned from this inquiry.

Inquiry Questions:

Did all of the seeds germinate?

Did all of the seeds grow at the same rate?

How can you sort the parts of the root and the stem?

What parts of this experiment validate your prediction?

What do you think the problem is with the seeds that did not form plants?

Which seed depth seems to have formed plants the fastest?

Which seed depth seems to have formed the healthiest plants? Compare the seed planting depth of the healthiest plants to the size of the seed with your ruler, can you conclude that "planting seeds x times deeper than their size is justified". What variable do you have for x?

How do you think farmers decide how deep to plant the seeds for all of the food that we eat?

What problems did you have with did you encounter during this inquiry?

Practical lessons can be learned from the seed:

- Seeds with bigger amounts of endosperm can feed the embryo plant longer, while it works its way toward light. Therefore, big seeds can usually be planted deeper.
- Seeds must absorb water for germination to begin; presoaking seeds may speed up the process.
- Available water is important to the newly emerged root.

Notes:

The key idea of this inquiry is to analyze how much energy is stored in a seed. As you try different varieties of seeds students will realize that not all seeds have enough energy stored up for the first leaves to make it out of the soil.

Lesson Extension:

An interesting extension is to transplant the plants to the garden so you child can continue to watch their growth.

You can also grow the plants until they have produced bean pods or other seeds of their own. If you allow these to remain on the plant until they are fully grown and then dried out, you can repeat the experiment in order to demonstrate the life cycle of the plant.

Parts of this lesson based on information from Washington State University.
http://gardening.wsu.edu/library/vege004/vege004.htm