Seeds to Seedlings: Propagating Seeds in the Classroom

Activity Overview
Students explore methods of propagation and investigate dormancy in seeds while relating those methods to natural processes.

Objectives

Students will:

- Investigate seed dormancy
- Explore seed dispersal mechanisms and animal interactions
- Explore the phenology of seedling germination, cotyledon stage, first true leaves
- Use observation skills and plant identification skills

Subjects Covered: Science and Math

Grades: K through 12

Activity Time: 15-30 minutes for Part 1, one month before planting activity; 30-45 minutes for Part 2

Season: Late Winter to late Spring

Materials: Seeds, water, sandpaper, ziplock bags, inert material (sterilized sand, vermiculite or peat), planting containers or trays (egg cartons and paper tubes work well), potting soil, refrigerator

State Standards

Science:

Discover how organisms meet their needs (F.4.1)

Investigate how organisms respond to internal/external cues (F.4.2)

Investigate structure & function of organisms (F.8.1)

Show organism's adaptations (F.8.2)

Discover changes in technology over time (G.4.2)

Determine how science discoveries change technology (G.4.3)

Background

For good germination, seeds generally require warmth, moisture, and eventually light. moitsture tends to be the limiting factor, but other factors also play a role in how well seeds germinate, or if they germinate at all. A seed contains an embryo, an endosperm, and a seed coat. Water must penetrate the seed coat for the seed to imbibe water, swell, and germinate. Although some spring-blooming species have seeds that germinate the same year they fall, other seed use "dormancy" to postpone germination until later—for example, seeds might drop in the fall, stay dormant through the winter, and germinate in the spring. Dormancy provides a safety net so the seed will not germinate until habitat conditions are favorable to the survival of seedlings. A seed must break dormancy to allow enough water to saturate the seed coat and trigger germination.

Seed treatment for breaking dormancy is used when propagating seeds. Seed treatments mimic natural processes, so it is important to think of what ecosystem the seeds came from when considering what type of treatment is required. There are four general treatments (and many variations) for breaking dormancy and eliminating the barriers to germination: dry-cold stratification; moist-cold stratification; scarification; and other treatments such as chemical (inhibitor), morphological, physiological, and embryonic (deep). Some seeds have double dormancy and require combinations of treatments.

Dry-cold stratification

Dry-cold stratification is exactly what it sounds like. The seed is stored in a dry condition while being exposed to native habitat temperature conditions—commonly called winter.

Dry-cold stratification requires only cool temperatures of 32 degrees Fahrenheit for one to two months. Most commercial seed has undergone this treatment already. Plants like lavender hyssop, lead plant, aster, and blazing-star require dry-cold stratification.

Moist-cold stratification

Moist-cold stratification requires cool temperatures of 32 degrees Fahrenheit, plus a moist, inert material such as sand, peat, or vermiculite. The moisture level should be like a moist sponge. The potential for seed rot can be reduced by first sterilizing the inert material in a 400-degree oven for one hour prior to wetting. Many species need a 30-day period of moist-cold stratification, although some may need as few as ten and others as many as 90 days. Lupine is a species that needs only ten days while wild quinine and bottle gentian need 30 days.

Identify skills needed for a career in science or technology (G.8.1)

Illustrate impact of science & technology (G.8.3)

Design an applied science model or machine (G.8.4)

Investigate local problem & propose scientific or technological solution (G.8.5)

Analyze scientific or technological innovation (G.12.3)

Choose a problem & identify scientific or technological solution (G.12.5)

Math:

Use reasoning abilities (A.4.1, A.8.1, A.12.1)

Communicate mathematical ideas (A.4.2), logical arguments (A.8.2, A.12.2)

Connect mathematical learning with other subjects (A.4.3)

Use vocabulary, symbols, notation (A.4.4)

Explain solutions to problems (A.4.5)

Analyze non-routine problems (A.8.3)

Develop effective oral & written presentations (A.8.4)

Explain mathematical concepts, procedures, & ideas (A.8.5)

Recognize & describe measurable attributes & units (D.4.1)

Demonstrate understanding of measurement (D.4.2)

Read & interpret measuring instruments (D.4.3)

Determine measurements by using standard tools (D.4.4)

Determine measurements by using basic relationships or estimations (D.4.5)

Identify & describe attributes in situations not directly or easily measurable (D.8.1)

Demonstrate understanding of measurement facts, principles, techniques (D.8.2)

Determine measurement directly by using standard units (D.8.3)

Scarification

Scarification is the act of breaking through the seed coat by rubbing sandpaper across it, by treating it with acid, or by pouring hot water onto the seeds. Different scarification techniques are used depending on the permeability and thickness of the seed coat. More often than not, scarification is an easy process of gently scratching the seed coat between two pieces of sandpaper. Acid scarification is used for seeds with tough, thick seed coats. Many of these larger seeds are food sources for birds and other animals. The acid scarification mimics the conditions the seed encounters when passing through an animal's digestive tract. Soaking seed in near-boiling water apparently breaks down the waxy cuticle associated with some species.

Other treatments

Other treatments include heat, harvesting immature fruits, and an application of plant hormones (regulators). Complete information on these methods can be found in the book *Plant Propagation: Principles and Practices* (see Additional Resources).

If seed is planted in the field in the fall, the physical and biological processes encountered in the soil will naturally break dormancy to allow the germination process the following spring. Some seed may take two to three years in the field to break dormancy.

Activity Description

Part 1: Seed Treatment

1. Verify seed treatment method. Proceed with following steps unless different techniques are recommended for your seeds. Seeds that do not need pretreatment can be planted right away.
2. Scarify seeds lightly with sandpaper or hot water.
3. For moist-cold stratified seed:
   - Fill ziplock bag with sterilized sand, vermiculite or peat and moisten.
   - Place moist seeds that need moist-cold stratification in ziplock bag.

   For dry-cold stratified seed:
   - Place dry seeds in ziplock bag.
4. Label bags.
5. Refrigerate bags for at least 30 days.
6. Compare how moist-cold seeds look after 30 days with those in dry-cold stratification. Plant seed using directions below.

Questions to consider

- What natural process are we imitating by using an abrasive or acid to penetrate the seed coat?
- What is the link to the food web in this process?

- Which seeds require moist-cold stratification and which do not? What is the shortest length of time required and what is the longest? How long can you keep seeds in moist-cold storage?
- Why might a particular species need hot, moist conditions to germinate?

Part 2: Seed Planting

1. Fill containers with soil and moisten very well; let sit to absorb water.
2. Remove seeds from refrigeration (see Part 1 above).
3. Plant seeds as deep as the seed is large; tiny seed can remain on the surface.
4. Water seeds well.
5. Place seeds in a south-facing window and under fluorescent lights for best results. Fluorescent lights need to remain on 24 hours per day unless you have very large windows; if you do, turn fluorescent lights off during the day and back on for the evening.
6. Continue to water daily as needed. Look for signs of germination. You will first observe the hypocotyl or stem of the seedling below the cotyledons. The cotyledons appear next: they are the leaves of the embryo and source of food for the young plant. Next the true leaves appear.
7. Once the seedlings have germinated and have grown their first true leaves, transplant them into growing trays or pots. If interested, see Additional Resources for a source for deep groove tube trays.

Questions to consider

- Compare the germination of species that do and do not require treatment.
- How densely can you plant seeds before they are negatively influenced by their seedling neighbors?
- Which species germinate the fastest? Some species, called pioneers, are the first to colonize a disturbed area. Do any of your species seem to be pioneers?

Extensions

- Chart the growth of your plants and monitor the phenology: when do they germinate, get their first true leaves, flower, and go to seed?
- Explore germination rates by counting out a specific amount of seed for each species. How many germinated? X number of seeds germinated out of 100 seeds will give you the percent germination. What trends do you see? Do some germinate faster than others?

Additional Resources

- Hartmann, H., Kester, D., Davies, F., Geneve, R. (2002). *Plant propagation: Principles and practices, 7th Edition*. Prentice Hall. Upper Saddle River, NJ.
- Hill, L. (1985). *Secrets of plant propagation: Starting your own flowers, vegetables, fruits, berries, shrubs, trees and houseplants.* Storey Books: North Adams, MA.
- Riveredge Nature Center. (1999). *Begin with a seed: The Riveredge guide to growing Wisconsin prairie plants*. WonderCat Graphics: Wauwatosa, WI.
- Rock, H. (1981). *Prairie propagation handbook. 6th Edition*. Wehr Nature Center, Milwaukee County Dept. of Parks, Recreation & Cultrue: Franklin, WI.
- Toogood, A. (Ed.). American Horticultural Society. (1999). *Plant propagation: The fully*

illustrated plant by plant manual of practical techniques. DK Publishers, New York, NY.

Supplies

- Deep Grove Tube Trays (5.5 inches deep), Growing Systems, Inc., 2950 N. Weil St., Milwaukee, WI 53212. Phone: 414-263-3131, Email: info@growingsystemsinc.com Website: www.growingsystemsinc.com

Assessments

- Look at different seeds and identify stratification techniques based on characteristics and/or species name.
- Describe the processes of plant growth from a dormant seed to a mature plant. Include drawings of each stage.
- Tell a story about a seed using terminology learned in this activity such as dormancy, stratification, seed coat, germination, cotyledons, and true leaves.