Science Unit: *Plants*
Lesson 3: *Seed Germination*

School year:	2004/2005
Developed for:	Queen Alexandra Elementary School, Vancouver School District
Developed by:	Paige Axelrood (scientist) and Janet Vesterback (teacher)
Grade level:	Presented to grade 3; appropriate for grades 1 – 5 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes
Notes:	Lesson requires extension by teacher for 1 week

Objectives

1. Introduce how to do a science experiment.
2. Learn about seed germination by comparing Mung bean seed germination under dry, moist and underwater incubation for 1 week.
3. Learn what is needed for seed germination and why the right amount of water and oxygen are important.
4. Learn about variability by comparing germinated seeds incubated under the same conditions.
5. Gain experience with the selection of characteristics for classification.

Background Information

Seeds provide plants with a method of reproduction. A germinating seed begins the life cycle of a plant. Seeds are produced by flowering plants (angiosperms) inside an ovary that generally develops into a fruit. Seeds are also produced inside cones by non-flowering plants called gymnosperms (such as conifers).

A seed contains the embryo, a source of food, and a protective seed coat. A seed, containing a living embryo, will germinate into a plant with an adequate amount of water, oxygen, a favorable temperature, and a substrate conducive to seed germination. Some plant species require either light or dark incubation for seed germination, whereas seeds from other species can germinate in both light and darkness. Some seeds become dormant and require a specific incubation condition or a sequence of environmental conditions before germination can proceed. For example, seeds of some plant species only germinate after cold incubation followed by warmer temperatures (such as many tree species). Some seed coats are very thick, requiring physical or chemical damage before water can penetrate and allow seed germination to proceed. Seed coat damage can result from various actions: several cycles of freezing and thawing of the seed, gnawing of the seed by an animal, or passage of the seed through an animal's digestive system after being eaten.

Vocabulary

Seed:	The part of a plant that contains a protective covering, stored food, and the embryo.
Germinate, Germination:	To start growing; water and oxygen are taken in through the seed coat and the seed coat gets soft; the embryo takes up water and starts to grow; the root emerges, followed by the shoot (the shoot contains a leaf or leaves and a stem).
Prediction:	To state what you think will happen (predictions help you think deeper).

Variation or Variability: Differences among individuals of the same type; (a germinating seed that is somewhat different than another germinating seed of the same kind).

Materials

- Mung bean seeds (purchased from a bulk food store)
- 6 plastic containers to soak seeds in water overnight
- strainer to rinse seeds
- paper towels

Each group of students will need the following:

- 1 plastic container containing rinsed seeds that were soaked in water overnight
- 1 empty plastic container
- water in a container
- plastic tray or cookie sheet
- 3 plastic Petri plates
- 1 dropper

In the Classroom

Introductory Discussion

1. Begin by discussing the parts of a seed and why seeds are important. Discuss the meaning of germination. Ask the students what is needed for a seed to germinate (living embryo, adequate amount of water, oxygen, favorable temperature, substrate conducive to seed germination, and light or dark requirements). Discuss how seeds germinate in the garden.
2. Describe how to do the seed germination experiment and ask students to first record predictions about how seeds will germinate under moist, dry and underwater conditions. The students will then set up their experimental treatments.
3. Review how to do a science experiment.
    - Make an observation and then ask a question OR start with a question: will seeds germinate the same if they are incubated under dry, moist and underwater conditions?
    - Think about what will happen if the seeds are incubated in dry, moist and underwater conditions. Write down what you think will happen. This is your prediction.
    - Set up an experiment (seed germination), and treat everything the same way except for one thing--what you want to test (the amount of water seeds are exposed to after they were soaked overnight in water). Test treatments will include room temperature incubation of seeds under dry, moist and underwater conditions. Discuss why you only change one thing (a variable).
    - Make observations.
    - Collect data, record and examine results (think about why things happened the way they did).
    - Make conclusions and explain results (compare results to predictions to help you think deeper).
4. Communicate results and conclusions.

Science Activity/Experiment

Experiment Title: Effect of Moisture on Mung Bean Seed Germination

Purpose of Experiment: To compare Mung bean seed germination during 1 week with three treatments: dry, moist and underwater incubation.

Experimental Treatments:

Test treatment 1	Dry incubation
Test treatment 2	Moist incubation
Test treatment 3	Underwater incubation

Methods:

The night before the lesson:

Rinse Mung bean seeds under running water using a mesh strainer. Place 4 teaspoons of seeds in each of 6 plastic containers and add 1 cup of water per container. Soak seeds overnight. Rinse seeds in a strainer under running water the next morning, place a moist paper towel in the bottom of each container, place the rinsed seeds on top of the towel, cover the containers and bring them to the classroom. Cut out paper towel circles to fit in the bottom of Petri plates (3 towel circles/plate).

The day of the lesson:

Students will be divided into 6 groups of 3-4 students per group. Students will set up their dry, moist, and underwater treatments in plastic Petri plates containing Mung bean seeds as follows:

5. Label each plate with the treatment type (moist, dry, and underwater).
6. Place 3 paper towel circles in the bottom of each plate.
7. Place one teaspoon of seeds on top of paper towels and gently spread seeds on towel.
8. Place the lid on the plate for the dry treatment.
9. Use the dropper to moisten the paper towels with water for the moist treatment and cover the plate with the lid. Water should be added daily (with a dropper) to the paper towels to keep them moist.
10. Place the plate for the underwater treatment in a plastic container and add water carefully until it fills the plate completely and covers all seeds. Water should be added daily as needed to keep seeds under water.
11. Place the plates on a tray and incubate them at room temperature near a window in the classroom where they will not be disturbed.
12. Record observations daily for a week.
13. Have students develop a classification system with three categories to sort the seeds from the moist treatment after one week of incubation. Then have students sort the seeds into three categories so that they can observe variability among seeds that were incubated under the same conditions.

Science Journal: Activity sheets with different sections can be prepared for students to record:

- their predictions for each incubation treatment
- their daily observations (written comments and a drawing after 1 week incubation)
- their conclusions (what happened and why did it happen)
- their drawings of the seeds incubated under moist conditions after they were classified into three categories and their records of the characteristics used to sort seeds

Closure Discussion

14. Review the parts of a seed, what the seed provides for the embryo to grow, and what is needed for seeds to germinate.
15. Discuss predictions and observations for seed germination for the dry, damp, and underwater experimental treatments.
16. Discuss what happened and why it happened.
17. Review how to do a science experiment and variability. Ask students to line up by height and talk about the variation in height among the 3rd graders in the class. Ask students to give other examples of variability.

References

18. Ardley, Neil. 1991. The Science Book of Things That Grow. Pp 10-11, Seed Needs (what a seed needs to germinate). Harcourt Brace Jovanovich, Publishers.
19. e.enclyclopedia Science, Google. 2004. Seed Plants, pp. 262-263, DK Publishing Inc.
20. http://plantphys.info/seedg/seed.html Koning, Ross E. 1994, Eastern Connecticut State University, [Seeds and seed germination, diagram of a barley seed, and related background information].
21. http://www.urbanext.uiuc.edu/gpe/case3/c3facts1.html University of Illinois Extension, [Information about seeds including seed structure and seed germination].

Teacher Assessment of Learning

22. Were students able to make predictions about what might happen to the seeds germinating under different conditions?
23. How successfully did students record their observations? How complete were their notes?
24. Were students able to analyze their results and draw conclusions based on those results?
25. Have students demonstrated a clear understanding by the end of the experiment of what a seed needs to grow?
26. Have students shown, in discussions or in their written conclusions, an understanding of the concept of variability? (seeds/plants exhibit differences in the way they grow to increase the chances of some surviving regardless of changing environmental circumstances.)

Extension of Lesson Plan

1. The seed germination experiment can be repeated and groups of students can be given the opportunity to design their own experiments. The seeds can be germinated under moist conditions (optimal for germination and seedling growth) and students can select a variable to test. For example, a variable can be the use different liquids to create the moist treatment such as water (control treatment) and water + fertilizer (test treatment). Alternatively, different environmental conditions such as temperature [room temperature (control treatment) and refrigerator (test treatment)] or light [near a window (control treatment) and in a cupboard (test treatment)] can be tested. One example of a variable could be discussed with students and then students could brainstorm to come up with their own variable to test and their own control and test treatments. The concept of a control treatment can be introduced to the students. A control treatment should be included in each experiment.
2. The teacher can take the children on a search to look for differences in the way plants of the same species grow and to think of reasons for those differences.