# Sleeping Seeds and the Scientific Method

### **Objectives**

- Students investigate seed dormancy
- Students discover treatments to break dormancy
- Students learn how scientists investigate phenomena
- Students have an opportunity to make observations
- Students create a hypothesis
- Students design experiment and test their hypothesis
- Students interpret results and prepare them for presentation
- Students draw conclusions and share with others

### <u>Skills</u>

- Scientific method
- Seed scarification
- Experimental design
- Data collection and interpretation
- Drawing based on data conclusions
- Critical and analytical thinking

#### Knowledge and Values Developed

- Understanding of how some plants "spread the risk" of sprouting all at one time
- Seed can be manipulated by humans
- Interaction between seed and environment
- Structure of hard seed
- Different seeds may possess different types of dormancy
- Horticulture can be used to conserve plants

# Activity 1 See'd with Your Eyes

In this exercise students will practice their observation skills. Students are asked to form small groups. Each group receives a package of different types of seed and fruit. Students may use a multi-sensory approach to experience seeds.

When they have finished, students are asked to illustrate their observations. Each group will then make a list of similarities and differences between the seed. The groups will put their lists on a flip chart for discussion. The space below may be used for illustrations.

### Activity 2

#### Seed Dormancy

Students will be introduced to the term seed dormancy. After a brief explanation students will use a concept map to expand on the term. Students will be asked to form small groups again. Each group should be different from the first. Using a piece of flip chart paper the group creates their concept map.

#### Steps For Creating A Concept Map

- 1) At the center of your sheet write the words "Seed Dormancy".
- 2) Divide your sheet into four parts by drawing a vertical and horizontal line.
- 3) Label the upper-right quadrant "Why".
- 4) Label the lower-right quadrant "What"
- 5) Label the lower-left quadrant "How does it work"
- 6) Label the upper-left quadrant "If"

Your page should look something like this:



The purpose of a concept map is to develop an understanding of a new subject. Always keep in mind that **there is no right or wrong answer** when you create a concept map. This is just a tool to develop your thinking.

When building the concept map your team may wish to start off in **quadrant 2**. In this space, try to define the concept of seed dormancy. In other words, write down what you think seed dormancy is or what the words mean. Once your group is satisfied with its definition of seed dormancy it can move to the first quadrant.

In **quadrant 1** your team identifies why seed dormancy may or may not be important. You can look at this from many points of view. For example, you may ask why seed dormancy is important to the seed or to the plant. You should definitely ask, "Why would seed dormancy be important to me". Make sure to write down all your answers.

Once you have completed section 1 and 2 move onto to quadrant 3. Here you think about how seed dormancy might work. Remember, there is no right or wrong answer! You may think your ideas are too crazy, but write them down anyways. After your group is satisfied go to quadrant 4. Here you ask "what if" questions. For example, "If dormancy did not exist what would happen"? The possibilities for "what if" questions are endless. Think of some that really interest you and write down the group answers. Each group should be prepared to share their concept map with others.

After discussing all the concept maps we will move into a discussion of the different types of dormancy, some treatments to break dormancy and the scientific method.

#### Types of Dormancy Found in Seed

<u>Physical Dormancy</u> - Seeds that are physically dormant usually have **hard**, **thick** seed coats that do not allow water to reach the embryo. Sometimes the seed coat may let water pass but some feature of the seed coat does not allow the embryo to germinate. Seeds that possess physical dormancy may stay that way for a long, long time. Some physically dormant seed can resist very high temperatures, even fire!

<u>Physiological Dormancy</u> - Seeds are said to be physiologically dormant when the **normal life processes within the embryo are delayed**. Different mechanisms can render a seed physiologically dormant. For example, some seed require light to initiate biochemical processes within the embryo that enable the seed to germinate. If these seeds are held in darkness they cannot germinate. Other seed have growth inhibitors near the embryo do not allow the seed to germinate. However, these inhibitors can be "turned off" by growth stimulants.

<u>Morphological Dormancy</u> - Seed with morphological dormancy have embryos that are **not fully developed** at the time of dispersal. In other words, the embryo needs time to grow inside the seed before it can germinate. *Pritchardia limahuliensis*, a species of palm found only on Kauai, is a good example of a plant with morphologically dormant seed.

<u>Mechanical Dormancy</u> - Seeds that have mechanical dormancy cannot germinate because some part of the **fruit coat** prohibits germination. Sometimes structures that surround the seed, like wings, are enough to block germination. To see pictures of seed with wings go to <u>www.google.com</u>, click on the images tab and enter winged seed as your search term.

<u>Chemical Dormancy</u> - Chemicals that block germination may be found in the **fruit coat** and **seed coat**. Germination cannot proceed until these chemicals are washed away or somehow inactivated. Seed from desert plants have chemical dormancy. These seed must wait and wait for sufficient rains to wash inhibitors from the seed coat.

As if that was not enough some seeds may have multiple dormancy mechanisms! Seeds that have underdeveloped embryos and require warm or cold temperatures for germination are said to be morpho-physiologically dormant. Other combinations exist.

#### A Scientific Way of Thinking

Good Morning fellow scientists! Today we will be exploring how scientists use the **scientific method** to explain certain events or happenings, also called **phenomena**. Scientists often try to find explanations for phenomena to help them make better predictions about future events.

The first step in the scientific method is **observation**. In this step you use your senses, especially your eyes, to start describing what you observe. Scientists make observations to describe phenomena. After making observations scientists try to explain their observations. A guess or explanation that can be tested through experimentation is called a **hypothesis** (plural hypotheses). A good hypothesis should lead to successful predictions about the experiments you plan.

When a hypothesis has been created the scientist comes up with **experiments** to test the hypothesis. This is the third step in the scientific method. As you will see today any number of experiments may be used to test your hypothesis. During experimentation scientists collect **data**. Data is usually in numerical form. For example, data on seed experiments may include number of days to sprouting or total number of seed to sprout at the end of your experiment.

Once all the data has been collected scientists **interpret**, or try to make sense out of, the information. From these interpretations **conclusions** are made. A conclusion is an explanation for a phenomena based on the data collected during experimentation.

#### **Review of the Scientific Method**

- Observation
- Hypothesis
- Hypothesis Testing or Experimentation
  - Interpretation
    - Conclusions

#### How to Make Hard Seed Germinate

Hard seeds are amazing. Some are so hard you can hit them with a hammer, run them over with a truck or squeeze them in pliers and they won't break. Still others can be scratched with sandpaper or placed in boiling water only to have a few seeds germinate. The reason for this toughness is a thick seed coat. For instance, the seed coat may be several cell layers thick or may be made up of only a few cell layers that are packed very tightly.

Today we will discuss some treatments you can experiment with to make hard seed germinate. These treatments damage the seed coat in some way. This is known as scarification. Seeds can be scarified many ways. For example, seeds can be dipped in concentrated acid for various lengths of time sanded with sandpaper, allowed to sit in hot water or clipped with nail clippers. The purpose of these treatments is to let water into the seed. In some cases gases may be allowed to enter or escape from the seed.

## All of these treatments require adult supervision!!!!

#### Hot Water Treatment

- Place your seed in a mesh bag, a coffee filter will do the trick
- Close the bag or filter and tie the top with a long piece of string
- Fill a pot or beaker about half way with water
- Heat the water until it boils
- Remove the container from the heat and place your bag of seed in the water
- Allow the bag to remain in the water for different time periods
- After treating sow your seeds and observe

#### Mechanical Scarification

A) Sandpaper Method

- Select sandpaper of different grit
- Place seed in between two sheets of the same grit and rub
- You may also try wrapping the sandpaper around a block of wood or plastic and sanding a small amount at a time
- Try sanding for different times
- After treatment sow seeds and observe

- B) Filing Method
  - Select the type of file you want to use
  - File seed for different times or on different places on the seed
  - After treatment sow seeds and observe
- C) Clipping Method
  - Using a pair of large fingernail or dog nail clippers clip off pieces of seed coat
  - After treatment sow seed and observe

Seeds may also be mechanically scarified using a hammer or pliers to slightly crack the seed coat. Remember if you totally smash the seed it probably won't survive.

Seeds may also be treated with concentrated acid. This treatment should only be tried in a laboratory under close supervision.



# Activity 3

# Designing An Experiment

For this activity students choose the type of hard seed to work with. Following the scientific method students: 1) make observations of their experimental units 2) develop a hypothesis 3) decide on experiments to test their hypothesis 4) decide what type of data they will collect. Use the space below to outline the process. Be prepared to share your ideas with others.

Observations:

Hypothesis:

Experiments to test hypothesis:

Type of data to collect:

# Activity 3 Part 2

# **Conducting Your Experiment**

After we have finished sharing our ideas for experiments to perform it is time to get to work! Go ahead and carry out your experiment. On your return trip to Waipa you will collect data.

# Activity 4

# Science Conference

Locate your experiment in the shade house and collect data. Put your data in graphical form. Use this graph to interpret your findings and make conclusions. Each person will have a chance to present their findings to the group. Audience members will have a chance to ask questions and make comments.

