Getting Acquainted With Seeds

Annotation
Students will be familiarized with plant seeds, as well as the techniques used to make detailed observations about their physiology.

Hypothesis
Seeds have an up/down orientation and exhibit gravitropism. Thus, there is a best way to orient the seed when planting it.

Primary Learning Outcomes
At the end of this lesson, students will be able to:
- Use magnifying lenses, microscopes and dissecting tools
- Measure scales with rulers
- Understand scale and magnification
- Draw to scale, with accuracy and precision
- Identify seed external features and describe their functions
- Estimate the amount of water required by seeds in order to initiate germination

Assessed GPS

Characteristics of Science:
Habits of Mind:
SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.
a. Follow correct procedures for use of scientific apparatus.
b. Demonstrate appropriate technique in all laboratory situations.
SCSh3. Students will identify and investigate problems scientifically.
c. Collect, organize and record appropriate data.
e. Develop reasonable conclusions based on data collected.
SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.
a. Develop and use systematic procedures for recording and organizing information.
SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.
b. Consider possible effects of measurement errors on calculations.
e. Solve scientific problems by substituting quantitative values, using dimensional analysis and/or simple algebraic formulas as appropriate.

Content:
SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.
e. Relate plant adaptations, including tropisms, to the ability to survive stressful environmental conditions

Duration
Three to Five 50 minute periods

Materials and Equipment

Each workstation will consist of the following:
2 *Brassica rapa* (Wisconsin Fast Plants) seeds
2 pinto bean or similarly sized seeds
dissecting microscope with 20X to 40X magnification
needles for dissecting, e.g., #8 sewing needles
forceps to handle seed
pencil and paper for sketches
For dissection strips (optional or can be purchased, see reference)
transparency sheets
laminating sheets or clear contact paper
Clear adhesive tape
Clear double stick tape

Procedures and Background

Step 1, completed previously: Pre-soak seeds
Presoak enough *B. rapa* seeds for all students in a beaker or other container for 1 to 3 hours, then place on moist paper towel. Presoak enough pinto bean seeds for all students in a beaker or other container for 4 to 12 hours, then place onto moist towel. Students will later take one of each seed for their own study.

Step 2: Introduction to seeds (discussion)

Step 3: Introduction to microscope (discussion)

Step 4: Activity 1: Creating Dissection Strips
Students will complete **Student Activity 1.**

Step 5: Activity 2: Observing Size and Orientation
Students will complete **Student Activity 2.**

Step 6: Microscope Activity
Students will complete **Student Activity 3.**

Step 7: Seed dissection
Students will complete **Student Activity 4.**

Step 8: Discussion
Discuss results of Activities with the class. Elicit responses from students for the following questions:

- Does the measurement of data differ when gathered from the unaided eye, with the assistance of a magnifier or from a drawing? How do measurement data differ when gathered by each method?
- So, what is the best orientation for a seed to be in for best germination?

Assessment

Students will submit their Student Worksheet 1 and Class Worksheet 1. Worksheet responses will be assessed for completeness and consistency with class data.

Extension

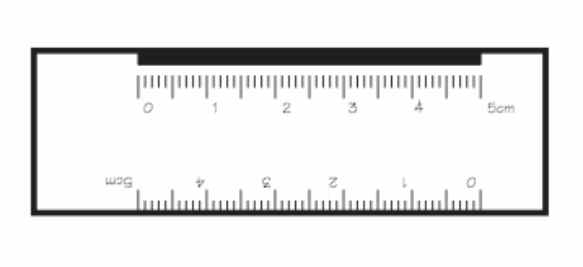
Have students compute mean and standard deviation for each of the measurements by using the data in Class Worksheet 1 and a graphing calculator. Along with summary statistics, students may plot selected data to check for data normality. For example, how much variation was measured among the lengths of the pinto beans? Or of the *B. rapa* seeds? Is the variation in each distributed normally (i.e., showing a bell curve)?

Sources

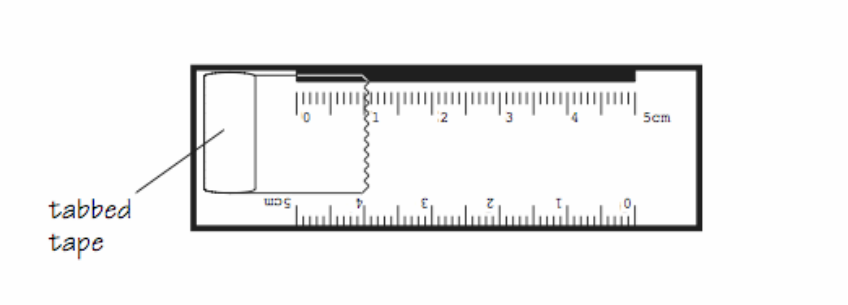
Wisconsin Fast Plants, University of Wisconsin-Madison, College of Agricultural and Life Sciences – Department of Plant Pathology
1630 Linden Drive, Madison, WI 53706
www.fastplants.org

Student Activity 1: Making and Using Dissection Strips

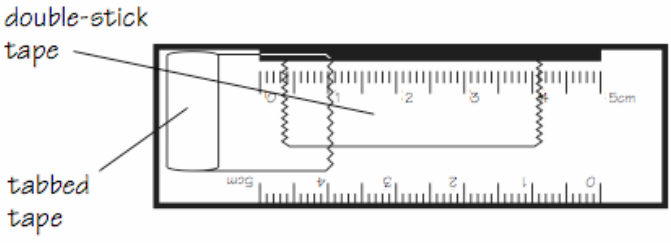
Dissection strips can be made by copying the black line master onto a transparency sheet. The copied transparency sheet can be stuck, printed side down, to a "do it yourself" laminating sheet or piece of clear contact paper, and then the individual strips can be cut out. Using the laminating sheet or contact paper as a sealer protects the printing from being pulled off during use of the strip, so strips can be reused.



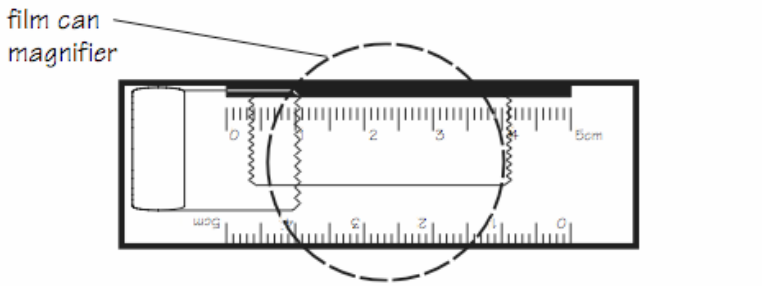
Once the strips are finished, they are ready for use. Begin by cutting a piece of clear 2 cm (3/4 inch) adhesive tape to be about 3 cm long. Fold over about 0.75 cm of this piece of tape to make a tab. Stick this tabbed piece of tape to the dissection strip, with the tab at the end of the strip.



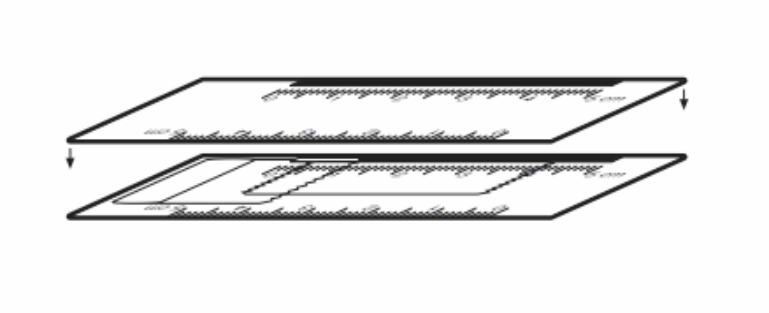
Cut a piece of clear double-stick tape. Place this piece near the top edge of the dissection strip so that the end of the piece overlaps the tabbed piece of tape by a few millimeters.



Specimens for dissection are placed on the double-stick tape. Once your specimen is in place, the specimen and strip can be placed under a dissecting microscope to make observations.



Once a dissection has been completed, the dissected specimen may be taped in a student notebook or removed from the strip by pulling up on the tabbed piece of tape. As this piece of tape is removed it will pull off the used double-stick tape and the strip will be ready for a new dissection. Alternatively, a second dissection strip may be placed over the first to preserve your specimen.



Observing through magnifier or microscope

- Observing with the aid of a lens or lens system (microscope) requires practice.
- Learn to relax as you observe.
- Practice keeping both eyes open. Try not to squint. If you are observing through a single lens, learn to see with one eye while training the other eye to relax and not concentrate on anything. Learning to observe is a useful talent that is easily learned with practice. It will come in handy when you draw your specimen as you can use your second eye to help you see your drawing while observing with the first eye. People normally have a stronger eye (the one that is most used) and is often the one used for microscopic observation, unless you are using a binocular stereo microscope then you would use both eyes to observe your object or specimen.

Drawing to Scale

1. Observe the specimen placed on a dissection strip in such a way that the scale lines of the ruler are observed together with the object.

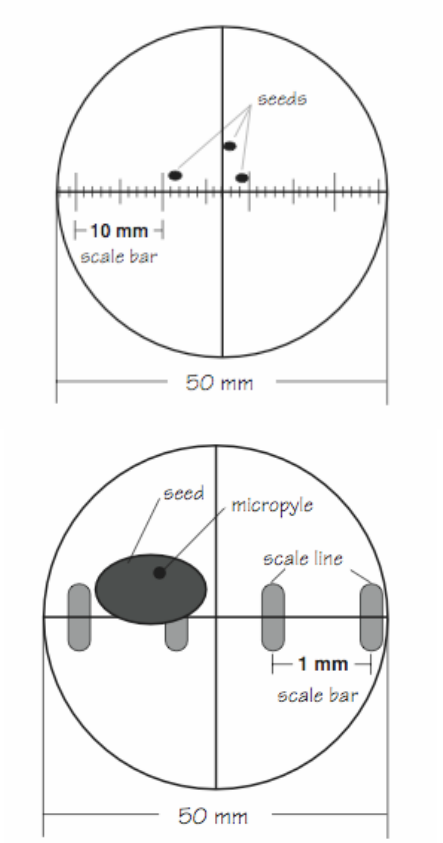
2. On a sheet of paper that you will draw a magnified picture of the object, first draw a portion of two adjacent magnified scale (ruler) lines being sure the that the distance between the two lines is accurately represented.

3. Draw a line, scale bar, between the two adjacent scale lines.

◆——◆
1 mm

4. Be sure to note and record on your drawing the length of the scale bar (e.g. 1 mm or 1 cm).

5. Next, draw your observed specimen as carefully as you can being sure that your drawing is in the same magnified portion as the drawing of the scale bar. If you have kept the magnified drawing of the scale bar and the object in accurate proportion to each other you have drawn you object to scale.



Calculating the Magnification of Your Drawing

If you have drawn the specimen accurately to scale the calculation of the magnification of your drawing is straight forward.

1. With a ruler or second dissection strip measure and record the length of your scale bar drawing. (Be sure to measure using the same scale used when previously drawing the object).
2. The magnification of your drawing will be equal to the ratio of the length of the drawn scale bar in relation to the actual distance of a scale bar on the ruler.

$$\text{magnification} = \frac{\text{length of drawn scale bar}}{\text{actual distance of a scale bar on ruler or scale}}$$

e.g., $\frac{1\text{ mm}}{22\text{mm}}$ = 22X magnification of drawing

Student Activity 2: Observing Size and Orientation

Procedure: Comparing Size

1. Place a pinto bean and a brassica seed (or other similar sized seed) on the sticky tape on a dissection strip (see WFPID Dissection Strips). Roll the seeds around until they are over the millimeter scale oriented with the long axis along the scale.

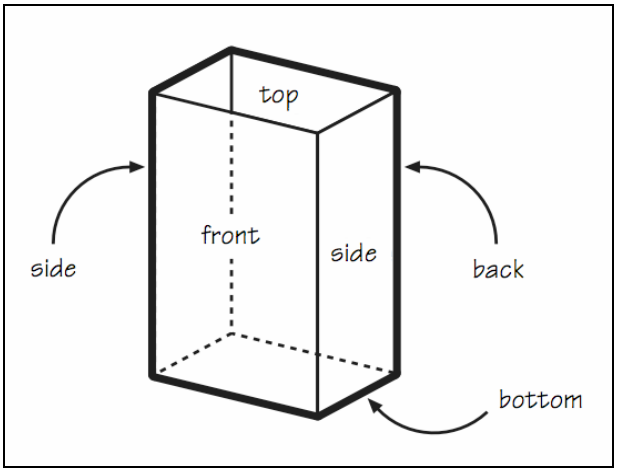
2. Measure to the nearest half or quarter millimeter the length of each kind of seed and record each estimate as a decimal (e.g., 6.25 mm). Record the measurements in Row 1 on the Student Seed Data Sheet (SSDS), with the brassica in Column 1 and pinto bean in Column 2. Enter these data in Rows 1 and 2 of the Class Seed Data Sheet under the appropriate student column number.
    a. Calculate what fraction of the pinto bean length is the brassica seed length. Enter the result on SSDS, Row 2, Column 1 as a fraction.
    b. Calculate how many times longer the pinto bean is than the brassica seed. Enter the result on SSDS, Row 2, Column 2 as a decimal.
    c. Proceed as if both seeds are spherical with diameters equivalent to their lengths and calculate their volumes. Enter the volumes on SSDS, Row 3, Columns 1 and 2. - Express the volume of the brassica seed as a decimal of the volume of the bean on SSDS, Row 4, Column 1. How many times larger in volume is the pinto bean? Enter this number on SSDS, Row 4, Column 2.

3. Place a film can magnifier or hand lens over the seeds and the scale.
    a. Observe and re-measure the magnified images of the length of each seed, estimating to the nearest quarter millimeter.
    b. Record the lengths on the SSDS under Row 5, Columns 1 and 2 for magnified measures. Also, record these lengths in Rows 3 and 4 of the Class Seed Data Sheet under the appropriate student column number. Note on the SSDS, Row 5, the magnification of the viewing lens.
    c. With the aid of a magnifier, are you able to measure the seed more accurately? Describe in writing why you were or were not.

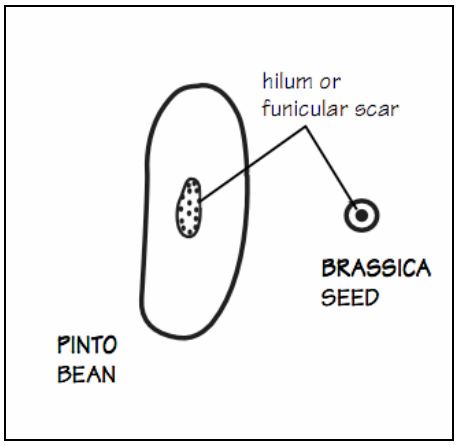
Procedure: Orientation of the Seed — Which Way is Up?

1. While each seed is on the dissection strip, roll it around with a needle or pencil point and observe its shape and features.

2. Can you determine which way is up on the seed? For this a point of view is needed.
    a. On Earth bottom is usually directed down or in the direction of the gravitational force (toward the center of the Earth). Up is opposite.
    b. Front can be arbitrarily determined as that view which presents most visible detail. Can you find the front of their seeds?



3. On the pinto bean, a distinctive oval light area on the seed coat will be observed. This is the hilum and is the scar where the developing seed was attached through the funiculus (like an umbilical cord) to the maternal tissue of the carpel or ovary. If the hilum is facing you, this is front.



4. Now roll the brassica seed around on the tape. With the aid of a magnifier, a darker circular area with a small lighter area in it will be seen. This is the remains of the funicular attachment.

5. Looking at the front view of the seeds, can you tell which direction is up and which is down?
    a. To answer this question you will need to observe and record details of their seeds under greater magnification using the dissection strip, a microscope and a dissection card for drawing to scale, estimating object sizes and calculating the magnification of the drawing.

Student Activity 3: Microscope Activity

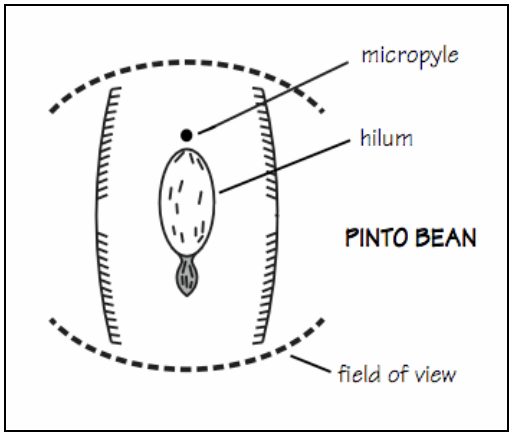
Procedure: Drawing to Scale — Measuring and Magnification

1. With the seeds still on the dissection strip and using a hand lens or film can magnifier on the dissection strip, follow the directions on Drawing to Scale in WFPID Dissection Strips. – Relax, keep both eyes open, but train your eye and brain to concentrate on the scale and the seeds. This will take some practice.

2. Make an accurate drawing to scale of the front view of the brassica seed, recording as much detail of the hilum and surrounding area as they can observe. - On the page where you have drawn the seed, record the following: - the object (e.g., the pinto bean) - the magnification of the lens (e.g., 5X, 10X, etc.) - the length represented by the scale bar (e.g., 1 mm, 0.5 mm, 0.25 mm, etc.) - the actual length of the scale bar in millimeters - an estimate of the length of the seed in decimal fractions, and - a calculation of the magnification of the drawing from the scale bar measures.

3. Repeat the same procedure with the pinto bean on a second page.

4. Now with the same seeds, place the strip under a dissecting microscope or lens with magnification between 10X and 40X.
    a. On another page or the same page, repeat the accurate drawing of the magnified millimeter scale and seeds and note how enlarged the scale marks have become.
    b. In estimating the dimensions of the seeds, measure from the centers of the scale marks.
    c. At the higher magnification, not all of the pinto bean will fit into the field of view. In this case, just draw to scale the details of the hilum area, observing the location of the micropyle, a minute hole in a depression at one end of the hilum and opposite the end with two small raised pear-shaped structures.

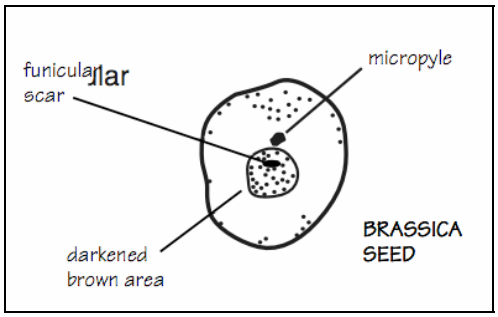


The micropyle is the hole in the ovule integuments through which the pollen tube passes on its way to double fertilization of the egg and polar nuclei.

The micropyle is also the weakest area in the seed coat, or testa, which splits under

pressure from the emerging root tip.

In brassica seeds, the micropyle is less conspicuous than in the bean, but appears as a minute raised area adjacent to the darkened circular area of funicular attachment.



5. Still using the higher magnification, complete the drawings of the scales and seeds in the right-hand circles of the two dissection cards.
    a. Calculate the magnification of their drawings.
    b. Enter the estimated length of their brassica seed measured from their drawing at the high power magnification on the Student Seed Data Sheet, Row 6, Column 1, indicating the magnification of the lens used, and on the Class Seed Data Sheet, Row 5.

Student Activity 4 – Seed Dissection

Procedure: On the Front View — Which Way is Up?

1. Returning to the question of which way on the front view of the seed is up, take a pinto bean and a brassica seed that have been soaking in water for one to four hours. Dry off the excess water and place them on the dissection strip next to the dry seeds that have been measured.

2. Observe, measure and record the length of each soaked seed on the Student Seed Data Sheet, Row 7, and on the Class Seed Data Sheet, Rows 6 and 7. Then, as with the dry seeds, calculate the volumes and enter them in SSDS, Row 8, Columns 1 and 2.

3. Calculate the average volume increase of the brassica seed upon soaking. Enter this calculation in the SSDS, Row 9, Column 1. Repeat for the pinto bean and enter the calculation in the SSDS, Row 9, Column 2. - What causes the increase in seed volume? Is the increase in seed volume due entirely to water uptake (imbibition)? How can this question be tested?

4. Under magnification examine the front views of the soaked seeds, comparing them with the drawings of the dry seeds. Has anything changed? Can the hilum and micropyle still be seen?

5. Keep the location of the micropyle of the soaked pinto bean in view. With a sharp dissection needle cut through the testa around the hilum, peeling back the seed coat to expose the white or pale cream embryo. As this is done you will see the rounded tip of the embryonic root pointing towards the micropyle. Make a front view drawing of the embryo in the orientation with root tip pointing down.