Getting Acquainted with a Seed

Observing Seed Anatomy, Drawing to Scale, and Seed Orientation

Introduction

In this activity students become acquainted with the anatomy and biology of seeds. They will use lenses and scales and make drawings to scale. Students will measure and calculate magnifications and they will begin to understand relationships among these. They will organize and summarize their data and, as they do so, they will be developing the understanding and skills needed to undertake more detailed investigations on the biology and reproduction of Fast Plants. This activity should be used in conjunction with the WFPID *Dissection Strips*.

Questions

- On a seed, which way is up?
- Does a seed "know' which way to grow? If so, *how* does a seed 'know' which way to grow?
- When planting a seed, is there a best way to orient the seed?

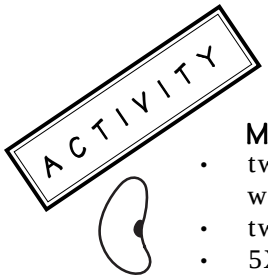
Time Frame

This activity will take two or more 50 minute class periods. During the first period students will make a dissection strip and become familiar with its use in conjunction with magnifying lenses and microscopes for observing, measuring and recording data from seeds. The dissection, organization, analysis and discussion of student and class data could take another period. Further periods can be spent graphing and statistically analyzing data.

Learning Objectives

This activity is designed to strengthen students' observational and quantitative skills. In participating in this activity students will:

- learn to use magnifying lenses, microscopes and dissecting tools for detailed observation;
- measure scales with rulers;
- draw to scale, with accuracy and precision to understand scale and magnification;
- learn features of the external anatomy of seeds that are associated with certain features of the internal anatomy of seeds; and
- estimate the amount of water required to be taken up by seeds in order to initiate germination.



The Bean and the Brassica

Materials

- two brassica seeds (Fast Plants), one dry and one that has been presoaked in water for 1 to 3 hours, then placed on moist paper towel
- two pinto bean seeds, one dry and one presoaked for 4 to 12 hours
- 5X hand lens
- dissecting microscope with 20 to 40X magnification
- two dissection strips
- fine dissection needles, e.g., tuberculin syringes with #23 or #25 needle, or #8 sewing needle
- forceps to handle seed
- pencil with eraser for sketches
- Student Seed Data Sheet
- Class Seed Data Sheet
- student research notebooks or paper worksheets

Department of Plant Pathology, 1630 Linden Drive, Madison, WI 53706 1-800-462-7417 wfp@fastplants.cals.wisc.edu

Procedure: Comparing Size

1. Have students 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.

   - 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.

   - 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.

   - 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.

> "From the leaves and downs,
> and beards of plants,
> we come at last to the seeds;
> and here indeed seems to be
> the cabinet of nature,
> wherein are laid up its jewels..."
>
> - Robert Hooke, 1667

3. Place a film can magnifier or hand lens over the seeds and the scale.

   - Observe and re-measure the magnified images of the length of each seed, estimating to the nearest quarter millimeter.

   - 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.

   - With the aid of a magnifier, are students able to measure the seed more accurately? Describe in writing why you were or were not.

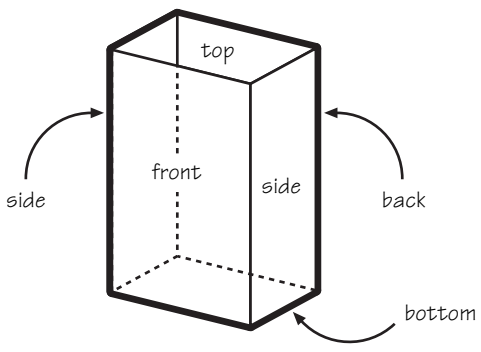
Procedure: Orientation of the Seed – Which Way is Up?

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

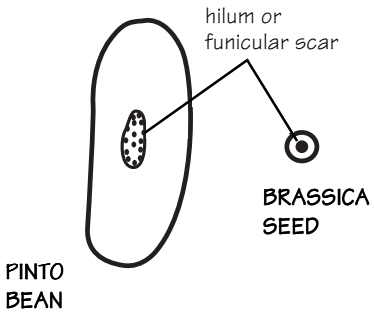
2. Can students determine which way is up on the seed? For this a *point of view* is needed.

   - On Earth *bottom* is usually directed down or in the direction of the gravitational force (toward the center of the Earth). *Up* is opposite.

   - *Front* can be arbitrarily determined as that view which presents most visible detail. Can students 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?

   - To answer this question students 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.

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*.

   - Encourage students to relax, have them keep both eyes open, but training their eye and brain to concentrate on the scale and the seeds. This will take some practice.

2. Students should 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 they have drawn the seed have students 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.

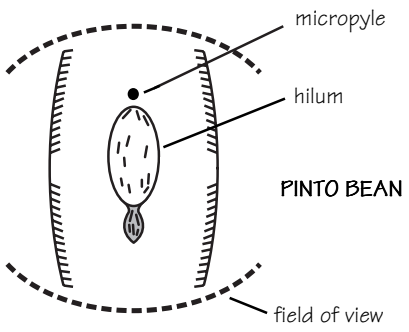
4. Now with the same seeds, place the strip under a dissecting microscope or lens with magnification between 10X and 40X.

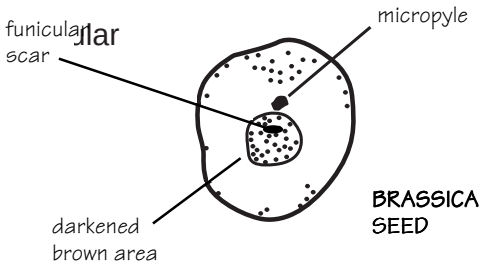
   - On another page or the same page, repeat the accurate drawing of the magnified millimeter scale and seeds and note how enlarged the scale marks have become.

   - In estimating the dimensions of the seeds, measure from the centers of the scale marks.

   - 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, students should complete the drawings of the scales and seeds in the right-hand circles of the two dissection cards.

   - Students should calculate the magnification of their drawings.

   - Students should 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.

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 students 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.

Concluding Activities and Questions

In completing this Activity, students will have made detailed observations of seeds which will provide them with further insight into plant biology and prepare them for further experimentation, including those on germination (see WFPID *Germination*). If available, use data analysis software or a calculator to create graphical and statistical summaries of student and class data. Have students consider the following:

- How much variation was measured among the lengths of the pinto beans? Or of the brassica seeds? Is the variation distributed normally?

- 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?

Student Seed Data Sheet

Date _____

Student Name _____

Seed Types: Column 1: brassica or other similar-sized seed
Column 2: pinto bean

Row	Character/Activity	Column 1		Character/Activity	Column 2
1	Length of dry brassica seed as measured by eye (mm)			Length of dry pinto bean as measured by eye (mm)	
2	Ratio of brassica seed length to pinto bean length (fraction)			Ratio of pinto bean length to brassica seed length (decimal)	
3	Brassica seed volume, assuming seed is spherical (mm^3)			Pinto bean volume, assuming bean is spherical (mm^3)	
4	Ratio of brassica seed volume to pinto bean volume (decimal)			Ratio of pinto bean volume to brassica seed volume (decimal)	
5	Length of dry brassica seed as measured with ___ X lens (mm)			Length of pinto bean as measured with ___ X lens (mm)	
6	Length of dry brassica seed from ___ X drawing (mm)				
7	Length of soaked brassica seed (mm)			Length of soaked pinto bean (mm)	
8	Volume of soaked brassica seed, assuming seed is spherical (mm^3)			Volume of soaked pinto bean, assuming seed is spherical (mm^3)	
9	Increase in brassica seed volume caused by soaking (percentage)			Increase in pinto bean volume caused by soaking (percentage)	

Class Seed Data Sheet

Date _____

Teacher Name _____

		Student Data**																Statistics			
Row	Measurement*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	n	r	x	s
1	Length of dry brassica seed (SSDS Row 1, Column 1)																				
2	Length of dry pinto bean (SSDS Row 1, Column 2)																				
3	Length of dry brassica seed measured with ___X lens (SSDS Row 5, column 1)																				
4	Length of dry pinto bean measured with ___X lens (SSDS Row 5, Column 2)																				
5	Length of dry brassica seed from ___X drawing (SSDS Row 6, Column 1)																				
6	Length of soaked brassica seed (SSDS Row 7, Col. 1)																				
7	Length of soaked pinto bean (SSDS Row 7, Col. 2)																				

* these measurements were recorded on the Student Seed Data Sheet in the Row and Column indicated, and should be transferred to the appropriate Student Data columns

** this Class Seed Data Sheet will hold data from up to 16 students