Unit B: Seed Germination, Growth, and Development

Lesson 1: Identifying Seed Germination Processes and Requirements

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Describe the process of seed germination.
2. Discuss the conditions required for seed germination.
3. Explain the importance of seed quality.

Recommended Teaching Time: 3 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has been developed for use with this lesson plan
- http://plantsinmotion.bio.indiana.edu/plantmotion/earlygrowth/germination/germ.html
- http://www.mbgnet.net/bioplants/grow.html

List of Equipment, Tools, Supplies, and Facilities:

Writing surface
Projector
PowerPoint Slides
Transparency Masters
Copies of student lab sheets
Thin Plastic Bottle
Rice (enough to fill 1/2 the bottle)
Fine textured sand (enough to fill 1/2 the bottle)
Warm Water
Material and Equipment needed for LS: B 1-1 and LS: B1-2

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide 2):

- Amylase
- Germination
- Phytochrome
- Protease
- Scarification
- Stratification
- Turgid
- Viability
- Vigor

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Fill a clean plastic bottle, one half full with rice. Add fine textured sand to fill the container. Shake the bottle until the rice and sand are evenly distributed and the contents fill the bottle to the top. Place the bottle on a pan at the front of the class. At the start of class ask students to present hypotheses as to what will happen when the contents in the bottle are completely saturated with water. List the predictions on the board. Fill the bottle with water as you collect the student hypotheses. Use warm water to speed the process. Within 45 to 55 minutes expect the bottle to swell and expand due to the build up of osmotic pressure caused by the rice's absorption of water.

**** Use this activity to lead discussion over the process of seed germination.**

Summary of Content and Teaching Strategies

Objective 1: Describe the process of seed germination.

(PowerPoint Slide 3 and 4)

I. ***Germination*** is the process by which the seed embryo begins growth. A seed is considered to have germinated when the embryonic root emerges from the seed coat. Many important crops are grown from seed. Wheat, Rice, cotton, and vegetables are started from seeds. Seed germination is a complex process that begins when conditions are favorable for growth.

A. Some plants produce seeds, which germinate immediately once they are released. Others produce seeds that have internal dormancy mechanisms and remain dormant until conditions are favorable before the seed can germinate. **(PowerPoint Slide 5 illustrates the germination process)**

(PowerPoint Slide 6)

1. ***Stratification*** is a dormancy mechanism that involves temperature. Seeds with this mechanism must experience a period of cold temperature before the seed can germinate.

(PowerPoint Slide 7)

2. ***Scarification*** is a dormancy mechanism that involves the breakdown of the seed coat. Some plants have very thick and tough protective seed coats. These seed coats prevent water and oxygen from entering the seed. The seed coat must be broken before germination can begin. The seed coat can be damaged or broken by the acid produced in the animal stomach, soil micro organisms, repeated freezing and thawing, mechanical stress from the grinding in the gizzard of birds, being stepped upon, chewed, etc.

(PowerPoint Slide 8)

B. There are three major stages in the germination process.

1. Germination begins with the seed's absorption of water. Most dormant seeds have 5–10% moisture content. When conditions are right, water is absorbed very rapidly. Most water is absorbed through the micropyle. As the cells hydrate, they swell and become ***turgid*** or rigid. The moisture triggers an increase in cellular respiration. Oxygen must be present for cellular respiration.

(PowerPoint Slide 9)

2. In stage two, metabolic activity surges. Proteins are synthesized. Gibberellins stimulate the production of enzymes. The enzyme ***amylase*** converts stored starches to sugars. The enzyme ***protease*** breaks down stored proteins into amino acids. The sugars and amino acids are directed towards cell division, growth, and differentiation sites at the root and shoot meristems or tips.

(PowerPoint Slide 10)

3. Metabolic processes increase in the third phase of germination. The swelling of cells causes the seed coat to rupture. The primary root or radicle emerges downward, and the stem grows upwards. The shoot begins manufacturing food through photosynthesis. The roots absorb water and nutrients. **(PowerPoint Slide 11 illustrates the enzyme activity during germination)**

**** Ask questions during instruction to gauge student understanding of the concepts. Use TM: B1-1 to draw the germination process on the board. Have the students explain what you just presented. TM: B1-2 can also be used to show the enzyme activity a little more clearly.**

To reinforce the concepts presented with this objective, have the students complete the laboratory exercise LS: B1-1—Scarification of tree seeds.

Objective 2: Discuss the conditions required for seed germination.

(PowerPoint Slide 12 and 13)

II. Germination begins when favorable conditions exist for the survival of the developing plant. The conditions for germination include moisture, air, optimal temperatures, and possibly light or darkness.

A. Water triggers germination processes and is necessary as the embryo grows and develops.

(PowerPoint Slide 14)

B. All seeds need oxygen to germinate. Oxygen is required for cellular respiration, a process necessary for converting stored food into energy. Seeds germinate at a wide range of temperatures, ranging from 0°C to 40.6°C. However, the optimum temperature for most seeds lies between

18.3°C and 26.7°C. Temperature influences the speed of metabolic activities. Metabolism is faster when temperatures are warm than when temperatures are cool.

(PowerPoint Slide 15)

C. Seeds of some plants need exposure to light before they will germinate. Seeds of other plants require darkness in order to germinate, and there are those that are not influenced by light or darkness. Seeds that are light sensitive have a photoreceptor pigment, called ***phytochrome***, found in the seed coat. This pigment sends messages to the seed instructing it to initiate or to stop germination.

****Engage the students in discussion on factors that influence seed germination. Use TM: B1-3 to show different crops optimum germination temperatures. PowerPoint Slide 16 will also help with this. Feel free to add other crops from your area. Ask the students if they know of other crops that should be added to the list.**

Objective 3: Explain the importance of seed quality.

(PowerPoint Slide 17 and 18)

III. Seed quality and proper storage of seed are crucial to achieving desired high germination rates. High quality seeds produce healthy seedlings. Seed quality refers to both viability and vigor.

A. ***Viability*** is the ability of seeds to germinate under optimal conditions.

(PowerPoint Slide 19)

B. ***Vigor*** is the ability of seeds to germinate under different conditions and still produce healthy plants.

C. Seed producers test seeds to determine the percentage of seeds that will germinate. Germination rates from the tests are printed on the seed container label.

D. Until the seeds are sold and planted they must be kept in storage. A goal is to maintain seed viability and vigor during the storage period. The best seed storage conditions typically consist of cool temperatures (about 4.4°C) and low humidity (approximately 15%).

****Take a field trip to a local seed dealer or have a local seed dealer come to class. Prepare the students in advance to ask questions regarding seed quality and storage. Prepare the host for the visit as well. Complete laboratory exercise using LS: B1-2—Warm Germination Test.**

Review/Summary: Use the student learning objectives as a guide to summarizing the lesson. Have students explain terms, processes outlined in the lesson, and the content associated with each objective. Student responses can be used in determining which objectives require greater review or whether further instruction is necessary. Questions on PowerPoint Slide 20 can also be used to help review the material covered.

Application:

LS: B1–1—Scarification of tree seeds.
LS: B1-2—Warm germination test.
TM: B1-1—Germination process.
TM: B1-2—Enzyme activity during germination.
TM: B1-3—Favorable temperatures for germination of common crops.

Evaluation: Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure the student's performance on classroom participation, laboratory assignments, and written tests or quizzes.

Answers to Sample Test:

Part One: Matching

1 = d, 2 = i, 3 = g, 4 = e, 5 = j, 6 = b, 7 = c, 8 = h, 9 = f, 10 = a

Part Two: Completion

1. embryonic root
2. cool temperatures (about 4.4°C), low humidity (approximately 15%)
3. 5–10%
4. conditions are favorable
5. Germination rates
6. faster
7. oxygen
8. Gibberellins
9. quality, proper storage
10. 18.3°C and 26.7°C

Part Three: Short Answer

1. Germination begins when favorable conditions exist for the survival of the developing plant. The conditions for germination include moisture, air, optimal temperatures, and possibly light or darkness.

2. Seed quality and proper storage of seed are crucial to achieving desired high germination rates. High quality seeds produce healthy seedlings. Seed quality refers to both viability and vigor.

Sample Test Name_____

Test

Unit B Lesson 1: Identifying Seed Germination Processes and Requirements

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Amylase
b. Germination
c. Vigor
d. Phytochrome
e. Protease
f. Scarification
g. Stratification
h. Turgid
i. Viability

_____ 1. Light sensitive photoreceptor pigment found in the seed coat.
_____ 2. The ability of seeds to germinate under optimal conditions.
_____ 3. A dormancy mechanism that involves temperature.
_____ 4. Enzyme that breaks down stored proteins into amino acids.
_____ 5. The ability of seeds to germinate under different conditions and still produce healthy plants.
_____ 6. The process by which the seed embryo begins growth.
_____ 7. When cells are hydrated and rigid.
_____ 8. A dormancy mechanism that involves the break down of the seed coat.
_____ 9. An enzyme that converts stored starches to sugars.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. A seed is considered to have germinated when the _____ _____ emerges from the seed coat.

2. The best seed storage conditions typically consist of _____ _____and _____ _____.

3. Most dormant seeds have _____ moisture content.

4. In general, seeds remain dormant until _____ _____ _____ before the seed can germinate.
5. _____ _____from tests are printed on the seed container label.

6. Metabolism is _____ when temperatures are warm than when temperatures are cool.

7. Aside from water, all seeds need _____ to germinate.

8. _____stimulate the production of enzymes.

9. Seed _____and _____ _____ of seed are crucial to achieving desired high germination rates.

10. The optimum temperature for most seeds to germinate lies between _____degrees.

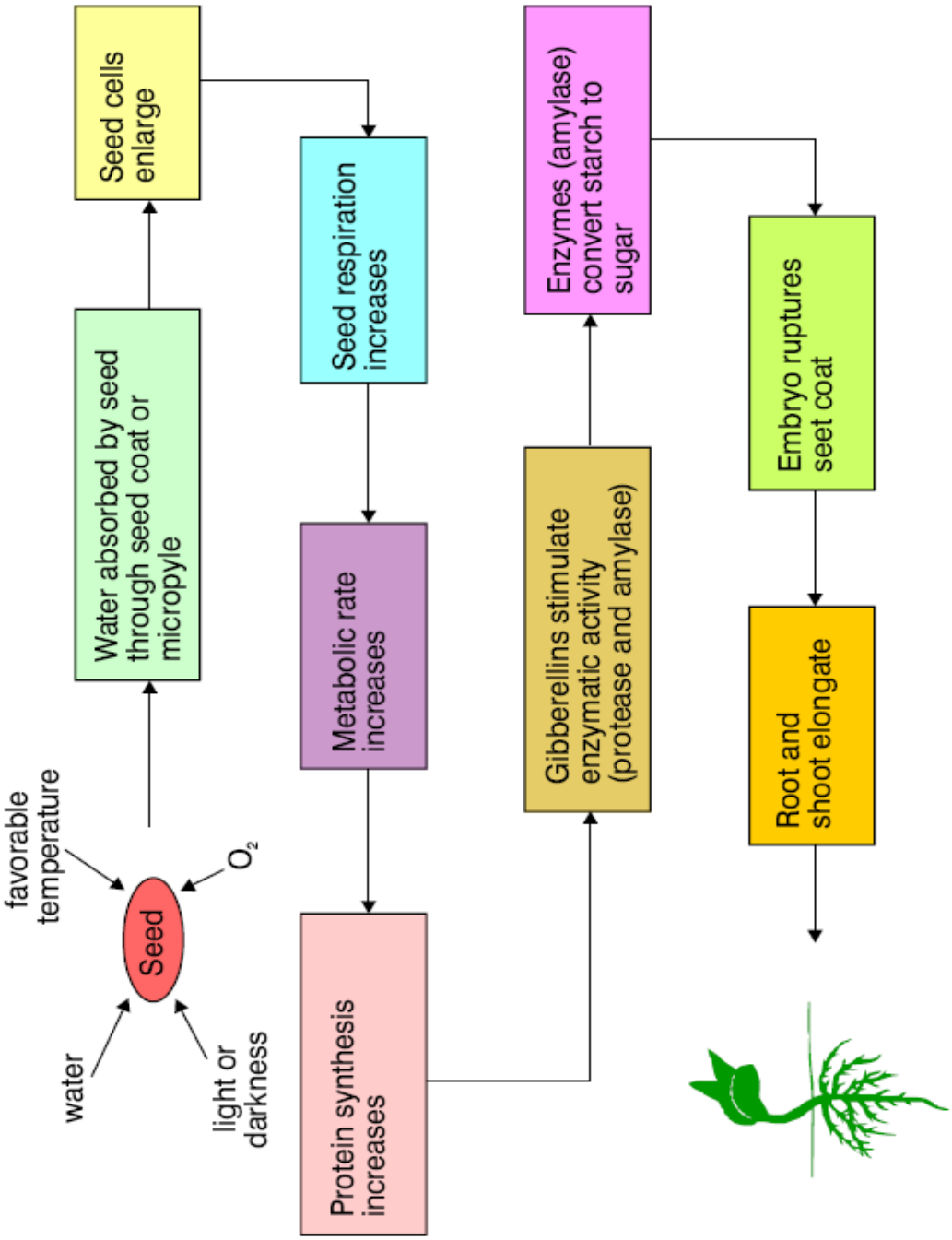
Part Three: Short Answer

Instructions. Provide information to answer the following questions.

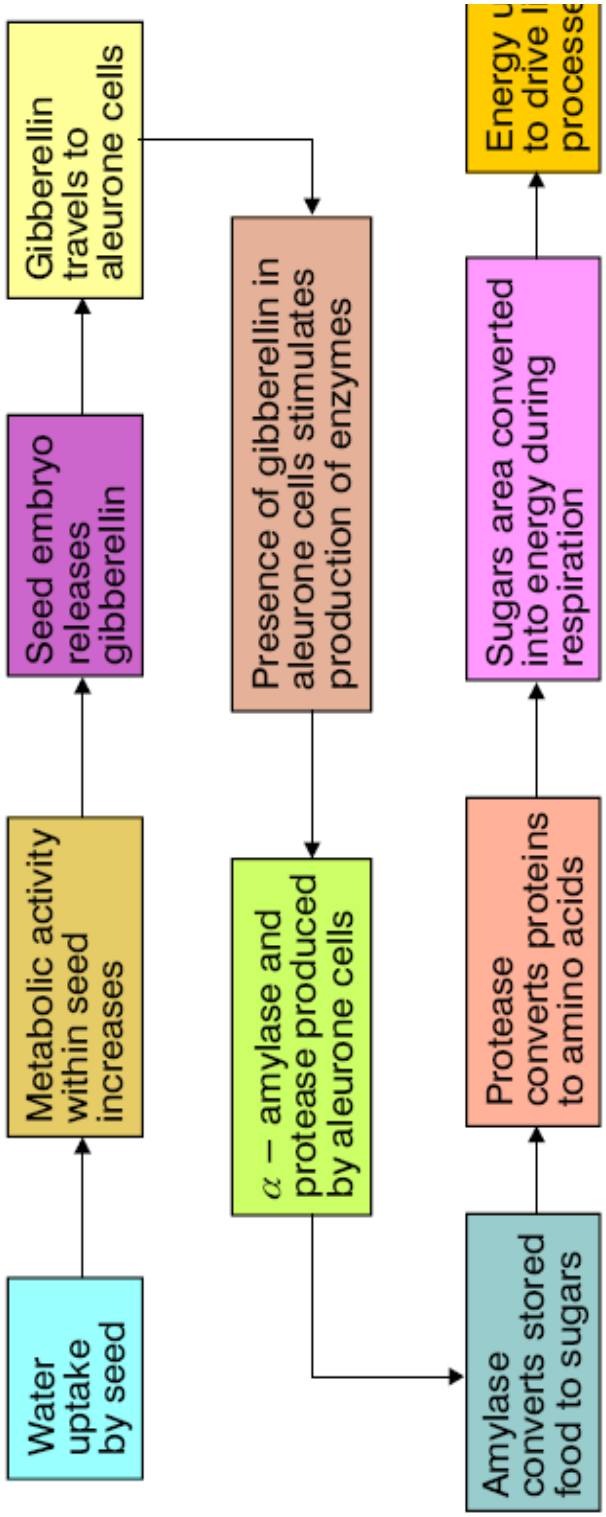
1. When does germination begin?

2. Why is seed quality important?

THE GERMINATION PROCESS



GERMINATION



TM: B1-3

FAVORABLE TEMPERATURES FOR GERMINATION

Crop	Minimum (°C)	Optimum (°C)
Maize	10	23.9
Rice	15	25
Pea	4.4	23.9
Snap bean	15.6	29.4
Sorghum	10	23.9
Barley	5	24
Squash	15.6	35
Tomato	10	23.9
Wheat	1.7	18.3

LS: B1-1 Name_____

Lab Sheet

The Scarification of Tree Seeds

Purpose:

Scarification is the artificial way to prepare hard seed coats for germination. There are three methods or treatments that will usually make seed-coats permeable to water: (1) soaking in a solution of sulfuric acid, (2) soaking in hot water or immersing the seed for a short period in boiling water, or (3) mechanical scarification. In nature this is accomplished by microbial action, physical wear, or by passing through the digestive system of an animal. Breaking this seed dormancy is known as scarification. The following lab is an example of scarification.

Materials needed:

Large seeds that require scarification to germinate
Files or hacksaws
Growing medium
4" plastic pot
Marking pens

Procedure:

1. Label one side of a plastic pot "control" and the other side "scarified."
2. Fill the pot with pre-moistened growing medium. Firm it lightly. The medium level should be just below the lip of the pot.
3. Plant two unaltered seeds about ½ inch deep on the "control" side of the pot.
4. Select two other seeds to be scarified. Using a file or hacksaw, file or saw through the seed coats until the white cotyledon becomes visible.
5. Plant the scarified seeds about ½ inch deep on the side of the pot labeled "scarified."
6. Set the pot in a bright location at about room temperature and maintain a moist, but not wet medium.
7. What do you expect to happen? Will all of the seeds germinate? Why or why not?

8. Grow the young trees, and then transplant them to the landscape.

LS: B1-2 Name_____

Lab Sheet

Warm Germination Test

Purpose:

Students will determine the germination rate of a seed sample.

Materials:

Wheat. rice or other vegetable seeds
Paper towels
Gallon sealable plastic bags
Water

Procedure:

1. Place two moistened paper towels on a lab table.
2. Lay 25 seeds down the center of the paper towels.
3. Roll the paper towels tightly.
4. Make three more paper towel bundles each with 25 seeds.
5. Insert the bundles into the gallon plastic bag.
6. Close the plastic bag.
7. Position the bag so the bundles stand on end. Place the bag in a location that is kept at room temperature.
8. Once the seeds are in place, ask the students what factors might affect the number of seeds that will germinate. Ask each student to predict the number of seeds that will germinate. Announce that a prize will be given to the student whose prediction is closest to the actual results.
9. Open the bag on days 3, 5, and 7 and count the number of germinated seeds. A germinated seed is one whose root has emerged.
10. Use the germination numbers collected on the seventh day to calculate germination rates.
11. A good germination rate would be one over 90%.
12. Record the data collected in the following table on the next page:

	Seeds Germinated	Percent Germination	Seeds Germinated	Percent Germination	Seed Germi
Bundle #1					
Bundle #2					
Bundle #3					
Bundle #4					
Total					