Lesson C3–1

Identifying Seed Germination Processes and Requirements

Unit C. Plant and Soil Science

Problem Area 3. Seed Germination, Growth, and Development

Lesson 1. Identifying Seed Germination Processes and Requirements

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: **II:** Address taxonomic or other classifications to explain basic plant anatomy and physiology.

Benchmark: **II-A.** Examine unique plant properties to identify/describe functional difference in plant structures including roots, stems, flowers, leave and fruit.

Performance Standard: **3.** Describe germination process and conditions.

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.

List of Resources.

The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Osborne, Edward W. *Biological Science Applications in Agriculture*. Danville, IL: Interstate Publishers, Inc. 1994

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology*. Danville, IL: Interstate Publishers, Inc. 2003

Other Resources. The following resources will be useful to students and teachers:

Herron, Ray V. *The Science of Agriculture: A Biological Approach*. Albany, New York: Delmar. 2002

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets

Terms.

The following terms are presented in this lesson (shown in bold italics):

Amylase
Germination
Imbibition
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 mayonnaise or pickle jar one half full with soybeans. Add fine textured sand and shake the jar until the beans and sand are evenly distributed and the contents fills the jar to the top. Place the jar 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 is completely saturated with water. List the predictions on the board. Fill the jar with water as you collect the student hypotheses. Use warm water to speed the process. Within 30 to 45 min-

utes expect the glass to crack due to the build up of osmotic pressure caused by the seeds' imbibition of water.

Summary of Content and Teaching Strategies

Objective 1: Describe the process of seed germination.

Anticipated Problem: What is the process of seed germination?

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. Corn, soybeans, 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.

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.
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.

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

1. Germination begins with the seed's absorption or ***imbibition*** of water. Most dormant seeds have 5–10% moisture content. When conditions are right, water is imbibed very rapidly. Most water is imbibed 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.
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.
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.

Begin the lesson with an interest approach to capture the attention of the students. Clearly state the objectives of this lesson. Obtain a PowerPoint presentation or build a PowerPoint presentation to be used as a guide for classroom instruction. Utilize the text and transparency masters in this lesson in the PowerPoint presentation. Have students take notes during lecture-discussion. Ask questions during instruction to gauge student understanding of the concepts. To reinforce the concepts presented with this objective, have the students conduct the LS: C3–1A—Scarification of tree seeds.

Objective 2: Discuss the conditions required for seed germination.

Anticipated Problem: What conditions are required for seed germination?

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.

   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 32°F to 105°F. However, the optimum temperature for most seeds lies between 65°F and 80°F. Temperature influences the speed of metabolic activities. Metabolism is faster when temperatures are warm than when temperatures are cool.

   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.

Continue with the PowerPoint presentation. Engage the students in discussion on factors that influence seed germination.

Objective 3: Explain the importance of seed quality.

Anticipated Problem: Why is seed quality important?

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.

   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 40°F) and low humidity (approximately 15%).

Take a field trip to a local seed dealer. Prepare the students in advance to ask questions regarding seed quality and storage. Prepare the host for the visit as well. Conduct a laboratory exercise using LS: C3–1B—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 at the end of each chapter in the recommended textbooks may also be used in the review/summary.

Application.

LS: C3–1A—Scarification of tree seeds.

LS: C3–1B—Warm germination test.

TM: C3–1A—Germination process.

TM: C3–1B—Enzyme activity during germination.

TM: C3–1C—Favorable temperatures for germination of common crops.

Evaluation. Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student 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 40°F), 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. 65°F and 80°F

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

Lesson C3–1: 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. Imbibition
d. Phytochrome
e. Protease
f. Scarification
g. Stratification
h. Turgid
i. Viability
j. Vigor

_____ 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. The absorption of water.

_____ 8. When cells are hydrated and rigid.

_____ 9. A dormancy mechanism that involves the break down of the seed coat.

_____ 10. 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

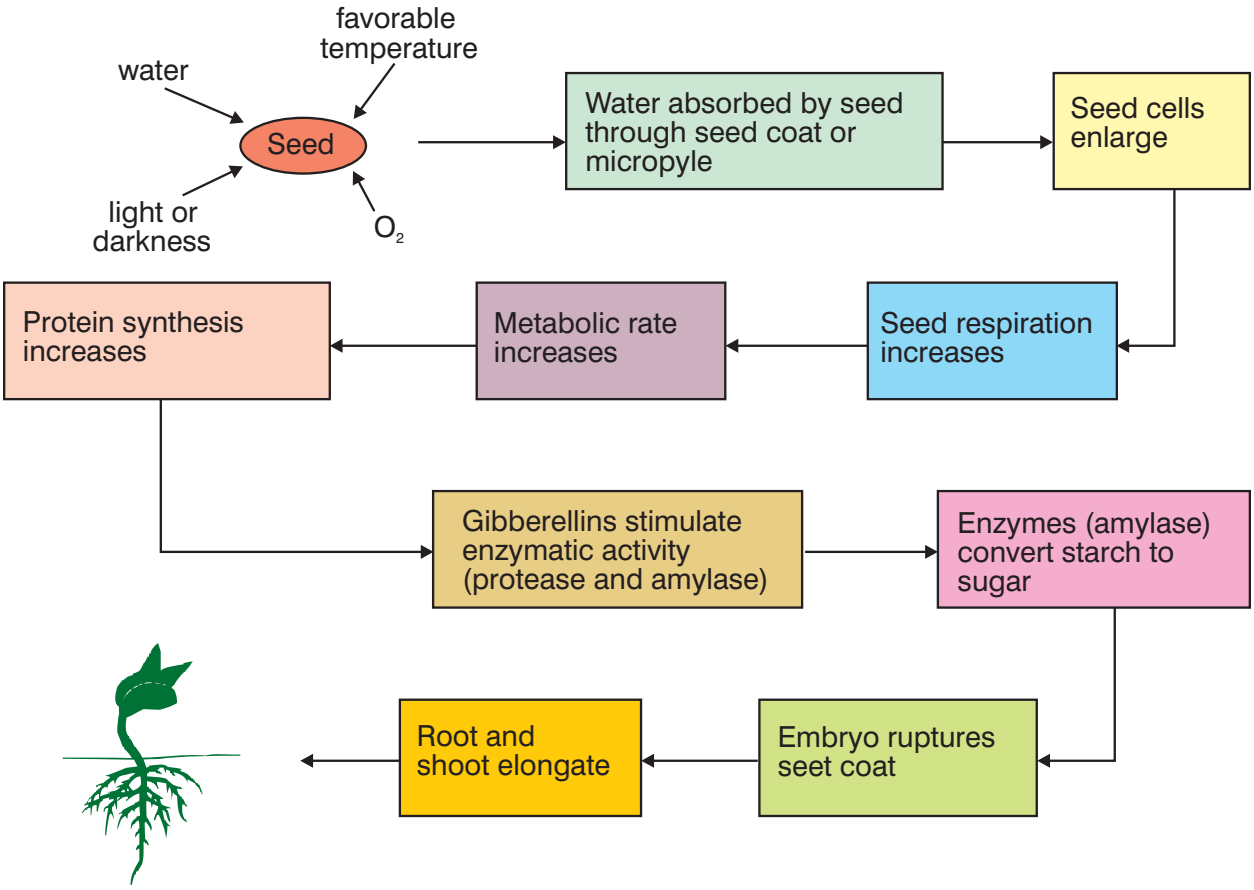
Instructions. Provide information to answer the following questions.

1. When does germination begin?

2. Why is seed quality important?

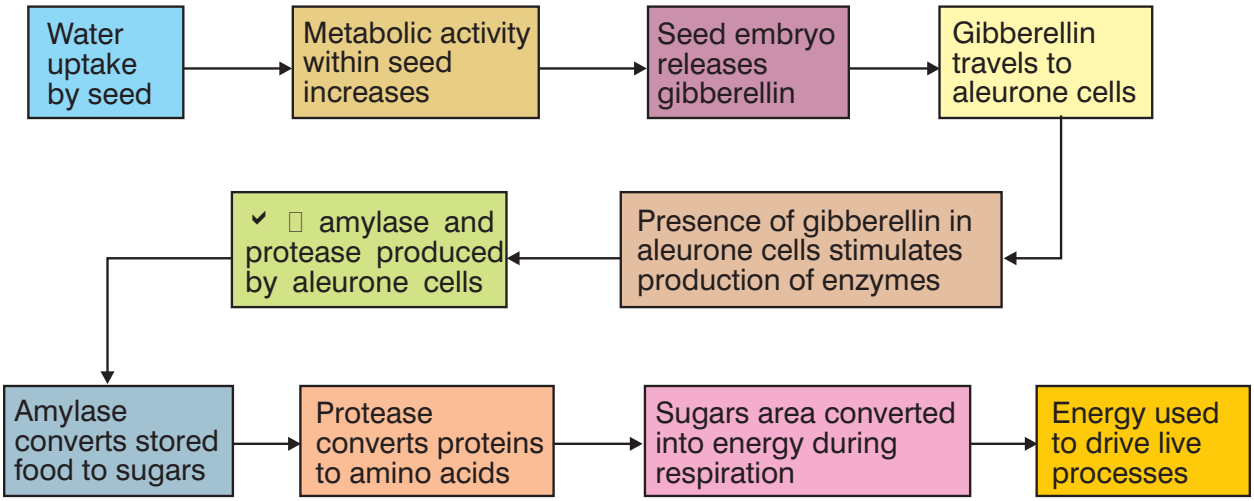
TM: C3–1A

THE GERMINATION PROCESS



TM: C3–1B

ENZYME ACTIVITY DURING GERMINATION



TM: C3–1C

FAVORABLE TEMPERATURES FOR GERMINATION

Crop	Minimum (°F)	Optimum (°F)
Corn	50	75
Oats	35	65
Pea	40	75
Snap bean	60	85
Sorghum	50	75
Soybean	50	70
Squash	60	95
Tomato	50	85
Wheat	35	65

 Name_____

Lab Sheet

The Scarification of Tree Seeds

Purpose:

When the seed coat is broken or worn down, germination is delayed. 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. Some common plants whose seeds require scarification to germinate are geranium, lupine, blackberries, honeylocust, and Kentucky Coffeetree. The following lab is an example of scarification.

Materials needed:

Large seeds that require scarification to germinate (honeylocust, Kentucky Coffeetree)
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.

 Name_____

Lab Sheet

Warm Germination Test

Purpose:

Students will determine the germination rate of a seed sample.

Materials:

Soybean, corn or other 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:

	Day 3		Day 5		Day 7	
	Seeds Germinated	**Percent Germination**	**Seeds Germinated**	**Percent Germination**	**Seeds Germinated**	**Percent Germination**
Bundle #1						
Bundle #2						
Bundle #3						
Bundle #4						
Total						