Model-Based Inquiry in Biology Three-Dimensional Instructional Units for Grades 9–12

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TASK 1. WHAT'S INSIDE A SEED?

Teacher Notes

Task 1. What's Inside a Seed?

Purpose

This task gives students an opportunity to learn more about the internal structure of a seed and what happens to the parts of the seed when it germinates. To accomplish this task, students dissect beans, seeds, and nuts and then watch several videos that show what happens to a seed when it germinates. These ideas help students understand how the life cycle of large multicellular plants, such as General Sherman, began as a small seed.

Important Content

The three main parts of a seed are the embryo, endosperm, and seed coat. The embryo is the most important part of the seed because it contains all the cells necessary to mature into a developed plant. The embryo field has three main parts: the primary root (radicle), endosperm, and embryonic leaves. Once germination occurs, the primary root is the first part to appear from the seed. The primary root provides a stable support system for the growing seedling. The endosperm supplies nutrients for the entire embryo during the process of germination. The embryonic leaves are the first leaves to emerge aboveground and are accompanied by the endosperm in order to receive all available nutrients until they are depleted. The seed coat, which can be thick or thin, is the outermost part of the seed and protects all the internal parts of the seed by preventing phys-ical, temperature-related, or water damage. The seed coat ensures that the internal parts remain inactive until optimal conditions are met for germination.

Scientific Ideas That Are Important to Think About During This Task

- · All seeds have similar structures inside. All seeds containing embryo, a seed coat, and
- Seeds begin to germinate (grow or develop) when water is added to them. The first structure

Timeline

Approximately one class period.

Materials and Preparation

The items needed for this investigation are listed in Table 1.3 (p. 36). You may purchase the see from a big-box retail store such as Walmart or Target or through an online retailer such as Amazon. Be sure to buy seeds intended for planting and not ones meant for consumption. The other materials may be purchased through a science education supply company such as Ward's Science, Flinn Scientific, or Carolina Biological Supply.

Teacher Notes

Item	Quantity
Safety goggles, nonlatex apron, and vinyl or nitrile glov	es 1 per student
Scalpel	2 per group
Hand lens	2 per group
Forceps	2 per group
Petridish	1 per student
Electronic scale	1 per group
Pinto bean seeds	4 per group
Lima bean seeds	4 per group
Kidney bean seeds	4 per group
Corn seeds	4 per group
Pine nuts (pine seeds)	4 per group
Sunflower seeds	4 per group
Pea seeds	4 per group
Computer or tablet with internet access	1 per group
500-ml beakers	7 per class
Paper towels	1 roll per clas
Student Handout	1 per student

This task has students explore seed german. rials list. Label one beaker for each type of seed, and then place use the beakers. Fill with water and soak the seeds for at least 24 hours before beginning this take percent class begins, simply drain off the water. Place the materials in a central location in the classroom the ortudents can get them during the task.

safety precautions:

- · Wear sanitized indirectly vented chemical-splash goggles, nonlatex aprons, and vinyl or nitrile gloves during setup, hands-on activity, and cleanup.
- Be careful with scalpels. They are sharp and can cut or puncture skin.

TASK 1. WHAT'S INSIDE A SEED?

- Use caution handling glass labware, which can shatter and cut skin or eyes.
- Never taste or eat any food items used in a lab activity.
- Clean up any spills on the floor immediately to avoid a slip or fall hazard.
- Wash hands with soap and water when the activity is completed.

Procedure This lesson plan is only a suggestion. It is included here to illustrate how you can facilitate student thinking during this task. We encourage you to modify this lesson plan by asking different questions, using different examples, and providing different scaffolds as appropriate to better meet the needs of students in your class.

Introduction of the Task (10 minutes)

- 1. Have students sit in groups of three or four.
- 2. Give each student one copy of the Student Handout for Task 1.
- 3. Read the Introduction and Initial Ideas sections of the handout aloud, having students follow along. It is a good idea to show a picture of General Sherman and seeds from a giant sequoia at this point in the lesson so students have the anchoring phenomenon of the unit in mind as they start this task.
- 4. Ask students to draw the structures that they think are inside a seed on their own on their handouts. Remind them to be sure to describe the functions of those structures in their pictures.
- 5. Give students an opportunity to share their pictures with the others in their group.
- 6. Ask one student from each group to share how their ideas about what is inside a seed and the functions of these structures were similar to or different from the ideas of others in the group.

Making Observations and Taking Measurements (30 minutes)

- king Observations and Taking Measurements (30 minutes)
 1. Read the section of the handout called Your Task aloud to students.
 2. Show them the available materials and ask how they might use some of the equipment, such as the scalpel, petri dish, and electronic scale. Don't be afraid to offer some suggestions, but do not require that every group do everything the same way. Give them a DIICAR choice.
- 3. Go over the safety precautions for this task.
- 4. Give students about 15 minutes to dissect the seeds. Have them record what they observe or measure on their handouts.
- 5. As students work, move from group to group and check in with them. It's important to ask them questions that will help them connect what they are doing to the goal of the task and the anchoring phenomenon. (See the Back Pocket Questions for Task 1 on pages 38-39 for some suggestions.)

Teacher Notes

- 6. Ask students to clean up their workstations and return the materials. Be sure to keep the dissected seeds. Students will use the dissected parts in Task 2.
- 7. Give students about 10 minutes to watch the three videos of seeds germinating. Remind them to record what they observe on their handouts.

Putting Ideas on the Table (10 minutes)

1. Give an interactive lecture to introduce some ideas that students might find useful for naling sense of what they did. We recommend, as a minimum, introducing the following ideas

- · Names of the three main parts of seeds: the embryo, endosperm, and seed coat (but not the functions of these structures).
- Names of different parts of seedlings, such as roots, stem, and leaves (but not the functions of these structures).
- · The idea that trees are multicellular organisms, which, like all multicellular organisms, are a system of interacting subsystems. These subsystems are groups of cells that work together and are specialized for particular functions.
- 2. Encourage students to keep a record of the ideas they find important in the section called Some Useful Ideas From My Teacher on the Student Handout so they can refer to them later in the unit. Remember, your goal here is to put some ideas on the table to help your students make sense of what they are seeing and doing, not to tell them what they should have learned.

Adding Information to the Summary Table (10 minutes)

- 1. Give students 5 minutes to decide what to add to the Summary Table at the end of the Student Handout.
- 2. Have one student from each group share what the group figured out, how they know (their evidence for what they figured out), and how this information will help them
- explain the anchoring phenome. Once each group has shared, ask the entire class to decide wine column of the class Summary Table for Task 1. Help students reach consensus about what to add to the Summary Table. Only add an idea to the Summary Table if everyone the class agrees with that idea. 3. Once each group has shared, ask the entire class to decide what should be added to each

Back Pocket Questions

As students work in groups, it is important to engage with each group to help press and extend students' thinking around the ideas at play in this task. Following are some example questions you might ask:

1. Helping students get started: What parts of the seed are you seeing? What do you think they do?

Unit 1. From Molecules to Organisms

TASK 1. WHAT'S INSIDE A SEED?

- 2. Pressing further: This seed will eventually be a larger plant. How do you think the parts of the seed you're seeing become a large plant?
- 3. Following up: What makes you think that? Can you say more?

Filing Out the Summary Table

Table 1.4 includes examples of the responses students may come up with when they fill out the Summary Table. This is provided here only as a behind-the-scenes roadmap and is not meant to be shared with students.

Table 1.4. Example Summary Table for Task I

What we learned	How it helps us explain the phenomenon			
All seeds have similar structures inside. All seeds contain an embryo, seed coat, and endosperm. Seeds begin to grow (germinate) when water is added to them. The first structure to appear is roots. The next structures are a stem and small leaves	General Sherman only needed water to start growing. The embryo inside a tree seed increases in size once it germinates and becomes a seedling, and the endosperm gets smaller.			
4				

Hints for Implementing This Task

- s for III... As mentioned earlier, it IS III... consumption! Students may have experience with germinating seeds... great place for a student with specialized knowledge to share **Descible Extensions** Additional seeds, including large tropical seeds, can be used to show diversity in seed struc-ture. Coconuts are the largest seed in the world! Or of upplication

Possible Extensions

Student Handout

TASK 1. WHAT'S INSIDE A SEED?

Introduction General Sherman is the largest tree in the world. A tree, like all multicellular organisms, is a sysof the reproductive system of trees, as in most plants, is to produce seeds. To explain how General Sherman got so big, you will therefore need to first figure out what is inside a seed and what happens to the parts of a seed when it germinates. This is important because the function of a living

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things to *plan and carry out an investigation* to determine what is inside a seed and what happens to the parts of a seed when it germinates. To accomplish this task, you will cut open and examine the contents of at least six different kinds of seeds. You will then watch a time-lapse video of a germinating seed. Be sure to keep track of anything you observe or measure as you work in the Observations and Measurements section of your handout.

Unit 1. From Molecules to Organisms

TASK 1. WHAT'S INSIDE A SEED?

Available Materials

You and your group may use any of the following materials during this task:

- Safety goggles, nonlatex apron, and
- Scalpel Fland lens vinyl or nitrile gloves (required)

 - Force
 - Petri dish
 - Computer or tablet with internet access
 - Electronic scale

- Pinto bean seeds
- Lima bean seeds
- Kidney bean seeds
- Beakers
- Corn seeds
- Pine nuts (pine seeds)
- Sunflower seeds
- Pea seeds
- Paper towels

Safety Precautions

Follow all normal lab safety rules. In addition, be sure to take the following safety precautions:

- Wear sanitized indirectly vented chemical-splash goggles, nonlatex aprons, and vinyl or nitrile gloves during setup, hands-on activity, and cleanup.
- Be careful with scalpels. They are sharp and can cut or puncture skin.

Be careful wind
Use caution handling glass inc.
Never taste or eat any food items used in a ...
Clean up any spills on the floor immediately to avoid a since.
Wash hands with soap and water when the activity is completed.

Observations and Measurements
Use the space below to keep a record of what you observe or measure as you work with the seeds.
Or or principal of the second of the space below to keep a record of what you observe or measure as you work with the second.

Activity Watch the following and begin to grow: www.youtube.com/watch?v=sMK-BKUYM0s&t=16s www.youtube.com/watch?v=w77zPAtVTuI&t=7s www.youtube.com/watch?v=Y6vgAnMhGxs&t=6s Watch the following videos to see what happens to different types of seeds after they germinate A new d of what you note. A new d of what you n

Unit 1. From Molecules to Organisms

TASK 1. WHAT'S INSIDE A SEED?

