Kentucky Soybean Board

Kentucky Agriculture & Environment in the Classroom, Inc.

KADF
KENTUCKY AGRICULTURAL DEVELOPMENT FUND

SOYBEAN SCIENCE

Let's Learn About Germination, Plant Life Cycles, and Structures

All About Soybeans

Soybeans are one of Kentucky's top cash crops because they provide a good source of protein and oil. The beans are often crushed into meal for livestock feed, and the oil can be used in many ways. Soybeans are also important for crop rotation since they are a legume and can fix their own nitrogen. This reduces the amount of fertilizers that need to be applied to the soil.

History

Soybeans originally came from China, where they had been grown for thousands of years. Americans began growing them in the mid-1800s, and they are now grown across the United States, as well as the world.

Soybeans in Kentucky

Some Kentucky farmers plant soybeans in May and harvest them in September. If they have a crop of winter wheat or other cool-season grain, however, farmers will harvest the wheat in June and immediately plant soybeans in the same fields. Harvest is delayed until October or November, but this allows farmers to grow two crops in one year on the same land. The practice is called double-cropping. Once soybeans are harvested, they may be sold to a soybean processing plant or a grain elevator that will transport the soybeans to where they are needed. Many of Kentucky's soybeans are exported and shipped around the world to feed people and livestock.

Soybean Uses

The soybean is high in oil (20 percent) and is the only bean that is considered a complete protein (40 percent) containing all the essential amino acids. This nutrition factor makes it a healthy choice for both humans and animals.

Whole soybeans can also be processed into soy milk, soy sauce, soy flour, tofu, tempeh, and miso. If the oil is extracted for food and industrial uses, the remaining protein, fiber, and carbohydrates are processed into soybean meal. Most U.S. soybean meal is used to feed livestock. Poultry consume the most soybean meal in Kentucky, but it is also fed to pigs, beef cattle, dairy cattle, horses, and fish, among other animals.

Soybean oil is one of the leading vegetable oils used worldwide and can be found in many American food products:

- Coffee Creamers
- Bakery Products
- Cooking Oils, Shortenings, and Sprays
- Candies
- Margarine
- Chocolate Coatings
- Mayonnaise and Salad Dressings

Soybean oil is also used to make soy lecithin, which makes chocolate and other foods smooth and creamy.

Renewable soybeans are also used in many industrial products such as biodiesel fuel, particle board, soaps and cosmetics, printing inks, and protective coatings on CDs and DVDs.

Kentucky Academic Standards

NGSS

4. Structure, Function, and Information Processing

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

What's In a Soybean?

Seed and Plant Structures for 4th Grade & Secondary Plant Science

Purpose:

Students will develop an appreciation and understanding of the natural development of seeds, learn the anatomy and function of each seed part through a seed dissection, and classify seeds as monocots or dicots.

Estimated Time: Three 30-minute sessions plus a week of observation

Resources & Materials Needed:

- Digital Google Slide Presentation "What's In a Seed?" Located at www.teachkyag.org/lessons/soybean-structures
- Hand lens
- Corn seeds and raw pine nuts (optional)
- Dish of water for soaking
- Seed structures activity sheet 1 & 2
- Optional Resources:
  - Kentucky Farms Feed Me Virtual Field Trip to a Soybean Farm
  - Soy-The Miracle Bean informational poster
  - Soybean Facts
  - Soybean Ag Mag
  - *Full of Beans: Henry Ford Grows a Car*

Vocabulary Words:

seed: made within the flower through reproduction, a seed contains the material to grow a new plant

seed coat: protective outer covering of the seed

embryo: the "baby" plant inside a seed

cotyledon: food supply for the embryo to grow. The cotyledon, which is a mix of starches, oil, and protein, is the largest structure of the seed

monocot: a class of plants that contains only 1 cotyledon

dicot: a class of plants that contains 2 cotyledons

hilum: place where the seed attaches to the seed pod

micropyle: small hole under the hilum where water enters the seed

Kentucky Soybean Board

Looking for more soybean learning fun?

The Kentucky Soybean Board has soybean science kits available for teachers to borrow. The kits are designed for grades 4-9 and align to many Kentucky Academic Standards.

Visit https://kysoy.org/education to learn more about the kit and find additional lessons.

All About Seeds

What is inside of a **seed**? A new plant? Maybe a new tree? Will your students believe you? Seeds have the potential to grow into productive plants. How can such a small package contain such potential? This lesson contains a simple yet enlightening activity you can do with your students to help them understand seeds and seed development.

Seeds have many uses. Some seeds can be eaten, like sunflower seeds, pumpkin seeds, peanuts, and coconuts. We can extract oil from some seeds and grind other seeds to make flour. Seeds are used to grow fruits and vegetables to eat, as well as flowers, trees, and other plants that we enjoy in our surroundings. Seeds are all around us.

Most seeds can be stored for a long time and kept in a dormant or nongrowing state. Each seed contains all the genetic information for the plant it can grow into. Once a seed is placed in the proper environment, it will germinate and begin to grow. Proper temperature and moisture are critical for a seed to germinate.

Flowering plants and their seeds can be classified into two groups: **monocots** and **dicots**. The number of cotyledons (seed leaves) distinguishes whether a seed is a monocot or dicot. Monocots have one cotyledon and dicots have two. In most dicot seeds, the cotyledons store the food that the seed will use to grow until it gets its first true leaves and begins to make its own food. In many monocot seeds, the food supply for the embryo is stored separately in tissue called the endosperm. The cotyledon absorbs and transmits the food from the endosperm to the embryo.

Generally, when monocots germinate and begin to grow, a single leaf will emerge from the soil. Monocot plants are characterized by having parallel veins and thin, strap-like leaves. Examples of monocot plants include grass, daylilies, corn, and coconuts.

Dicots generally emerge from the soil with more than one leaf. Many dicots' cotyledons emerge from the soil, turn green, and perform photosynthesis. These types of seedlings are the easiest to recognize as dicots because they have two leaves (the cotyledons) that look different from the leaves of the mature plant. Dicot plants have veins that form a net-like pattern across the leaves. Most flowers and fruit and vegetable plants are classified as dicots.

Botanists classify or categorize plants to make it easier to study and understand them. There are hundreds of thousands of different plant species, so it would be very difficult to study them all. Breaking them up into smaller groups with similar characteristics helps organize the way we study and think about plants. Not all plants are classified as monocots or dicots—this is a classification used only for the group that botanists call flowering plants. Older plants that developed earlier in the history of Earth are classified differently, although they have some similar parts. Ferns and pine trees are examples of plants that are not flowering plants and therefore are neither monocots nor dicots. It is interesting to compare pine nuts to monocot and dicot seeds because they have similar parts, but pine nuts have more than two cotyledons (the cotyledons of the pine nut look like the "leaves" of the embryo).

Five parts of a seed are discussed in this lesson: the **seed coat**, the **cotyledon**, the **embryo**, the **hilum**, and the **micropyle**. Almost all seeds have these parts whether they are monocots, dicots, or neither (e.g., conifers like pine and spruce trees). The seed coat is the outer covering, which provides protection for the seed. The seed coat can be thin, like on a bean seed, or thick and hard, like on a pine nut or coconut. The food supply is a large part of the seed that contains the nutrients and energy that the embryo will use to grow. In dicots, the cotyledons generally contain the food supply. In other seeds, the food supply is separate from the cotyledons and is commonly called the endosperm. The purpose of the food supply is to nourish the embryo. The embryo is the "baby" plant, or the portion of the seed that will develop into the seedling's leaves and roots.

In soybeans, the hilum (where the seed attaches to the inside of the pod) and the micropyle (small hole under the hilum where water enters the seed) are quite noticable. The micropyle is not visible with the nake eye in monocots.

Interest Approach - Engagement

Play a guessing game with your students. Tell them that you will give them a series of clues. As they hear the clues, they will guess the item you are thinking of. Give the following clues until the students guess, "seed."

- It is used to make oils that we use in cooking.
- They are usually smaller than a coin.
- They are made inside of a flower.
- They can be stored for a long time until they are ready to be used.
- They can grow into a plant.
- Some are eaten.

Then share slides 1-5 of the slide presentation.

Procedures

Activity 1: Seed and Young Plant Dissection
DAY 1

1. Have students create a soybean germination greenhouse. They will observe and dissect the young seedling in a week.
2. Use slides 6-16 and follow the directions to create the greenhouses in your soybean seed science kit and have students write their names on their bag. You may want to make several more in case the seeds do not germinate. Have students remind you what seeds need to germinate.
3. Place the bags in a box or drawer for the few days. Tape them to a window or lighted wall to allow students to observe them for the last few days. Soybean seeds do not need light to germinate, but they will begin searching for light soon. **OPTIONAL:** Have students draw their seeds each day in their science journals and explain what is happening during the germination process.
4. Place several more soybean seeds in a dish of water for 24 hours at room temperature. You may also choose to soak corn seeds and pine nut seeds so they may compare different types of seeds.

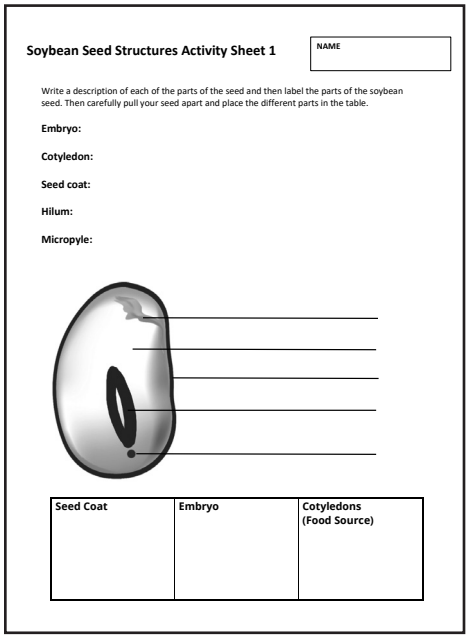
DAY 2

1. Provide students a copy of **Seed Structures Activity Sheet 1**.
2. Use slide 17 to show students the parts of a seed. Have them label the diagram on their activity sheet and write the functions of the seed coat, food supply, and embryo.
3. Drain the seeds from Day 1 Step 4 and pass out one of each seed to students. Follow the instructions on the next page to dissect each seed. Have students place each dissected seed part in the labeled box at the bottom of the activity sheet.

This lesson was adapted by Farm Scholar, LLC for Kentucky Agriculture and Environment in the Classroom from a lesson created by Debra Spielmaker (Utah Agriculture in the Classroom).

Did You Know?:

- A Coco-de-mer palm, aka double coconut, produces the largest seed. It can weigh up to 40 pounds!
- The smallest seeds can be the size of a speck of dust.
- Seeds can sense gravity and will always grow up.



Soybean Seed Structures Activity Sheet 1

NAME

Write a description of each of the parts of the seed and then label the parts of the soybean seed. Then carefully pull your seed apart and place the different parts in the table.

Embryo:

Cotyledon:

Seed coat:

Hilum:

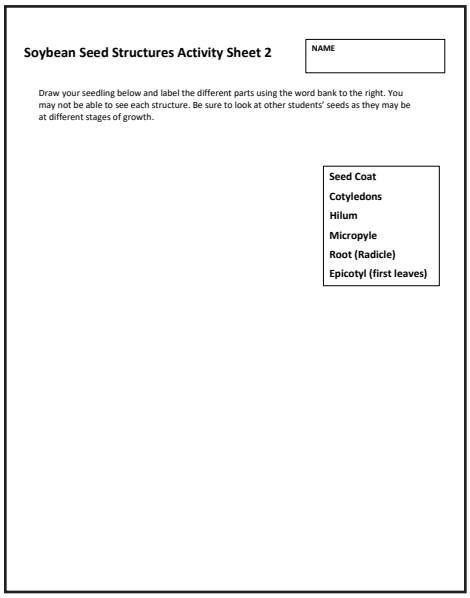
Micropyle:

Seed Coat	Embryo	Cotyledons (Food Source)

- **Bean Seed:** Carefully have students remove the bean seed coat, which, before the soaking, protected the seed food source (cotyledons) and the embryo, which will become the new plant. Next, have the students gently split the bean seed—the two halves are the two cotyledons. This is where the bean seed stores the food that is used for growth until it gets its first true leaves and begins to make its own food. The students should be able to see a little lump near the edge of one cotyledon. Don't touch it yet! Carefully study this lump (a hand lens may be useful). This is the embryo—the new plant! If students look closely, they should see the delicate, translucent leaves. Finally, instruct them to separate the embryo from the cotyledon, place it on a flat surface, and look to see not only the leaves, but also the embryonic roots.
- **Corn Seed:** For contrast, ask the students to try to open the corn seed. You'll probably see a lot of students squish their seeds, but if they carefully remove the seed coat, and then press their fingernail into the endosperm, the cotyledon and the new embryo can be removed.
- **Pine Nut:** Finally, perhaps the most interesting seed to dissect is a pine nut. Ask students to gently remove the seed coat. They may have to crack this with their teeth. Next, tell them to push their fingernail through the food source and gently open it to see the embryo—a baby tree.

4. Students should now have three seed coats, three food sources, and three seed embryos in the corresponding boxes of their activity sheets. Use glue or tape to attach them.

DAY 7


Soybean Seed Structures Activity Sheet 2

NAME

Draw your seedling below and label the different parts using the word bank to the right. You may not be able to see each structure. Be sure to look at other students' seeds as they may be at different stages of growth.

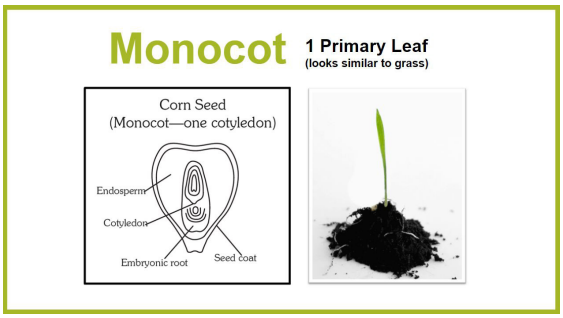
Seed Coat
Cotyledons
Hilum
Micropyle
Root (Radicle)
Epicotyl (first leaves)

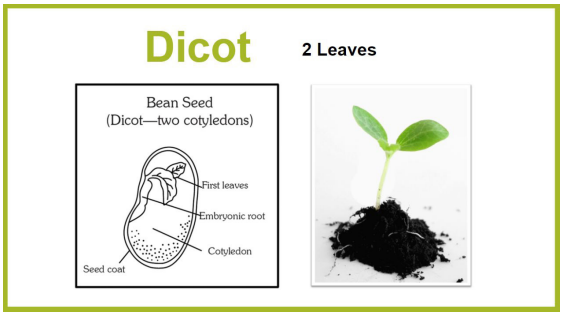
1. Provide each student a Soybean Structures Activity Sheet 2 and their seed greenhouse.
2. Have them carefully remove the paper towel with the small seedling on top and then remove the seedling. The roots may be attached to the towel, so ask them to be very gentle while removing it. They should then place the seed on the activity sheet. If the seed coat is still attached to the cotyledons, you can also have them carefully remove it and place it next to the seedling on their paper. Tweezers may be helpful.
3. With the hand lens, have them observe the different parts of the seedling to see if they can match the seedling parts to the seed drawings in the slide presentation (slides 20-21).
4. Ask students to draw a larger representation of their seedling and then label the different structures. Encourage students to look at others' seeds and drawings as they may be at different stages of growth.
5. Summarize what the students have learned. Aren't seeds amazing! We don't think about what is inside a seed when we eat them, but given the right conditions, seeds truly are a miracle with the potential for life and the ability to sustain lives—like yours and mine. Review by asking these questions:
    - What are seeds used for?
    - Do we eat any seeds or are they used just to grow new plants?
    - Which part of the seed is the outer covering that protects the inside?
    - Which part of the seed is the largest, and what is its purpose?
    - Which part of the seed will grow into the new plant?

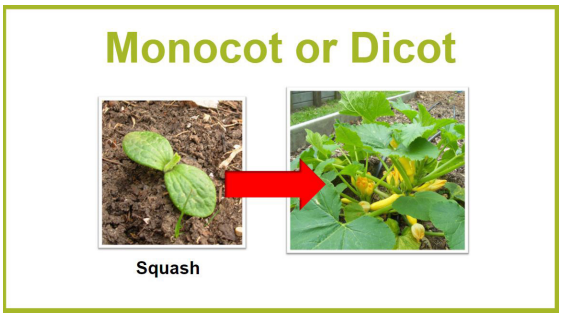
OPTIONAL: Ask students to the complete the **Soybean Germination Worksheet** as an assessment. They will explain what is happening during the germination process using the new terms they have learned.

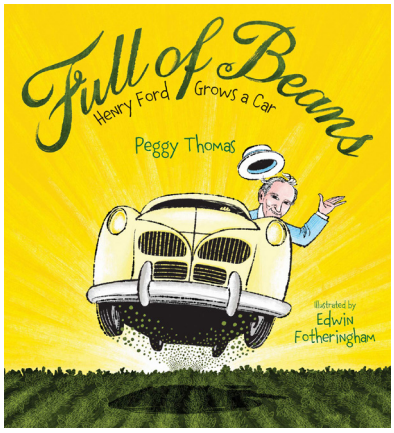
Activity 2: Monocots and Dicots

1. Tell your students that most seeds can be classified into two groups: monocots and dicots.
2. Break the words into smaller pieces to define. Mono=one, di=two, and "cot" is short for cotyledon. Therefore, a monocot seed has one cotyledon and a dicot seed has two cotyledons. Tell students that corn is a monocot and beans are dicots. Discuss the differences they observed between the corn and bean seeds they dissected. Use the information provided in the Background section of this lesson to discuss the differences between monocots and dicots.
3. Beginning with slide 24 of the slide presentation, show students the diagrams and examples of monocot and dicot seeds and seedlings.
4. Have students apply their knowledge and identify the next eight plants on the slide presentation as monocots or dicots. Each slide shows the seedling just after it emerges from the soil as well as the mature plant that the seedling will become. If there is one single leaf on the seedling, it is probably a monocot. You can also identify monocot plants by their long strap-like leaves that are similar to grass. If the plant is a dicot, the seedling will probably have two leaves. Use a method of formative assessment to identify the plants in the slide presentation. For example:
    - Have all students stand in the center of the room. Instruct them to go to the far left of the room if the plant is a monocot and to the far right of the room if it is a dicot. Show students the picture, identify the correct answer, and continue to the next plant following the same procedure.
    - Use student response boards (white boards or chalk boards). Instruct students to write, monocot or dicot on their response boards and hold them up.
    - Pass out a sheet of scrap paper to each student. Have them write monocot on one side and dicot on the other. Ask students to hold up the correct answer as you show the picture of each plant.









Full of Beans: Henry Ford Grows a Car is a great book to showcase the many ways soybeans can be used to make many non-food products.

Soybean Seed Structures Activity Sheet 1

NAME

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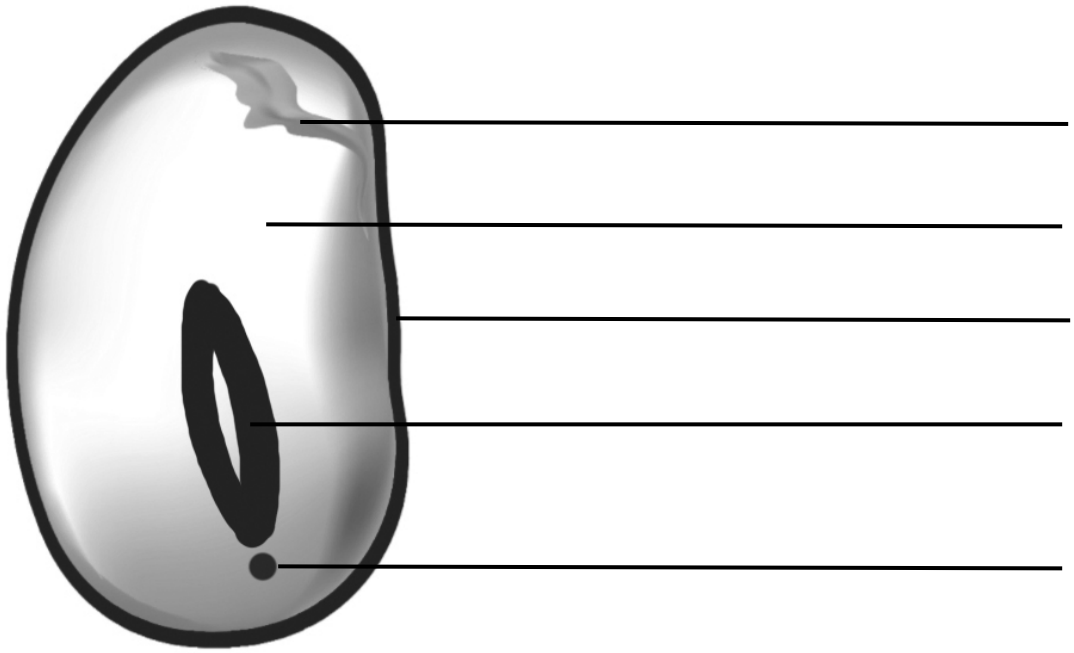
Cotyledon:

Seed coat:

Hilum:

Micropyle:



Seed Coat	Embryo	Cotyledons (Food Source)

Soybean Seed Structures Activity Sheet 2

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