

Lesson 2

Seeds

Note to the Teacher: For the first portion of this lesson, you will need a magnifying glass, a sunflower seed, and several bean seeds. Begin soaking a few of the bean seeds in hot water 30 minutes before you begin the lesson.

Did you know that inside every seed is a tiny living thing? That living thing is a little baby plant, fast asleep. A baby plant doesn't sleep the way you and I do. It is a different kind of sleep. We say that the plant is **dormant**. The word dormant comes from the Greek word **dorm**, which means **to sleep**. The baby plant stays dormant until it gets what it needs to wake up. When it wakes up, it begins to grow into a little plant called a **seedling**. When it does this, it uses all the soft fleshy material inside the seed for food until it is ready to make food on its own using sunlight, water, and air.

What do you think the baby plant needs to wake up? Make some guesses. There are really only three things the baby plant needs to wake up: warmth, water, and air. You might think that it

needs soil, but it doesn't. The plant will not use the chemicals found in soil for a few days or weeks, because the seed itself has everything it needs to begin growing. You might think that a baby plant needs sunlight to wake up and begin growing, but it doesn't. In fact, many seeds begin growing underground where there is no sunlight at all. A seed only needs warmth, water, and air to wake up. Later on, it will begin to need sunlight. If there is sunlight present, the plant will use it to grow nice and healthy. If there is no sunlight present, the plant will grow anyway, but it will grow differently. It won't be as



Each of these sunflower seeds contains a baby plant, the plant's food, and a protective coating. The seeds need only warmth, water, and air to begin to grow into beautiful sunflowers.

healthy. Its stem will grow longer and longer, searching for sunlight. If it never finds the sunlight, it will eventually die, because it needs light to make food for itself once the food in the seed runs out.

When the temperature is just right and there is water and air present, the baby plant begins to emerge from inside of the seed. If the temperature is not warm enough, or there is no water or air, the baby plant will stay snuggled inside its seed, fast asleep. Do you ever feel like staying in bed under your covers? A baby plant will stay under its covers until it has what it needs to grow.

Sometimes, a baby plant sleeps for a few weeks inside its seed. Can you imagine sleeping for a few weeks? Sometimes, a baby plant can sleep for years! Believe it or not, it can even sleep for thousands of years, if it must! Now that's a long sleep, isn't it? How do we know that a baby plant can sleep for thousands of years inside its seed? Well, there was once a king in Egypt named Tutankhamen (toot' un kah' muhn). We call him King Tut. He lived about 1,300 years before Jesus was born. That was more than 3,000 years ago! One day, not so very long ago, scientists found King Tut's tomb. Do you know what a tomb is? A tomb is a place where people bury their dead. Inside the tomb was a jar of bean seeds! The baby plants inside the bean seeds had been dormant for more than 3,000 years! Do you think they could still grow after all of that time? Well, the scientists took them home and planted them, and guess what? They grew! They grew into lovely bean plants. The bean plants even made seeds that grew into new bean plants. To this day, there are people growing bean plants that originally started with King Tut's bean seeds!



King Tut's burial mask was recovered from his tomb.

Seeds are one of God's most special and important creations. It is amazing that inside of every seed is a baby plant waiting to awaken and become a grown plant. The baby inside the plant is called an **embryo** (em' bree oh). Did you know that you were once an embryo? When you were inside your mother's womb, you were a little embryo. Of course, you weren't a plant embryo, and you didn't act like one either! You weren't dormant; you were wide awake most of the time. You were actively moving, jumping, and kicking. As you grew, you opened your eyes, sucked your thumb, and even had the hic-ups every now and then. There was a certain time when you would come out. No matter what, you were coming out in about nine months. There was no way you were going to wait 3,000 years before you came out into the world!



You were an embryo while you were growing in your mother's womb.

God created humans and plants very differently, but we see the signs of the same Creator in both humans and plants, don't we? We all begin as embryos, and we all begin protected inside something. Your mother's womb protected you when you were an embryo. What protects a plant embryo? Can you guess? Did you guess the shell of the seed? That's right, and now it's time for you to learn more about a seed's shell.

Testas

If you have a bean seed and a sunflower seed, get them now. Look at the shells of your seeds. The shell, or coat, of a seed is called the **testa** (test' uh). The testa protects the embryo, much like a winter coat protects a person from a cold winter's chill. What color is your winter coat? Wouldn't it be strange if everyone in the world had the exact same coat? That would be kind of boring, wouldn't it? Well, God must not like things to be boring, because He gave different coats to every seed He made. This means each plant's seed has a different testa.



Look at your sunflower seed. What color is its testa? Is it striped? Is your coat striped? What color is the bean seed's testa? Do you know what an acorn testa looks like? An acorn has a little "hat" to go along with its winter coat, doesn't it? Have you ever seen the seeds that a palm tree makes? They are called coconuts, and they have a very interesting testa! Testas come in all different shapes, sizes and colors. Seeds from some plants have thin testas, like a spring jacket. Seeds from other plants have testas that are thick and strong, like an Eskimo's coat. The walnut seed's testa is wrinkly and very strong. Coconut seed testas are strong, brown, and "furry." Corn seed testas are thin, smooth, and yellow. Lima bean testas are thin, smooth, and white. God designed so many interesting testas when He filled the world with seeds. Do you remember the seeds that you planted in your light hut? What did their testas look like? Were they all the same shape? Were they all the same color? Were they all the same size?



A coconut is the seed of a palm tree. Its testa is brown and "furry."

Take Off Your Coat!

When your coat gets wet or when it's warm outside, do you take it off? Well, that's what the seed does when its coat gets wet and warm. When the seed is soaked in water, such as after a warm spring rain, the testa gets waterlogged and soggy. The testa then comes off, and the sleeping embryo gets the water.

Look closely at the bean testa with a magnifying glass. In the curve of the bean seed there is a little "scar." That's the seed's belly button! Every seed has a belly button. It's actually called a **hilum** (high' lum), and it is where the seed was attached to its mother. You have a belly button as well, and it is also the place



where you were attached to your mother. Can you find the hilum on the sunflower seed? It's not on the pointed part; it's on the other side of the sunflower seed.

What Do You Remember?

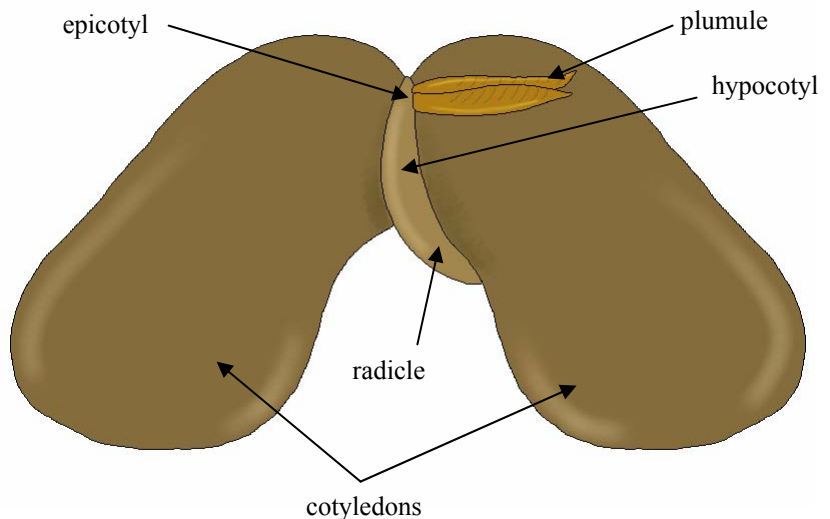
What is a seed? What does “dormant” mean? What does a seed need to wake up and begin growing? What is the baby plant in a seed called? What is the seed's testa? What does it do? What is the hilum on a seed?

Activity Open a Seed

Would you like to see a plant embryo for yourself? Do you have a bean seed that has been soaking in warm water? If so, get it now. Examine the seed. Do you see how wrinkled the testa is? It is wrinkled because it absorbed water and began to detach from the seed. This allowed the water to get into the seed so that the embryo could begin to grow.

Now pull apart your seed very slowly and carefully. If you were very careful, you will see a tiny growth inside of the seed. Look closely. Doesn't it almost look like a tiny plant? That is part of the embryo! Study it with a magnifying glass.

There are five main parts to the embryo in your seed: the **cotyledons** (kot' uh lee' dunz), the **radicle** (rad' ih cul), the **hypocotyl** (hi' puh kot' uhl), the **epicotyl** (ep' uh kot' uhl), and the **plumule** (ploom' yool). Can you find and point to these parts on your embryo? You might not be able to see the plumule, because it might have been broken off when you pulled the seed apart. Now that you know the five main parts, you can learn a little bit about what these parts do.



This is a drawing of the inside of a bean seed. The insides of other seeds can look different from this, but it is a good example.

Inside the Seed

The **cotyledons** are the biggest part of this embryo. They have a special purpose. They provide food for the embryo once the seed opens and the embryo starts growing into a plant. To grow, the embryo needs food, and it gets that food from the cotyledons until it can start making food for itself. You will learn about how a plant makes food for itself later. It is important for you to understand that you are looking at what is called a “mature seed.” That means the seed can sprout as soon as it gets the water, warmth, and air that it needs. When the seed is attached to its mother plant (remember the hilum, where it attaches to its mother?), it is not yet mature.

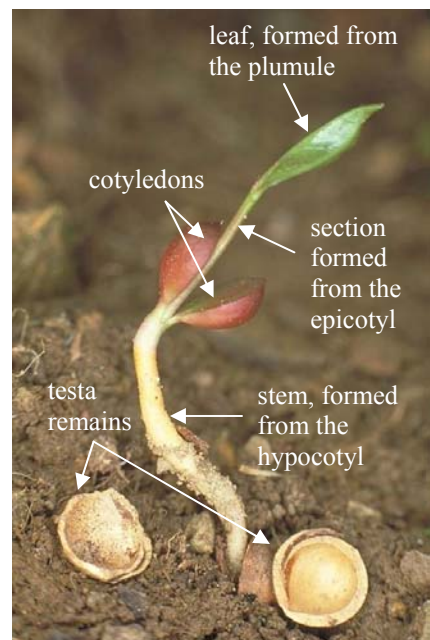
What’s the difference between a mature seed and an immature seed? In bean seeds, one big difference is the cotyledons. When the seed is immature, its cotyledons are small, and it has an **endosperm** (en’ doh spurm). The endosperm is food for the embryo, but the embryo cannot eat it. To help the embryo eat the food, the cotyledons absorb the endosperm. This causes the cotyledons to grow into the biggest part of the embryo. When the seed finally opens and the embryo begins to grow, the cotyledons give it the food that they have absorbed.

Now remember, God made a lot of different kinds of seeds. Not all of them look like bean seeds. In some seeds, the cotyledons do not absorb the endosperm right away. Instead, they start to absorb the endosperm after the seed has opened. Then, they pass the food immediately to the embryo. In those kinds of seeds, the cotyledons are much smaller than in the seed that that you have been looking at, and the endosperm is there as a separate part of the seed.

The **radicle** is the embryo’s root. It grows into the plant’s root. When the radicle grows, it makes tiny little hairs. Those hairs are not hairs like you and I have; they are little fibers that go searching for water, oxygen, and nutrients. When they find these things, they absorb them and send them into the rest of the plant. You will do an experiment in a moment where you will get to watch the radicle grow and see these tiny little hairs.

The **hypocotyl** will become the stem. It will elongate (that means grow longer) and go searching for light if none is present. If light is present, it doesn’t have to grow as long, so it will grow thicker. If no light is present, it will elongate further, hoping that by growing longer, it will reach light.

The **epicotyl** is the top of the embryo. It holds the **plumule**, which will become the first true leaves of the plant. Why do I say “true leaves?” Well, when the embryo begins to



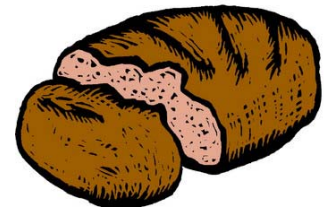
This is a picture of a plant sprouting.

grow, the cotyledons actually look like leaves as well. They are not as green as the true leaves, but they look very similar to leaves. Because of this, some call the cotyledons the first leaves of the plant. However, they are not true leaves. **Plumule** is a Latin word that means **feather**. The plumule of your bean seed kind of looks like feathers, doesn't it?

Not all epicotyls have a plumule (leaves that have already developed). Most embryos do not have their true leaves when they are an embryo, but the bean embryo does. Have you ever seen a baby born with teeth? It doesn't happen often, but when it does, it's a big surprise. Usually the teeth don't grow in until a lot later. Well, that is what it's like for the bean plant. It already has its first true leaves, even though most plant embryos do not.

Since the bean plant starts out with its true leaves already developed, that gives it a head start on growing. After all, the leaves are a vital part of the plant. They actually make food for the plant. Why would God design one kind of seed to have a head start on growing? Most likely, it is because beans have a lot of protein. Protein is a very important nutrient that we must eat to stay healthy.

In Ezekial 4:8-13, we read that God told the prophet named Ezekiel to lie on the ground and eat only a certain kind of bread every day for more than a year. That bread was made with beans and other ingredients, and it provided all the protein he needed to live during that whole time. This shows us that beans are a good source of protein. God made beans so that they grow easily. They can grow in the coldest places and even with only a little water and light. It's not by accident that beans are easy to grow and that they are so healthy for us. God designed it that way to take care of us in difficult times of drought. In this way, God shows us His love and care with the simple little bean seed.



Beans are important seeds to have. If our food was ever difficult to get, but we had bean seeds, we could grow them and nourish our family. You may want to begin a seed collection. If you do, be sure to collect bean seeds!

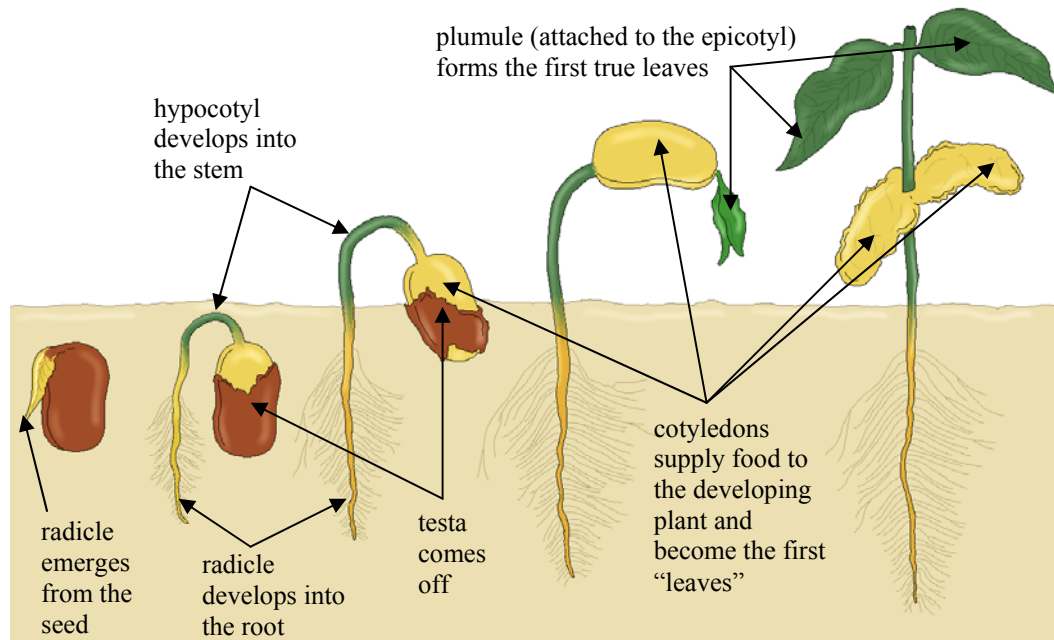
Tell someone everything you can remember about the insides of a seed.

Germination

When water surrounds the seed, the testa loosens, just as you saw in the seed that you had been soaking. Water then gets inside the seed, and the embryo wakes up! This starts a process called **germination** (jur' muh nay' shun).

The radicle is the first thing to push its way out of the seed. After that, the hypocotyl and epicotyl poke out. They must go straight up through the dirt and break through the surface of the soil.

Now remember, the hypocotyl becomes the stem, and the epicotyl holds what will become the first true leaves of the plant (the plumule). In between the epicotyl and plumule, you will find the cotyledons. They come out of the soil with the plant, looking a lot like leaves. We often call them **seed leaves**. It's truly amazing that the cotyledons inside the seed transform so quickly into what look like leaves! The drawing below shows you how this process happens.



Do you remember what a seed needs to germinate? It needs warmth, air, and water. Do you remember that it doesn't need soil? Soil is filled with chemicals that the growing plant will need to stay healthy, so why doesn't the embryo need soil when it begins to germinate? Remember that all the nutrition it will need for several days is packed within the seed's endosperm. In some seeds, like your bean seed, the cotyledons absorb the endosperm. That means the cotyledons have all of the nutrition that the baby plant will need for several days. In other seeds, the cotyledons just absorb the endosperm as the baby plant needs the nutrition. Either way, all of the nutrition that the baby plant needs starts in the endosperm and ends up going through the cotyledons to the baby plant.

Can you guess what kind of food the endosperm is filled with? What is your very favorite thing to eat? Ice cream? Cake? Cookies? Whatever it is, it just might have some sugar in it. Well, guess what? The endosperm also has sugar in it! It has other nutrients that the plant needs as well, but it definitely has sugar. This is not the same kind of sugar you enjoy eating, but it is still sugar. Plants love sugar! They love sugar even more than you, because they cannot live without sugar. It is their food. It is so important to plants that God has designed them to make it themselves inside their leaves. What if you made sugar inside yourself that you could eat all day long?

Since God created plants to make their own food, they don't eat other plants to survive the way we do. They also don't eat animals to survive the way we do. We (and most of the creatures in

creation) depend on other life forms to survive. We consume other parts of God's creation to live, so we are called **consumers**. Plants produce their own food, so they are called **producers**.

What Do You Remember?

Describe germination. What is the top part of the embryo called? What are the feather-like leaves on the embryo called? Where is the embryo's root, and what is it called? What is the nutrition within the seed called before it gets absorbed by the cotyledons? What is the testa? Explain how the testa comes off for germination. What is a producer? What is a consumer? Are plants producers or consumers? Are people producers or consumers?

Notebook Activities

Create a page for this lesson in your notebook. Make an illustration of the different parts of a seed. Use your seed as an example. Label the parts on your illustration. Place your illustration in your notebook.

Older Students: Write down all that you remember about seeds in your notebook.

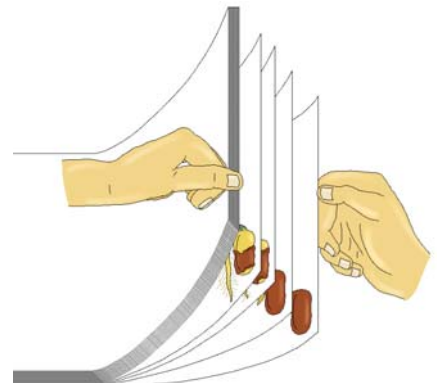
Younger Students: Tell your parent / teacher all that you remember about seeds so that she can write it down in your notebook.

Design a Coat

Do you remember what a seed coat is called? It's called a testa. We learned that there are many different colors and types of seed coats. I would like for you to design a special seed. Make the seed coat the color and pattern you would like to have if you were a seed. What kind of plant would your seed produce? Where would it grow? What would you name it? Put your drawing in your notebook.

Make a Germination Animation

Have you ever made a flip book? It is simply a notepad with pictures drawn in the bottom corner. The pictures show the same thing in changing positions or with changing features. If you position your hand so that it can flip through the book quickly, showing the pictures one after another at a very fast pace, it looks like your picture is moving. This is a simple version of how they make animated movies. In this activity, you are going to make a flip book of a seed germinating.



You will need:

- ◆ A pencil
 - ◆ A pad of paper (You can staple pieces of paper together to make one if you don't have one.)
1. Start with the page at the bottom of the pad. Neat the bottom of that page, draw the seed.
 2. On the next page up, draw the same size seed at the same position, but then draw the radicle beginning to peek through.
 3. On the next page, draw the radicle longer, but keep the seed in the same place.
 4. On the next few pages, continue to draw the radicle longer, but also draw the epicotyl coming out.
 5. In each successive picture, draw the seedling getting bigger and bigger, going through each of the stages drawn in the illustration on page 27.
 6. Once you have finished, hold the pad down so that the bottom page (the one with just the seed drawn on it) is showing, but the other pages are curled up above it.
 7. Let the pages fall down one at a time. As you watch, it will look like the seed is growing into a seedling right before your eyes!

Project Germination

You will grow some seeds inside plastic bags so that you can watch their development and make a guess about which ones will grow best. You will write down all that you are going to do for this experiment and make a good guess about what you think is going to happen on the special science experiment sheet provided at the beginning of this book. It is called the *Scientific Speculation Sheet*. To speculate means to make guesses about something. You will use a sheet like that for many of the experiments that you do in this book.

You will need:

- ◆ Three plastic Ziploc[®] bags
- ◆ Three paper towels
- ◆ Three or more turnip seeds (or bean seeds)
- ◆ Tape
- ◆ A ruler (It should read centimeters.)
- ◆ A Scientific Speculation Sheet (found at beginning of book)

Instructions

1. Wet three paper towels with water and place one inside each of the plastic bags.
2. Place a seed in each plastic bag. If you have more than three seeds, you can put more than one seed in each plastic bag. Zip the bag closed once you have put the seed or seeds in it.
3. Tape the first bag to a window that receives sunlight. Make sure your seed faces the window.
4. Place the second bag in your refrigerator.
5. Place the third bag in a dark closet that no one usually opens and never gets any light.
6. On your Scientific Speculation Sheet, write down your experiment and your good guess about what will happen to each seed. For example, guess whether or not each seed will germinate, and guess which one will grow fastest and which one will grow slowest. This is called a **hypothesis** (hi pahth' uh sis).
7. Make a Seed Growth Chart for each bag. In other words, you will have one Seed Growth Chart for the seed that is in the bag taped to the window, another Seed Growth Chart for the seed in the dark closet, and another for the seed in the refrigerator. A sample Seed Growth Chart is given below.
8. To fill out each chart, use the ruler to measure the length of the plant (not the seed) each day. Put a dot in the square that marks the day you are making the measurement and the measurement that you made. For example, today is Day 1. Your seed has not grown at all today, so put a dot in the square that has "Day 1" on the bottom and "0 cm" to the left. Tomorrow will be Day 2. If any of the seedlings have sprouted, measure their lengths. Suppose that one seedling is 2 cm long by then. If that's the case, put a dot in the square that has "Day 2" below it and "2 cm" to its left.

Seed Growth Chart

6 cm												
5 cm												
4 cm												
3 cm												
2 cm												
1 cm												
0 cm												
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12

9. At the end of twelve days, compare the Seed Growth Charts. The seed that has dots highest on the chart the soonest is the one that grew the fastest. Which one was that? Was your hypothesis correct?

Monocotyledons and Dicotyledons

Do you remember from Lesson 1 that we classify seed-making plants into angiosperms and gymnosperms? Those are two different phyla. Botanists further classify the angiosperms into two classes based on the number of cotyledons the seed has: **monocots** and **dicots**. **Di** means **two**. This tells us that dicots have two cotyledons. **Mono** means **one**. There is only one cotyledon in a monocot seed. Based on what you saw in your bean seed, is the bean plant a monocot or a dicot? Since it has two cotyledons, it is a dicot!

Why is it important to determine whether or not a plant is a monocot or dicot? Believe it or not, monocot plants look different from dicot plants. Look, for example, at the two photographs below.



Corn is a monocot. Notice the veins in the husks and leaves. They do not branch at all. They run straight up and down.



The primrose plant is a dicot. Notice how the veins in the leaves branch out from a center vein.

Monocot leaves have veins going upwards to the top of the leaf, not branching out from a thick, center midrib vein. Next time you are looking at the leaf of a plant, look at the veins. If the veins never branch out but instead just form lines that run up and down the leaf, the plant is a monocot. If the veins branch out from a vein running down the middle of the leaf, the plant is a dicot.

Another difference between monocots and dicots can be seen if you look at their flowers. Remember, angiosperms are flowering plants, so all monocots and dicots make flowers. However, their flowers are usually a bit different. Monocot flowers usually have petals in multiples of three. Can you count by threes? Three, six, nine. If you count the petals on a flower and find that there are three, six, or nine petals, then the plant is most likely a monocot. On the other hand, dicots usually have flowers that have petals in multiples of four or five. In other words, dicot flowers might have four petals or eight petals. They might also have five petals or ten petals. Look at the photographs on the next page to see what I mean.



The daffodil is a monocot. Notice that it has six petals around the flower.



The marigold is a dicot. Notice that it has five petals around the flower.

It is useful for you to know how to identify whether or not a plant is a monocot or a dicot. The easiest way, of course, is to open up the plant's seed and count the number of cotyledons. If there is one, the plant is a monocot. If there are two, the plant is a dicot. If you don't have seeds handy, however, looking at the leaves or the flowers will usually do the trick.

Explain to someone else the difference between monocots and dicots. Make sure you describe the differences between the seeds, leaves, and flowers.

Activities

Identify Plants

Are these plants monocots or dicots? Look at the leaves and flowers to help you decide.



A



B



C



D

Nature Walk in a Yard

Today you will take your notebook, paper, and some colored pencils outside on a search for monocots and dicots. Monocots are the most difficult to find in nature, especially in winter. Look for leaves that have vertical (going up and down) veins that travel the length of the leaf or flowers that have petals in multiples of three. I will give you a hint on how to find at least one monocot. Get down on your knees on any lawn. Look carefully at the blades of grass. Notice the veins. Draw the monocots you find and label them in your notebook. Do the same thing for dicots. After you have drawn a picture of a monocot or dicot, label your drawing so others will know why the plant you drew is a monocot or a dicot.

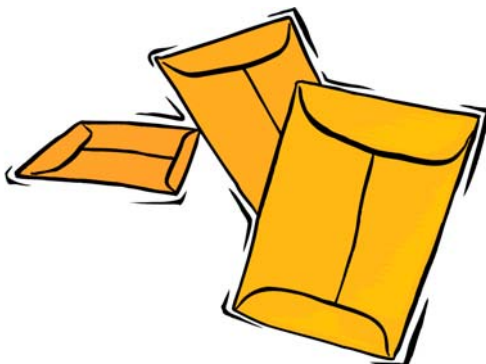


Optional Winter Activity

If you cannot go outside today, put it off for a while and do the following project. You may want to do this activity even if you are able to go out.

Go through old magazines from which you have permission to cut out pictures. If none are available, you can use the internet to find botanical gardens or flower shops. When you come across a picture of a plant, leaf or flower, try to identify whether it is a monocot or dicot. Cut out or print the picture and glue it onto a piece of paper. Label it as a monocot or a dicot. Be certain to write down why you think it is a monocot or dicot. Place your completed, labeled pictures in your notebook.

Project Seed Collecting



This is a good time to begin a seed collection. Every time you eat a piece of fruit, save the seeds and let them dry out. When they are dry, place them in tiny envelopes, such as coin envelopes. You can also make envelopes with the pattern on the next page. Seal them up and put them in a special place. If you have page protectors with small pouches designed for sports card collections, you can place your seed envelopes in those pouches. Label your seeds. They will keep for a long time!

Seed Collection Envelope Pattern

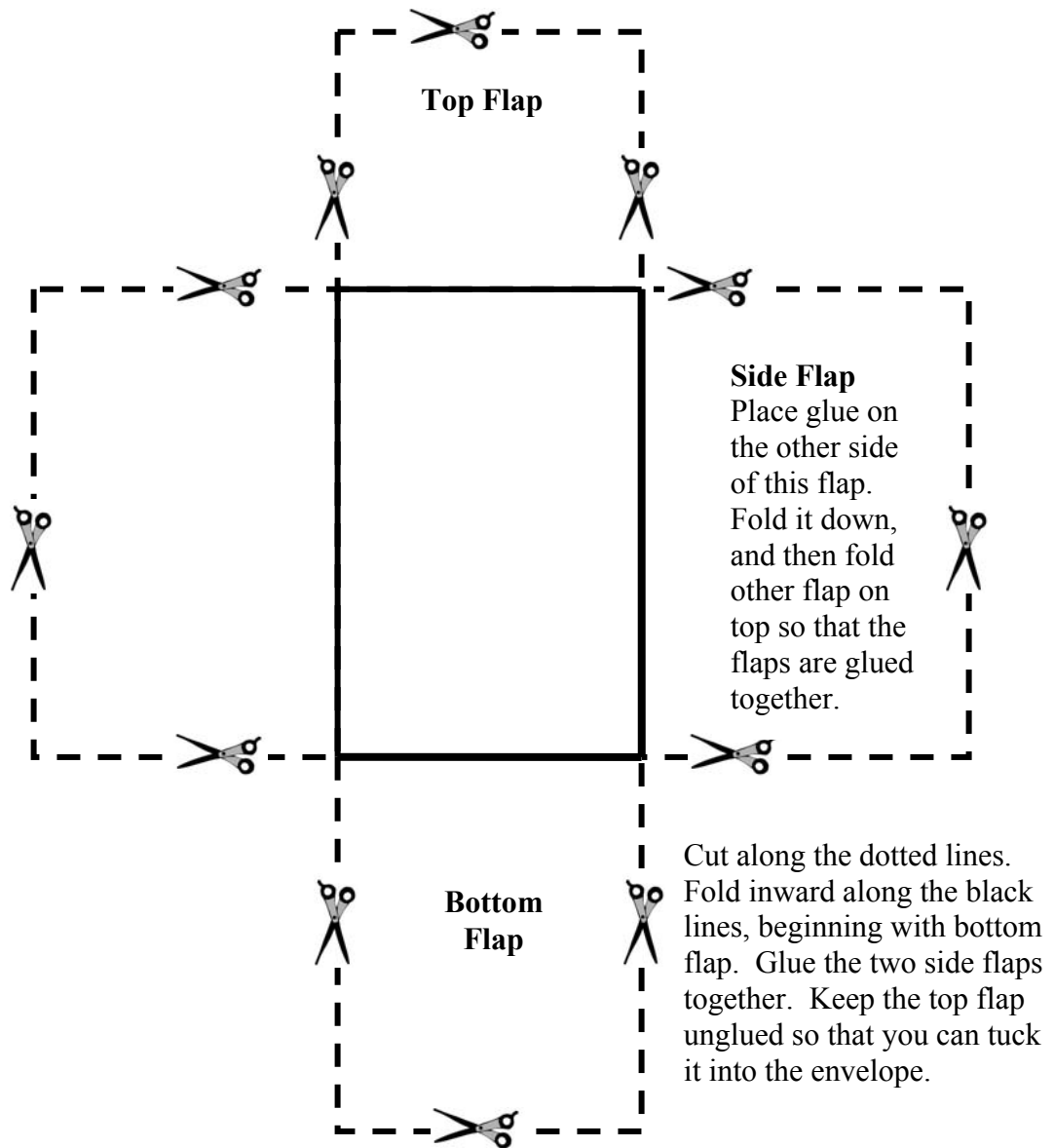


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