Introduction to
PLANTS

BACKGROUND INFORMATION—PLANTS

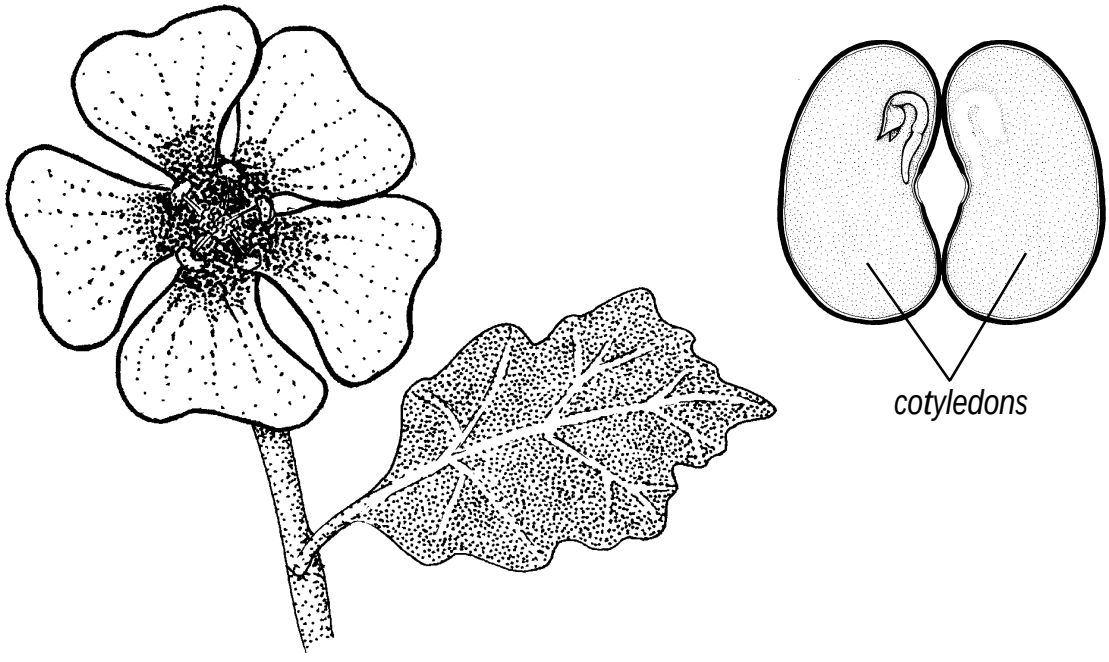
Plants are astounding in their variety and their abundance. They can live in the harshest desert, the coldest tundra, or under the ocean. They can break through solid rock with their roots or travel hundreds of miles. The tiniest plants may be less than a centimeter high, but the tallest can be hundreds of feet tall. Plants play an integral part in our lives—providing the oxygen we breathe and the food we eat. Without plants, our lives, and the lives of other animals, wouldn't exist.

The first land plants appear in the fossil record around 435 million years ago during the Silurian Period. Since then, they have diversified greatly and become the basic source of food, either directly or indirectly, for most of life on Earth. Plants produce their own food using **chlorophyll,** a green pigment unique to plants. All plants are multi-cellular and each plant cell is surrounded by a **cell wall**. The cell wall contains a special carbohydrate, called **cellulose,** that gives the plant its rigidity.

Plants are generally divided into two major groups: Seedless plants (includes mosses and ferns) and those with seeds. The plants that form seeds are then divided into two more groups. The non-flowering **gymnosperms** (includes conifers, cycads, and ginko trees) produce their seeds in a cone or cone-like structure. **Angiosperms**, or flowering plants, (such as wildflowers, cacti, and grasses) produce seeds in a flower. Just like animals, plants respond to their environment, acquire energy, reproduce, grow, and change throughout their life cycle.

Angiosperms are very diverse and include not only the plants with conspicuous flowers but also many trees (such as oak, willow, elm, maple, birch), fruits, vegetables, nuts, herbs, cactus, corn, wheat, rice, other grains, and grasses. Angiosperms are divided into two broad groups: the **monocots** and the **dicots**. The names refer to the fact that the embryo in the monocots has one cotyledon ("seed leaf," the food storage part of the seed) and in the dicots there are two cotyledons. This feature can be observed by comparing a monocot, such as corn, which does not naturally split into sections, with a dicot, such as peanuts, which naturally split into two parts. Monocots usually have leaves with veins that are parallel to each other and flowers with petals in multiples of three. Grass, lilies, corn, and palm trees are all examples of monocots. Dicots usually have leaves with a net-like pattern of veins and flowers with petals in multiples of four or five. Roses, beans, orange trees, apples and dandelions are all examples of dicots.

Monocot leaf, flower, and seed



Dicot leaf, flower, and seed

The Seed and Seedling

Plants produce **seeds** that come in all shapes and sizes. An apple tree produces seeds in the core of an apple, a pine tree produces pine nuts in a cone, and an oak produces acorns. Some seeds stay close to the parent plant, but others travel farther by blowing in the wind, floating on water, shooting out of an exploding pod, attaching to an animal's fur, and/or passing through an animal's intestines.

For a seed to grow, or **germinate**, it needs the right amount of water and warmth. Inside the seed, the embryo uses stored food to begin growing roots. Once the roots are able to get nutrients from the soil, a plant shoot grows upward and breaks through the soil. During the germination process, plants use hormones to "read" and respond to their environment. A response in growth toward or away from environmental stimuli is called **tropism**. **Geotropism** is the tendency of the roots of a germinated seed to grow in the direction of the gravitational pull and the plant shoot to grow away from the gravitational pull. Another important tropism is **phototropism**. In phototropism, the leaves and stems of a plant grow towards the sunlight. This is especially important to a forest **seedling,** which grows in the shadow of larger trees.

Through a process called **photosynthesis**, plants use sunlight to make their own food. Photosynthesis is a chemical reaction that takes place in a cellular structure called a **chloroplast.** Chloroplasts are located in the cells of green plant parts such as leaves and stems. Chlorophyll, the green pigment inside the chloroplast, absorbs light energy. During photosynthesis, light energy is used to convert water and carbon dioxide into food (carbohydrates) and oxygen. In addition to sunlight, growing seedlings will seek water and minerals from the soil.

Plants and Water

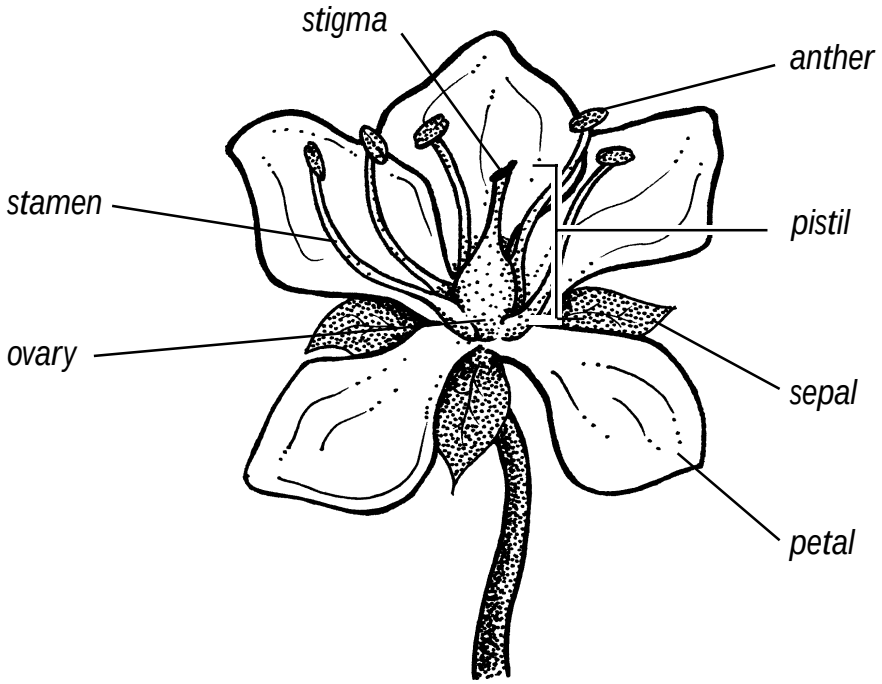
As with all organisms, water is essential to plants. It is used in photosynthesis, it helps transport food and minerals throughout the plant, and it helps the plant stand upright.

Water is constantly being pulled through a plant because of a process called **transpiration**. Transpiration is the evaporation, or loss of water vapor, from the leaves. Because water molecules "stick" together, water is pulled upward through the plant by water that is evaporating from the leaves. As this occurs, the plant takes more water from the soil through its roots. Minerals from the soil are pulled along with the water and are distributed throughout the plant as well.

Gases such as oxygen, water vapor, and carbon dioxide pass into and out of the plant through structures on the leaves and stems called **stomata**. The stomata are openings, or pores, that are opened and closed by **guard cells** on either side. The guard cells regulate the intake of carbon dioxide and the release of oxygen. Water also exits through the stomata. In dryer climates, where plants need to conserve water, stomata generally stay closed during the day and open at night to prevent too much evaporation. The stomata open and release the oxygen (a by-product of the day's photosynthesis) and take in carbon dioxide to use in photosynthesis the next day.

Flowers

A **flower** is an important part of the life cycle of a flowering plant. Flowers contain the structures used in plant sexual reproduction. The thin, vase-like structure in the center of a flower is called the **pistil**. The long, skinny structures that surround the pistil are called **stamens.** They produce pollen, the male sex cells. The sticky tip of the pistil, called the **stigma**, receives pollen. **Pollination** occurs when pollen is transferred from a stamen to the stigma. The female sex cells are produced and contained inside the **ovary,** located at the rounded base of the pistil. When pollen meets the female sex cells in the ovary they become **fertilized** and begin to produce seeds. The seed then grows inside the ovary until it is ready to be released. The petals, stamens, and pistil either wilt or become part of the fruit that forms around the seed.



How does pollen travel from the stamens of one plant to the stigma of another plant? Winds often carry pollen to the right place, but other plants rely on pollinators. Pollinators are animals such as insects, birds, or bats that drink flower nectar for food. The flower's shape, bright colors or strong scents attract them. As the pollinator reaches to the bottom of the flower for nectar, it rubs against the stamen, collecting pollen on its body. When it arrives at the next flower, some of the pollen can rub onto the stigma and pollination can occur.

Food Storage in Plants

Plants store excess carbohydrates in a number of structures, including the stem, leaves, and roots. For example, a carrot is stored food in the plant's root and a white potato is stored food in the plant's stem. This stored food can be used later by the plant during reproduction or during rapid periods of growth. It also becomes a vital source of food for animals, including humans!

The seeds and fruit are also storage places for extra carbohydrates. The stored food in the seed nourishes it during germination before there is a plant to photosynthesize. The stored nutrients in seeds and fruit also indirectly aid in **seed dispersal**. Animals that eat the seeds and fruit deposit the seeds in a new place, where under the right conditions, the seeds will sprout and continue the life cycle of the plant.

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INFORMACIÓN BÁSICA—LAS PLANTAS

Las plantas son asombrosas tanto en su variedad como en su abundancia. Pueden vivir en el desierto más seco, en la tundra más fría o en el océano. Pueden atravesar rocas sólidas con sus raíces o viajar a través de cientos de millas. Las plantas más pequeñas pueden medir menos de un centímetro de altura pero las más altas pueden tener una altura de cientos de pies. Las plantas desempeñan una función esencial en nuestras vidas, nos proveen el oxígeno que respiramos y los alimentos que comemos. Sin las plantas, nuestras vidas y las vidas de otros animales no existirían.

De acuerdo con los fósiles que se han encontrado, sabemos que las primeras plantas terrestres aparecieron hace aproximadamente 435 millones de años durante el período Silúrico. Desde entonces se han diversificado mucho y se han transformado en la fuente básica de alimentación, de manera directa o indirecta, para la mayor parte de la vida terrestre. Las plantas producen su propia alimentación usando **clorofila**, un pigmento verde que se encuentra sólo en las plantas. Las plantas son multicelulares y cada una de sus células está rodeada por una **pared celular**. La pared de la célula contiene un carbohidrato especial llamado **celulosa** que otorga rigidez a la planta.

Las plantas generalmente se dividen en dos grupos principales. Las plantas sin semillas (musgos y helechos) y las plantas con semillas. A su vez, las plantas que producen semillas se dividen en otros dos grupos. Las plantas que no producen flores, **gimnospermas** (coníferas, cicadáceas y árboles ginkgo), producen sus semillas adentro de un cono o de una estructura parecida a un cono. Las **angiospermas**, o plantas con flores (flores silvestres, cactus y gramas o pastos) producen sus semillas dentro de una flor. Al igual que los animales, las plantas responden al medio ambiente, absorben energía, se reproducen, crecen y cambian a través de su ciclo vital.

Las angiospermas son muy diversas e incluyen no sólo plantas con flores visibles, sino también muchos árboles (por ejemplo, el roble, el sauce, el olmo, el arce, el abedul), frutas, verduras, nueces, hierbas, cactus, mazorca o maíz, trigo, arroz y otros granos, además de otras gramas. Las angiospermas se dividen en dos grupos amplios: las **monocotiledóneas** y las **dicotiledóneas**. Los nombres se refieren a que el embrión en las monocotiledóneas tiene un solo cotiledón ("la hoja dentro de la semilla," es decir la parte de la semilla donde se almacenan los alimentos) y las dicotiledóneas tienen dos cotiledones. Esta característica se puede observar comparando una monocotiledónea, tal como el maíz, que no se divide naturalmente en dos secciones y

una dicotiledónea, tal como el cacahuate (o maní) que se divide naturalmente en dos partes. Las monocotiledóneas usualmente tienen hojas con nervaduras paralelas entre sí y flores con pétalos agrupados de a tres. Las gramas, los lirios, el maíz y las palmas son ejemplos de monocotiledóneas. Las dicotiledóneas, en general, tienen hojas con nervaduras reticuladas y flores con pétalos agrupados de a cuatro o cinco. Ejemplos de dicotiledóneas son: rosas, frijoles, naranjos, manzanos y diente de león.

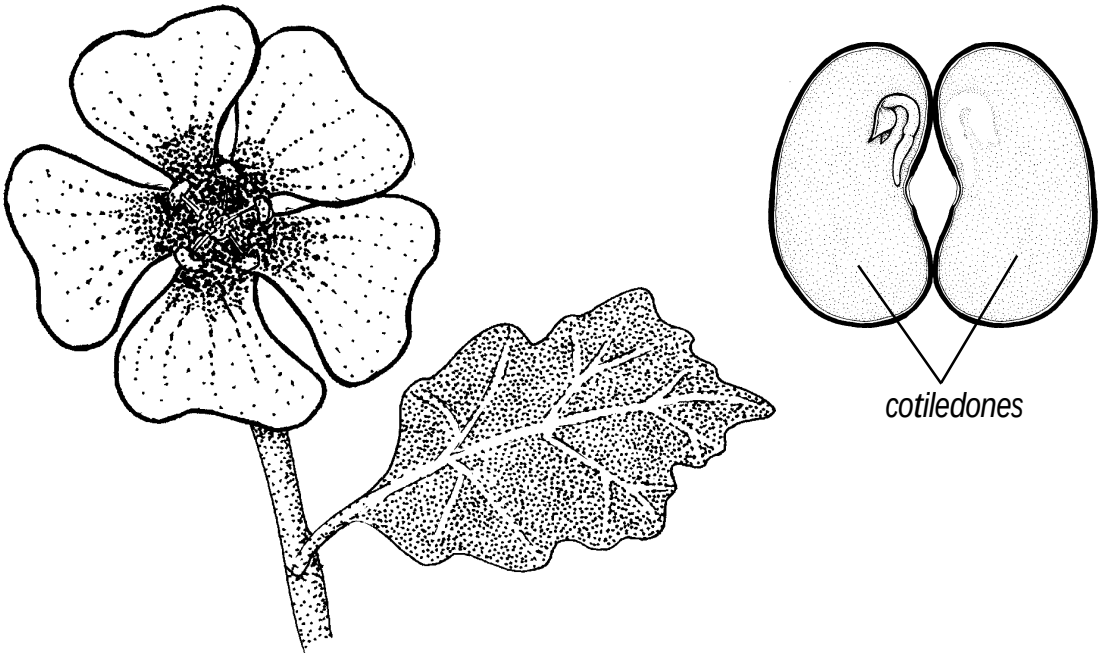
Las semillas y la plántula

Las plantas producen **semillas** de todo tipo de formas y tamaños. Un manzano produce sus semillas en el centro de la manzana, un pino produce semillas en un cono y un roble las produce en una bellota. Algunas semillas permanecen cerca de la planta paterna, pero otras se desplazan lejos por medio del viento, flotando en el agua, mediante la explosión de una vaina, al adherirse a la piel de un animal y/o al atravesar los intestinos de un animal.

Para que una semilla crezca, o **germine**, se necesita la cantidad justa de agua y la temperatura adecuada. El embrión usa el alimento almacenado para comenzar a desarrollar raíces dentro de la semilla. Una vez que las raíces pueden obtener nutrientes de la tierra, la planta crece hacia arriba y atraviesa el suelo. Durante el proceso de germinación, las plantas utilizan hormonas para "leer" las señales provenientes del medio ambiente y poder responder. El crecimiento de la planta hacia o en dirección opuesta a los estímulos del medio se llama **tropismo**. **Geotropismo** es la tendencia de las raíces de una semilla germinada a crecer en la misma dirección que la fuerza de gravedad y del resto de la planta a crecer en dirección contraria a la fuerza de gravedad. Otro tropismo importante es el **fototropismo**. Mediante el fototropismo, las hojas y los tallos de la planta crecen en dirección a la luz. Esto es especialmente importante para las **plántulas** que crecen a la sombra de árboles grandes.

Las plantas utilizan la luz del sol para fabricar su propio alimento a través de un proceso llamado **fotosíntesis**. La fotosíntesis es una reacción química que se produce dentro de una estructura celular llamada **cloroplasto**. Los cloroplastos se encuentran en las células de ciertas partes de las plantas verdes, tales como las hojas y los tallos. La clorofila es un pigmento verde que se encuentra en el interior del cloroplasto y que absorbe la energía de la luz. Durante la fotosíntesis, la energía de la luz se utiliza para convertir agua y dióxido de carbono en alimento (carbohidratos) y oxígeno. Además de la luz del sol, los brotes buscarán agua y minerales del suelo.

Hoja, flor y semilla de las monocotiledóneas



Hoja, flor y semilla de las dicotiledóneas

Plantas y agua

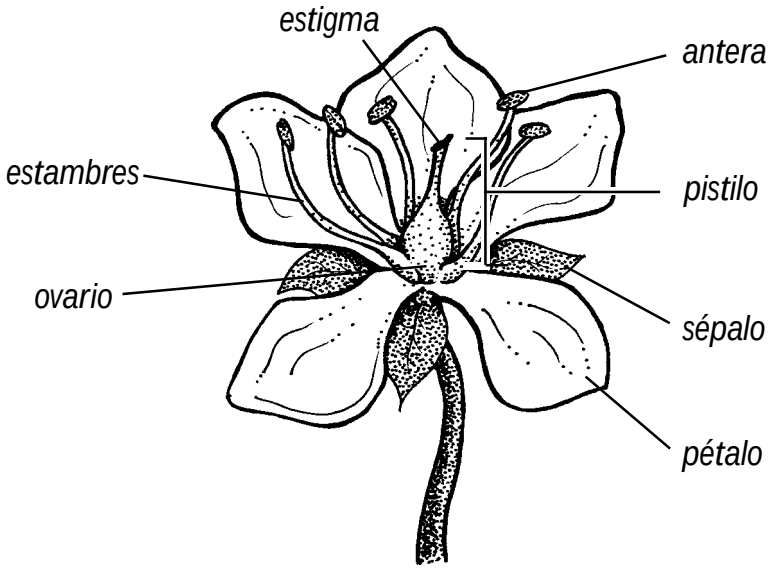
El agua es esencial para las plantas, de la misma manera que lo es para el resto de los organismos. Se utiliza en el proceso de fotosíntesis, ayuda a transportar alimentos y minerales a través de la planta y ayuda a que la misma se mantenga erguida.

El agua pasa constantemente a través de la planta mediante el proceso de **transpiración**. Transpiración es la evaporación o pérdida de vapor de agua a través de las hojas. Como las moléculas de agua se atraen entre sí, el agua transita hacia la parte superior de la planta arrastrada por el agua que se evapora por las hojas. Al mismo tiempo, la planta extrae más agua del suelo a través de las raíces. Los minerales del suelo son absorbidos junto con el agua y se distribuyen a toda la planta.

Los gases, tales como el oxígeno, el vapor de agua y el dióxido de carbono pasan hacia el interior y exterior de la planta a través de ciertas estructuras llamadas **estomas**. Los estomas son orificios, o poros, que se abren o se cierran por la acción de las **células guardianas**, ubicadas a ambos lados del poro. Las células guardianas regulan la entrada de dióxido de carbono y la salida de oxígeno. El agua sale sólo a través de los estomas. En climas secos, donde las plantas necesitan conservar agua, los estomas permanecen cerrados durante el día y se abren en la noche para evitar demasiada evaporación. Los estomas se abren y liberan oxígeno (un derivado de la fotosíntesis de ese día) y absorben dióxido de carbono para usar en la fotosíntesis del día siguiente.

Flores

Una **flor** es una parte importante del ciclo vital de las plantas con floraciones. Las flores contienen las estructuras que se usan en la reproducción. La estructura delgada con forma de florero ubicada en el centro de la flor se llama **pistilo**. Las estructuras largas y delgadas que rodean al pistilo se llaman **estambres**. Éstos producen polen, las células sexuales masculinas. El extremo pegajoso del pistilo, llamado **estigma**, recibe el polen. La **polinización** ocurre cuando el polen se transfiere de un estambre al estigma. Las células sexuales femeninas se producen y se almacenan dentro del **ovario**, que está en la base redondeada del pistilo. Cuando el polen se encuentra con las células sexuales femeninas en el ovario, éstas son fertilizadas y comienzan a producir semillas. Las semillas crecen dentro del ovario hasta que están listas para ser liberadas. Los pétalos, los estambres y el pistilo o bien languidecen y se secan o forman parte de la fruta que se desarrolla alrededor de la semilla.



¿Cómo viaja el polen de los estambres de una planta hasta el estigma de otra planta? A menudo, el viento lo deposita en el lugar adecuado, pero otras plantas necesitan agentes polinizadores. Los agentes polinizadores son animales, tales como insectos, aves o murciélagos que beben el néctar como forma de alimentación. La forma de las flores, los colores vívidos y los perfumes fuertes los atraen. Cuando el agente polinizador llega al fondo de la flor para buscar néctar, frota su cuerpo contra los estambres y el polen se adhiere al mismo. Cuando llega a la próxima flor, parte de ese polen puede adherirse al estigma y así es como ocurre la polinización.

Almacenamiento de alimentos en las plantas

Las plantas almacenan el excedente de carbohidratos en varias estructuras, que incluyen los tallos, las hojas y las raíces. Por ejemplo, una zanahoria almacena los alimentos en la raíz de la planta y una papa blanca almacena los alimentos en el tallo de la planta. La planta puede usar los alimentos almacenados en algún otro momento, durante la reproducción o durante los períodos de crecimiento rápido. ¡Además, las plantas son una fuente vital de alimentos para animales, incluyendo seres humanos!

Las semillas y los frutos también son lugares donde se almacena el excedente de carbohidratos. Los alimentos almacenados en la semilla la alimentan durante la germinación, antes de que exista una planta que pueda tomar ventaja del proceso de fotosíntesis. Los nutrientes almacenados en las semillas y en las frutas colaboran indirectamente con la **dispersión de semillas**. Los animales comen las semillas y las frutas y las depositan en un nuevo lugar, donde bajo condiciones favorables, las semillas crecerán y continuarán con el ciclo vital de la planta.

WHAT'S INSIDE A SEED?

¿Qué hay adentro de la semilla?

Grades		
2–8	3–4	45–60 min.

Purpose

Students will observe and identify the parts of a lima bean seed, compare it to other seeds, and determine the difference between a monocot and a dicot.

Materials

Seeds: lima beans, corn, peas, peanuts, and sunflower seeds
Scalpel or knife
Student Activity Sheet
Pencil or pen

Concepts

- Each seed structure has a different function.
- Seeds can be divided into monocots (one cotyledon) and dicots (two cotyledons).

Conceptos

- Cada estructura dentro de la semilla tiene una función diferente.
- Las semillas se pueden dividir en monocotiledóneas (un cotiledón) y dicotiledóneas (dos cotiledones).

Safety

Do not let younger students use the scalpel. Cut open hard seeds yourself.

Vocabulary

Radicle
Plumule
Endosperm
Seed coat
Cotyledon (pronounced: cot-il-e-don)
Plant embryo

Vocabulario

Radícula
Plúmula
Endospermo
Tegumento o cáscara
Cotiledón
Embrión de la planta

In Advance

Gather and soak lima bean and pea seeds (if using dry peas) for 24 hours before beginning the activity. Make copies of the Student Activity Sheet.

Procedure

1. Introduce activity

Ask students if they know the function of a seed. They should mention that a seed is produced by the parent plant and, under the right conditions, a seed will grow into a new plant. When a seed is opened, there is usually a baby plant (**embryo**) that is surrounded by a food supply. Although most seeds have similar parts, they can look very different. Your students will be observing some of those differences.

2. Set-up

Divide students into groups of 3 or 4. Give each group a soaked lima bean, a corn kernel, a pea, a peanut, and a sunflower seed. Give each individual student a copy of the Student Activity Sheet.

3. Take apart the seeds

Beginning with the lima bean, have students carefully peel off the outer covering (**seed coat**). Have them split the seed in half and identify the seed parts using the diagram from the Student Activity Sheet.

Next, have students try to split the corn kernel in half. They will find that some kinds of seeds naturally divide in half, while others don't. Seeds that can be split into two equal halves, or **cotyledons**, are called dicotyledons or dicots (*di* means two). Seeds that can't be easily split into two halves are called monocotyledons or monocots (*mono* means one).

Tell students to record their observations on the Student Activity Sheet. Then, have students open the pea, peanut, and sunflower seeds, identify the seed parts, and record what they see. Help students open the seeds with a scalpel or knife if necessary. When students have finished dissecting their seeds and recording their observations, tell them to answer the questions on the Student Activity Sheet.

4. Review observations

Ask students which seeds are monocots and which seeds are dicots. Which seeds were more difficult to open? Which seeds had plant parts that were more difficult to identify? Review the answers to the questions on the Student Activity Sheet.

Questions to Ask During the Activity

1. What will the **radicle** become? (The root.)

2. What will the **plumule** become? (The seedling.)

3. How are the cotyledon and the **endosperm** alike? (Both store food to be used by the growing plant embryo. The endosperm produces the cotyledon before germination.)

Preguntas sobre el tema de la actividad

1. ¿En qué se convertirá la radícula? (En la raíz)

2. ¿En qué se convertirá la plúmula? (En la plántula)

3. ¿En qué se parecen el cotiledón y el endospermo? (Ambos almacenan alimentos para que utilice el embrión de la planta mientras crece. El endospermo produce el cotiledón antes de germinar.)

Why it Happens/More on the Topic

Seeds are the reproductive part of the plant. If you break open a seed, you can usually find a miniature plant (called an embryo) that is surrounded by a food supply. If the embryo is planted in the right conditions, it will grow into a new plant.

The plant embryo inside the lima bean and the corn kernel is the small bump made up of the plumule (the future seedling) and the radicle (the future root). The corn kernel is more likely to have some endosperm surrounding the plant embryo and the leafy cotyledon. Inside the lima bean, the cotyledon has likely already used up the endosperm.

Algo más sobre el tema...

Las semillas son la parte reproductiva de la planta. Si tú abres una semilla, en general encontrarás una planta en miniatura (llamada embrión) rodeada de una provisión de alimentos. Si plantas el embrión bajo condiciones propicias, éste crecerá hasta convertirse en una nueva planta.

La pequeña protuberancia que se encuentra dentro del frijol de media luna y del grano de maíz es el embrión de la planta, compuesto de la plúmula (la futura plántula) y la radícula (futura raíz). Lo más probable es que el grano de maíz tenga algo de endospermo rodeando al embrión de la planta y al cotiledón Lo más probable es que el cotiledón, dentro del frijol de media luna, ya haya consumido el endospermo.

Modifications

Use only the first page of the Student Activity Sheet with younger students.

Extensions

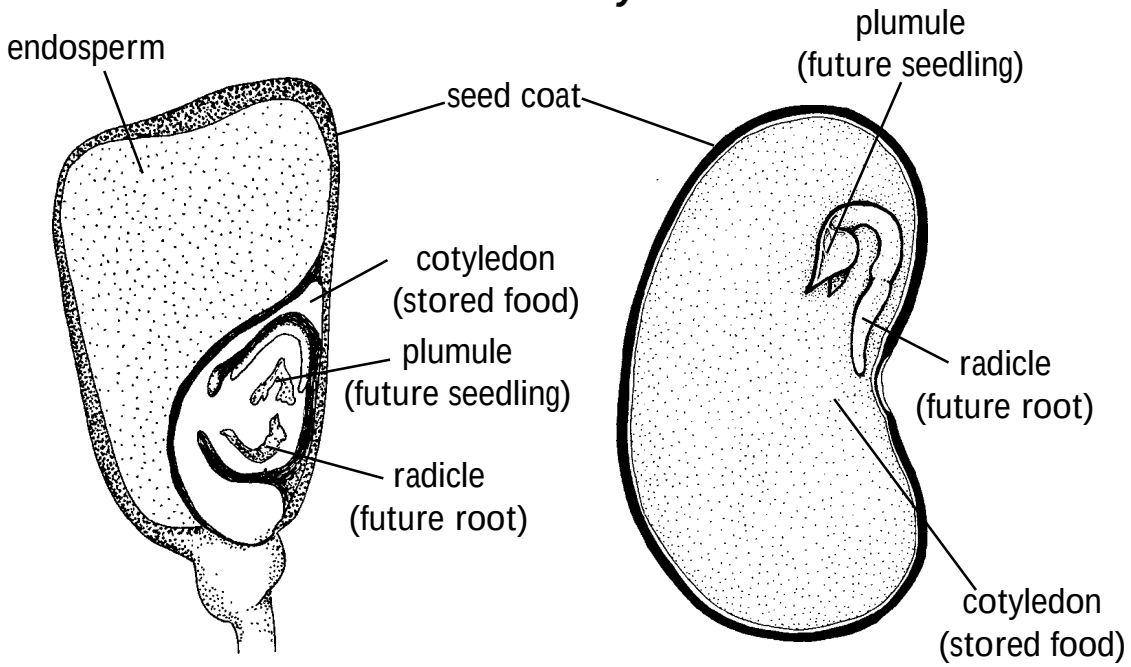
Place a soaked lima bean, corn kernel, pea, peanut, and sunflower seed into a plastic bag containing a moistened paper towel. Put the bags in a warm spot and allow the seeds to germinate. Have students dissect the seeds and identify the same seed structures. Compare them to the seed structures they observed before germination.

References

The New Mexico Museum of Natural History and Science. Proyecto Futuro Life Sciences Curriculum. First edition. Albuquerque, NM, 1996.

WHAT'S INSIDE A SEED?

Student Activity Sheet



monocot seed ***dicot seed***

1. Record your observations on the chart below.

Type of Seed	***Seed Coat*** (hard or soft)	***Easily Opened?*** (yes or no)	***Number of Cotyledons*** (one or two)	***Seed Category*** (monocotyledon or dicotyledon)
Lima Bean				
Corn kernel				
Pea				
Peanut				
Sunflower seed				

WHAT'S INSIDE A SEED?
Student Activity Sheet (continued)

1. What is the function of the seed coat?

2. What is the function of the cotyledons?

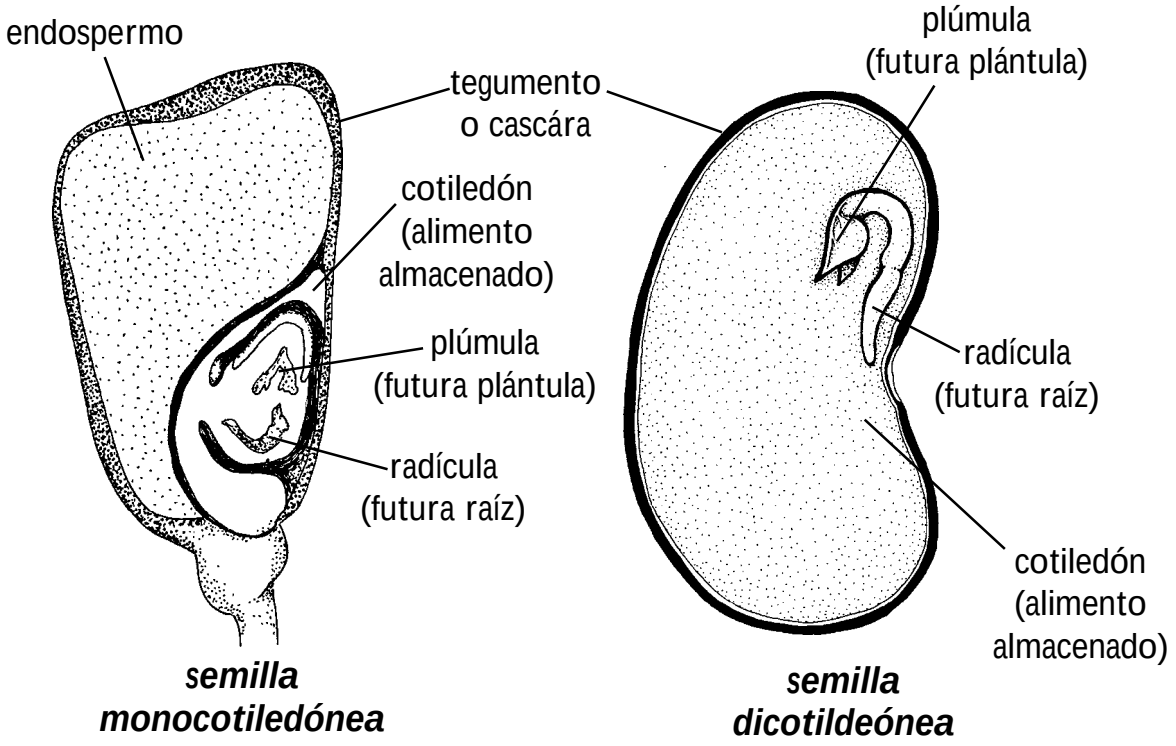
3. How do the seeds use the stored food?

4. What does the plumule turn into in an adult plant?

5. What does the radicle turn into in an adult plant?

6. Would a seed planted without a plumule or radicle develop into a seedling? Why or why not?

¿QUÉ HAY ADENTRO DE LA SEMILLA?
Actividades prácticas para el estudiante



semilla monocotiledónea ***semilla dicotildeónea***

1. Escribe tus observaciones en el cuadro siguiente.

Tipo de semilla	***Tegumento*** (duro o blando)	***¿Se abre fácilmente?*** (sí o no)	***Número de cotiledones*** (uno o dos)	***Categoría de semilla*** (monocotiledónea o dicotiledónea)
Frijol de media luna				
Grano de maíz				
Chícharo (arveja)				
Cacahuate (maní)				
Semilla de girasol				

¿QUÉ HAY ADENTRO DE LA SEMILLA?
Actividades prácticas para el estudiante (continuación)

1. ¿Cuál es la función del tegumento?

2. ¿Cuál es la función de los cotiledones?

3. ¿De qué manera usan las semillas el alimento que almacenan?

4. ¿En qué se convierte la plúmula cuando la planta es adulta?

5. ¿En qué se convierte la radícula cuando la planta es adulta?

6. ¿Crees que si plantas una semilla que no tiene ni plúmula ni radícula logrará transformarse en una plántula? ¿Por qué sí o por qué no?

SEED DISPERSAL WALK

Paseo para dispersar las semillas

Grades		
3–8	3–4	1–2 hours

Purpose

Students will collect seeds outside, then determine how the seeds are dispersed.

Materials

Small bucket, plastic grocery bag, or large zip-lock bag (one per group)
Large, old socks (at least one per group)
Outdoor area with trees and other plants
Student Activity Sheet
Gardening gloves (optional)
Hand lenses (optional)

Concepts

- Plants need to produce enough seeds to ensure that some of them will germinate and grow.
- Plants have different methods of dispersing their seeds.

Conceptos

- Las plantas necesitan producir suficientes semillas para asegurarse de que algunas de ellas van a germinar y a crecer.
- Las plantas utilizan diferentes métodos de dispersión de las semillas.

Safety

Students should handle sharp seeds and plants with care. Gardening gloves may be used. Some students may be allergic to certain plants or pollens. Have other students in the group handle those seeds and plants. Emphasize the importance of not disturbing plants and animals.

Vocabulary

Seed dispersal
Germinate

Vocabulario

Dispersión de las semillas
Germinación

Procedure

1. Introduce activity

Ask students if they were a plant how they might disperse their seeds to areas where they can **germinate**. Be sure students understand that most seeds will do better if they are dispersed far away from the parent plant or other plants. (The seed won't have to compete for sunlight, water, nutrients, etc.) Without describing **seed dispersal** strategies, tell students they will be collecting and observing some seeds to see if their ideas are accurate.

2. Seed dispersal walk

Divide the class into groups of 3 or 4 students. Take the groups outside to an area with trees and other plants. Give each group a container for the collected seeds (a bucket or plastic bag), a large sock, and gardening gloves (if available). Have a student from each group put the sock over their shoe and explain that as they walk, some seeds will stick to the sock. These seeds should be put into the collecting container. Students can take turns wearing the sock, but all members of the group should look for and collect other seeds as they find them. Remind students to be careful when touching sharp or prickly seeds and plants.

3. Look at the seeds

Bring the collected seeds into the classroom and have students sit with their groups. Hand out the Student Activity Sheet. Tell students to draw pictures of the seeds on the Student Activity Sheet. Based on each seed's characteristics, students should try to guess how the seed is dispersed and mark that space on the Student Activity Sheet.

4. Review

Gather the seeds and have students explain their guesses about how the seeds are dispersed. Using the information in the "Why it Happens" section of this activity, review the different methods of seed dispersal. Ask students if they would change their guesses based on this new information.

Questions to Ask During the Activity

1. Do you think any of the same plants grow near your home?

2. Why is it important that seeds be spread far from the parent plant? (If new seeds grow next to the parent plant, they need to compete for sunlight, water, and nutrients.)

3. Which is the least common method of seed dispersal in this area? (Water.)

Preguntas sobre el tema de la actividad

1. ¿Crees que algunas de estas plantas crecen cerca de tu casa?

2. ¿Por qué es importante que las semillas se dispersen lejos de la planta paterna? (Si las nuevas semillas crecen al lado de la planta paterna, competirán para obtener luz solar, agua y nutrientes.)

3. ¿Cuál es el método menos común de dispersión de semillas? (Agua)

Why it Happens/More on the Topic

Most plants reproduce using seeds. Plants need to make enough seeds to ensure that some will grow into thriving new plants. They use various dispersal mechanisms to make sure the seeds reach an area where there is enough sunlight, water, and nutrients. If a seed lands too close to the parent plant or another established plant, it will need to compete for sunlight, water, and nutrients. The most common methods of seed dispersal are:

WIND – Dandelions, cottonwoods, and milkweed plants have seeds attached to fluffy "parachutes" or tufts that can be carried by the wind. Maple seeds spin in the wind on wing-like attachments. Tumbleweeds roll in the wind, shaking seeds out as they travel. Some plants produce tiny seeds that can be blown in the air or on the ground for long distances before settling.

WATER – Coconuts can travel for miles in the ocean before washing ashore and sprouting in the sand.

HITCHHIKING – Burdock seeds have burrs, or little hair-like extensions with tiny hooks, that stick to the fur of animals. Thorny seeds, like goatheads, also stick to animal fur and can be carried long distances before being picked off or falling off. Hitchhiking seeds were the inspiration for velcro!

ANIMAL FOOD – Some seeds are dispersed because they are stored or eaten by animals. Nuts are collected by animals such as squirrels. When a nut is buried and forgotten, it can grow into a new plant. Some seeds are dispersed when an animal eats the surrounding fruit. Some seeds are dropped while the animal is eating the fruit. In

some cases, the animal swallows the fruit whole, and the seeds are dispersed in that animal's droppings. In fact, some seeds need to be partially digested in order to germinate.

SHOOTING SEEDS – Some plants shoot their seeds up to fifty feet from the parent plant. Garden peas will shoot their seeds if the pods are allowed to fully dry. Wood sorrel produces a "pop" as its pods burst open and shoot out seeds.

Algo más sobre el tema…

La mayoría de las plantas se reproducen mediante semillas. Las plantas necesitan producir suficientes semillas para asegurarse de que algunas crecerán y se transformarán en plantas nuevas y prósperas. Las plantas utilizan numerosos mecanismos de dispersión como forma de asegurarse de que las semillas alcancen un área donde hay suficiente luz del sol, agua y nutrientes. Si una semilla se deposita muy cerca de la planta paterna o de otra planta ya establecida, va a tener que competir para obtener luz solar, agua y nutrientes. Los métodos de dispersión más comunes son:

VIENTO - Algunas plantas, tales como el diente de león, el álamo o la asclepiadea (o algodoncillo), tienen semillas adheridas a unos "paracaídas" cubiertos de plumones o borlas que pueden ser transportadas por el viento. El arce produce unas semillas con prolongaciones que parecen alas y vuelan por el aire formando espirales. Las plantas rodadoras, como su nombre lo indica, dan vueltas con el viento y sacuden las semillas al rebotar mientras se desplazan. Algunas plantas producen semillas tan diminutas que pueden volar distancias largas en el aire o en la tierra antes de detenerse en un lugar.

AGUA - El coco puede viajar muchas millas en el océano antes de depositarse en una playa y germinar en la arena.

HACER *AUTO-STOP* - Las semillas de la bardana tienen cardos o extensiones vellosas con ganchos pequeñísimos que se adhieren a la piel de los animales. Las semillas con espinas como los "toritos" pueden viajar distancias largas antes de que se caigan o que el animal las sacuda. ¡La observación de las semillas que hacen *auto-stop* inspiró la invención del *velcro*!

ALIMENTO PARA ANIMALES - Algunas semillas se dispersan al ser almacenadas o ingeridas por distintos animales. Animales, tales como las ardillas, recolectan nueces. Cuando las entierran y se olvidan de ellas, éstas pueden crecer y convertirse en una

Algo más sobre el tema (cont.)

nueva planta. Algunas semillas se dispersan cuando el animal come la fruta que la rodea. Otras semillas se caen al suelo cuando el animal come la fruta. En algunos casos, los animales se tragan la fruta entera y las semillas se dispersan con los excrementos. De hecho, algunas semillas necesitan ser digeridas parcialmente para que puedan germinar.

DISPARO DE SEMILLAS - Algunas plantas arrojan sus semillas, a veces a distancias de hasta cincuenta pies de la planta paterna. El chícharo de jardín arroja sus semillas cuando la vaina está totalmente seca. La acetocilla hace un ruido especial, como un chasquido, cuando la vaina explota, se abre y dispara las semillas.

Modifications

For younger students (including K-2): Instead of using the Student Activity Sheet, have students draw the seeds they collected, then discuss seed dispersal as a class.

Extensions

Have students plant some of the seeds they collected in potting soil. Be sure they label each container with a drawing or name of the seed. Put the containers in a warm spot and water occasionally. When plants emerge, see if students can match the young plants with those growing in the area where the seeds were collected.

References

Ardley, Neil. The Science Book of Things That Grow. San Diego, CA: Gulliver Books, 1991.

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Nelson, Leslie W. and George C. Lorbeer. Science Activities for Elementary Children. Dubuque, IA: William C. Brown Company Publishers, 1972.

The New Mexico Museum of Natural History and Science. Proyecto Futuro Life Science Curriculum. First edition. Albuquerque, NM 1996.

STUDENT ACTIVITY SHEET

Seed Dispersal Walk

Draw an example of each kind of seed you collected. Guess how that seed might be dispersed, then mark the appropriate box next to your drawing.

DRAWING	*Wind*	*Water*	*Attaching to an Animal*	*Eaten or Stored by an Animal*	*Shot Out of a Pod*

ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE

Paseo para dispersar las semillas

Dibuja un ejemplo de cada tipo de semilla que has recogido. ¿Cómo crees que se dispersó esa semilla? Haz una suposición y luego marca la columna correspondiente a tu dibujo.

DIBUJO	***Viento***	***Agua***	***Adheridas a un animal***	***Ingeridas o almacenadas por un animal***	***Disparadas de una vaina***

WHAT DO SEEDS NEED TO GERMINATE?

¿Qué necesitan las semillas para germinar?

Grades		
3–8	*3–4*	*Day 1: 30 mins.* *Days 2–6: 10 mins./day*

Purpose

Students will predict what conditions are best for seed germination, set up an experiment to test their predictions, record their observations, and summarize results.

Materials

Pinto beans or lima beans, soaked overnight (about 25 per group)
Petri dishes with lids, OR bowls or cups with plastic wrap (5 per group)
Masking tape and marker
Paper towels
Water
Refrigerator
Student Activity Sheets

Concepts

- Seeds need adequate water and warmth to germinate.
- Seeds do not need sunlight to make their own food. Seeds use stored food until they grow into seedlings that can photosynthesize.

Conceptos

- Las semillas necesitan una cantidad de agua adecuada y temperatura templada para germinar.
- Las semillas no necesitan luz solar para producir sus propios alimentos. Las semillas utilizan el alimento almacenado hasta que crecen y se convierten en plántulas que pueden llevar a cabo el proceso de fotosíntesis.

Vocabulary

Germinate

Vocabulario

Germinación

In Advance

Make copies of the Student Activity Sheets.

Procedure

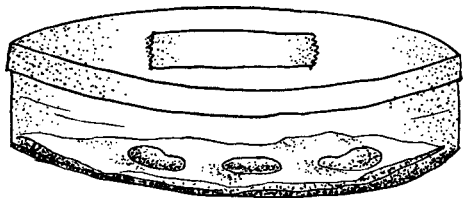
1. Introduce activity

Ask students if they can list what conditions seeds need in order to **germinate**. Are they the same things plants need to grow? What kind of experiment can test their ideas about what seeds need to grow?

2. Set-up

Divide students into groups of 3 or 4 and give each group about 25 soaked seeds, 5 dishes or bowls, 5 paper towels, 5 pieces of masking tape, and a marker. Have students place a folded paper towel into each dish or bowl and attach a piece of masking tape to the container. With the marker, have students label each container with one of the following :

1. moderate water, sun
2. moderate water, no sun
3. moderate water, cold
4. under water, sun
5. no water, sun



Also have students mark their containers with a group name or number.

Next, tell students to place about 5 seeds on top of each paper towel. Pour enough water in the "moderate water" containers to moisten the paper towels. Cover the seeds and paper towel with water in the container labeled "under water." Put plastic wrap or a lid over all 5 containers. Place the containers marked "sun" in a sunny area of the classroom, the containers labeled "cold" in a refrigerator, and the containers marked "no sun" in a dark box or closet.

3. Predict

Hand out the Student Activity Sheets to each student. Explain that they should write down their predictions about how the seeds they prepared might grow. They should consider the variables in the experiment and what they know about where seeds normally grow. Have students keep the Student Activity Sheets in a place where they can use them during the week.

4. Collect and record data

Over the next 5 days, have students check their seeds and record their findings on the Student Activity Sheets. If the paper towels are drying out in the containers labeled "moderate water" or "under water," students should add water.

5.Conclude activity

When the seeds have germinated and grown noticeably (around the fifth day), have students take the seeds out of the containers to make their final observations. They should record their data on the Student Activity Sheets and write down their conclusion about what seeds need to germinate. As a class, discuss their results and conclusions. Are there other variables that some seeds might need to begin germinating? (Some seeds need to pass through the digestive tract of an animal before germinating. Some need the heat of a fire. Others need more or less water, etc.) How could an experiment be set up to test some of these other variables?

Questions to Ask During the Activity

1. What are the variables in this experiment? (Moisture, light, and temperature.)

2. Could your results be different with other types of seeds? (Yes, other types of seeds may need different amounts of water or warmth.)

3. Why don't seeds need sunlight to live and germinate? (Seeds don't photosynthesize like plants do. The seed uses stored food to grow rather than making its own food through photosynthesis.)

4. Which part of the seedling emerges from the seed first? Why is this important? (The roots emerge first so the seedling can begin to get the nutrients and water it will need.)

Preguntas sobre el tema de la actividad

1 ¿Cuáles son las variables en este experimento? (Humedad, luz y temperatura)

2 ¿Podrían ser diferentes tus resultados si hubieras usado otro tipo de semillas? (Sí, es posible que distintas semillas necesiten una cantidad de agua diferente o una temperatura distinta.)

3 ¿Por qué razón las semillas no necesitan luz del sol para vivir y germinar? (Las semillas no pueden realizar la fotosíntesis como lo hacen las plantas. Las semillas usan el alimento que tienen almacenado para crecer en vez de producir su propio alimento a través de la fotosíntesis.)

4 ¿Qué parte de la plántula emerge de la semilla primero? ¿Por qué razón es esto importante? (Las raíces emergen primero para que la plántula pueda comenzar a recibir los nutrientes y el agua que necesita.)

Why It Happens/More on the Topic

Only the seeds under the right conditions will germinate. The seeds without the proper amount of water or warmth were unable to thrive. The amount of sun did not matter because seeds, unlike plants, do not need light to make food. Seeds use stored food rather than making food through photosynthesis.

Algo más sobre el tema…

Las únicas semillas que germinarán son las que se encuentran bajo condiciones adecuadas. Las semillas que no reciben la cantidad de agua apropiada o la temperatura templada necesarias no lograrán prosperar. La cantidad de luz del sol fue irrelevante porque las semillas, al revés de las plantas, no necesitan luz para producir alimentos. Las semillas utilizan los alimentos almacenados en vez de producir alimentos a través de la fotosíntesis.

Modifications

For younger students (including K-2), simplify the variables in the experiment. For instance, use only light vs. dark, moderate water vs. no water, or warm vs. cold conditions.

Older students can measure the length of the growing roots and shoots each day and make a graph of the results for each set of variables.

Extensions

Have students collect other types of seeds and set up an experiment to see what the ideal conditions are for those seeds to germinate.

References

Ardley, Neil. The Science Book of Things That Grow. San Diego, CA: Gulliver Books, 1991.

Harlow, Rosie and Gareth Morgan. Fun With Science: Energy and Growth. New York, NY: Warwick Press, 1991.

STUDENT ACTIVITY SHEET

What Do Seeds Need To Germinate?

1. Write your predictions for each container below:

Container	***Predictions***
Moderate water, sun	
Moderate water, no sun	
Moderate water, cold	
Underwater, sun	
No water, sun	

STUDENT ACTIVITY SHEET

What Do Seeds Need To Germinate? (continued)

2. Record your observations for each day:

	Day 1	***Day 2***	***Day 3***	***Day 4***	***Day 5***
Moderate water, sun					
Moderate water, no sun					
Moderate water, cold					
Underwater, sun					
No water, sun					

3. What happened to the seeds in each container? What do you think seeds need in order to germinate?

ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE

¿Qué necesitan las semillas para germinar?

1. Escribe tus predicciones para cada recipiente en el espacio indicado:

Recipiente	***Predicciones***
Agua en cantidad moderada, sol	
Agua en cantidad moderada, ausencia de luz solar	
Agua en cantidad moderada, frío	
Sumergidas en agua, sol	
Ausencia total de agua, sol	

ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE

¿Qué necesitan las semillas para germinar? (continuación)

2. Escribe diariamente tus observaciones:

	Día 1	***Día 2***	***Día 3***	***Día 4***	***Día 5***
Agua en cantidad moderada, sol					
Agua en cantidad moderada, ausencia de luz solar					
Agua en cantidad moderada, frío					
Sumergidas en agua, sol					
Ausencia total de agua, sol					

3. ¿Qué les sucedió a las semillas en cada recipiente? ¿Qué crees que las semillas necesitan para germinar?

WHAT COMES OUT OF A LEAF?

¿Qué emerge de las hojas?

Grades		
3–8	Whole Class	Day 1: 20 mins. Days 2–4: 15 mins./day

Purpose

Students will observe water and oxygen being released from leaf surfaces as a result of transpiration and photosynthesis.

Materials

House plant with flat leaves
Pond weed or other aquatic plant (from a pet store or biological supply company)
Clear jar
Bowl (much larger than the jar)
Plastic wrap or small sandwich bag
Water
String
Piece of cardboard

Concepts

- Water evaporates (or transpires) from plant leaves.
- Oxygen and food (sugars or carbohydrates) are produced when a plant photosynthesizes. Oxygen can be seen as gas bubbles when a photosynthesizing leaf is underwater.

Conceptos

- El agua se evapora (o transpira) por las hojas.
- Al realizar la fotosíntesis, la planta produce oxígeno y alimentos (azúcares y carbohidratos). El oxígeno se puede observar en forma de burbujas cuando el gas se libera de una hoja que está realizando la fotosíntesis bajo el agua.

Vocabulary

Transpiration
Evaporation
Water vapor
Xylem (pronounced: zi-lem)
Photosynthesis
Chlorophyll (pronounced: clor-o-fill)
Stomata

Vocabulario

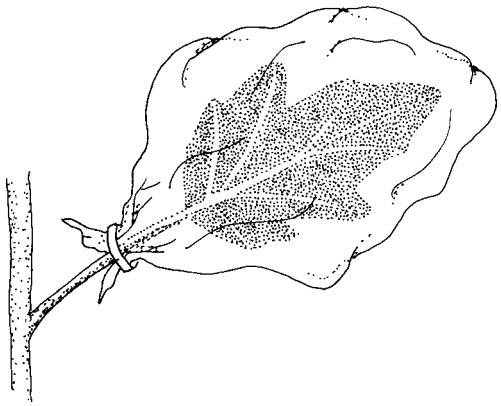
Transpiración
Evaporación
Vapor de agua
Xilema
Fotosíntesis
Clorofila
Estoma

Procedure

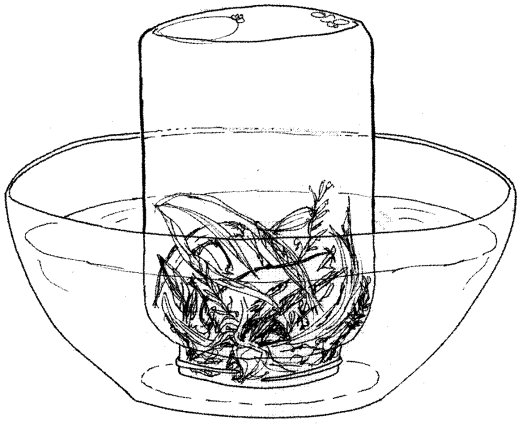
1. Set-up

Begin by telling students that you will be setting up two experiments to see what comes out of leaf surfaces.

To set up the first experiment, wrap a square of plastic wrap or a sandwich bag around a leaf (or several leaves) of the house plant. Tie the plastic at the base, leaving about an inch of space between the leaves and the plastic. Place the plant in a light area of the classroom.



To set up the second experiment, fill the bowl about three-quarters full of water. Place the pond weed into the jar and fill the jar to the top with water. While holding the cardboard over the top of the jar, carefully turn the jar upside down into the bowl of water. Remove the cardboard and place the bowl in a sunny spot.



2. Observe

The next day, have students look at the leaves that were covered in plastic. Ask them what differences they notice (some water droplets should be collecting inside the plastic). Also, have them take a look at the plants submerged in water. What has changed on the leaf surfaces? (They should see bubbles appearing on the leaves.) Ask them what must be causing these changes. Using the information in the "Why It Happens" of this activity, explain why there is water gathering on the plastic and why bubbles are forming on the leaf surfaces.

3. Predict

Now that students have observed the bubbles on the pond weed and understand that they are formed during **photosynthesis**, ask them to predict what will happen if the pond weed is placed in a dark area. Place the pond weed set-up in a dark area of the classroom or in a closet.

4. Observe and discuss

On the third day, have students observe the pond weed set-up again. What happened? Are the bubbles appearing on the leaves more quickly or more slowly? Why?

Questions to Ask During the Activity

1. Why do plants need water? (Water is used during photosynthesis. Water also helps transport minerals and food from one part of the plant to another.)

2. How is water leaving the leaf surfaces? (It is **evaporating**—called **transpiration** in plants—from the surfaces of the leaves. As water is transpired, the water inside the plant is pulled upward through small tubes called **xylem**.)

3. What does the plant make during photosynthesis? (Oxygen and food in the form of sugars or carbohydrates.)

4. What do plants need for photosynthesis to occur? (Sunlight, water, and carbon dioxide gas.)

5. Why are there fewer bubbles when the pond weed is placed in a dark area? (The plant cannot photosynthesize when there is no sunlight.)

Preguntas sobre el tema de la actividad…

1. ¿Por qué necesitan agua las plantas? (El agua se usa durante el proceso de fotosíntesis. El agua también ayuda a transportar minerales y alimentos de un lugar de la planta a otros.)

2. ¿De qué manera se desprende el agua de las hojas? (Se **evapora** de la superficie de las hojas. En las plantas este proceso se llama **transpiración**. A medida que ocurre la transpiración, el agua que se encuentra en el interior de la planta es atraída hacia arriba a través de pequeños tubos llamados **xilemas**.)

3. ¿Qué produce la planta durante el proceso de fotosíntesis? (Oxígeno y alimentos en forma de azúcares o carbohidratos.)

4. ¿Qué necesitan las plantas para que se produzca la fotosíntesis? (Luz del sol, agua y dióxido de carbono.)

5. ¿Por qué hay menos burbujas en el estanque cuando se colocan las algas en un área con sombra? (La planta no puede realizar la fotosíntesis cuando no hay luz del sol).

Why It Happens/More on the Topic

Water evaporates, or transpires, from plant leaves. When water evaporates, it becomes **water vapor**. Water vapor is a gas that is not usually seen unless it condenses into droplets like it does when it gathers on the plastic wrap.

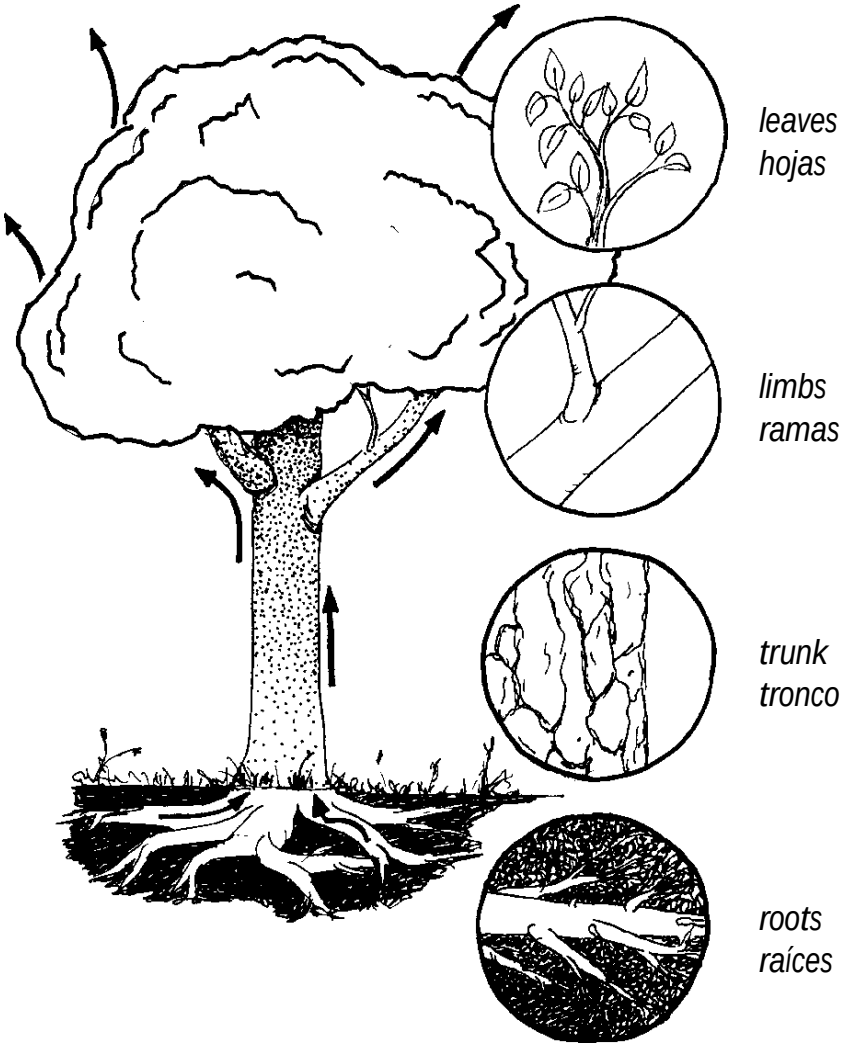
Photosynthesis is a chemical reaction that takes place in the **chlorophyll** of green plants. Photosynthesis uses sunlight to change water and carbon dioxide gas into food for the plant. A bi-product of the process is oxygen, which is released into the air. The oxygen and water is released through small holes, called **stomata**, in the leaves and stems.

Algo más sobre el tema...

El agua se evapora, o transpira, a través de las hojas. Cuando el agua se evapora, se transforma en **vapor de agua**. El vapor de agua es un gas que en general no se ve, a menos que se condense y forme gotitas como sucede cuando se juntan dentro de una bolsa de plástico.

Algo más sobre el tema (continuación)

La fotosíntesis es una reacción química que se produce en la **clorofila** de las plantas verdes. La fotosíntesis usa la luz del sol para transformar el agua y el dióxido de carbono en el alimento para la planta. El oxígeno que se libera en el aire es un derivado del proceso. El oxígeno y el agua se liberan a través de pequeños orificios, llamados **estomas**, que se encuentran en las hojas y en el tallo.



Flow of Water

Flujo del agua

Extensions

Have students try wrapping leaves on an outdoor plant with a plastic bag. Measure the water that collects in the bag over a 24 hour period. Calculate how much water the entire plant gives off each day. Try the experiment on a sunny, warm day, and also on a cloudy, cool day.

References

Ardley, Neil. The Science Book of Things That Grow. San Diego, CA: Gulliver Books, 1991.

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THE LIVING LEAF
La hoja llena de vida

Grades		
3–8	4–5	Day 1: 15 mins. Day 3: 45 mins.

Purpose

Using several experiments, students will discover that plants need sunlight, carbon dioxide, and chlorophyll to photosynthesize.

Materials

Healthy green house plant with large, individual leaves (one per group)
(plants grown during other activities may be used)
Tin foil
Petroleum jelly
Rubbing alcohol
Container large enough to submerge a leaf (one per group)
Hot plate for boiling water (optional)
Student Activity Sheet

Concepts

- Plants make their own food through photosynthesis.
- Plants have a green pigment, called chlorophyll, that is necessary for photosynthesis.
- Plants need sunlight and carbon dioxide to photosynthesize.

Conceptos

- Las plantas producen sus propios alimentos a través de la fotosíntesis.
- Las plantas tienen un pigmento verde, llamado clorofila, necesario para la fotosíntesis.
- Las plantas necesitan luz solar y dióxido de carbono para realizar la fotosíntesis.

Safety

If you will be using boiling water for the chlorophyll extraction, do not let students near the water. Dip the leaves into the boiling water yourself, then give the leaves to students.

Vocabulary

Photosynthesis
Chlorophyll
Carbon dioxide

Vocabulario

Fotosíntesis
Clorofila
Dióxido de carbono

In Advance

Make copies of the Student Activity Sheet. On the third day, you may want to set up the chlorophyll extraction demonstration in advance, if time will be limited.

Procedure

1. Introduce the activity

Begin by asking students if they know how plants get the food they need to grow and function. After several responses, tell them that plants produce their own food through a process called **photosynthesis**. In order for plants to photosynthesize, they need certain things. They will be setting up a couple of simple experiments to see what happens when a leaf is unable to get what it needs to photosynthesize.

2. Set-up

Divide the class into groups of 4 or 5 students. Give each group a house plant, three pieces of tinfoil (large enough to cover a leaf), and the petroleum jelly. Instruct each group to select three healthy leaves and cover them with tinfoil. Also have each group thoroughly cover another three leaves with the petroleum jelly. Set the plants in an appropriate place (sun or shade depending on the type of plant) for the next two days.

3. Observe

On the third day, hand out the Student Activity Sheets and have students retrieve their houseplants. Tell them they will be writing down their observations and their hypotheses about their houseplant. Students will need to remove the tinfoil from the leaves to see underneath. When students have completed their Student Activity Sheet, discuss their hypotheses about what plants need to photosynthesize and stay healthy. Use the information in the "Why It Happens" section of this activity to guide your discussion.

4. Set up and observe

In addition to needing **carbon dioxide** from the air and energy from the sun to photosynthesize, leaves rely on a green pigment, called **chlorophyll**. To extract chlorophyll from a leaf, have each group place a fresh leaf in a container with a small amount of rubbing alcohol. After a few hours, observe the leaf and the rubbing alcohol. Much of the chlorophyll from the leaf should be in the rubbing alcohol. To speed up the process, the leaves can be dipped into boiling water before placing them in the rubbing alcohol. Explain to students that chlorophyll is necessary for photosynthesis. Plant parts that do not contain this green pigment do not photosynthesize.

Questions to Ask During the Activity

1. What are the variables in the experiment where you covered the leaves in the tinfoil and petroleum jelly? (Light and air)

2. What is the control in the experiment? (The uncovered leaves on the plant.)

3. What does the plant need to take in for photosynthesis to occur? (Carbon dioxide gas from the air, energy from the sun, and water from the soil.)

4. Where in the plant does photosynthesis occur? (In the green parts of the plant where chlorophyll is present.)

Preguntas sobre el tema de la actividad

1. ¿Cuáles son las variables en el experimento en el cual cubriste las hojas con papel de aluminio y con vaselina? (Luz y aire)

2. ¿Cuál es la variable que actúa de control en el experimento? (Las hojas de la planta dejadas al descubierto.)

3. ¿Qué necesita la planta para que se produzca la fotosíntesis? (Dióxido de carbono del aire, energía del sol y agua del suelo.)

4. ¿En qué lugar de la planta se produce la fotosíntesis? (En las partes de color verde de la planta donde hay clorofila.)

Why It Happens/More on the Topic

The leaves that were covered with tinfoil were not able to photosynthesize properly. The sunlight necessary for photosynthesis was blocked.

The leaves that were covered in petroleum jelly were not able to get carbon dioxide gas from the air. Carbon dioxide is also necessary for photosynthesis.

The other leaves on the plant should not have changed much during the experiment. As long as the plant receives water and nutrients from the soil and some leaves can get carbon dioxide gas and sunlight, the plant will be able to photosynthesize and survive.

Photosynthesis can only take place in the parts of the plant that contain chlorophyll, a green pigment.

Algo más sobre el tema...

Las hojas cubiertas con papel de aluminio no pudieron realizar la fotosíntesis apropiadamente. La luz del sol que es necesaria para realizar la fotosíntesis fue bloqueada.

Las hojas que se cubrieron con vaselina no pudieron recibir suficiente dióxido de carbono del aire. El dióxido de carbono es necesario para realizar la fotosíntesis.

Las otras hojas de la planta no deberían haber cambiado demasiado durante el experimento. Mientras la planta reciba agua y nutrientes del suelo y algunas hojas puedan recibir dióxido de carbono y luz solar, la planta podrá realizar la fotosíntesis y sobrevivir.

La fotosíntesis sólo puede producirse en las partes de la planta que contienen clorofila, un pigmento verde.

Modifications

For younger students (including K-2), use the experiments as demonstrations and discuss observations rather than using the Student Activity Sheet.

Extensions

Have students investigate photosynthesis in trees that lose their leaves in the fall. Does the tree continue to photosynthesize? If not, how does the tree survive? Why do the leaves turn different colors in the fall? Do those colors aid in photosynthesis?

References

Bosak, Susan V. Science Is...A source book of fascinating facts, projects, and activities. Markham Ontario, Canada: Scholastic Canada, 1991.

Raven, Peter H., Ray F. Evert, and Susan E. Eichhorn, editors. Biology of Plants. Fifth edition. New York, NY, Worth Publishers, 1992.

STUDENT ACTIVITY SHEET
The Living Leaf

Record your observations and hypotheses below:

Leaf	***Observations***	***Hypothesis***
Tinfoil-covered leaf		
Vaseline-covered leaf		
Uncovered leaf		

ACTIVIDADES PRÁCTICAS PARA EL ESTUDIANTE

La hoja llena de vida

Escribe tus observaciones y tus hipótesis en el espacio a continuación:

Hoja	***Observaciones***	***Hipótesis***
Hoja cubierta con papel de alumino		
Hoja cubierta con vaselina		
Hoja sin cubrir		

SMART ROOTS AND SHOOTS

Raíces y brotes inteligentes

Grades		
3–8	2–4	Day 1: 30 mins. 10 mins. periodically over the next several weeks.

Purpose

Students will determine if roots and shoots respond to gravity (geotropism) and sunlight (phototropism).

Materials

Pinto or lima beans soaked overnight (4 per group)
Large, clear jar with lid (1 per group)
Paper towels
Water
Masking tape and marker
Seedling (bean plants grow quickly) in a small pot
Box with lid (at least the size of a shoe box)
Cardboard
Student Activity Sheets

Concepts

- Seeds, seedlings, and plants use chemicals to sense and respond to their environment.
- Seeds can sense gravity and respond by sending shoots upward and roots downard into the soil.
- Seedlings can sense sunlight and will grow towards it.

Conceptos

- Las semillas, las plántulas y las plantas usan sustancias químicas para percibir y responder a su medio ambiente.
- Las semillas perciben la fuerza de gravedad y como respuesta, envían los brotes hacia arriba y las raíces hacia abajo, hacia la tierra.
- Las plántulas pueden percibir la luz solar y crecerán hacia ella.

Vocabulary

Geotropism
Phototropism
Germination

Vocabulario

Geotropismo
Fototropismo
Germinación

In Advance

Make copies of the Student Activity Sheets. Construct the plant maze with the box and cardboard (see diagram on next page). Soak bean seeds overnight.

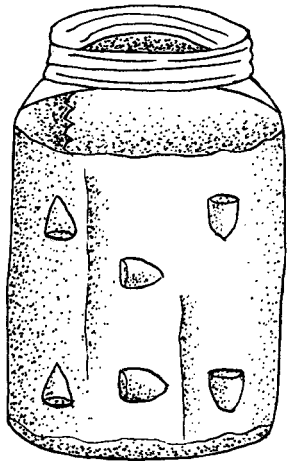
Procedure

1. Introduce activity

Ask students if they have ever seen a plant grow with its leaves in the soil and its roots growing towards the sun. Have they ever seen a plant growing towards the dark? Explain that plants have the ability to sense their surroundings and grow in a particular direction. Tell students that they will be setting up a couple of experiments that will show how seeds and seedlings respond to their environment.

2. Set-up

For the first experiment, divide the class into groups of 2-4 students. Give each group a jar and 4 beans. Tell students to line the inside of the jar with paper towels, then moisten the paper towels. Place each of the seeds between the paper towels and the jar, about half way up. Each seed should be oriented in a different position: one facing up, one down, one left, and one right. Put the lid on the jar and label the jar with a group number or name using the masking tape and marker.

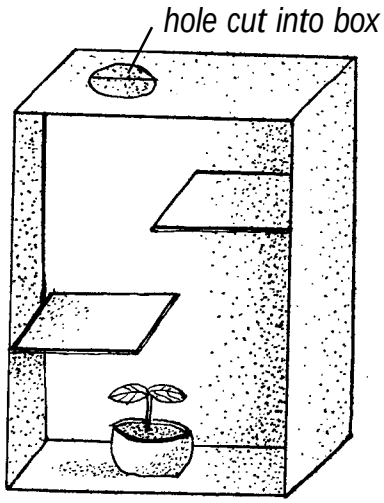


3. Hypothesis

Hand out the Student Activity Sheet and have students draw a picture of the orientation of their seeds in the jar. Also have them write down their hypothesis about how they think the roots and shoots will emerge when the seeds **germinate**. Tell students they will be watching their seeds over the next week to see what happens. Also remind them that they may need to add water to the paper towels to keep the seeds moist. Place the jars in a sunny spot in the classroom.

4. Set-up

Take out the plant maze that you constructed and the potted seedling. Place the seedling in the bottom of the box. Show students that there is a hole in the top of the box for light to get in. Close the box. Ask students if they think the plant will grow through the maze towards this small amount of light? Remember to water the plant regularly during the experiment.



5. Observe

Have students observe their seeds after the fifth day. The seeds should be starting to germinate. Tell students to draw the positions of the roots and shoots on the Student Activity Sheets. Was their hypothesis supported?

6. Further set-up

After students are finished with their observations, have them turn their jars upside down and put them back in the sunny area of the classroom.

7. Hypothesis

Ask students if they think the orientation of the roots and shoots will change over the next few days. Have them write their hypothesis on the Student Activity Sheet.

8. Observe and discuss

About three days later, have students observe their seeds again and draw their observations on the Student Activity Sheet. Was their second hypothesis supported by their observations? What could the seeds be sensing that helps them send the roots downward and the shoots upward?

About a week after setting up the plant maze, also have the class observe the growth of the seedling. What changes do they notice? Have them check the seedling after two weeks and after three weeks. The seedling should be growing towards the light. Ask students why the seedling is growing in the direction it is. What do plants need sunlight for? Does anyone know how the seeds and seedlings are sensing and responding to their environment?

Questions to Ask During the Activity

1. What is the function of the roots? (Roots obtain water and nutrients from the soil so the plant can grow and reproduce.)

2. What is the function of the shoot? (The shoot will eventually sprout leaves that will help the plant make food using sunlight and carbon dioxide gas.)

3. Why is it important that a germinating seed be able to sense gravity? (By sensing gravity, the seed can send its roots downward into the soil and its shoots upward towards the sun, no matter what position the seed is in the soil. If this did not happen, the plant would not be able to get what it needs to grow and reproduce.)

4. Why is it important for a seedling to grow towards the sun? (Plants need sunlight to make food and grow.)

Preguntas sobre el tema de la actividad

1. ¿Cuál es la función de las raíces? (Las raíces obtienen el agua y los nutrientes del suelo para que la planta pueda crecer y reproducirse.)

2. ¿Cuál es la función del brote? (Con el tiempo, las hojas van a emerger del brote y ayudarán a que la planta produzca alimentos usando luz solar y dióxido de carbono.)

3. ¿Por qué es importante que una semilla que está germinando pueda percibir la fuerza de gravedad? (Al percibir la fuerza de gravedad, la semilla puede enviar las raíces hacia abajo en el suelo y los brotes hacia arriba en dirección a la luz solar, sin tomar en cuenta la posición en que se encuentra la semilla. Si la planta no percibiera la fuerza de gravedad, no podría recibir lo que necesita para crecer y reproducirse.)

4. ¿Por qué es importante que la plántula crezca en dirección a la luz solar? (Las plantas necesitan luz solar para producir alimentos y crecer.)

Why It Happens/More on the Topic

Plants use specific chemicals (often called hormones) to respond to their environment. Humans also use hormones to sense and respond to our environment. Stress can trigger hormones, like adrenaline, that helps us respond to a stressful situation. When a seed senses and responds to gravity it is called **geotropism**. When a plant senses and responds to light, it is called **phototropism**.

Algo más sobre el tema...

Las plantas usan unas sustancias químicas (a menudo llamadas hormonas) para responder a los estímulos del medio ambiente. Los seres humanos también utilizamos nuestras hormonas para percibir y responder a los estímulos de nuestro medio ambiente. El estrés puede desencadenar la producción de hormonas, por ejemplo la adrenalina que nos ayuda a responder ante situaciones estresantes. **Geotropismo** es la percepción y respuesta de la semilla a la fuerza de gravedad. **Fototropismo** es la percepción y respuesta de la planta a la luz.

Modifications

Rather than using the Student Activity Sheet with younger students (including K-2), have them draw their seed observations on a separate sheet of paper and discuss their ideas about what is happening to the seeds. They may need help setting up their jars as well.

Extensions

Plants respond to their environment in other ways also. Some flowers open and close depending on the time of day. Climbing vines seek support that will help them grow upwards. Venus fly traps respond to the movement of an insect. Have students investigate and write a short report about other ways plants respond to their environment.

References

Ardley, Neil. The Science Book of Things That Grow. San Diego, CA: Gulliver Books, 1991.

Bosak, Susan,V. Science Is...A source book of fascinating facts, projects, and activities. Markham, Ontario, Canada: Scholastic Canada, 1991.

Daniel, Lucy, editor. Merrill Life Science: Laboratory Manual. Teacher Annotated Edition. Columbus, OH: Glencoe Macmillian/McGraw-Hill, 1993.

STUDENT ACTIVITY SHEET

Smart Roots and Shoots

Record your hypothesis and observations of the seeds on the first and fifth days.

Drawing of the seed positions in the jar before germination (Day 1)	***Hypothesis***	***Drawing of the seed positions in the jar (Day 5)***

STUDENT ACTIVITY SHEET

Smart Roots and Shoots (continued)

Record your hypothesis and observations of the seeds on the fifth and eighth days (after turning the jar **upside down**).

Drawing of the seed positions in the jar (the jar should be upside down)	***Hypothesis (Day 5)***	***Drawing of the seed positions in the jar (Day 8)***

ACTIVIDADES PRÁCTICAS PARA LOS ESTUDIANTES

Raíces y brotes inteligentes

En el primero y en el quinto día, escribe tus hipótesis y tus observaciones sobre las semillas.

Dibujos de la posición de las semillas en el frasco antes de la germinación–primer día	***Hipótesis***	***Dibujos de la posición de las semillas en el frasco–quinto día***

ACTIVIDADES PRÁCTICAS PARA LOS ESTUDIANTES

Raíces y brotes inteligentes (continuación)

En el quinto y en el octavo día, escribe tus hipótesis y tus observaciones sobre las semillas (después de haber puesto el frasco boca abajo).

Dibujos de la posición de las semillas en el frasco (el frasco debe estar al revés)	***Hipótesis–quinto día***	***Dibujos de la posición de las semillas en el frasco–octavo día***

FLOWERS, FRUITS, AND CONES

Plantas, frutas y conos

Grades		
3-8	2	45–60 min.

Purpose

Students will compare plants that produce seeds in a flower and those that produce seeds in a cone.

Materials

Lily, or similar flower (one per group)
Apple (one half per group)
Pinecone—preferably with seeds still attached (one per group)
Piece of paper
Pen or pencil
Small piece of black construction paper (one per group)
Copies of flower diagram (one per group)
Knife (teacher use only)

Concepts

- Plants that produce seeds are divided into two groups: plants that produce seeds in a flower (angiosperms) and plants that produce seeds in a cone (gymnosperms).
- Some parts of a flower can be recognized in the fruit it produces.
- Seeds in a cone are not enclosed like seeds in a flower.
- Reproduction in gymnosperms is different than in angiosperms.

Conceptos

- Las plantas que producen semillas se dividen en dos grupos: las plantas que producen semillas dentro de una flor (angiospermas) y las plantas que producen semillas en un cono (gimnospermas).
- En la fruta se pueden reconocer partes de la flor.
- Las semillas en un cono no están encerradas como lo están las semillas dentro de una flor.
- La reproducción de las gimnospermas es diferente de las angiospermas.

Safety

Only the teacher should use the knife to cut the apples and flowers.

Vocabulary

Flower
Pistil
Stigma
Stamen
Anther
Ovary
Sepal
Petal
Pollen
Pollination
Fertilization
Angiosperm
Gymnosperm (pronounced: jim-no-sperm)

Vocabulario

Flor
Pistilo
Estigma
Estambre
Antera
Ovario
Sépalo
Pétalo
Polen
Polinización
Fertilización
Angiosperma
Gimnosperma

In Advance

Make copies of the flower diagram. Cut apples in half. Find pinecones and flowers.

Procedure

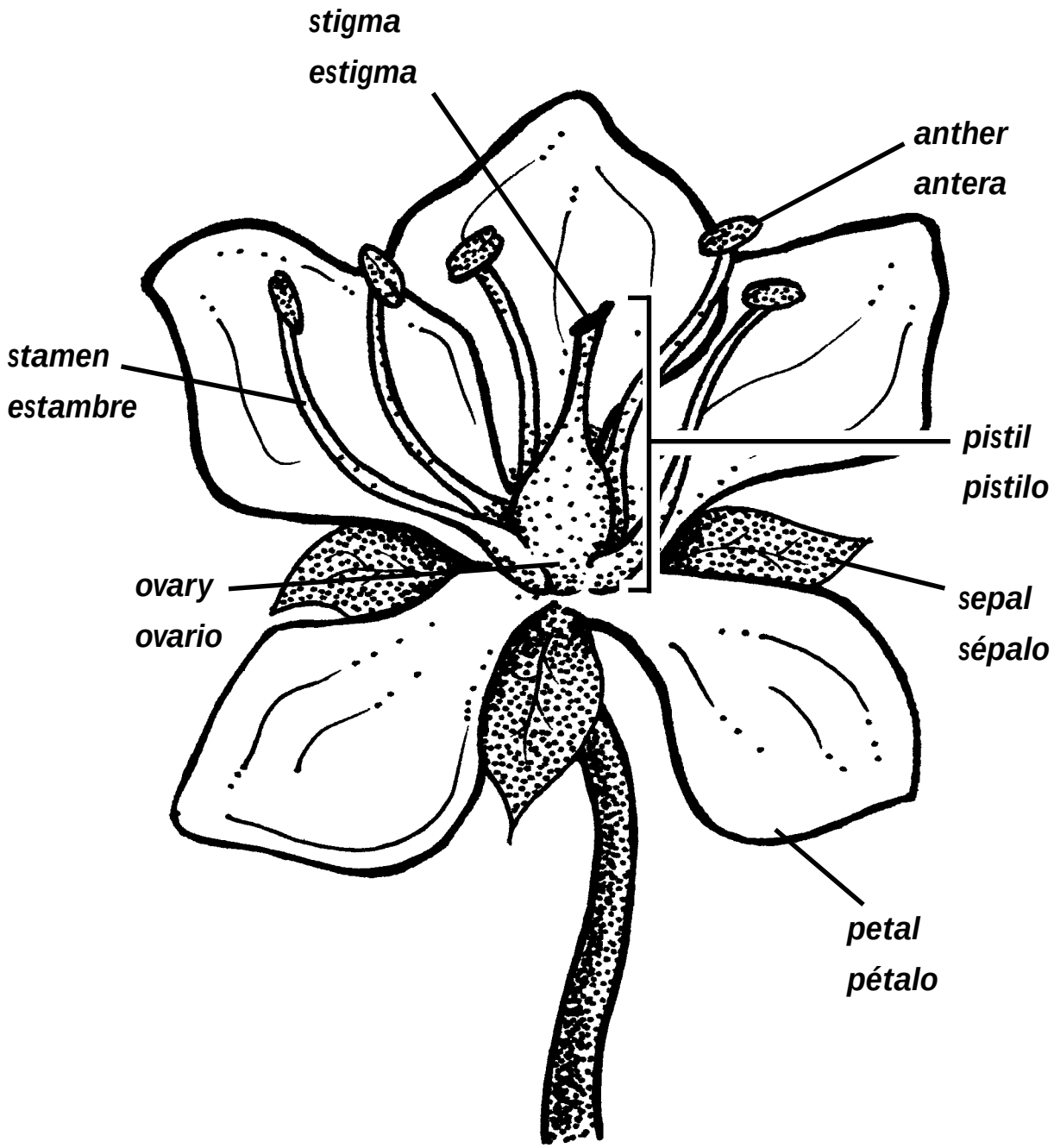
1. Introduce activity

Ask students where on a plant they can find seeds. They should mention in a fruit or flower. If no one mentions that seeds can be found in a cone, ask them where they can find a seed on a pine tree. Tell students that seed-bearing plants are divided into two main groups, depending on where those seeds are found. Plants that produce seeds in a flower are called **angiosperms**. Non-flowering plants are called **gymnosperms** and usually produce their seeds in a cone or cone-like structure. Tell students that they will be taking a closer look at flowers and cones to see how these plant groups differ.

2. Set-up

Divide students into pairs and give each pair a flower, half an apple, a pine cone, a piece of black construction paper, and a copy of the flower diagram.

Flower Diagram
Diagrama de una flor



3. Flower dissection

Before students begin to take their flower apart, have them use their flower diagram to identify some of the parts of their lily. They should easily be able to see the **petals**, **sepals**, **pistil**, **stamens**, **anthers**, and **stigma**. When they have found these parts, have the students carefully pull out one of the stamens. Tell them to gently rub the anther on the piece of black construction paper. Do they know those are tiny **pollen** grains that come off the anthers? Which part of the flower needs to receive the pollen before the flower will produce seeds? (The stigma).

Next, cut through each flower (teacher only) vertically so the **ovary** is split in two lengthwise. (The ovary is located at the rounded base of the pistil.) Have students observe the ovary and look to see if there are seeds inside.

4. Label flower parts

Have students separate the flower parts, putting them on the white piece of paper. Tell them to identify and label the following parts of their flower on the paper: petal, sepal, pistil, stamen, anther, stigma, and ovary.

5. Observe the apple

Next, have your students look at the cross section of the apple. Do they see any parts of the apple that look like the parts of the flower? (They should notice the seeds, sepals, and stem. They should also realize that the apple is an enlarged ovary with seeds inside.) What is the advantage of having the ovary grow into a large fruit?

6. Observe the pinecone and discuss

Have students look closely at their pinecone. Can they find the seeds? What is the big difference between where the seeds are on a pinecone and where they are on a flower? (They should notice that the seeds on a pinecone are not enclosed while the flower seeds are). Are other flower structures present on the pinecone?

Questions to Ask During the Activity

1. What is the function of the flower? (It is the reproductive structure of angiosperms.)

2. What is the function of the pinecone? (It is the reproductive structure of gymnosperms.)

3. What is the function of the stamen in a flower? (The stamen produces the pollen.)

4. What is the function of the stigma in a flower? (The stigma catches the pollen so that **pollination** and **fertilization** can occur.)

5. What is the function of the petals of a flower? (The petals attract insects and protect the inner structures of the flower.)

Preguntas sobre el tema de la actividad

1. ¿Cuál es la función de la flor? (Es la estructura reproductiva de las angiospermas.)

2. ¿Cuál es la función del cono del pino? (Es la estructura reproductiva de las gimnospermas.)

3. ¿Cuál es la función de los estambres de la flor? (Los estambres producen polen.)

4. ¿Cuál es la función del estigma de la flor? (El estigma captura el polen para que se lleven a cabo la **polinización** y la **fertilización.**)

5. ¿Cuál es la función de los pétalos de la flor? (Los pétalos atraen insectos y protegen la estructura interna de la flor.)

Why It Happens/More on the Topic

Flowers contain the structures used in sexual reproduction of angiosperms. The thin, vase-like structure in the center of a flower is called the pistil. The long, skinny structures that surround the pistil are called stamens. They produce pollen, the male sex cells. The sticky tip of the pistil, called the stigma, receives pollen. Pollination occurs when pollen is transferred from a stamen to the stigma. The female sex cells are produced and contained inside the ovary, located at the rounded base of the pistil. When pollen meets the female sex cells in the ovary they become fertilized and begin to produce seeds. The seed then grows inside the ovary until it is ready to be released. The petals, stamens, and pistil either wilt or become part of the fruit which forms around the seed.

Reproduction in gymnosperms is different than in angiosperms. The seeds are arranged on a female cone rather than being contained in an ovary. Pollen is produced in separate, male cones. Pollination depends on pollen blowing from the male cone to the female cone.

Algo más sobre el tema...

Las flores contienen las estructuras que se necesitan para la reproducción sexual de las angiospermas. La estructura delgada, con forma de florero en el centro de la flor, se llama pistilo. Las estructuras largas y delgadas que rodean al pistilo se llaman estambres. Éstos son los que producen polen, las células sexuales masculinas. El polen llega al extremo pegajoso del pistilo, llamado estigma. En el momento en que el polen se transfiere del estambre al estigma es cuando ocurre la polinización. Las células sexuales femeninas se producen y se almacenan en el ovario, localizado en la base del pistilo. Cuando el polen se encuentra con las células femeninas en el ovario, éstas son fertilizadas y comienza el proceso de producción de semillas. Luego, las semillas crecen dentro del ovario hasta que están listas para liberarse. Los pétalos, los estambres y el pistilo o bien se marchitan o se convierten en parte de la fruta que se forma alrededor de la semilla.

La reproducción de las gimnospermas es diferente de la de las angiospermas. Las semillas se ubican en un cono femenino en vez de en un ovario. El polen se produce de manera independiente, en conos masculinos. La polinización depende de que el polen vuele del cono masculino al femenino.

Extensions

Have students bring in and dissect a flower from their garden or neighborhood. Compare the different shapes, sizes, and colors of the various parts of each type of flower. Can they figure out how each of the flowers are pollinated, based on the differences of the flower parts? (Hint: Brightly-colored flowers tend to attract bees and hummingbirds. Flowers with strong scents that open at night tend to be pollinated by bats or nocturnal insects.)

Good References for Flower Structure

Audesirk, Teresa, Gerald Audesirk, and Bruce E. Byers, editors. Life on Earth. Second edition. Upper Saddle River, NJ: Prentice Hall, Inc., 2000.

Daniel, Lucy, Edward P. Ortleb, and Alton Briggs. Merrill Life Science. Teacher Wrap-Around Edition. Lake Forest, IL: Glencoe-Macmillan/McGraw-Hill, 1993.

Raven, Peter H., Ray F. Evert, and Susan E. Eichhorn, editors. Biology of Plants. Fifth edition. New York, NY: Worth Publishers, 1992.

A DIVERSITY OF LEAVES
La gran variedad de hojas

Grades		
K–2	Whole Class	45–60 min.

Purpose

Students will gather a variety of leaves, then make leaf rubbings to show the different sizes, shapes, and vein patterns of their leaves.

Materials

Leaves (a variety of shapes and sizes, including pine needles)
Paper
Crayons (with paper wrap removed)

Concepts

- Leaves come in many sizes and shapes
- Leaves have veins to help transport water and nutrients through the leaf.

Conceptos

- Las hojas tienen una gran variedad de formas y tamaños.
- Las hojas tienen nervaduras que las ayudan a transportar el agua y los nutrientes.

Safety

If you take your students outside to collect leaves, be sure to identify the boundaries your students must not cross.

In Advance

Remove paper wrap from the crayons or select crayons that have already been unwrapped. Find an outdoor site for collecting leaves.

Procedure

1. Explain the activity

Begin by telling students they will be taking a close look at different leaves. Explain that they will be going outside to collect some leaves, then doing an art project using the leaves when they return to the classroom.

2. Take the class outside

Take the students outside to the site you have selected for collecting leaves. Identify the boundaries of the area they will be using. Explain that they should each collect 8 leaves of all different shapes and sizes. Tell students that pine needles can also be collected—they are the leaves from a pine tree. Give students about 10 minutes to collect their leaves.

3. Return to the classroom and begin art project

Bring students back to the classroom with their leaves and give each student a piece of paper. Also give students an assortment of crayons to share.

Before students begin, demonstrate how to make a leaf rubbing. Place a leaf on a flat surface, then put a piece of paper over the leaf. Using the side of the crayon, rub the paper over the area where the leaf has been placed. The crayon should highlight the edges and veins of the leaves in most cases. Tell students they can arrange the leaves however they like under their paper and can use more than one color crayon. It will be easier if they only place one leaf under the paper at a time. Give them 10 or 15 minutes to complete their rubbings.

4. Discuss the leaf rubbings

When students have completed their leaf rubbings, hold up a few to show the class. Ask students what parts of the leaves show up best. Do they know what the lines are in the center of some of the leaves? Do they know what the leaf veins are for? Do they recognize any of the leaves from a particular tree or shrub?

Questions to Ask During the Activity

1. What are some of the different textures of the leaves you have collected? (Leaves can be smooth, fuzzy, waxy, sticky, bumpy, etc.)

2. Can you tell which leaves fall from the tree in the autumn and which don't?

3. What are leaf veins for? (They help to transport water and nutrients to the leaves.)

Preguntas sobre el tema de la actividad

1. ¿Qué tipo de texturas diferentes tienen las hojas que recolectaste? (Las hojas pueden ser suaves, vellosas, enceradas, pegajosas, rugosas, etc.)

Preguntas (continuación)

2. ¿Cuáles son las hojas que caen de los árboles en otoño y cuáles no?

3. ¿Para qué sirven las nervaduras de las hojas? (Ayudan a transportar agua y nutrientes hacia las hojas.)

Modifications

Instead of making leaf rubbings with the leaves, you can make leaf prints. Using a paintbrush, paint the underside of a leaf, then carefully press it onto a piece of paper. Be careful not to drag the leaf across the paper if you don't want the print to smear.

Extensions

Help your students identify some of the leaves they collected. Tree and shrub identification books can be found in the local library. Have students label their leaf rubbings with the names of the trees or shrubs they came from.