SCIENTISTS IN SCHOOL
SCIENTIFIQUES À L'ÉCOLE

Teacher Resource Package

Let us help you piece together the science!

Background Information an overview of the topic and theoretical concepts.

Hands-on Activities

Activity 1 - pen/paper activity
Activity 2 - short, easy-to-do activity (30-60min)
Activity 3 - short, easy-to-do activity (30-60min)
Activity 4 - longer activity (greater than 1 hr)
Activity 5 - complex activity

Teacher Resources

Literary Resources
Website Resources
Interactive White Board Resources
Multi-media

Student Resources

Literary Resources
Interactive Websites

Please help us improve our teacher resource packages!

If you have any feedback about this package or suggestions for new resources to include, please don't hesitate to contact us at: inquiries@scientistsinschool.ca.

Plants Do Amazing Things!

Drrinngg…Drrinngg…yeah, it's recess time! Time for a quiet break…you head outside to the front of the school…away from the noise…you take a deep breath of fresh air and have a seat on the wooden bench in the shade of a maple tree…you slip off your shoes and feel the grass between your toes…you pull a red apple out of your cotton lunch bag and take a crunchy bite while enjoying the sweet scent of flowering lilacs. From the fresh air to the cotton lunch bag, it is all thanks to plants! We need plants to survive: they provide us with food, they improve the quality of the air we breathe and they provide us with shelter, materials for clothes, medicine and accessories such as cloth bags.

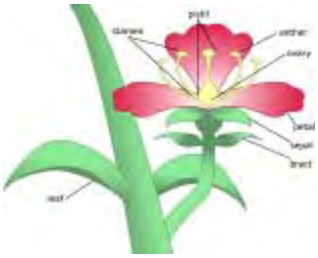
Background Information

Plants appeared on Earth about 400 million years ago and represent one of the five main kingdoms of living things. Plants grow everywhere and many are able to live in harsh places such as cracks in pavement, dry deserts and underwater. The only places where plants don't grow are the hottest driest deserts and areas covered in snow and ice.

Classification of Plants

Botany is the study of plants. The one trait that all plants share is an ability to produce their own food. Botanists estimate that there are approximately 400,000 different species of plants ranging from the smallest flowering plant in the duckweed family to the largest tree, the giant sequoia. Angiosperms, or flowering plants, are the most successful plants on Earth. They have increased in number in the last 100 million years due to various adaptations of their flowers, fruits and seeds.

Plants can be classified based on a number of different characteristics. These include the presence of cells and tubes to transport water and nutrients, called vascular tissue; whether they are flowering or non-flowering; whether they produce spores or seeds; and the types of seeds they produce. The following flowchart illustrates a simple method of plant classification.



Plant Kingdom

- Non-flowering Spore-bearing
  - Moss, Liverwort, Hornwort
    - no roots
    - no vascular tissues
  - Fern, Horsetail, Club Moss
    - roots
    - vascular tissues
- Seed-producing
  - Gymnosperms
    - vascular tissues
    - naked seeds
    - e g pine tree, ginkgo
  - Angiosperms Flowering Plants
    - vascular tissues
    - seeds in ovary/fruit
    - e.g. daisy
    - Monocot
      - seed is single piece
      - e.g. corn
    - Dicot
      - seed is two pieces
      - e.g. rose

Photosynthesis

Plants are autotrophic meaning that they are self-nourishing, producing their own food through a process called photosynthesis. The leaves contain a green pigment, chlorophyll, which absorbs energy from the sun. This light energy combines with carbon dioxide and water to produce chemical energy which is stored as sugars and starches. This food is used to fuel growth and nourish the development of the plant.

Parts of a Plant

The three most basic parts of a plant are:

1) Roots anchor the plant and absorb water, nutrients and minerals from the soil.
2) Stems provide support and the transportation system for the plant. The stem consists of two main tubes: xylem, which carries water and nutrients up to the leaves for use as raw materials for photosynthesis; and phloem, which carries dissolved products of photosynthesis to other parts of the plant.
3) Leaves absorb sunlight and produce food in the form of sugar molecules through the process of photosynthesis.

The flowering part of the plant is responsible for producing seeds that in turn create new plants. The flowers are typically composed of petals and sepals that protect the male parts of the flowers, known as stamens, and the female part of the flower, known as the pistil. Intensely coloured flowers often attract pollinators such as bees or birds that aid in the fertilization of seeds. Germination, the process by which a seed develops into a plant, is often triggered by a dormant inactive period, light, rain, extreme heat or a cold spell.

Adaptations

Plants have many adaptations to survive extreme environments. For example, on glaciers and at high mountain elevations plants grow low to the ground to be protected from the elements. In the desert, succulent plants have a waxy surface to minimize water loss through transpiration. Transpiration is a process where water enters a plant through the roots, travels to the leaf and then evaporates to the atmosphere through small pores on the underside of the leaf, called stomata. Conifer needles have a tough waxy coating that makes them resistant to frost, traps water and minimizes transpiration in the winter. Brightly coloured fruit attracts birds and animals which eat them, subsequently aiding in seed dispersal.

Importance of Plants

Plants have many benefits which include: producing oxygen, absorbing carbon dioxide, increasing underground water resources, filtering out dust, acting as windbreaks, moderating temperature, reducing noise, covering and protecting soil, providing shade, providing food and shelter for wildlife, providing food, wood and paper for humans as well as providing fiber for clothes and as a source for many medicinal ingredients. Trees are particularly important for minimizing and preventing erosion and sedimentation around streams and lakes. Their extensive root system holds the soil in place and prevents the soil from being too compacted. Trees are important in the water cycle as the trees filter a lot of the water and expel it through transpiration.

Fun Fact! "Leaves of Three, Beware of Me": Poison Ivy

Poison ivy produces a compound called urushiol. Touching poison ivy will cause an allergic reaction in many humans and some primates, usually in the form of an itchy rash on the skin.

Activity 1: Provincial Flower or Tree

Time: 30 minutes

Other Applications: Canada, Heritage and Early Settlements

Key Terms: flower, emblem

Group Size: Pairs

Materials (per pair):

- ☐ set of game pieces using the templates provided called "Province and Territory Images and Flower Emblem Descriptions" and "Provincial and Territorial Flower Emblems"
- ☐ map of Canada
- ☐ computer and/or research time

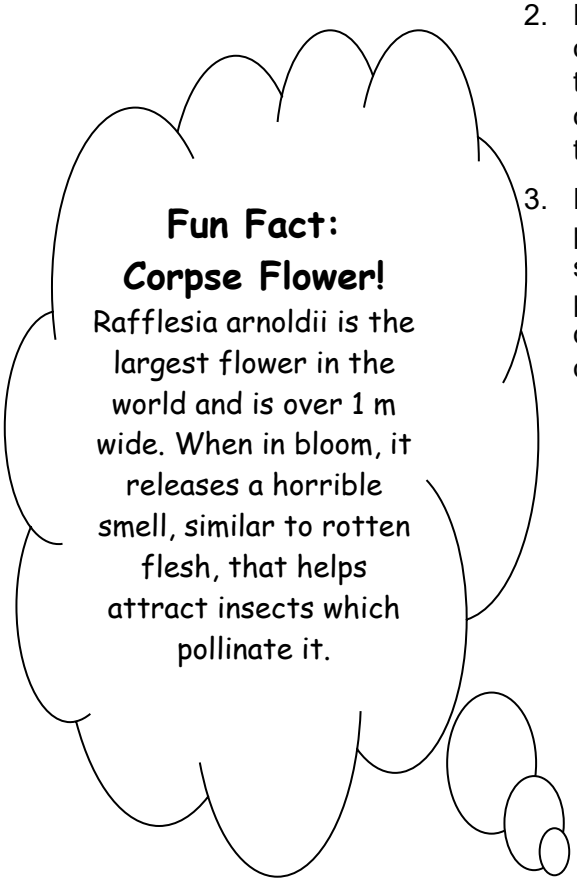
Learning Goal: Students will learn about the flower emblems of Canadian provinces and territories.

Flower or floral symbols are selected to represent native wildflowers that reflect the province or territory's habitat and natural surroundings. A few sample websites and book resources for information about provincial and territorial flowers include:

- http://canadaonline.about.com/od/symbolsprov/a/provincial-flower-emblems-canada.htm *(16/02/16)*;
- http://www.knightsinfo.ca/flowers.html *(16/02/16)*;
- http://www.aitc.sk.ca/saskschools/canada/emblems/nwt.html *(16/02/16)*;
- http://publications.gc.ca/site/eng/9.693005/publication.html *(28/02/16)*;
- *Symbols of Canada: Flowers.* 2010. Deborah Lambert. Weigl Publishers Inc. ISBN 9781553889311 *(21/01/2016)*

Procedure:

1. Print the "Province and Territory Images and Flower Emblem Descriptions" and the "Provincial and Territorial Flower Emblems" sheets included. Cut out the various images to create game pieces and consider laminating the pieces for re-use. For the "Province and Territory Images and Flower Emblem Descriptions" game pieces, cut along the lines and fold.
2. Provide a map of Canada and a set of game pieces to each pair of students. Have students take turns matching a province or territory with the flower emblem. The students can flip the image of the province and read the description of the flower or habitat to give them clues and help with the identification and matching.
3. Have each student or pair of students select a Canadian province or territory. Have students develop a presentation to share with the class about the flower emblem of their chosen province or territory. Encourage students to include pictures and descriptions of the plant or flower. The following are suggested questions to research:
   - why is the flower a symbol of the particular province or territory?
   - when and/or how was it designated as the flower emblem?
   - is the plant or flower protected?
   - what is unique about its habitat?
   - does it grow elsewhere in Canada?
   - is the plant or flower useful to humans or animals?
   - are there any Indigenous people or pioneer connections with the plant?



Teacher Answer Key and Discussion:
The chart below outlines the correct floral emblem for each province and territory. Detailed descriptions of the flowers and plants can be found online and in books. The table below outlines a few additional interesting facts about each flower emblem.

Province/Territory	Flower	Facts
Alberta	Wild Rose	- selected by students in 1930 - grows from Quebec to British Columbia - thorns are a protective adaptation - rosehips are a source of winter food for birds - used to make tea and jam - Indigenous people use the plant to heal skin infections and fight colds - petals can be used for perfume
British Columbia	Pacific Dogwood	- selected in 1956 - only floral symbol that is a tree - illegal to pick or destroy tree - spring flowering 6-8m tree - the white “petals” are specialized leaves that protect the 30-40 small green flowers in the centre - grows in moist ground near streams - produces bright fall foliage and red berries which provide food for wildlife - strong wood can be used for cabinetmaking and tool handles
Manitoba	Prairie Crocus	- selected by students in 1906 - blooms early in spring, often in snow - found in flat open grasslands - outer coating of hair on stems protects it from sudden temperature changes
New Brunswick	Purple Violet	- selected in 1936 - found in moist meadows and along riverbanks across much of Canada - relative of the pansy - flowers can be used in jam and syrup - flowers can also be used as medicine for colds and coughs
Newfoundland and Labrador	Pitcher Plant	- selected in 1954 - chosen by Queen Victoria to be engraved on Newfoundland penny in the 1880s, penny used until 1938 - carnivorous plant grows in bogs and marshes - Indigenous people used plant to cure smallpox and to treat stomach ailments
Northwest Territories	Mountain Avens	- selected in 1957 - small shrub that grows in central and eastern Arctic in open and well-drained areas on high barren ground - it grows low to the ground to protect from strong, cold winds - when the top of the avens begins to twist, that is a sign for Inuit to move inland to hunt caribou

Province/Territory	Flower	Facts
Nova Scotia	Mayflower	- selected in 1901 - derived name from Massachusetts pilgrims, the first flower they saw when they arrived in North America - Mayflower is the name of the boat that brought them to Plymouth Rock
Nunavut	Purple Saxifrage	- selected in 2000 - grows in wet swampy areas called muskeg or tundra - has small thick leaves with tiny hairs for protection from cold - when in full bloom, Inuit know young caribou are being born - flowers are eaten and used to make dye, stems and leaves used to make tea
Ontario	White Trillium	- selected in 1937 - white symbol associated with peace and hope - movement during first World War to make it a national flower and to plant on gravestones of Canadian servicemen overseas - also called “wake robin” as they bloom when robins return to Ontario - leaves used by Indigenous people for food (similar to spinach) and roots for variety of medicinal uses
Prince Edward Island	Lady’s Slipper	- selected in 1947 - type of orchid, also called “moccasin flower” - grows in shady and moist woodlands - illegal to pick flowers
Quebec	Blue Flag	- in 1999, this indigenous floral emblem replaced the non-native white garden lily that was the emblem since 1963 - grows in moist soil on edge of waterways
Saskatchewan	Western Red Lily	- selected in 1941 - thousands covered the prairies when pioneers first arrived - today, this rare flower is protected by law - steamed roots were eaten instead of potatoes - tea made from leaves used to treat coughs, fevers and stomach disorders
Yukon	Fireweed	- selected in 1957 - grows along sides of roads, forest clearings and after a fire - grows by runners, a special root called stolon - all parts of plant can be eaten - delicious honey is made from fireweed flowers

Province and Territory Images and Flower Emblem Descriptions
(page 1 of 2)

British Columbia

The plant grows on southern coast of Canada, near the Pacific Ocean.

Manitoba

Lavender flowers with yellow centres bloom very early in spring.

Nova Scotia

Plant is named after a famous ship that carried settlers to New World in 1620.

It is considered the first flower of spring

New Brunswick

It is a common purple flower growing in wetlands and forests of Eastern Canada.

Newfoundland and Labrador

The plant thrives in marshy areas.

Reddish showy flowers attract insects that are trapped in leaves and provide food for plant

Alberta

The plant has prickly stems and produces a fruit called rosehip.

Province and Territory Images and Flower Emblem Descriptions
(page 2 of 2)

Short white flowers that can grow on rocky ground.

The orchid's name comes from the shape of its petals which look like a slipper or women's shoe.

A bright purple flower that grows like a mat over rocks and gravel.

"Trf" means three in Greek.

The plant has three leaves and flowers with three petals.

A blue iris found in wetland areas.

A tall plant with stunning orange-red flowers.

One of the first plants to grow after a fire.

Province and Territory Flower Emblems


Pitcher Plant


White Trillium


Wild Rose


Mountain Avens


Lady's Slipper


Pacific Dogwood


Mayflower


Blue Flag


Prairie Crocus


Purple Saxifrage


Western Red Lily


Purple Violet


Fireweed

Activity 2: Turning Scraps into Plants!

Time: 20 minutes and then observe growth for few days to weeks

Keywords: bulb, tuber, root, stem

Group Size: Small groups or pairs

Materials:

- ☐ vegetable scraps
- ☐ sharp paring knife (non-serrated knife)
- ☐ cutting board
- ☐ popsicle sticks and waterproof marker for labels
- ☐ pie plates and pebbles
- ☐ glass dishes/bowls
- ☐ pots and triple mix potting soil (containing compost)
- ☐ small hand trowel
- ☐ water

Learning Goal: Students will learn about how to grow plants using vegetable scraps.

New plants are usually started from seed. However, you can also start new plants from various parts of a parent plant such as roots, tubers, stems or bulbs. There are many different plants that can be grown from vegetable scraps as well as different ways to try and start growing plants. The examples below were ones that are easier to grow with reliable results. The photos were taken over a two week period. There are many online resources such as:

- http://www.simplehouseholdtips.com/foods-you-can-regrow-from-kitchen-scraps.html *(02/06/16)*;
- http://foodrevolution.org/blog/reduce-food-waste-regrow-from-scraps/ *(02/06/16)*.

Procedure:

1. Either purchase fresh vegetables (organic vegetables will often produce best results) or have students bring in some vegetables from home such as beet tops, carrot tops, leeks, lettuce, green onions and potatoes. Divide students into pairs or small groups and assign one vegetable per group.
2. Have students decide how they would like to try and grow their vegetable – potted in soil or a dish with pebbles; cut off specific pieces or leave as is. Provide the materials for growing their vegetable.
3. Specific procedures for different vegetables are outlined below. Cut the vegetables for the students, if necessary. Have students label their pots or dishes and place them in a brightly lit part of the classroom.
4. Over the next two weeks, examine plants daily for new leaf growth and new roots. Water the dishes or keep the soil moistened as necessary. If scraps did not grow, brainstorm for new ideas to make it grow and try again.
5. Depending on what is being grown, the produce can be eaten in class (salad, leafy greens for sandwiches), plants can be transplanted into soil and taken home or some plants can be transplanted in a school garden.

Beet

1. Use a fresh beet with small new leaves sprouting. Plant the root about two-thirds into a pot of soil. In addition to nutritious greens, beets are a beautiful plant with dark red stems.

Alternatively, cut off the top one-third of the beet and place in a pie plate filled with pebbles. Fill the pie plate half-full with water. Harvest the greens as they grow.

Carrot

1. Cut off the top 5 – 10 cm of the carrot. Place the carrot in a pie plate with pebbles. After the leaves sprout, they are fairly short-lived. Carrot tops can be used in a salad, stock or pesto as well as feeding pets such as rabbits and guinea pigs. Alternatively, the entire carrot can be planted in a deep pot. In about two months, the carrot will produce a white feathery type of flower.

Leek, Green Onion & Lettuce

1. Place the leftovers (leek root base, green onion root base or lettuce heart) into a shallow dish with some water. Harvest the greens as they grow.

Leek:

Green Onion:

Romaine Lettuce:

Potato

1. Use potato tubers with small buds showing. Cut the potato into chunks approximately 5 – 10 cm square so there are three to four eyes per piece. Let the pieces sit overnight to form a hardened callus.
2. The pot size will depend on how many pieces are planted. Use a 30 cm pot for three to four potato pieces. Fill the pot one-third full with a rich soil containing compost.
3. Place the potato on the soil and cover with about 5 cm of soil. Once the plants begin to sprout they can be planted outside or kept in the pot.
4. As the plant starts to grow, pile up the soil so that only about 2.5 cm of plant is showing until the depth of the soil is about 45 cm. Potatoes can be harvested in about two to three months once they are finished flowering and the foliage starts to yellow.

Discussion:

Plants are amazing living things in that plant cells have the ability to duplicate all the parts and functions of a plant. For example, many trees can be cut at the stump and eventually new shoots will start to grow around the stump area. As a result, some vegetable scraps can continue to grow even after being harvested.

Plants need water and sunlight to grow roots and shoots. The plants can grow in water and pebbles for a while but they will eventually need soil to get the proper nutrients to continue growing new roots and shoots. Many plants are propagated by taking a cutting from a leaf, stem or root. Then by providing the right conditions, those cuttings are able to create an entirely new plant.

Fun Fact: What is the Difference Between a Bulb, Corm, Tuber, Rhizome and Tuberous Root?

Geophytes are plants with underground food storage units that provide the plant with the energy it requires to grow and flower. A bulb, such as an onion or tulip, is a compressed stem surrounded by scales that are modified leaves to store food. A corm, such as a crocus, contains modified stem tissue to store food. A tuber, like a potato, is an underground enlarged stem with many "eyes" that have the ability to sprout into new plants. A tuberous root, such as a sweet potato, looks like a tuber but is an enlarged root. A rhizome, such as ginger, is simply an underground stem.

Activity 3: From Flower to Fruit

Time: 15-30 minutes

Keywords: flower, fruit, stamen, pistil

Group Size: Individual or pairs

Materials (per student or pair):

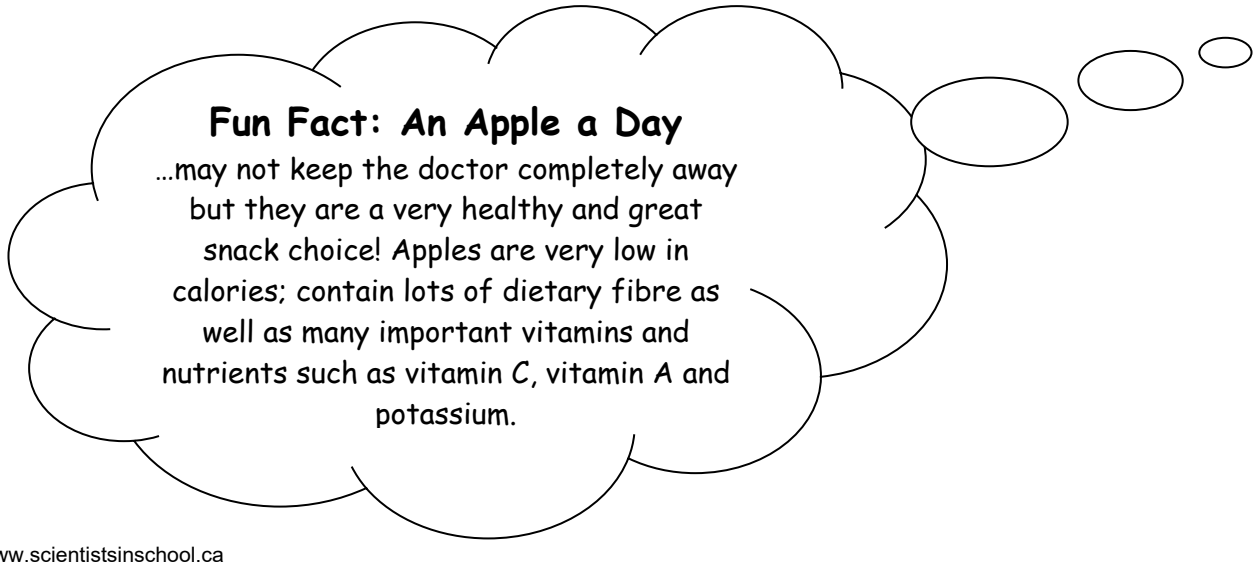
- ☐ half an apple
- ☐ flower (optional)
- ☐ magnifying glasses, if available
- ☐ "From Flower to Fruit" datasheet per student

Learning Goal: Students will compare a fruit with a flower and learn about the similarities and differences between them.

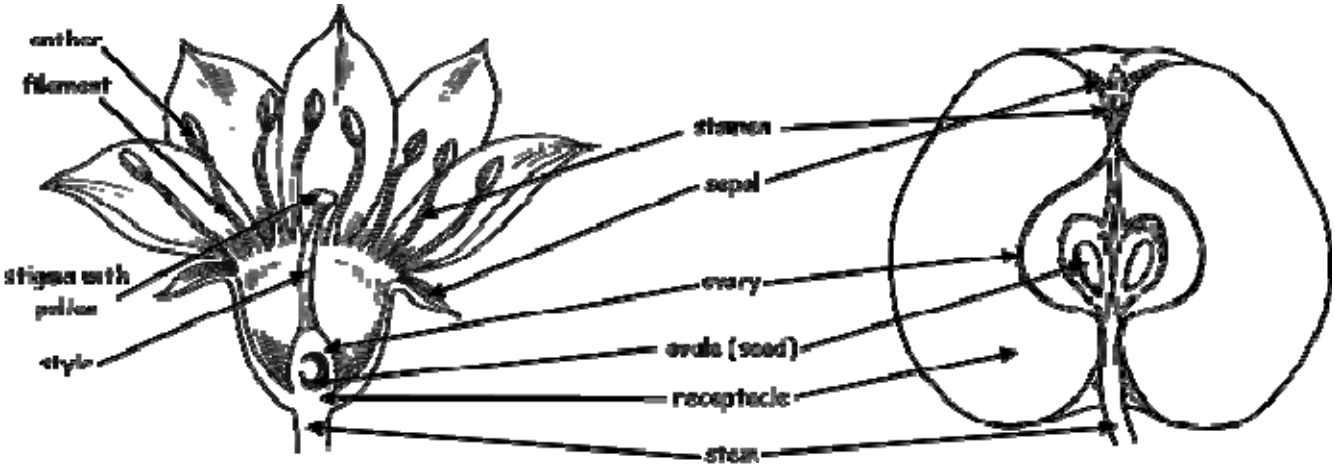
Most plants need flowers to reproduce. Petals are often the most beautiful and conspicuous part of a flower. Sepals are small, leaf-like parts below the petals and they protect the flower. Stamens are the male part of the flower and produce pollen. The pistil is the female part of the flower which grows in the centre and produces seeds. Flowers often contain oils with pleasant scents to attract birds and insects which move pollen from the stamens to the pistils of the same flower or other flowers. Producing fruit is one way a plant can ensure that seeds travel greater distances. Animals and birds eat the fruit but usually cannot digest the seeds. The seeds are then deposited along with organic nutrient-rich feces in a new location where the seed can then grow.

Procedures:

1. Slice apples in half from the stem to the stamens so it creates a cross-section. Pick some wildflowers or purchase flowers such as tulips, alstroemeria or lilies (alternatively students can use the flower diagram on the handout for comparison).
2. Provide each pair of students with half an apple and a flower to examine. Hand out the "From Flower to Fruit" datasheet to each student.
3. Explain the difference between a stamen and a pistil. On the flower picture on their datasheet, have students colour the stamens one colour and the pistils another colour.
4. Have students draw a line from the flower labels found in the middle of the datasheet (stamen, sepal, ovary, ovule, receptacle and stem) to the matching respective part on the apple. Students can examine the real apple for a closer look at these plant parts.



Discussion
The diagram below illustrates the completed “From Flower to Fruit” datasheet.



The sepals act like armor and protect the flower before it opens. On the apple, the sepals have become withered but still resemble very small leaves.

The stamens are the male reproductive parts of the flower. On the flower, the anther part of the stamen contains the pollen grains. When a pollinator, such as a hummingbird or a butterfly, lands on the flower, the pollen grains rub off onto its body. The pollinator will then either spread the pollen grains to the pistil or carry the pollen grains to another flower, of the same species, and rub it on that flower’s pistil. The pistil is the female reproductive part of the flower. The stigma part of the pistil is the sticky part that will capture the pollen grains. The pollen will grow a pollen tube through the style and into the ovary to fertilize the ovules. The fertilized ovules develop into seeds that are seen in the apple. In the apple, the stamens are withered and have become the feathery brown-black pieces on the bottom of the apple next to the sepals.

The receptacle is the part of the flower stalk that supports the flower. It is often round in shape. In the apple, the receptacle along with the outer wall of the ovary, becomes the fleshy part of the apple and is an important food source for many animals and birds. The inner wall of the ovary becomes the core of the apple that surrounds and protects the seeds.

Fun Fact: Flowers as Food!

Broccoli is a flower you eat. Flowers of squash plants, such as pumpkin blossoms, can be fried in a batter and eaten. Flowers of violets and pansies can be candied or frozen into ice cubes. Dandelion flowers can be made into jellies, added to salads, or made into tea. Before you eat any flower, make sure it is safe. Some plants are poisonous or have been sprayed with harmful pesticides.

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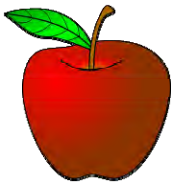
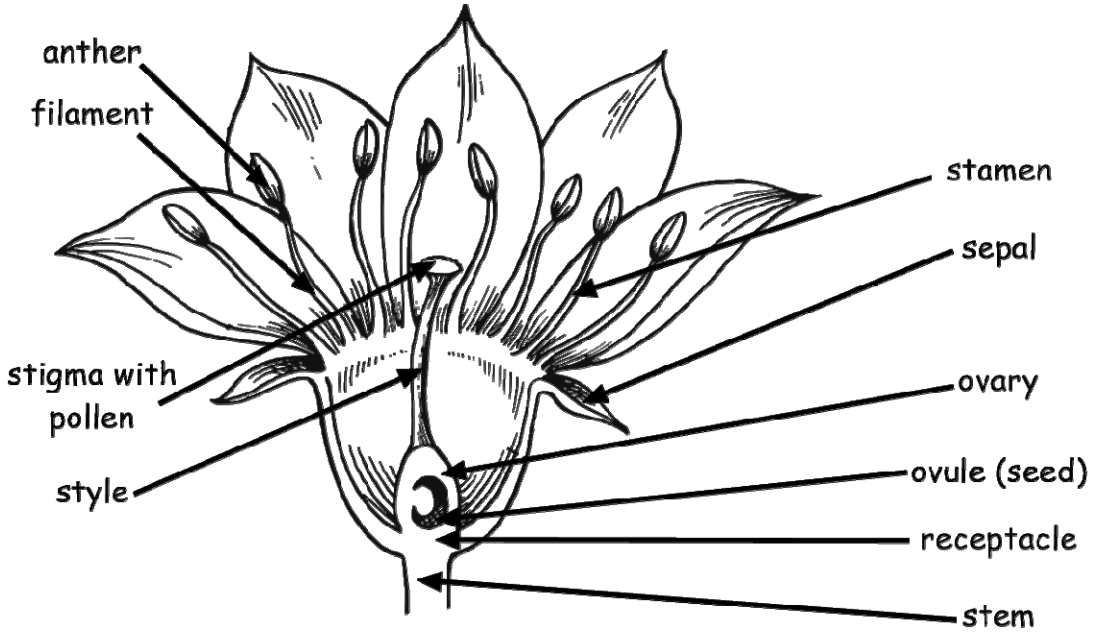
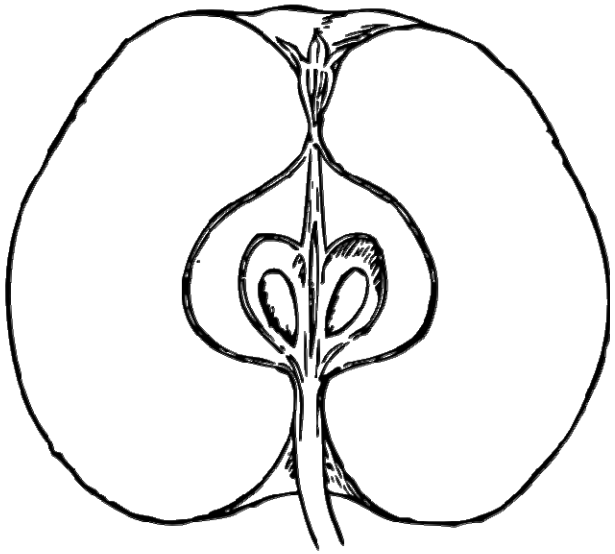
Name: _____

From Flower to Fruit!







Pistil (female part of flower) = stigma + style + ovary

Stamen (male part of flower) = anther + filament

Activity 4: Magic of Germination and Gravity!

Time: 30 minutes followed by 5 to 10 minutes daily for two weeks

Key Terms: germination, gravity

Group Size: Pairs

Materials:

- ☐ radish seeds
- ☐ CD covers or resealable sandwich bags and tape
- ☐ paper towels
- ☐ waterproof marker
- ☐ pipette or dropper
- ☐ water
- ☐ small plastic ruler (mm)
- ☐ magnifying glass (optional)
- ☐ "Magic of Germination and Gravity" datasheet per student

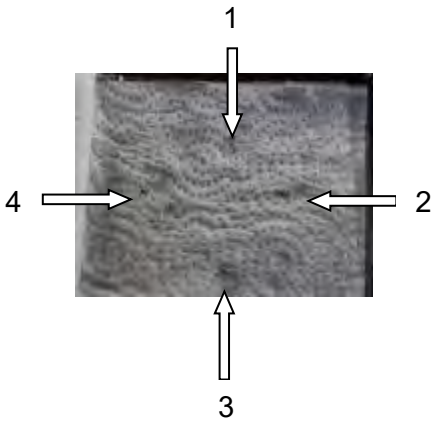


Figure 1: Set-up of the seeds

Learning Goal: Students will germinate their own seeds and discover how gravity affects plant growth.

Germination is the process by which a seed sprouts and grows into a seedling. The successful germination of most seeds depends on water, light, oxygen and temperature. Gravity is the force that pulls objects towards the Earth.

Tips: This activity is better suited to the spring or fall seasons when the windows are not really cold. Bean seeds may be used instead of a radish seed however they are bigger, heavier seeds and may shift as the containers are turned. Bean roots grow faster and larger which make observations more difficult. Beans also seem to have a higher incidence of mold. CD covers are recommended over resealable plastic bags because they are easier to open and close when adding water, they are reusable and they are easier to turn and manipulate.

Procedure:
Day One

1. Provide each pair of students with materials. Have students label the two containers (CD cases or bags) as A and B.
2. Fold a paper towel to fit into each container so that there are at least four layers. Moisten the paper towels using a pipette and water.
3. Open up the layers of paper towels so that there are two layers on top and two layers on bottom. Place four radish seeds on the bottom layer of the paper towels: one seed at the centre top; another at centre bottom; one on the left side; and another on the right side, as in Figure 1. Cover seeds with the top two layers of the paper towel and ensure that they are not too close to the edge.
4. Gently place the paper towels in the container. Label each container with numbers one to four by each seed as in Figure 1.
5. Either tape the bags to a bright window or lean the CD case against a window so that number 1 is at the top.
6. Check the containers daily to ensure that the paper towels are moist. When the paper towels appear dry, gently open the containers and add water with a pipette. If there is excess water at the bottom of the containers it should very gently be removed with a pipette or poured out to prevent the growth of mold.
7. Hand out the "Magic of Germination and Gravity" datasheet to each student. Record observations as their seeds change in the "Notes" section of their datasheet, for example: seed coat cracking, seed coat falling off, root growth and first leaf growth.
8. When most of the seeds have germinated and the roots are about 2 cm long, have students draw a picture of their seeds on the datasheet. This usually occurs by Day 4.

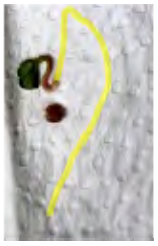
9. Have students measure the length of the roots (mm) and record the measurement on the seeds they have drawn on their picture.

10. Ask the students what they think will happen if they rotate their containers. Will the seedlings continue to grow in the same direction? Divide the pairs of students into 3 groups and have them rotate their "B" container in one of the following three directions:
    - Group 1: 90 degrees, ¼ rotation clockwise (number 1 is now at 3 o'clock);
    - Group 2: 180 degrees, ½ rotation clockwise (number 1 is now at 6 o'clock)
    - Group 3: 270 degrees, ¾ rotation clockwise (number 1 is now at 9 o'clock).
11. Continue to make daily observations and moisten the paper towels as necessary. The timing for final measurements will depend on the rate of seedling growth.
12. Approximately 10 days after the containers have been rotated (i.e. Day 14), have students draw a picture of their seeds and include the root measurements for both containers, A and B. Have a class discussion and compare everyone's results.

Observations:
The students will observe the germination process. The cotyledon is the part of the seed that stores food for the plant as it starts to grow. The seed coat will crack and the embryo plant will emerge. The students will observe the growth of the embryonic root, called the radicle and then the embryonic leaf, called the plumule. Sample observations on Day 4:

After container B is turned, the students will observe that the root starts to change direction and grow downwards towards the centre of the Earth. Sample observations on Day 14:

Rotated ¾ turn (270 degrees): The root has been highlighted to show that it did a 90 degree turn to grow downwards.



Rotated ½ turn (180 degrees): The highlighted root did a 180 degree turn to continue growing downwards.

Discussion:
Geotropism is a term used to describe the way plants grow relative to gravity. Negative geotropism is the tendency of stems to grow in a direction opposite to the pull of gravity. Positive geotropism is the tendency for roots to grow towards the pull of gravity. Plants grow in a certain direction because of a hormone called auxin. Auxin will cause a plant cell to elongate. An increase in auxin will increase the growth of stem cells but will inhibit the growth of root cells. Gravity will pull the auxin down towards the lowest part of the stem and roots of a plant. More growth occurs in the cells on the lower side of the stem and less growth in the cells on the lower side of the root. As a result, the stem will bend up and the root will bend down. Why would plants grow in a particular direction? Negative geotropism of roots will increase the chances that the plant finds water. Positive geotropism of stems will increase the chances of finding light for photosynthesis.

Extension: Try putting a mature plant on its side and place it in the dark. Observe the position of its leaves after one and two weeks.

Name: _____

Magic of Germination and Gravity!

Observations after a few days:

A

B

Notes:_____
_____
_____

Notes: _____
_____
_____

Circle the direction you rotated container B: $\frac{1}{4}$ turn $\frac{1}{2}$ turn $\frac{3}{4}$ turn

Observations after a few days following rotation:

A

B

Notes: _____
_____
_____

Notes: _____
_____
_____

Activity 5: To Grow or Not Grow?

Time: up to 4 weeks

Other Application: Soil

Group Size: 4-6 students per group

Materials per group:

- ☐ 12 pots (biodegradable peat pots are efficient as students can take them home and plant them directly into their gardens)
- ☐ 2 seed packages (sunflowers or beans work well due to their larger size and easier manipulation)
- ☐ seed starter or potting soil
- ☐ trays (plastic trays with no holes in the bottom)
- ☐ toothpicks, waterproof marker and masking tape for labels
- ☐ watering can
- ☐ ruler or soft measuring tape to measure growth
- ☐ wooden stakes and nylons to stake tall plants
- ☐ "To Grow or Not Grow? Effect of Light and Water on Seed Germination and Growth" datasheet per student

Learning Goal: Students will explore how light and water affects seed germination and plant growth.

Experimental Design: The following experiment outlines how to test for the effect of light and water on seed germination and growth. Other variables that could be examined include the type of soil (e.g. seed starter mix, sand, loam, etc.), the addition of fertilizer or organic compost or different temperatures, for example classroom and outside temperature (dependant on the time of year). Groups could be assigned a specific condition in which to grow their seeds and at the conclusion of the experiment the different conditions can be compared among the groups.

Procedure:

1. Fill 12 peat pots with potting soil. Create labels for each pot by writing on masking tape with a waterproof marker and putting it around toothpicks. Label the pots as follows:
   - three pots as light / moist;
   - three pots as light / dry;
   - three pots as dark / moist; and
   - three pots as dark / dry.
2. Place the "moist" labelled pots in a sealed tray to prevent water leakage. For the six pots labelled as moist, water the soil thoroughly. The six pots labelled as "dry" will not be given any water for the duration of the experiment.
3. Plant two seeds per pot at the appropriate depth based on seed package information. The general rule of thumb is that seeds should be planted as deep as they are long. Ensure the seeds are covered with soil.
4. Place the six pots labelled "dark" (dark/dry and dark/moist) in a tray in the darkest possible area such as a storage closet or black bin. Place the other six pots labelled "light" (light/dry and light/moist) near a window.
5. Keep the moist-labelled pots moist by watering daily or every other day. It is OK to miss over a weekend. After germination, they can be watered every 2-3 days.
6. Hand out one datasheet per student, "To Grow or Not Grow? Effect of Light and Water on Seed Germination and Growth". Record the date that seeds were planted (day 1). Record the day when the first sign of germination is noticed. Measure and record the amount of growth (cm) every 2 to 3 days and ensure the date or Day Number is recorded each time. Record values for both seeds from one pot in the same box (see sample completed datasheet).
7. At a height of 10 cm, if both seeds have germinated, pull out and discard the weaker seedling. Continue recording the height of the seedling regularly for a total of 3-4 weeks. Record any other observations – colour of leaves, type of growth, etc.

8. As seedlings germinate, turn the tray in different directions as the seedlings will lean towards the light. As they get taller, students may need to stake the seedlings to prevent them from falling over (wooden stakes and strips of old nylons work well).
9. At some point, some seedlings will begin to grow their true leaves (i.e. not the first leaves which are the cotyledons or seed leaves). Have students record when this growth begins (L=leaves).
10. After 3-4 weeks and the conclusion of the experiment, seedlings can be taken home and planted outside or re-potted into larger pots.

Observations:

A completed example datasheet for "To Grow or Not Grow? Effect of Light and Water on Seed Germination and Plant Growth" has been included. Students should observe that seeds did not germinate without water. Seeds germinated in both the light and dark conditions. The seedlings will grow faster in the dark as they are looking for light. However the seedlings in the dark will be yellow and straggly as compared to the green, compact plants grown in the light.

Discussion:

Discuss with students why two seeds were planted in each pot and why three pots were set up for each condition. In some cases, the rate of germination and plant growth will vary within a pot as well as compared among the three pots in the same experimental condition. Replication in science experiments is important when there are so many variables that can impact growth. The results should be averaged among all samples.

After three to four weeks, have a class discussion about the results. What conditions resulted in the earliest germination? Why? Seed germination depends on many factors such as the type of soil, temperature and the amount of water given. Seed germination does require water and often is faster in the dark depending on the species of plant. Seed germination does occur underground and therefore is affected by the depth the seed is planted and how much light penetrates to the seed.

Plants need light to manufacture food and grow. Without light, a seed will germinate and continue to grow using its own stored energy. The plant will grow quickly looking for a source of light. However, the lack of light will prevent the process of photosynthesis. As the food stores are used up from the seed, the plant becomes weakened and it will eventually wither and die.

Extensions:

This experiment lends itself to many different variations and is an exceptional experiment to combine with soil studies.

1. Experiment with different types of soil such as perlite, seed starter mix, garden soil, sand, etc. Seeds will germinate quickly in perlite but it does not sustain growth very well. Seeds will germinate and grow quickest in the seed starter mix. Seeds will germinate in sand but this soil type will not sustain plant growth.
2. Experiment with different types of mature plants in soil. For example, transplant annuals (impatiens, marigolds) into different types of soil and observe their growth and flowering capabilities over time.
3. Using a similar procedure as previously described, experiment with the effect of nutrients by giving some pots liquid fertilizer and compare the growth to pots given water only. The seedlings will be stronger and healthier over time when given fertilizer. This experiment may take a little longer to see any significant effects on plant growth.

An Example of a Completed Datasheet – "To Grow or Not Grow? Effect of Light and Water on Seed Germination and Plant Growth"

G = germinate; L = true leaf growth

(if both seeds germinated in the pot, the weaker plant was removed when the strongest reached 10cm height)

Condition	Pot # (2 seeds per pot)	Day 6	Day 7	Day 8	Day 10	Day 12	Day 16	Day 23
Light Moist	1			G	1	7	8	17L
	2				G	7.5 + 3	11	19L
	3			G	G + 4	9	12	19L
Observations							- green leaves, upright stems	- sturdy plants - large green leaves
Dark Moist	1	G	3	G + 9	12	21	24	24
	2	G	4 + 6.5	12 + 7	16	19	21	22
	3	G	4	13	14	broke		
Observations					- stems laying down		- yellow	- limp, weak straggly plants
Light Dry	1							
	2							
	3							
Observations	- seeds never germinated							
Dark Dry	1							
	2							
	3							
Observations	- seeds never germinated							

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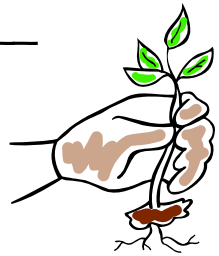
SCIENTIFIQUES À L'ÉCOLE

Name: _____



To Grow or Not Grow?
Effect of Light and Water on Seed Germination and Plant Growth

Date seeds were planted (Day 1): _____

Condition	Pot #	Day ___	Day ___	Day ___	Day ___	Day ___	Day ___	Day ___
Light Moist	1							
	2							
	3							
Observations								
Dark Moist	1							
	2							
	3							
Observations								
Light Dry	1							
	2							
	3							
Observations								
Dark Dry	1							
	2							
	3							
Observations								

Teacher Resources

Literary Resources

Don't Throw It, Grow It! Debroah Peterson and Millicent Selsam. 2008. Storey Publishing. ISBN 978-1-60342-064-8. An excellent book outlining what plants need to grow, how plants grow and techniques to grow plants from fruit and vegetable scraps.

Practical Botany for Gardeners: Over 3000 Botanical Terms Explained and Explored. Geoff Hodge. 2013. University of Chicago press. ISBN 978-0226093932. A simplified book that explores the world of botany including plant types and plant parts.

Eyewitness Plant (DK Eyewitness Books). David Burnie. 2011. DK Children. ISBN 978-0756660352. An exciting look at the fascinating world of plants featuring stunning real-life photographs of flowers, fruits, seeds, leaves, and a unique eyewitness view of plant anatomy and growth.

Website Resources

http://www.scienceforkidsclub.com/plants.html *(12/02/16)* A comprehensive website with information about plants and ideas for a variety of activities.

http://www.mbgnet.net/bioplants/main.html *(28/01/16)* A great site to learn about the biology of plants.

http://www.biology4kids.com/files/plants_main.html *(28/01/16)* A great site to learn all about plants.

http://www.backyardnature.net/botany.htm *(25/01/16)* An interesting website with many links to information about the basics of botany and links for gardening tips and tools for plant identification.

http://www.saps.org.uk/primary/teaching-resources *(28/01/16)* Background information about plants and activity ideas.

http://www.hort.vt.edu/HORT6004/network/schoolgardens.html *(20/02/16)* Information about school gardens including history and how to start a school garden.

http://usc-canada.org/what-we-do/beyond-the-farm/sow-and-save *(28/01/16)* Background information, resources and student activities focused on seeds and biodiversity.

http://sciencenetlinks.com/lessons/look-at-those-seeds-grow/ *(19/02/16)* A great activity to do with a lima bean so that students can learn the parts of a seed and what they need to grow into plants.

Interactive White Board Resources

"Plants"
http://exchange.smarttech.com/details.html?id=0cdc561f-8f6b-408a-9054-46f059bfa990 *(28/02/16)*
A brief introduction to plant groups and how seeds disperse.

"All About Plants"
http://exchange.smarttech.com/details.html?id=44057c00-a5b6-4ca1-9d00-023b7909dfe6 *(28/02/16)*
Information and activities about the different parts of plants and their functions.

"Photosynthesis"
http://exchange.smarttech.com/details.html?id=7bef96a5-89af-4624-97c7-80f01141cc51 *(28/02/16)*
Overview on the basics of photosynthesis.

Multi-media

http://www.makemegenius.com/science-videos/grade_3/seed--germination-for-kids 4:25 min. *(17/02/16)* This video illustrates the concepts of seed germination and seed dispersal. Also on the parent website are videos for plant adaptations, photosynthesis, pollination, plant parts and functions.

http://www.2learn.ca/kids/listSciG4.aspx?Type=50 *(28/02/16)* Link with a number of videos as well as list of interactive websites such as why leaves change colours, growth of trees and pollinators.

Student Resources

Literary Resources

Understanding Plants: Plants of the World. Claire Llewellyn. 2007. Smart Apple Media. ISBN 9781599200323. This series explores the importance plants have on our planet, the different types of plants and the effects on humans and animals.

Bean - Watch It Grow. Barrie Watts. 2005. Smart Apple Media. ISBN 1583405038.
Stunning photography that outlines the entire cycle of a bean from seed to flower, fruit and seed again.

The Life of Plants Series (Classification, Growth, Habitats, Parts, Products, Reproduction). 2002/2008. Louise Spilsbury. Heinemann Publishing. ISBN 978-1432915063 (Parts) 978-1432915056 (Classification). A series of botany books that contain experiments, activities, glossary, resources with excellent photos and illustrations.

The All About Series: Official Flowers. Barb McDermott and Gail McKeown. 2001. Nelson Thomson Learning. ISBN 0176194665. A book about official floral emblems of Canada.

Interactive Websites

http://www.bbc.co.uk/schools/scienceclips/ages/7_8/plants_grow.shtml *(28/02/16)*
An interactive game to learn about what helps a plant grow well.

http://www.bbc.co.uk/schools/scienceclips/ages/9_10/life_cycles.shtml *(28/02/16)*
An interactive game to learn about the parts of a flower,

http://www.e-learningforkids.org/science/lesson/norway-plants-growth-and-nutrients/ *(28/02/16)*
An interactive game to learn about the growth of plants.

http://www.e-learningforkids.org/science/lesson/norway-plants-and-their-properties/ *(28/02/16)*
An interactive way to learn about the parts of a plant.

http://www.virtualmuseum.ca/sgc-cms/expositions-exhibitions/flora/english/game_create.html *(28/02/16)* Students can create and build their own plant.

References

In addition to resources listed above, the following were also used to develop this package:
Canada's Land and People series for each province/territory, 2008, Weigle Publishing *(25/02/16);* http://www.epicgardening.com/25-plants-that-you-can-regrow-from-your-kitchen-scraps/ *(02/06/16)*; https://www.bgci.org/policy/1521/ *(26/02/16)*; http://www.bioedonline.org/lessons-and-more/lessons-by-topic/plants-form-function/how-does-gravity-affect-root-growth/ *(03/06/14)*; https://openclipart.org/detail/230314/flower-parts *(28/01/16);* https://openclipart.org/detail/20800/apple-in-cross-section-1 *(28/01/16)*; http://www.clipartbest.com/clipart-dT8xXK9ac *(28/01/16)*; https://extension.illinois.edu/apples/edu-projects_4B.cfm *(28/01/16)*; http://www.sciencekids.co.nz/sciencefacts/plants.html *(25/02/16);* https://www.loc.gov/rr/scitech/mysteries/flower.html *(25/02/16);* http://www.avasflowers.net/facts-about-flowers-for-kids *(25/02/16);* https://www.localgardener.net/pages.php?lang=en&page=articles&action=view&vid=80 *(30/03/16);* http://www.cropsreview.com/root-crops.html *(30/03/16)*

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Get kids excited about science

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Scientists in School is a leading science education charity that reaches more Kindergarten to Grade 8 youth than any other science non-profit in Canada – more than 700,000 in the 2018-19 school year.

Through our hands-on, inquiry-based science, technology, engineering, math (STEM) and environmental classroom and community workshops, we strive to ignite scientific curiosity in children so that they question intelligently; learn through discovery; connect scientific knowledge to their world; get excited about science, technology, engineering and math; and have their interest in careers in those fields piqued.

By making science a verb - something you do - our workshops allow children's natural curiosity to reign, inspire kids to see themselves as scientists and engineers, and make connections between science and the world around them. This sets the stage for a scientifically-literate future generation who will fuel Canada's economic prosperity and think critically about the scientific challenges facing our society.

Scientists in School relies upon corporate, community, government and individual donors, as well as school board partners for support to develop new programs, continuously improve our existing programs, reach new geographic areas, provide complimentary workshops to less-privileged schools, and subsidize the cost of every one of our 24,872 annual classroom workshops.

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Imagination Level:

ArcelorMittal Dofasco, General Motors Canada, McMillan LLP, Superior Glove Works Ltd., TELUS

Discovery Level:

Alectra Utilites, Aviva Community Fund, Cadillac Fairview, CAE, Cameco Corporation, Canadian Nuclear Safety Commission, Carolyn Sifton Foundation, Celestica, Hamilton Community Foundation, MilliporeSigma, Modern Niagara, Niagara Community Foundation, Pendle Fund at the Community Foundation of Mississauga, Purdue Pharma, S.M. Blair Family Foundation, Society of Petroleum Engineers Canadian Educational Foundation, Syngenta Canada Inc., Systematix Inc., The McLean Foundation

Exploration Level:

Ajax Community Fund at Durham Community Foundation, Brant Community Foundation, Cajole Inn Foundation City of Brantford, Community Foundation Grey Bruce, Dwight and Karen Brown Family Fund – Ottawa Community Foundation, Elexicon Energy, LabX Media Group Charity Fund at the Huronia Community Foundation, Siemens Milltronics Process Instruments, The Community Foundation of Orillia and Area, The County of Wellington, The Source, The Township of Tiny, Whitby Mayor's Community Development Fund