








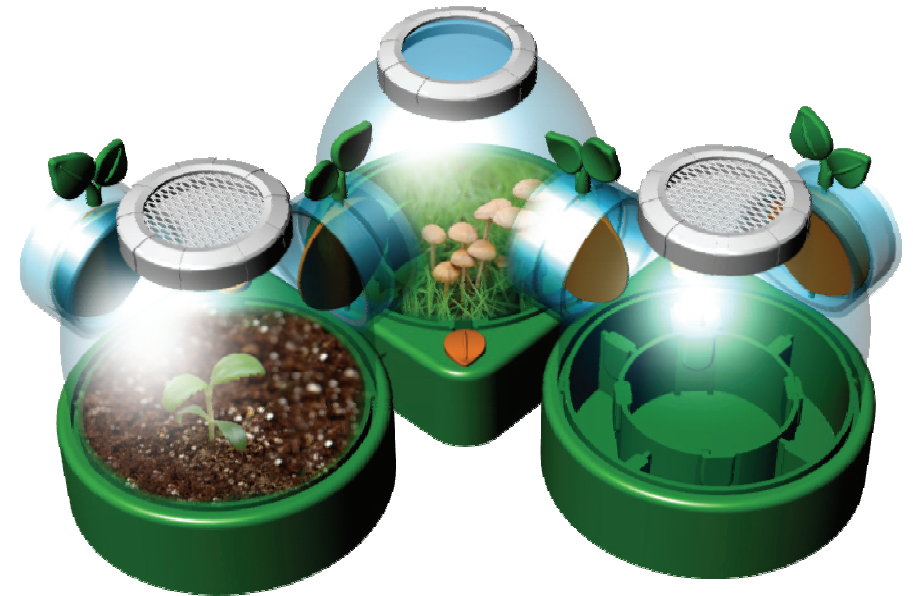
- Take one pH paper and cut into half with scissors.



- Use a clean pipette and transfer a few drops of the soil water on the pH water until it is saturated.
- Wait until the pH paper starts to change colour.
- Compare the colour of the pH paper against the pH chart below and record the corresponding value.

pH Reading Chart		
pH 7.5		Alkaline
pH 7.0		Neutral
pH 6.5		Slightly acidic
pH 6.0		Acidic
pH 5.5		Acidic
pH 5.0		Very Acidic
pH 4.5		Very Acidic

20-in-1 Plant and Insect Laboratory



Activity Guide

WARNING! Not suitable for children under 8 years due to small parts. Choking hazard. For use under adult supervision.

Activity 20: Testing soil pH

The soil 'acidity' or 'alkalinity', measured in pH units. The range is 1-14 (very acid to very alkaline; neutral pH7). Most soils are pH4-8. Most vegetables prefer pH6.5-7 and most fruit pH6-6.5. Soils tend to become acidic because of rainfall or plant decomposition. To reduce the acidity, people usually add limestone to the soil. Only small adjustment in pH are possible. A simple way to measure pH is by using pH paper.

Materials:

- Measuring cup
- pH paper
- Pipette
- Stirring rod

Additional materials:

- Gloves
- Soil
- Water
- Scissors (Adult help required)

Steps:

1. Wear gloves before touch the soil.
2. Take a small sample of soil, beneath the top layer. Put it inside the measuring cup.
3. Add some distill water until all soil are submerged. Stir well with the stirrer.



Activity 19: The life cycle of a bean plant

Some plants do not have flowers. No fruit is formed where seeds grow inside. However, they have a pod called a bean, which holds the seeds. There are many types of bean plants that grow in a similar way:

Stages of bean plant life cycle:

1. The bean seed is covered with a hard shell. In the presence of water, it swells and burst through the shell.
2. Root starts to grow from the seed downwards into the soil.
3. As the roots grows, a stem will also appear. The food stored inside the seed fuels the growth.
4. Leaves grow from the stem and extend towards the light.
5. As the bean continues to grow, a bean seed will appear as the part of the plant that is eaten. Examples of bean seeds that we eat are peas and lima beans.

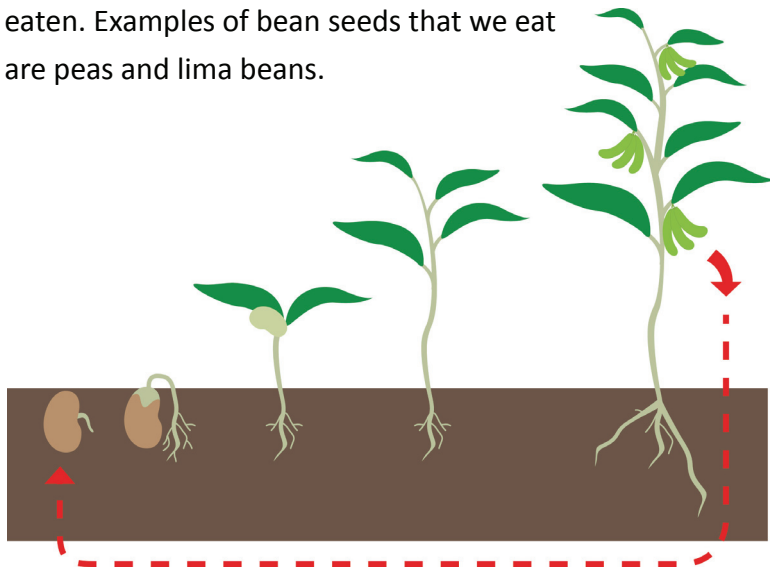





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Components and Accessories

Description	Quantity (pcs)
	3
	3
	27
	4

	1
	4
	2

My Gardening Journal

Date: _____
 Temperature: _____
 Weather: _____

What I did in my garden today:

Interesting things in my garden today ...

State of my Plants:

Things to do ...

Activity 18: Gardening journal








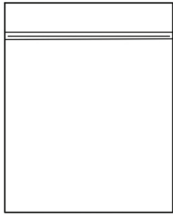



A gardening journal help you record and plan your gardening activities. It is a great way to learn and share in the fun and knowledge of gardening.

Additional material:

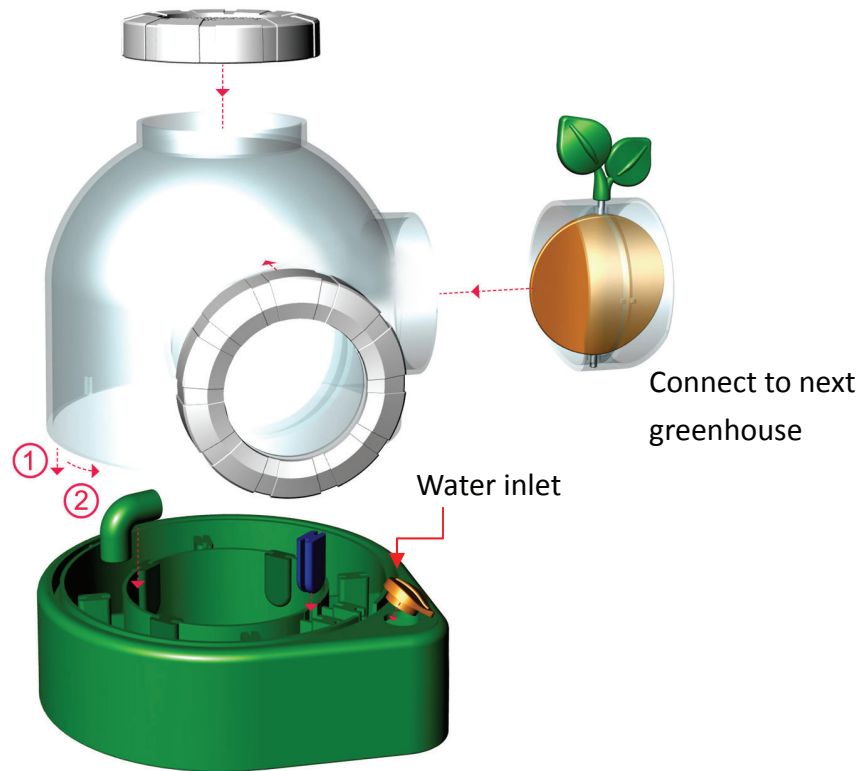
- A notepad or book with blank pages

Steps:

1. Your journal can be as plain or as fancy as you like. What's important is you keep the habit of writing what you did and note down any observation in your garden.
2. Record the date, temperature and what the weather like.
3. You can also write down your plan. What plants you are growing, their health, height and any flowers appear, etc. Your successes and failures and any personal thoughts can also be included.
4. Also include photos, drawings or even pressed flowers, leaves and seeds. When you look back, the garden journal is a precious record of your gardening activities and help you become a better gardener!

Spatula 	1	Paper Cup 	1
Pipette 	1	Cotton Ball 	4
pH Paper 	5	Measuring Cup 	2
Pair of Tweezers 	1	Plastic Bag 	3
Stirring Rod 	1		
Plaster Powder 	1		
String 	1		

Assembling the Greenhouse



12. The plants need light for growing, place the terrarium near the window or where there is plenty of indirect light. Do not put it under direct sunlight.
13. To keep your plants healthy, you need to take care of it sometimes. When molds or weeds appear, remove it immediately. Remember to wear gloves in doing so. You should also remove the old and wilting parts of the plant.

Tips:

- Don't over water your plants. Add water only when the soil and the wall are dry.
- You will see some fog or mist on the walls of the container. However, if too much condensation appears on the sides, you should open the top temporarily to allow it to dry a bit.
- Tropical plants are more suitable because they are used to high humidity and are more colorful.



Activity 1: Find seeds from fruit

What is a seed?

A seed is a plant structure that protects and nourishes a plant embryo so that it can grow into a new plant. Seeds come in a wide variety of shapes, colors, and sizes because they come from different plants, such as grasses, flowers, trees, shrubs or vegetables. Many seeds are also edible, such as sunflower seeds, tomato seeds, corn, and peas.

Where can you find the seeds?

Seeds form inside a plant's cone or fruit. All fruits and some vegetables cover and protect seeds. Seeds can be found in both dry and moist fruits. Moist fruit examples are peaches, pumpkins, apples, and blueberries; dry fruit examples are beans, wheat, corn, oats, rye, and rice.

How do we get the seeds out from a fruit?

Materials:

- Measuring cup or paper cup
- Stirring rod

Additional materials:

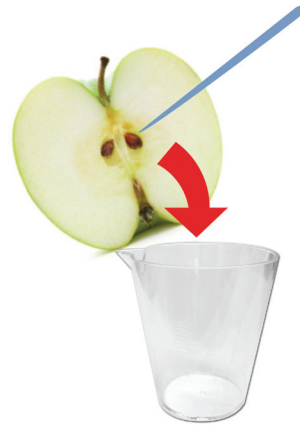
- An apple (or any fruit accessible at home)
- Knife

Steps:

1. Cut the apple in half. Ask an adult to do it for you.

8. Add some small decorations. You may also add some small stones or pebbles to cover the top soil. Make it look nice and neat.
9. Finally add some moisture by lightly watering your terrarium. Done!
10. Cover the top with the magnifying cap and close the door of the connecting tubes to minimize water loss.
11. Water the plants occasionally, once a week or two. Succulents or cacti only need to be watered once a month.

2. At the centre of the apple, you can see the brownish tear-drop-shaped seeds.
3. Take them out by stirring rod or fingers if necessary
4. Place the seeds inside the measuring cup and await for later plant growing experiment.



Tips

Good choices for fruits: apples, apricots, cherries, mangoes, papayas, plums, oranges, peaches, seeded grapes, tomatoes, green peppers, cherry tomatoes, kiwi, pomegranates, avocados, cucumbers, pumpkins, and watermelon.

Activity 2: Sprout your seeds

What is sprout?

Sprout is a newly grown shoot or bud from a seed. Their shoots mostly grow up in green colour from a white root.

What is good for sprouting?

Fresh, alive seeds in good condition sprout the best. If a seed will not sprout, this is an indication that it is "dead" and no longer generates growth.

2. Use one base and transparent cover and the magnifying cap of this set as the terrarium container. Use all the partitions for the soil because there is no need to reserve a separate water partition. Wear gloves when handling the soil, moss and activated carbon.
3. Place some small stones at the bottom of the base to help drainage. However, if there is not enough space for stones, they can be skipped.
4. Place a thin layer of activated carbon, it helps to filter the water and keep the soil fresh.
5. Optionally, add a layer of moss, this helps to separate the soil above from filtering down into the activated carbon and stones. It also act as a sponge to buffer excessive water.
6. Place a layer of potting soil, up to the top of the base. Use light soil for better drainage. Gently press the soil to remove air and level the surface.
7. Now add the plant you have chosen into the soil. Carefully lift the plant from its original container. Tease the root to remove any excess soil and help the plant move its roots into the new soil. Plant the roots into a hole in the new soil and move the soil to cover the hole.

Activity 17: Terrarium

A terrarium is a miniature garden grow inside a closed container. It is a self-sustaining environment and little to no maintenance is needed. It shows many aspects of how the ecosystem works, including photosynthesis, respiration and the water cycle.

Materials:

- 1 Greenhouse
- Magnifying cap
- 2 connecting tubes

Additional materials:

- Activated carbon (from garden supply shops)
- Potting soil
- Small stones
- Plants (small size)
- Sheet moss (optional)
- Gloves
- Decorative objects (optional)

Steps:

1. Choose plants that are small and don't need too much maintenance. Choose several that grow well together. Examples are ferns, succulents, miniature violets, mosses and cacti. You don't need to purchase them, you can collect some from your backyard, friends or the wood.

Chickpeas, wheat and rye berries, sunflower seeds and mung beans among all seeds always serve the best results of sprouting.

How to prepare seeds for sprouting?

To sprout a grain, seed or bean, first wash them and then soak them in cool to room temperature water. Soaking time varies between 4 and 12 hours until the seed is plump. After the initial soaking, keep the seeds damp.

How to sprout?

Materials:

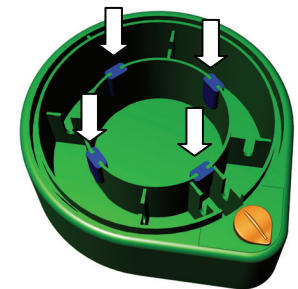
- 3 greenhouse units
- Appropriate amount of cotton balls
- Pipette

Additional materials:

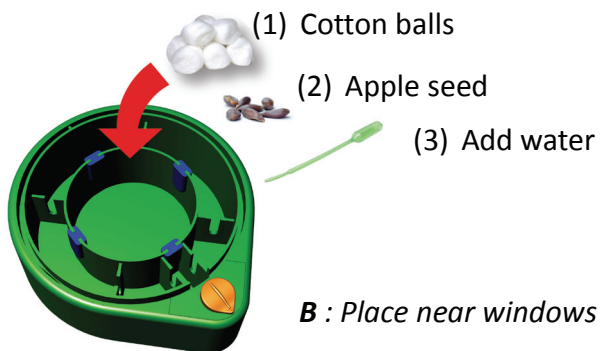
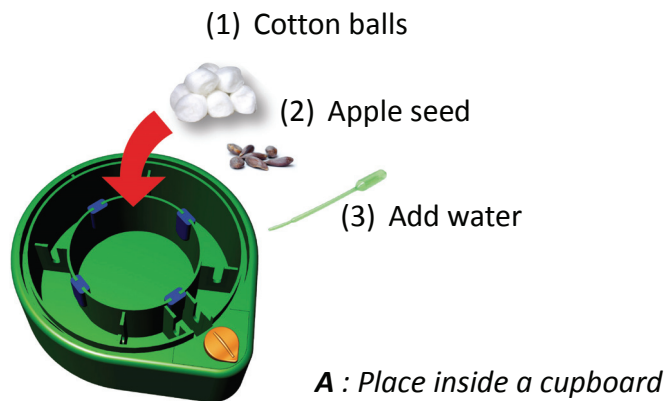
- Water
- Ruler or measuring tape

Steps:

1. Setup the greenhouses by installing plugs around the center area of the base. This prevent water from flowing out of the center area.



2. Gently tear the cotton balls into flatter thinner layer that roughly cover the base area of each greenhouses.
3. Place the cotton pads inside each greenhouses.
4. Use pipette to take up some water and wet the cotton pads of 2 of the greenhouses. Leave the cotton pad of the remaining greenhouse dry through the whole experiment and mark it with a sticker to indicate it is the only dry greenhouse.



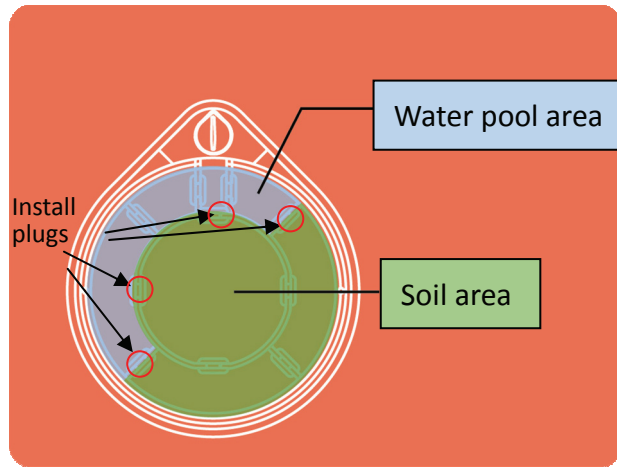
What happens?

The string consists of many individual fibers which act as a sponge soaked with water. When the amount of water becomes too heavy for the string, the water drips out at the deeper end of the soil in the flower pot. Therefore water is transported from the measuring cup to the soil. In this way, the plant in pot is supplied with fresh water supplied, as long as there is water in the cup.

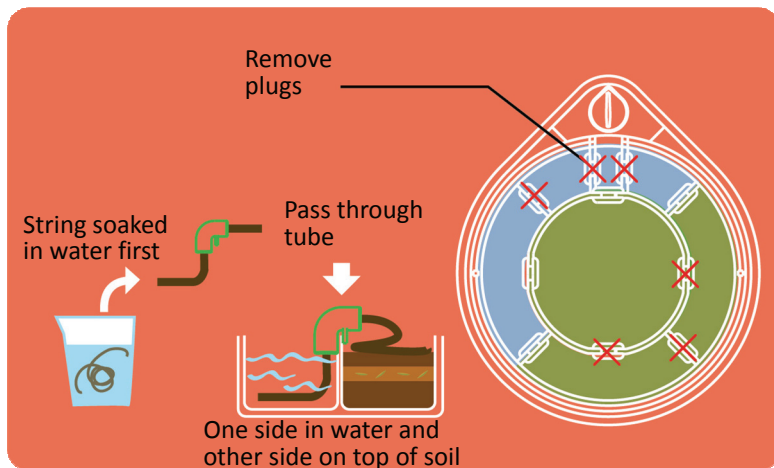
Activity 16: Fun facts of plants

- ✚ Avocados have the highest calorie content of any fruit. A large avocado has as many as 400 calories.
- ✚ 84% of an apple is water.
- ✚ The largest flower in the world is the Rafflesia arnoldii or “corpse flower”, which is up to 1 meter in diameter and weigh over 10 Kg. It is found in the rainforests of Indonesia. It has a bad, rotting odor to attract insects.
- ✚ A Great Basin Bristlecone Pine (*Pinus longaeva*) is measured by ring count to be 5063 years old. This is the oldest known tree in North America, and the oldest known living individual tree in the world.
- ✚ Bamboo is the fastest growing plant in the world. It can grow up to 17 cm in a single day!
- ✚ Strawberry is the only fruit which has its seeds on the outside. An average strawberry has up to 200 seeds!
- ✚ Rice is the most widely grown plant in the world!
- ✚ Trees lower air temperature by evaporating water in their leaves.
- ✚ The smallest tree in the world is dwarf willow (*Salix herbacea*). It grows to about 1 – 6 cm in height and is found in Greenland.

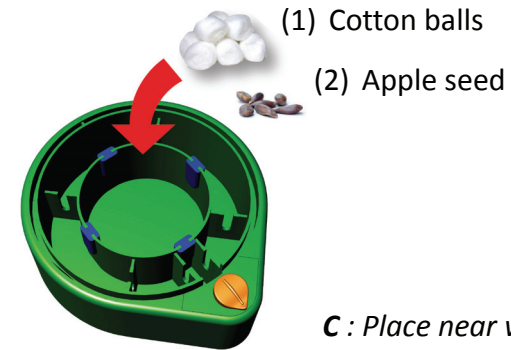
2. Install the plugs to block the water flowing into the soil partition. Remove the plugs inside each partition.



3. After soaking the string in a cup of water, pass it through the tube and install the tube on the ridge between the soil and water partition.



4. Put the soil and plant (or seeds) in the soil partition.
5. Put one end of the string in the water partition and bury the other end in the soil. Add water to the water partition.



5. Sprinkle approximately same amount of seeds onto each cotton pads.
6. Place one watered greenhouse inside a cupboard. Put the other greenhouses (one watered and one dry) near the windows.
7. Use pipette to water the cotton pads everyday. Do not water directly onto the seeds.
8. After one week, the seeds will sprout and grow into plants. You may compare the height of plants from each greenhouses by your own ruler or measuring tape.

What can you observe?

The watered greenhouse placed near the windows should grow into the tallest plants among all 3 units. Seeds need water to sprout and sprouts needs light to perform better in growing process. Without water, the dry greenhouse cannot grow at all.

Activity 3: Soil and water

How does soil act when it meets water?

When water seeps into soil, the colour of the soil becomes darker as it is wetted. This is called infiltration. During infiltration, water gives volume to soil when it is wetted.

Try to visualize how soil gets bigger

Materials:

- 2 Measuring cups

Additional materials:

- Water
- Soil

Steps:

1. Fill 1 measuring cup with 20ml soil and fill another with 20ml water.
2. Pour the 20ml water into the cup of soil.
3. Wait for 10 minutes and you will see all water is absorbed into the soil. The soil expands.



will be in one color while the other part will change to the other color that you have put in the cups.

What happens?

The flower takes up water through the fine vessels called xylem in the stem. Different parts of the stem will transport water to different part of the flower, hence bringing along the corresponding color change.

Activity 15: Auto water system

With the help of this simple setup, your plant can get the water it needs automatically.

Materials:

- 1 Greenhouse
- String
- Plugs
- Tube
- Measuring cup

Additional materials:

- Beadybed seeds or beans
- Soil
- Water

Steps:

1. Decide which partition in the base is for storing water and which partition is for the soil.

Activity 14: Water transport

How does the water move from the root to the other part of the plant. Let's find out in this experiment.

Materials:

- 2 Measuring cups

Additional materials:

- A white Carnation with long stem
- Water
- Food coloring (any color)
- Scissors (Adult help required)

Steps:

1. Add four to five drops of food coloring into each of the cups, use different color for different cup.
2. Ask an adult to cut the stem of the carnation flower with the scissors along the length of the flower until about half way up the stem.
3. Put each side of the splitted stem into one of the cups of colored water. Let the flower sit in the water for two to three days.
4. After two or three days, you will see the flower change to the same color as the water in the cups. For example, the left part



Activity 4: Grow your plants with shapes

Remember light is important for plant growing? Let's try an interesting experiment to prove it.

Materials:

- Greenhouse units

Additional materials:

- Seeds
- Cotton pads or soil
- Water
- Paper
- A pair of scissors

Steps:

1. Set the seed, cotton pads or soil into the greenhouse following Activity 2. You can choose to grow plants in as many greenhouses as you wish.
2. Wait for 3 days to see sprouting in progress.
3. Cut the paper into your preferred shapes with a pair of scissors. For example, heart shape, star shape or even alphabet shape of your own style. It is recommended to cut a shape smaller than the sprout area.

4. Place your paper shapes on top of the growing sprout.
5. Wait for another 4 days. You will see the sprout part that is not covered by your shape grows higher than the paper level.
6. Remove the paper. A hollow of an interesting shape appears in your plant.



**Vice versa, you may make a paper shape with hole inside to allow the sprout to grow through the hole of your chosen shape!*

Activity 5: Environment and plants

Other than water and light, the place where seeds are sowed also plays a large role in plant growth. Let's try it out!

Materials:

- 2 greenhouse units
- Pipette

3. Make a hole at the center of the aluminium foil where you will fit in a leaf.
4. Ask an adult to help cut a leaf close to the stem of the plant with a sharp knife. Cutting at an angle is preferred.
5. Insert the leaf stem into the hole of the aluminium foil, make sure the tip of the leaf stem is submerged in the water. Maintain the water level from so that the tip is always submerged.



6. Place the cup in a moderately warm and bright location but protect from direct sunlight. Watch out for pests and bugs.
7. Roots will start to grow from the tip of the leaf in 3-4 weeks.
8. The leaf with the roots are now ready to be put into a pot or the greenhouse with soil to grow further.

What happens?

Some plants like African violets are very easily propagated from leaf. Even inexperienced growers can quickly produce additional plants and expand their collection.

4. You should be able to see the veins and structure of the leaf.
Repeat with different leaves and compare the similarities and differences.

What happens?

The veins form a hierarchical structure on a leaf. They are vascular tissues responsible for bringing water from the roots to the leaves and move the food out of the leaves.

Activity 13: Plant from cut leaf

In this activity, you learn to grow a new plant by leaf cutting.

Materials:

- Measuring cup

Additional materials:

- African Violet Leaf (or other plants like Peperomia or Christmas cactus (*Schlumbergeria bridgesii*))
- Water soluble plant fertilizer (general purpose type will do)
- Aluminium foil
- Knife
- Water

Steps:

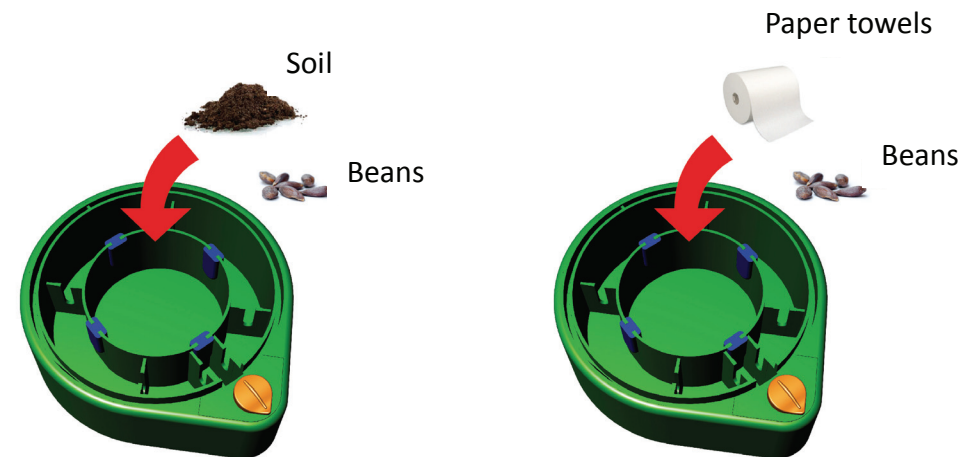
1. Dissolve a pinch of fertilizer in the measuring cup filled with water. Use a spoon and do not touch the fertilizer.
2. Make a cap for the cup using a piece of aluminium foil.

Additional Materials:

- Soil
- Paper towel
- Beans (it is recommended to use pre-germinated beans)
- Water

Steps:

1. Fill in 1 greenhouse with soil and another greenhouse with paper towel.
2. Sow your beans on each of the greenhouses.
3. Water both greenhouses by pipette regularly.
4. After a week or two, you will find the plant grown in soil is taller than the one in damped paper towel.



Plants tend to grow better from soil instead of artificially-manufactured paper towel!

Activity 6: Bean and water

In Activity 2, we mentioned dry seeds or beans can get plump after soaking. They will swell to at least twice their dry size.

How to prove the beans get bigger when they meet water?

Materials:

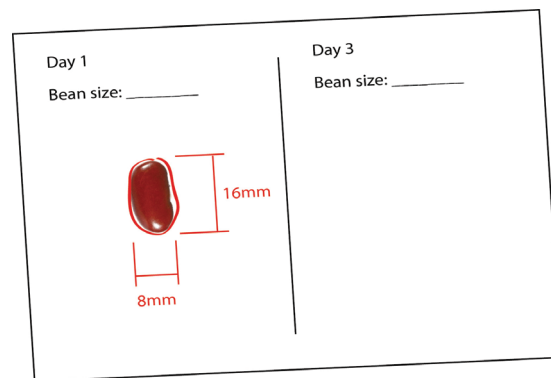
- Measuring cup

Additional materials:

- Plenty of beans (eg. Lentils, mung beans)
- Water
- Paper
- Pen
- Paper towel

Steps:

1. Place the dry beans onto a piece of paper.
2. Line along the shape of bean onto the paper by your pen. Keep the paper.



Activity 12: Leaf Rubbing

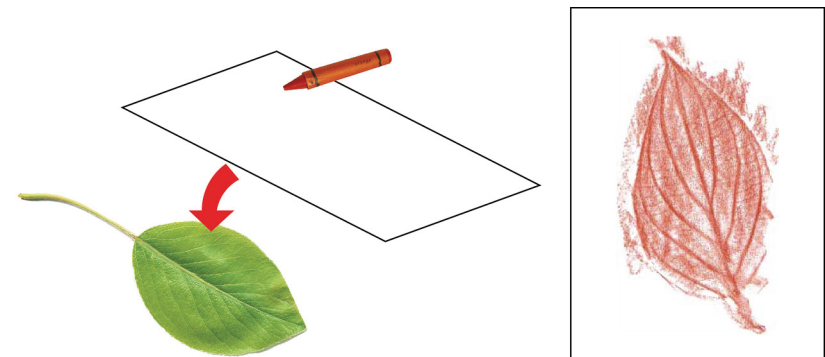
In this activity, you will see the detail structure of a leaf that you may not have noticed before.

Additional materials:

- Leaves
- Crayons
- Thin paper

Steps:

1. Find a tree and pick a fallen leaf of the type you like. Search for leaves that are still soft. You may collect several pieces of different shape and size. Gently break one off the tree in case you cannot find any fallen leaf.
2. Position the leaf on a table or any flat hard surface. Cover the leaf with a piece of thin paper.
3. Hold the paper in position with one hand while rubbing the long side of the crayon over the leaf. Keep rubbing until you see a perfect copy of the leaf on the piece of paper.



1. Cut a piece of construction paper large enough to cover a broad leaf. Ask an adult to help.
2. Wrap the construction paper around the broad leaf, use tape to secure it.



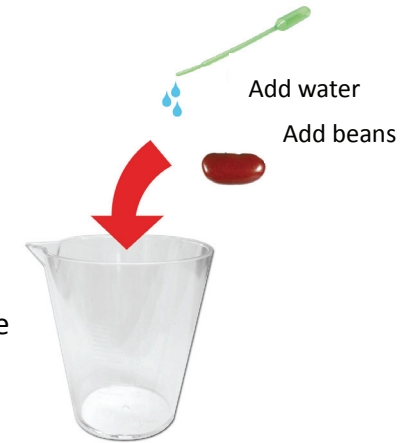
3. After a week, remove the construction paper and note the difference of this leaf from other leaves of the plant.

What happens?

The leaf's green color will pale in the absence of light. This is because the leaf cannot produce food without light.

Photosynthesis is the process by which green plants make their own food using sunlight, carbon dioxide from the air and water absorbed through the roots. The green color comes from the substance in the leaf called chlorophyll, which is essential for photosynthesis.

3. Fill the measuring cup with plenty of water.
4. Put the beans into the water.



5. Let it sit for 2 days. Take the beans out and gently dry them with paper towel.
6. Place the beans onto the paper kept after Step2. Line along the bean edge.
7. Compare the sizes of the shapes you drawn today with those from 2 days ago. Today's bean size is bigger!

Activity 7: Nutrients and plants

Nutrients can help plant growing. You can get a wide range of agricultural fertilizers from your local gardening shops, but be aware when using them. Fertilizers affect soil pH value. It does matter to the health of plants. Neither too alkaline nor too acidic of soil can boost plants to grow.

Materials:

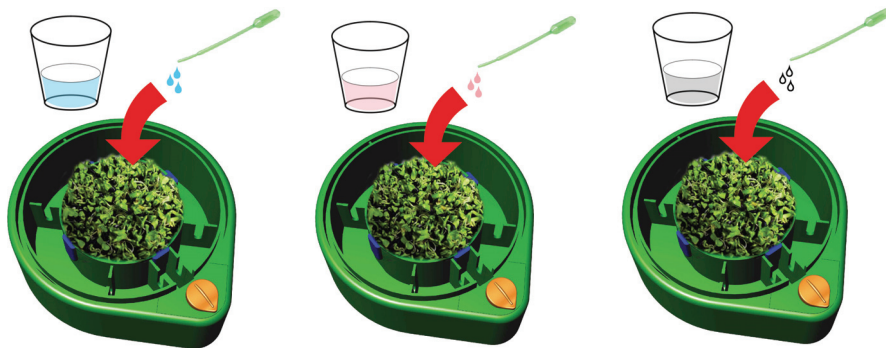
- 3 greenhouse units
- Pipette

Additional material:

- Water
- Soil
- Seeds or beans
- 3 containers (any plastic cups of your own)
- Salt (from your kitchen)
- Detergent (from your kitchen)

Steps:

1. Pour some soil into each greenhouse units.
2. Sprinkle seeds into soil and cover the seeds with thin layer of soil.
3. Fill all 3 containers with water.
4. Add a few spoons of salt into 1 cup of water. Add a few pumps of detergent into another cup of water. Do not add anything into the remaining cup of water to stay pure.
5. Using pipette, water each of the greenhouses with pure water, salty water and detergent solution separately.



Pure water

Salty water

Detergent solution

type of leave and the time of the year. Sometimes it may take as long as several hours.



What happens?

Plants absorb water primarily through their roots. They evaporate water through openings in their leaves in a process called transpiration. As with human respiration, trees tend to transpire more with increased temperatures, sunlight intensity, water supply, and size. When it gets too hot, though, transpiration will shut down.

Activity 11: Photosynthesis

Additional materials:

- A plant with broad leaves
- Black construction paper
- Tape
- Scissors (Adult help needed)

Steps:

plate under the plant to catch any drips.

5. After several days, the direction of the plant growth will become obvious. Note down your observation. What is the cause of the change in the growth direction?

What happens?

After several days, the stem of the plant will turn and grow upwards, against gravity. This behavior is called gravitropism. In fact, the shoots will tend to grow upwards while the roots of the plant will grow downwards. It is a general feature of all higher plants.

Activity 10: Transpiration

Materials:

- Plastic bag

Additional materials:

- A plant with leaves
- A string (Optional)

Steps:

1. Cover the leaf of the plant with a clear plastic bag. Close the bag with the zipper or a piece of string. Make sure the stem of the leaf is not damaged.
2. After some time, some small droplets of water will form inside the bag. The time needed is variable, depends on the size and

6. Place the fluid cups next to the corresponding greenhouses. Do not mix them up.
7. After a week, only the plant nurtured by pure water can survive.

Activity 8: Seed Power

Materials:

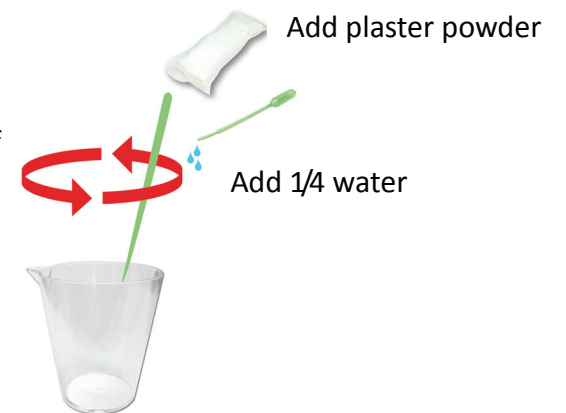
- 1 Greenhouse unit
- Measuring cup
- Paper cup
- Plaster powder
- Stirring rod
- Pipette

Additional materials needed:

- A few beans

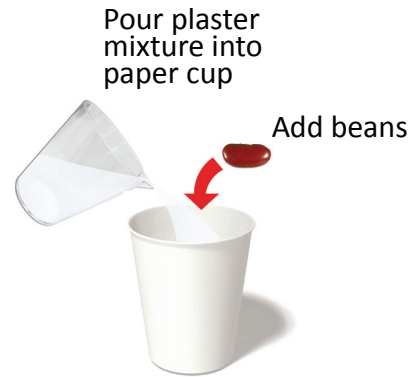
Steps:

1. Mix plaster powder with water (one part of water with 4 parts of plaster) in the measuring cup and stir well with the stirring rod.



2. Pour the plaster mixture into the paper cup up to half cup.

3. Drop two beans into the plaster mixture. Push them to about 1-2cm below the surface. Smooth out the top plaster.



4. Dispose the unused plaster mixture in the litter bin. Wash and clean the measuring cup after use.

5. Put the paper cup at the greenhouse base and cover it with the transparent cover and magnifying cap.

6. Move the greenhouse to a place with plenty of sunshine, such as near the window.

7. Wait a few days and note what happens.

You will see the beans breaking the plaster and start to grow!

What happens?

The bean is a seed which is the beginning of a plant. It contains stored energy that allows it to grow and develop. This energy is stored in the oils, fats and carbohydrates (starches) that fuel its growth. Under the right condition, the cells of the seed awaken and start to germinate. When they expand, they exert a force on the outside world.

Other example are when tree roots grow and break through concrete sidewalks and weeds grow through paved walkways.

Activity 9: Gravitropism

Additional materials:

- A Bean plant
- Sponge 2 pieces
- String

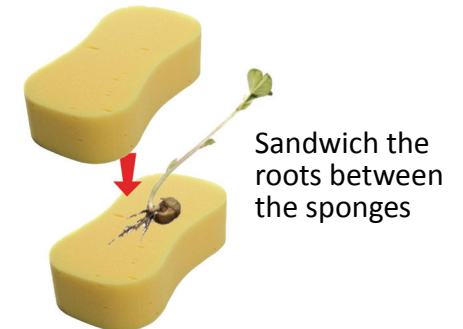
Steps:

1. Wet the two pieces of sponge with water. Make it well saturated but water is not dripping out.



2. Take a bean plant from the pot. Clean the roots by removing the soil. Be careful not to damage the root in doing so.

Tie a string



3. Sandwich the roots between the sponges and tie a string around to secure the position as shown.

4. Hang the plant in upside down position near a bright window. Water the plant everyday like a potted plant. You may want to place a

