

STEM KIT

EDUCATOR GUIDE

SEED SCIENCE

CREATED FOR BOTH HOME AND SCHOOL



**PERFECT FOR
THE CLASSROOM**

DESIGNED BY TEACHERS FOR TEACHERS

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LESSON OVERVIEW

Class Information

This lesson provides information on the growth of plants. This lesson will cover the life cycle of a plant, photosynthesis, plant characteristics and structure, and the importance of irrigation and sustainable agricultural practices.

CONCEPTS



Plant Life Cycle



Photosynthesis



Plant Characteristics



Plant Structure



Irrigation and Sustainability



LESSON OBJECTIVES

- Describe what makes a plant a plant.
- Explain the process of photosynthesis.
- Detail the basic structure of a plant.
- Understand the importance of irrigation and sustainable planting.

EDUCATIONAL STANDARDS

NGSS - Next Generation Science Standards

- **K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive.
- **2-LS2-1.** Plan and conduct an investigation to determine if plants need sunlight and water to grow.
- **5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water.
- **MS-LS1-6.** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

INTRODUCTION

Today we will be discussing everything plants! We will learn about what their characteristics are, what they need to grow, and what their basic structure is. We will also be learning about the value of irrigation and sustainable agriculture. Once we have learned about the science behind plants, we will be building our state-of-the-art planter and planting seeds. As we cultivate our seeds, we will see the life cycle of a plant unfold.

VOCABULARY

Germination - the beginning growth of a seed into a seedling.

Seed - a small object from a plant from which a new plant can grow.

Seedling - a young plant, grown from a seed.

Sprout - a part of a plant that has just begun to grow.

Agriculture - the science or art of cultivating the soil, growing crops, or raising livestock.

Sustainable - making sure the needs of the current generation are fulfilled, without putting future generations at risk, and while also maintaining a balance between the environment, the economy, and personal well-being.

VOCABULARY

Irrigation - the application of water to soil through the use of pumps, tubes, and/or hoses.

Botany - the biological study of plants.

Photosynthesis - the process by which plants, and some other organisms, take in water and carbon dioxide, and convert it into food when exposed to sunlight.

Pollination - The process of transferring pollen from the male portion of the flower (anther) to the female portion of the flower (stigma).

Pollen - a fine dust produced by plants that is carried to other plants of the same kind by the wind or by insects, so that the plants can reproduce.

Roots - the underground parts of a plant, without leaves, that absorb water and minerals, stores food, and keeps the plant in place.

Stem - main stalk of a plant that grows buds and shoots, and usually grows above ground.

Calyx - the green outer part of a flower, consisting of sepals.

Leaves - the often green, blade-like structure, at the end of a stem, on a vascular plant.

Bud - A small portion of a plant that develops into a flower, leaf, or shoots.

Anther - portion of the stamen that contains pollen.

Chlorophyll - green material that allows plants to create their food through the conversion of carbon dioxide

Sepal - each portion of the calyx, that surrounds the petals, and it is typically green and leaf-like.

Angiosperms - any plant that produces flowers, fruits, and seeds.

Gymnosperms - a close relative of angiosperms, these are plants that produce seeds, but no fruit or flowers.

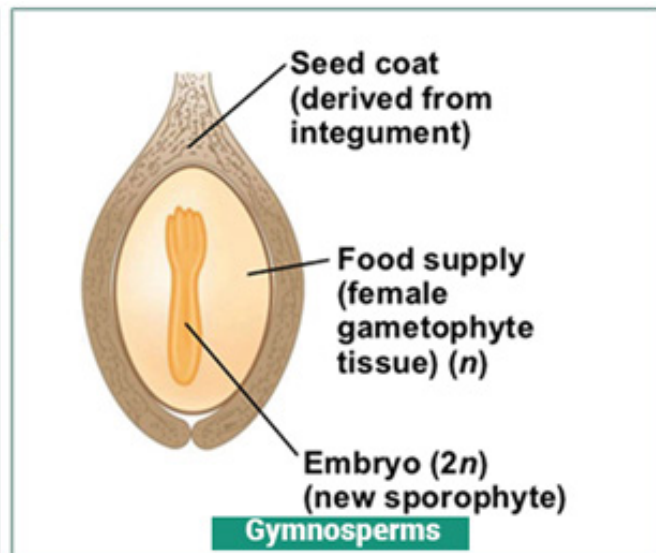
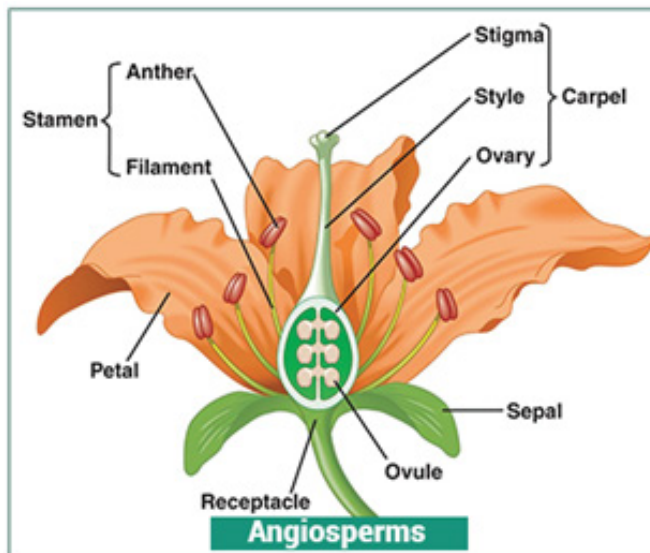
Ferns and Lycophytes - plants that are typically woody, and do not produce seeds, flowers, or fruits.

Vascular Plants - plants that have inner tissues, used for transporting materials through the plant.

Nonvascular Plants - plants that lack tissue, wood, flowers, and roots.

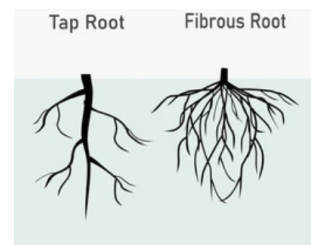
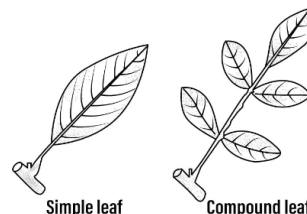
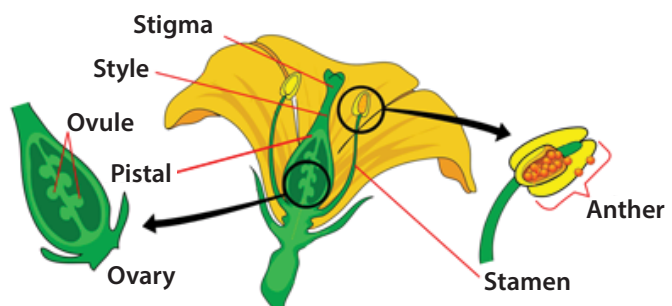
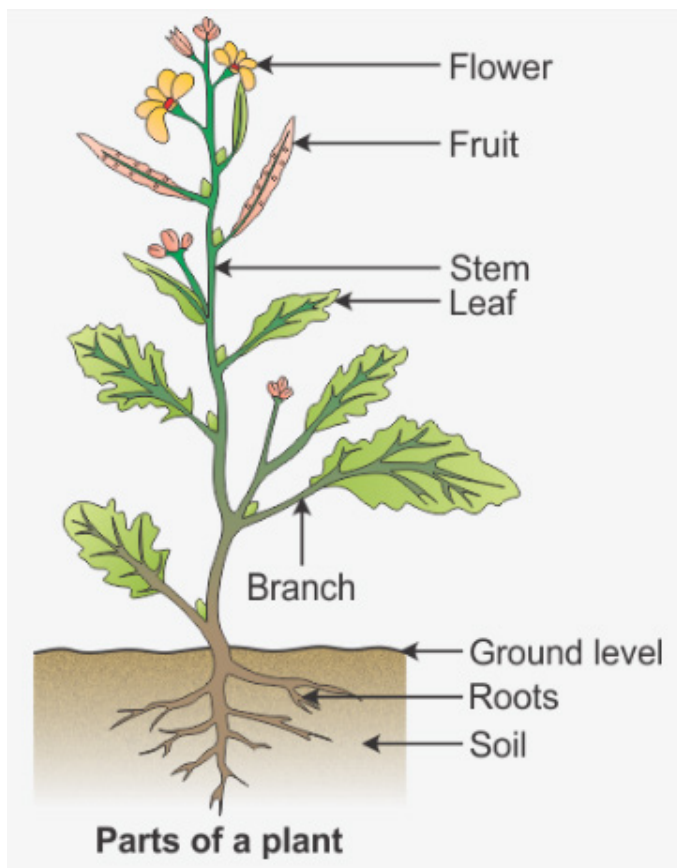
WHAT IS A PLANT?

A plant is a living organism, belonging to the kingdom Plantae. Plants cover a large portion of the Earth's surface. There are characteristics that plants have that allow scientists to identify them. Nearly all plants make their food through a process called photosynthesis. Plants have eukaryotic cells, that have rigid cell walls composed of cellulose. Plants can reproduce through the spreading of spores or with sex cells. While there are many different types of plants, they are usually divided into either vascular plants or non-vascular plants. Vascular plants contain tissues that transport materials through the plant, such as water. Vascular plants can be broken up into three types of plants: angiosperms, gymnosperms, ferns, and lycophytes. Angiosperms are plants that produce seeds, flowers, and fruits. Gymnosperms, a relative of angiosperms, produce seeds, but no flowers or fruit. Ferns and lycophytes are woody plants that produce no seeds, flowers, or fruit. Nonvascular plants are typically small and use diffusion and osmosis to transport material through the plant. Nearly all land plants are rooted in one location - some can direct their leaves toward sunlight and some can respond to touch.



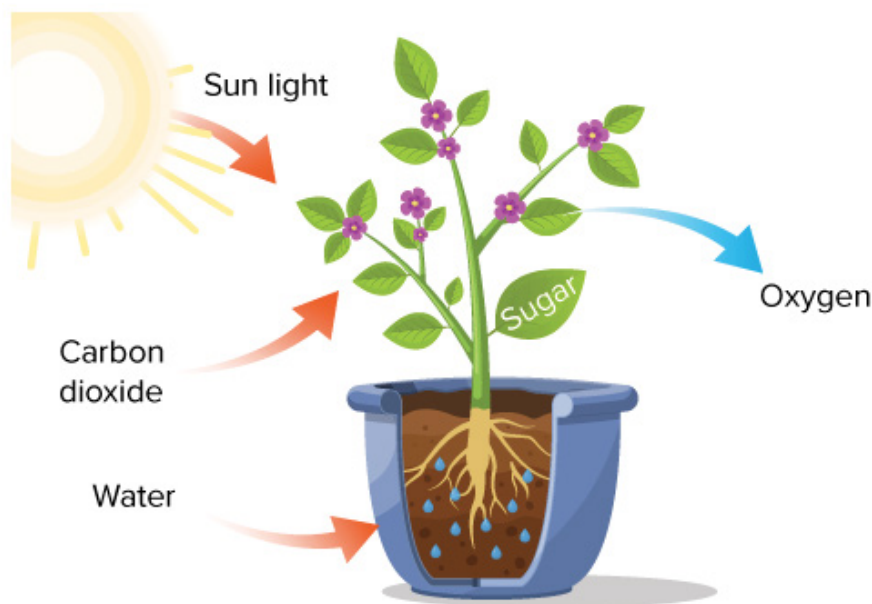
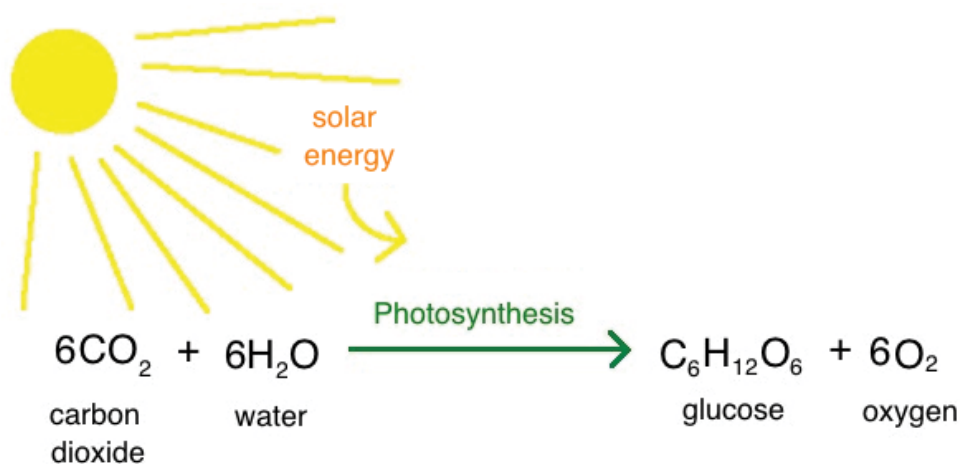
WHAT IS THE STRUCTURE OF A PLANT?

Each portion of a plant has a specific task to keep it alive. Vascular plants typically consist of three main parts: the leaves, the stem, and the roots. The leaves of a vascular plant aid in the process of photosynthesis. Leaves, which are commonly flat and thin, collect sunlight energy and collect carbon dioxide from the air. Leaves can be divided into compound leaves or simple leaves. The stem of a vascular plant is the main portion of the plant. Stems support the leaves and flowers of a plant. The tissues contained in the stem allow for material transport throughout the plant, as well as being a location where food can be stored. The roots of a vascular plant are typically found underground. Roots keep the plant from toppling over and keep them steady in the ground. Roots also gather minerals and water from the soil, and some plants store food here. There are two types of roots: fibrous roots and taproots. Fibrous roots consist of multiple roots that grow in all directions, while taproots have one major root.



WHAT IS PHOTOSYNTHESIS

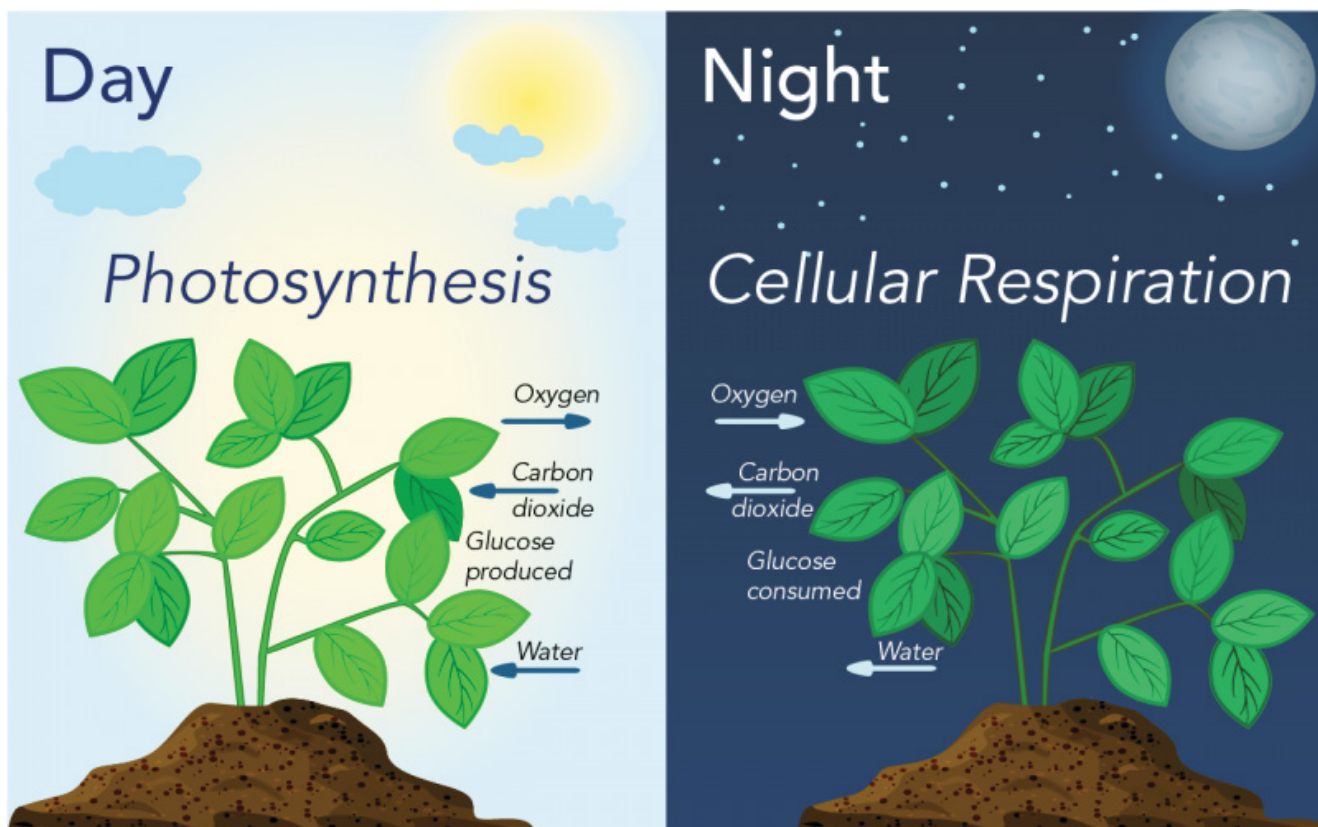
Plants can convert solar energy into chemical energy (sugar) through a process known as photosynthesis. Photosynthesis is a series of chemical reactions. These chemical reactions occur in chloroplasts within the cells of the plant. Chloroplasts are organelles that contain chlorophyll, a light-absorbing chemical. Photosynthesis requires three things to work: light, water, and carbon dioxide (CO₂). The carbon from the carbon dioxide provides the carbon needed for the product - sugar (glucose). To store glucose for long periods, plants will link molecules of glucose together, forming starch. Starch is an amazing source of energy and contains a large amount of it. This process doesn't just create energy for the plant but is also the foundation of our food chain.



WHAT IS CELLULAR RESPIRATION?

While photosynthesis provides the energy plants need, it isn't the end of the story. To grow and develop plants must respire. During the process of cellular respiration energy within the plant is slowly released. Cellular respiration uses the products of photosynthesis (oxygen and glucose) to create high-energy molecules. These molecules are used so that the plant may do the work it needs to live. The product of cellular respiration is carbon dioxide (CO_2) and water (H_2O).

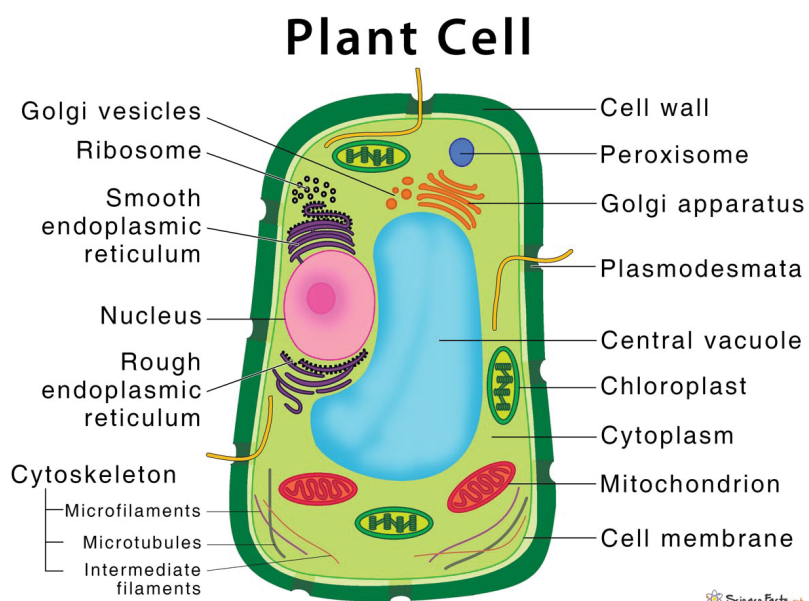
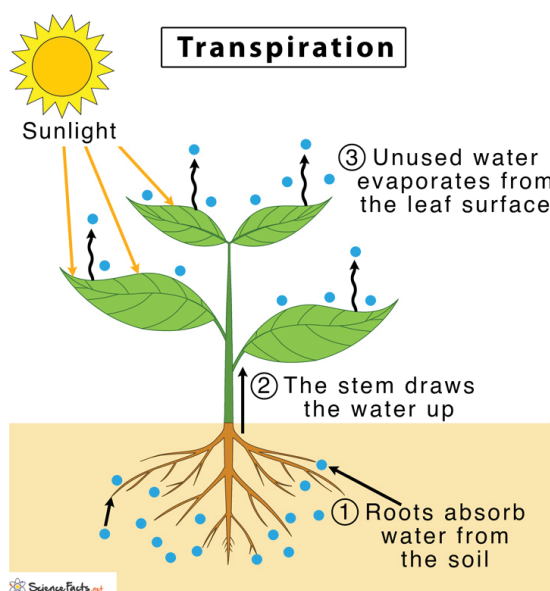
These products must be able to move in and out of the plant. Plants can release these products through stomates, which are pores found on leaves and young stems. For some plants, such as fruits and those with older roots and stems, these products can move through sponge-like layers of cells called lenticels. These products also may diffuse through young roots.



WHAT IS TRANSPIRATION?

It's known that plants require water to live and grow. As plants use and release water, they do so through a process called transpiration. Transpiration takes water up through the plant and releases it through tiny holes in the leaves known as stomata. While humans have blood vessels, plants have vascular tissues. These tissues allow for water and other materials to move throughout the plant.

There are different types of vascular tissue, each having its distinct job. The Xylem, one type of vascular tissue, distributes water and nutrients from the roots to the other parts of the plant. Another type of vascular tissue, phloem, brings sugars and other materials down from the leaves to the roots of the plant. The portion of the plant cell which holds the most water is known as a vacuole. Vacuoles take up the most space in a plant cell. When the plant cells have an appropriate amount of water, the vacuole will push against the cell wall. As this occurs, the structure of the plant becomes more rigid, making the plant sturdy. If the plant has less water than it needs, the plant is less rigid and appears wilted.

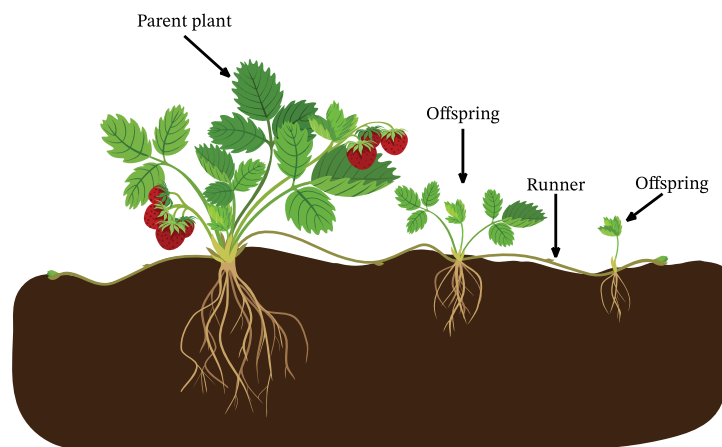
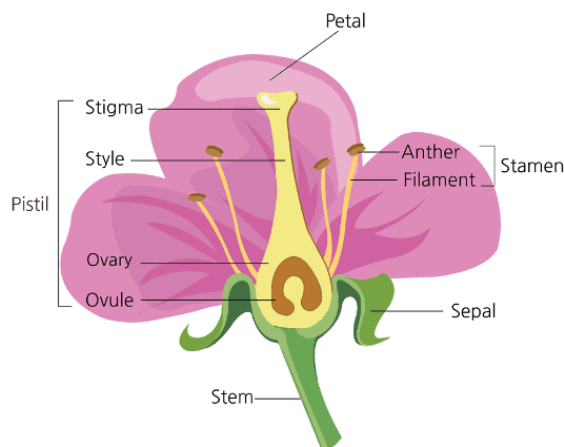


HOW DO PLANTS REPRODUCE?

Our lives are surrounded by plant reproduction and we barely notice. Pollen, which contains the sperm of a plant, causes some to have terrible allergies. When eating a piece of fruit, the flesh being eaten is the mature ovary of a plant. When people see bees hovering around flowers, they are promoting plant reproduction as they carry pollen from plant to plant.

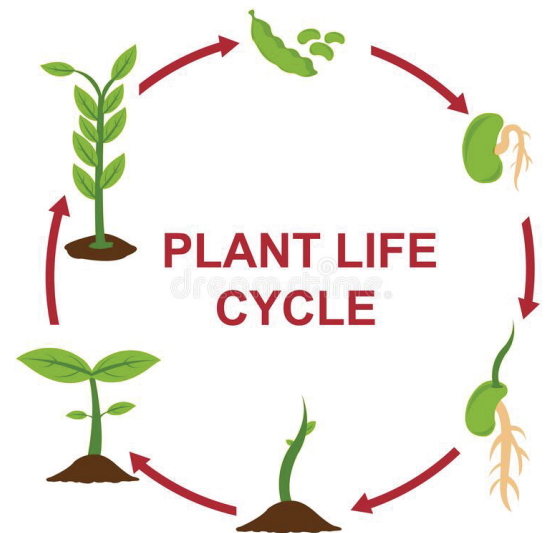
Flowering plants, also known as angiosperms, reproduce through the production of seeds. A flower contains both male and female parts. The male portion of the flower is called the stamens. The stamens hold pollen, which contains the plant's sperm. The female portion of the flower is called the pistils or carpals. The pistils of the plant contain the eggs. As the pollen matures, it must be transported. This transportation process, when pollen is transported to the pistils of a flower, is referred to as pollination. Once the sperm reaches the egg, fertilization occurs. After the egg is fertilized it becomes a zygote that will eventually develop into a seed and be released. This process of reproduction is important as it combines the genetic information from two parent plants, giving the offspring a new genetic profile.

Not all plants reproduce through sexual reproduction. Some plants reproduce through asexual reproduction. A plant can do this by growing new roots and shoots, eventually developing into a new plant. Because this plant has grown from its parent, it has the same genetic information and is considered a clone.

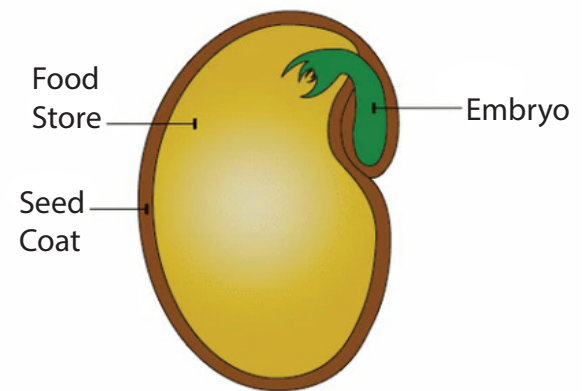


THE LIFE CYCLE OF A PLANT

The life cycle of a plant can be broken up into four main stages: the germination stage, the growth stage, the reproductive stage, and the pollination stage. Once a plant has gone through each of these cycles, it will have completed a full life cycle.



The germination cycle focuses on the first bits of growth of the seed. Once a seed is planted, or placed in an environment where it can begin its growth (such as putting seeds in a bag with a wet paper towel to get them sprouted), it will go from seed to sprout. The seed consists of an embryo, an outer shell, and the inner portion surrounding the embryo is food for the embryo. For the seed to germinate it needs moisture, oxygen, and the right temperature. Once it reaches the point of being considered a sprout, it will transfer onto a seedling or young plant. At this point, the plant will have grown roots, a stem, and leaves.

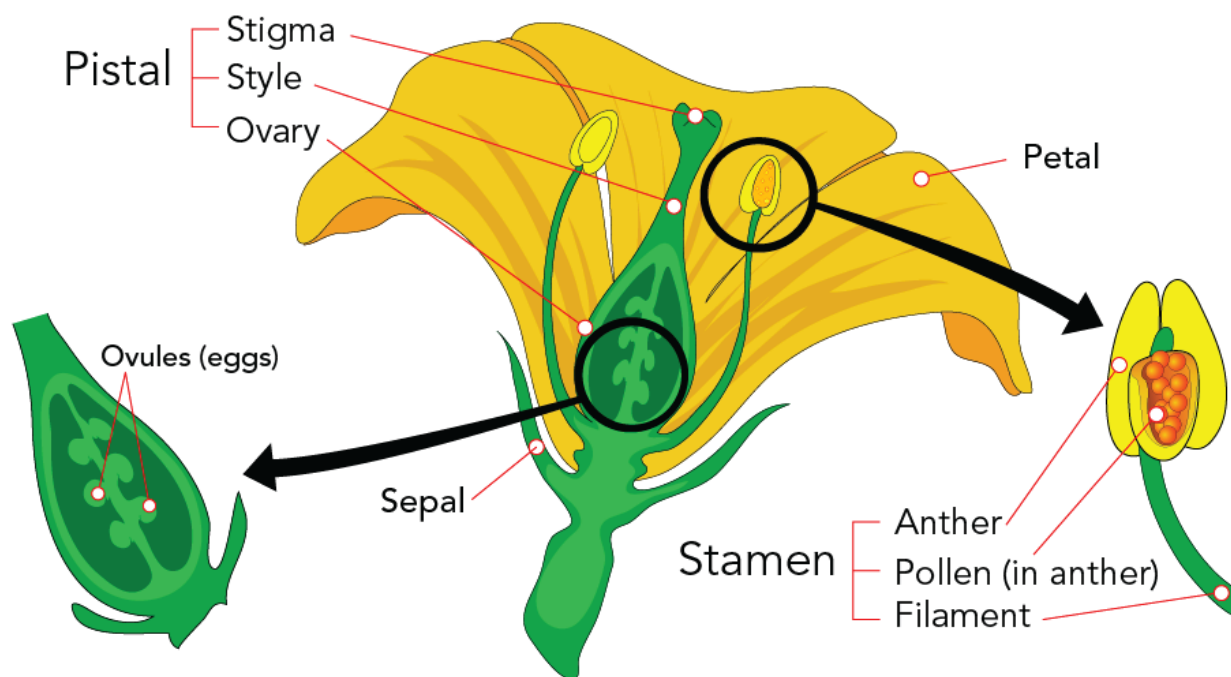


During the growth stage, the plant matures from young to adult. During this stage, the plant will perform photosynthesis and cellular respiration to continue its development. This stage will also show the plant gets larger, or taller, and buds, or young flowers, will develop.



THE LIFE CYCLE OF A PLANT

Once the plant has matured and produced flowers, it is time for the reproduction stage. As stated in an earlier portion of this guide, mature pollen, containing the plant's sperm, is released. This pollen can be transferred by a pollinator (such as a bee or butterfly), or by the wind. Once the pollen comes in contact with the female portion of a flower, an egg is fertilized, becoming a zygote. The process of the pollen being transferred from one flower to another is known as pollination and thus completes the pollination stage.



SUSTAINABLE AGRICULTURE

Typical agricultural procedures require a good portion of natural resources and affect the environment. The purpose of sustainable agriculture practices is to help preserve the environment, best use Earth's resources, and improve soil quality. Sustainable agriculture also seeks to improve profitable farm income, improve farm families and communities, and increase the production of human food and fiber needs. Each practice seeks to create a system for plant and animal production that will meet certain long-term goals. These long-term goals include providing enough agricultural products to meet demand and need, environment protection and expansion of the natural resource supply, and keeping up with the promotion of the agricultural economy.

There are a variety of sustainable agricultural practices, each with its specific perk. Some significant practices include:

Rotating crops and valuing diversity. When farmers plant a variety of crops, the soil is often healthier and pest control is often improved. Practices that support this are intercropping (growing different crops in the same area) or complex, long-term crop rotation.

Planting cover crops and perennials. Cover crops can include clover or rye, while perennials can include a wide variety of plants. The purpose of each of these types of crops is to protect and develop soil health. Soil health is protected and developed by the crops by preventing erosion, replenishing nutrients in the soil, reducing the need for fertilizers and pesticides, and keeping weeds from taking over.

Reducing or eliminating tillage. Tradition plowing, known as tillage, is used to prepare the soil for planting. Tillage can cause soil loss, although it does help with keeping weeds away.

Applying integrated pest management (IPM). Different mechanical and biological controls, among many others, can be put in place to keep pests under control while also using fewer chemical pesticides.

Integrating livestock and crops. Typical agriculture practices keep plants and animals separate. More and more evidence has shown that the smart integration of plants and animals can lead to farms being more efficient and profitable.

IRRIGATION

Irrigation is the application of water to soil through the use of tubes, pumps, and sprayers. This technique is primarily used in areas where drought is typical or predicted, or in areas with unpredictable rain. The use of irrigation practices is important for these areas, as well as others. Irrigation allows for the water available to a farmer to be used wisely. This practice also promotes productivity and profitability in the field. The water used in irrigation can come from a variety of sources, such as springs and wells, rivers and lakes, or even treated wastewater. There are also several types of irrigation systems. Some of these include irrigation practices such as surface irrigation, where water is poured over an area by gravity, or center pivot irrigation, where water is poured out through a system of sprinklers on top of wheeled towers in a circular pattern.



PROJECT OVERVIEW

Today's project will feature students building a planter, planting a seed, and observing the plant's life cycle. Students will be able to watch the root system develop through a window in the planter. Students will also be able to control the amount of light and water their plant receives. As the plant grows, students will be able to see what ingredients help their plant thrive (such as full light, or less water).

SAFETY WARNINGS:

Please read all safety warnings before use:

Choking Hazard: Small parts not for children under 6 years or any individual who have a tendency to place inedible objects in their mouths.

Do not allow water near a power socket or electrical plug.

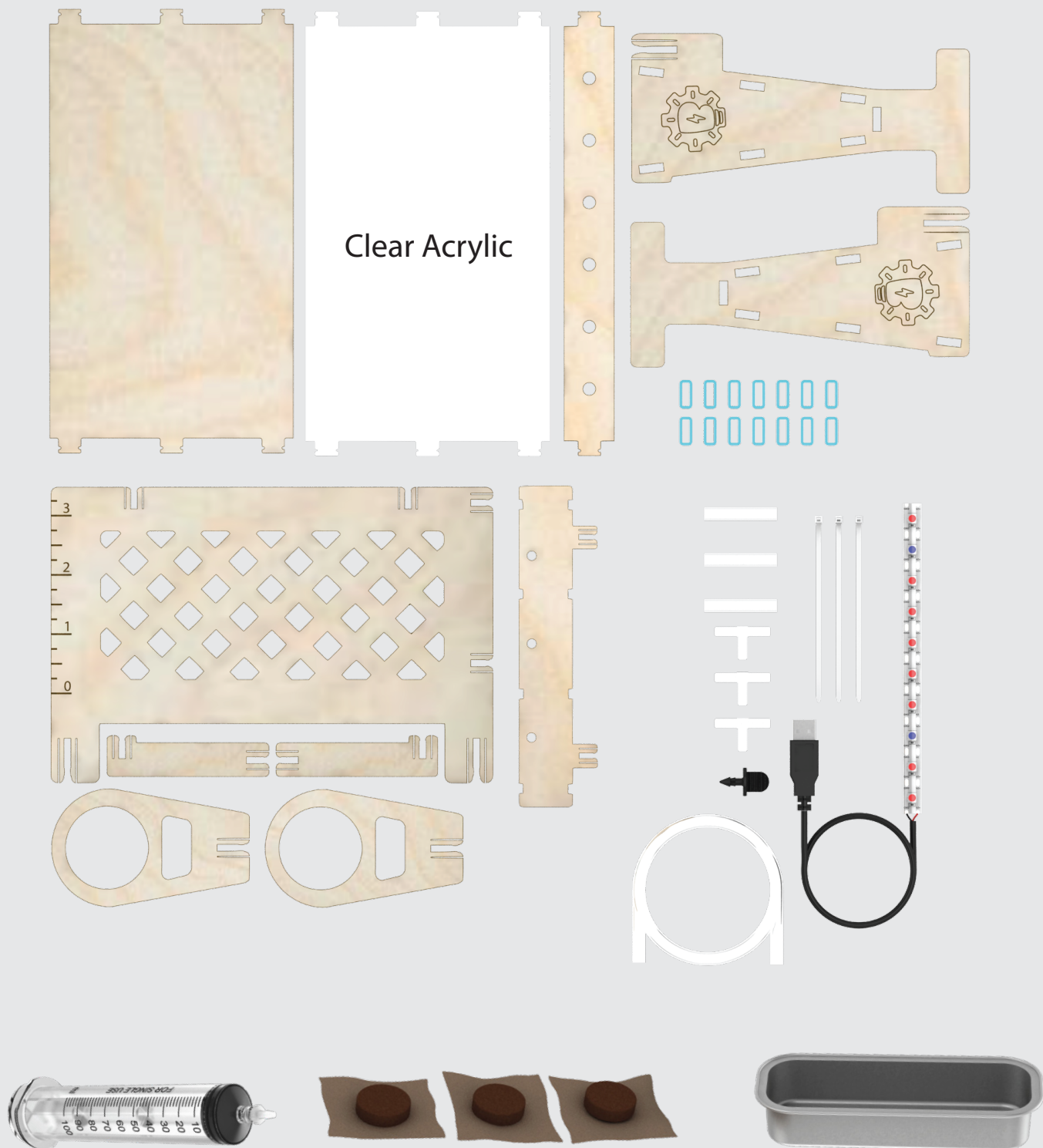
Adult supervision required.

MATERIALS

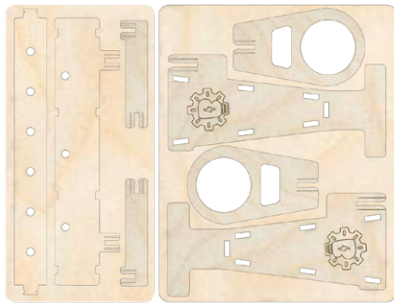
- Durable wooden construction pieces
- Plexiglass panel
- Plant grow LED strip
- Peet pellets & Pea seeds
- Syringe & Tubing
- Short tubing
- Barb End Plug
- T-Connectors
- Luer Adapter
- Foil Ramekin
- O-Ring fastener
- Zip ties



PARTS

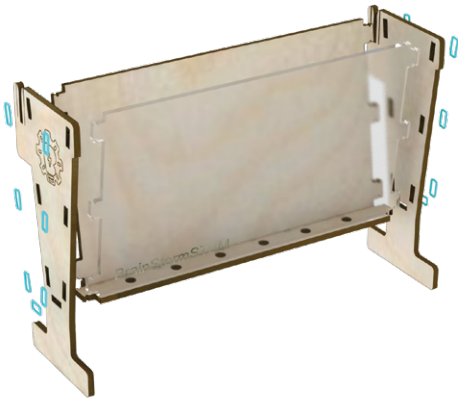


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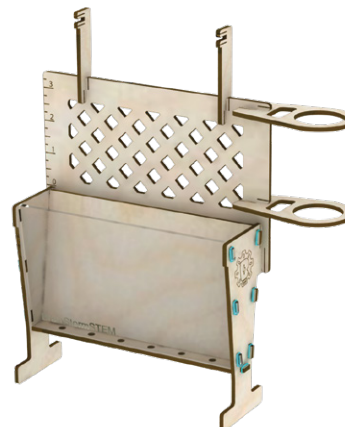


NOTE: If you can not break out the pieces by hand, use a blunt tool or a small knife to cut or punch them out. If you have no experience with tools or use a knife, get help from an adult. If there are any burrs, points or rough spots do to breaking or cutting, smooth them with a piece of sand paper.

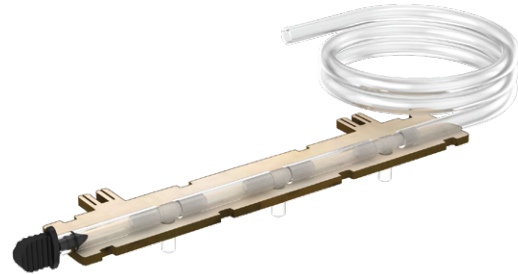
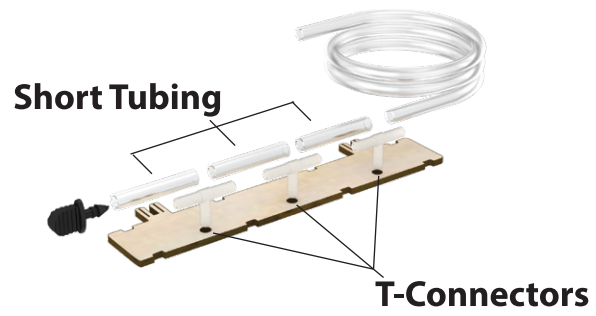
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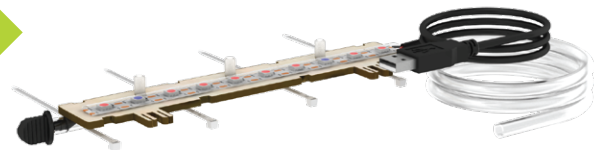
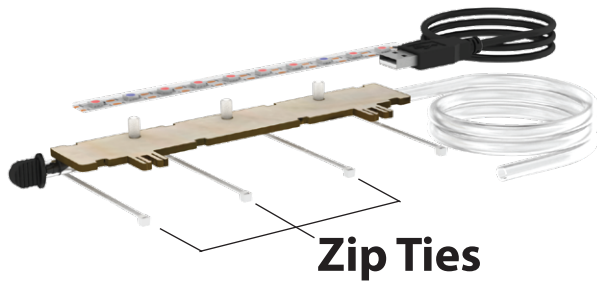
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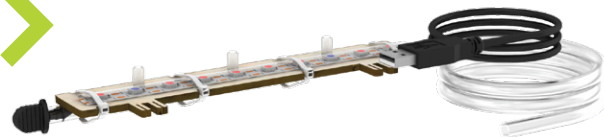
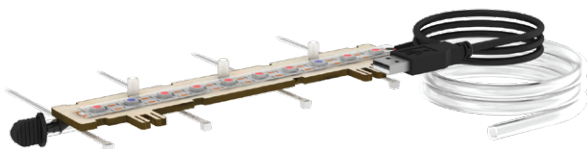
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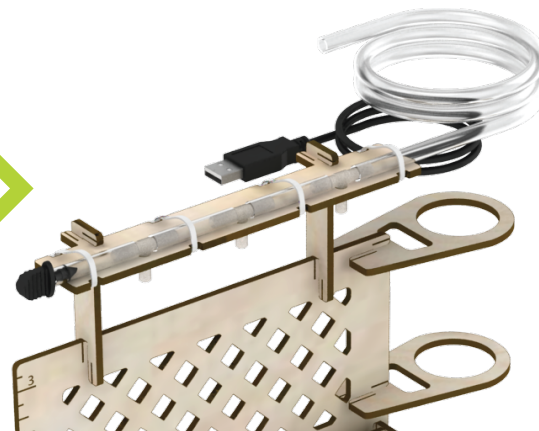
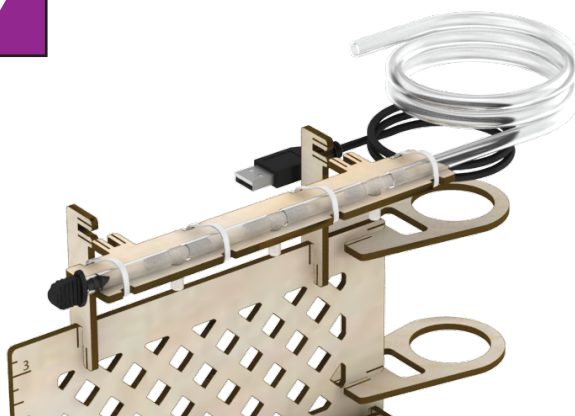
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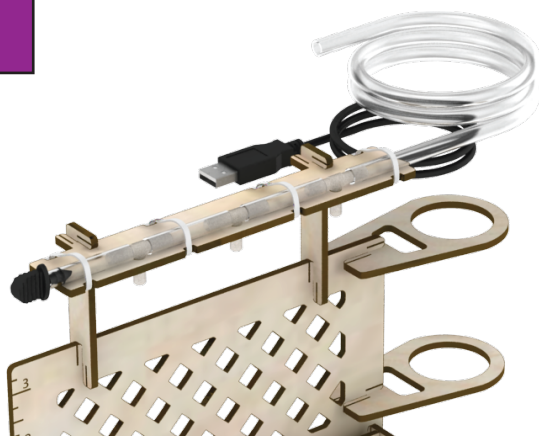
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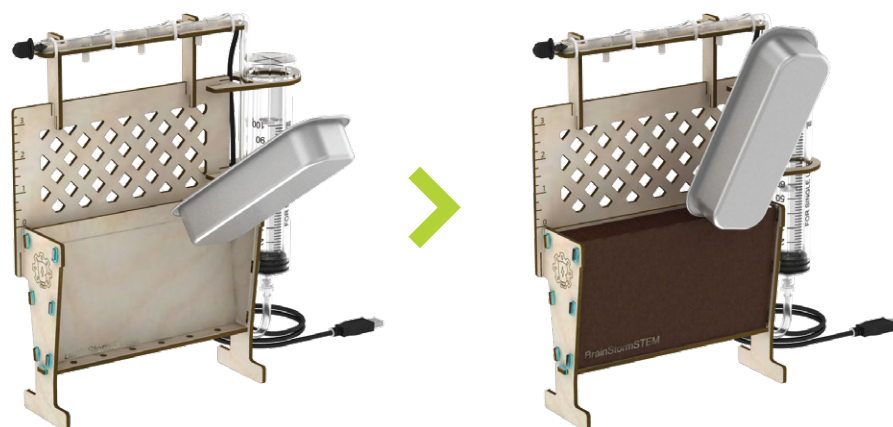
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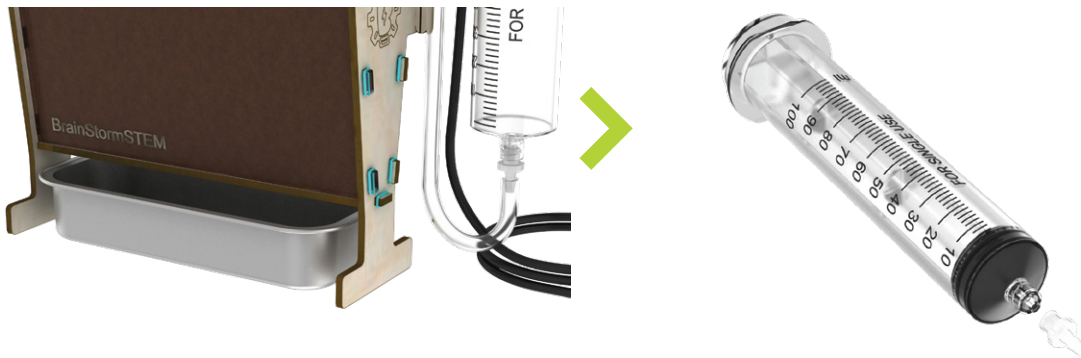


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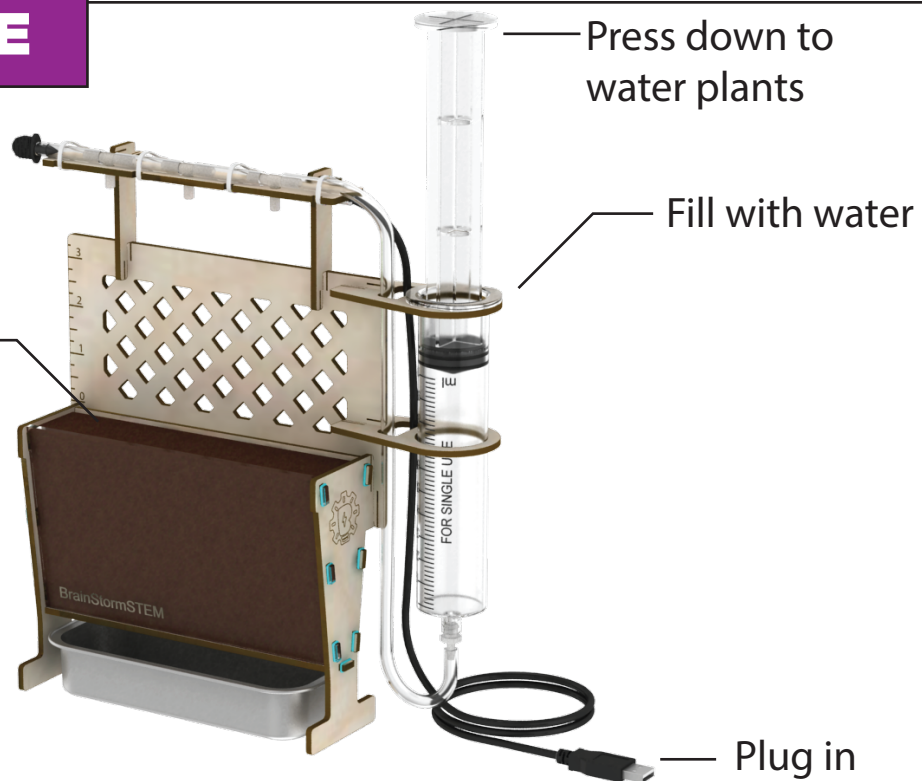
13

Fill with water



HOW TO USE

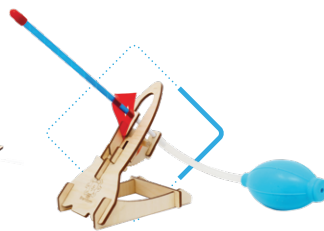
Plant Seeds



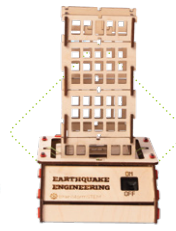
If you enjoyed this STEM Kit, check out some of our other Kits!



SOLAR OVEN



AIR-POWERED ROCKET



EARTHQUAKE ENGINEER



AND MORE!

ACTIVITY FOR PROJECT

The Brainstorm planter kit can be used to grow and observe a plant. If you would like the planter to be used in a more engaging classroom activity, it can be paired with the provided worksheets. There are both beginner and advanced worksheets to adjust to the level of your student's understanding.

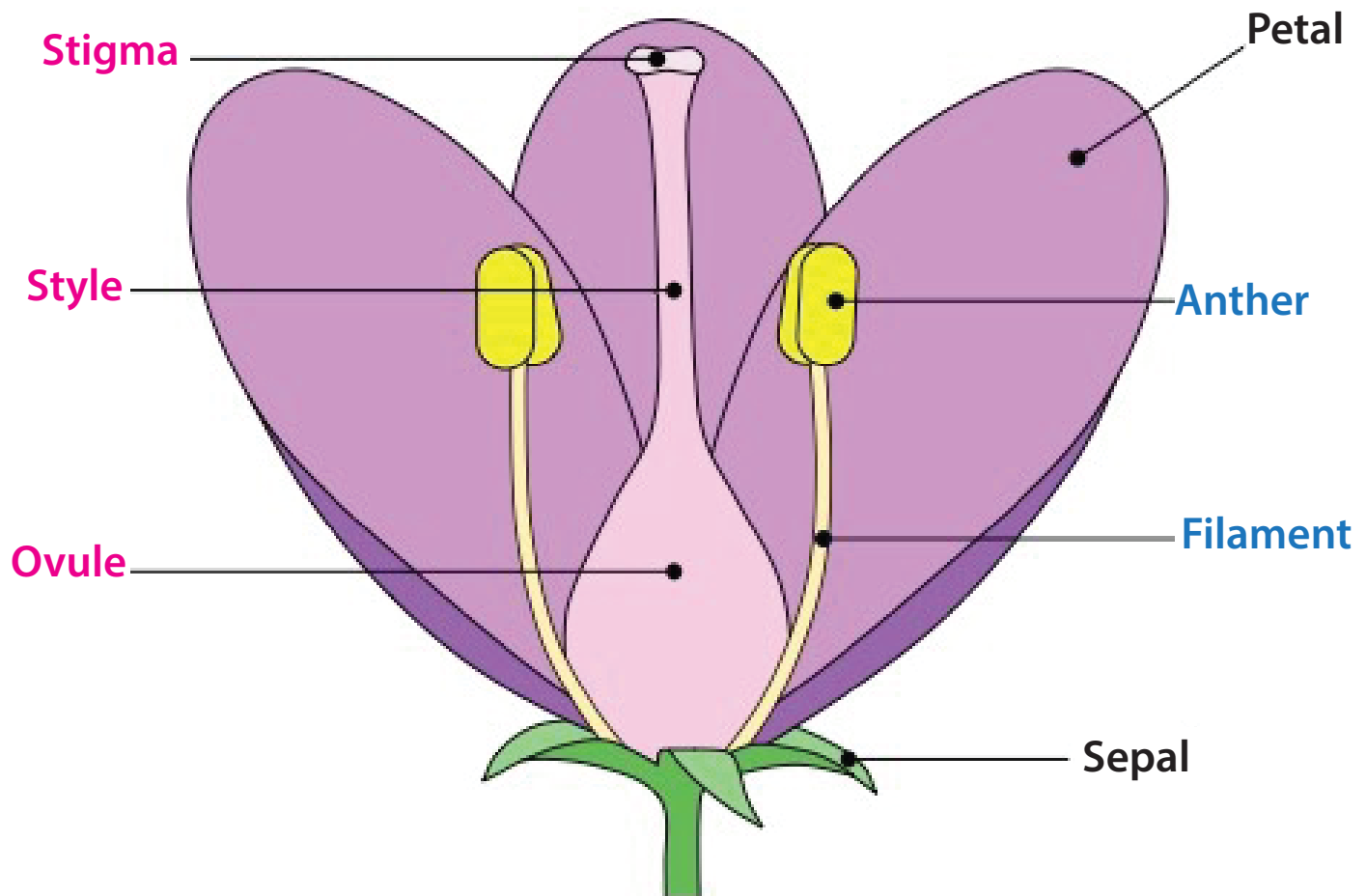
The planter will allow students to view the growth and life cycle of a plant. It will also allow students to control the amount of light and water the plant will receive. Students will be able to document each stage of growth for their plant and find what works best for their plant's growth.



Each of the worksheets is geared towards having the students identify plant life cycle stages. Each worksheet also discusses photosynthesis and what a plant needs to grow. On the beginner worksheet, students will draw and identify three life cycle stages, as well as identify what a plant needs to complete photosynthesis. On the advanced worksheet, students will label portions of a flower, describe how nonvascular plants get their water and nutrients, and draw the process of pollination.

Students will be able to see how changing the amount of water and light will affect their plants.

VISUAL FLOWER LABELING



PISTIL
The FEMALE parts
of the flower

STAMEN
The MALE parts
of the flower

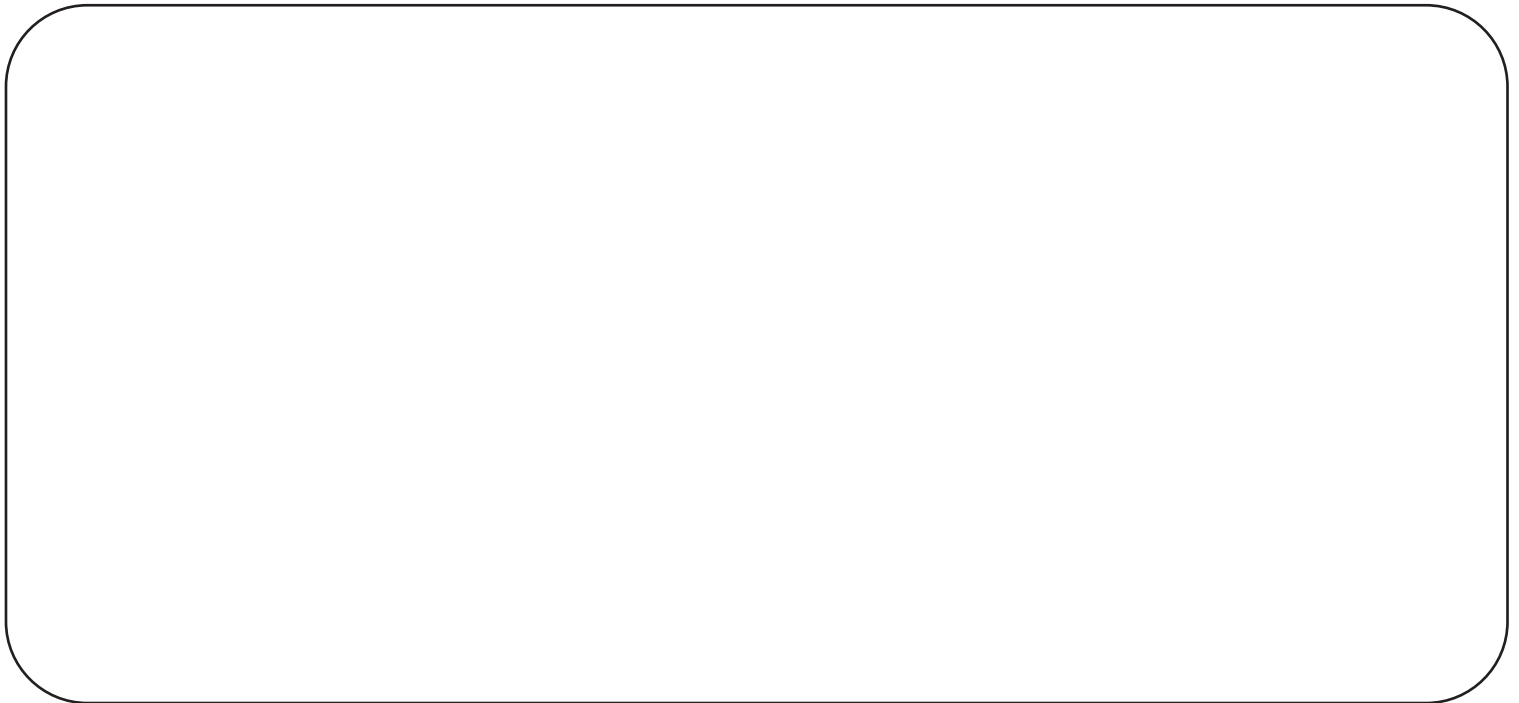
WORKSHEET (BEGINNER)

Name(s): _____

Date: _____

How Unbe-leaf-able! Pea Plant Growth

Draw the growth of your plants!



Circle the three things a plant needs to complete photosynthesis.

Soil	Oxygen	Water	Glucose
Sunlight	Carbon Dioxide	Nitrogen	Love
Fertilizer	Air	Dirt	Grass

Put the life cycle stages of a plant in order.

___ Seed germination ___ Pollination ___ Reproduction ___ Growth

List an example of a pollinator.

WORKSHEET (Advanced)

Name(s): _____

Date: _____

How Unbe-leaf-able! Pea Plant Growth

What are the products of photosynthesis?

What method do nonvascular plants use to get water and nutrients?

List two reasons why irrigation is important to agriculture.

1. _____

2. _____

Label the parts of the flower and which are the Male and Female parts.

