Botanical Explorations Teacher Guide



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Relevant Standards for Botanical Explorations

SS3A1.1- analyze primary and secondary sources	SS3A1.2- utilize technology resources to gather information from primary and secondary sources	SS3A1.3- define terms related to the social sciences	SS3G1.2- review basic map elements
SS3G2.5- identify natural and man-made landmarks in the United States	SS3G3.1- describe the climate and vegetation in the United States	SS4A1.1- analyze primary and secondary resources to identify significant individuals and events throughout Florida history	SS4A4.1- explain the effects of technological advances on Florida
SS4A6.3- describe the contributions of significant individuals to Florida	SS4A9.1- utilize timelines to sequence key events in Florida history	SS4G1.1- identify physical features of Florida	SS5A1.1- use primary and secondary sources to understand history
SS5A1.2- Utilize timelines to identify and discuss American History time periods	SS5G1.1- interpret current and historical information using a variety of geographic tools	SS5G1.2- use latitude and longitude to locate places	SC3L14.1- describe structures in plants and their roles in food production, support, water and nutrient transport, and reproduction
SC3L14.2- Investigate and describe how plants respond to stimuli	SC3L15.2- classify flowering and nonflowering plants into major groups	SC3L17.2- recognize that plants use energy from the sun, air, and water to make their own food	SC3N1.1- raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations
SC4L16.1- identify processes of sexual reproduction in flowering plants, including pollination, fertilization, seed dispersal, and germination	SC4L17.3- trace the flow of energy from the sun as it is transferred along the food chain through the producers to the consumers	SC4N1.1- raise questions about the natural world, use appropriate reference materials to obtain information, conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations	SC4N1.3- explain that science does not always follow a rigidly defined method but that science does involve the use of observations and empirical evidence
SC4N1.8- recognize that science involves creativity in designing experiments	SC5L14.2- compare and contrast the functions of organs and other physical structures of plants	SC5N1.1- define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types	SC5N1.2- explain the difference between an experiment and other types of scientific investigations
SC5N1.5- recognize and explain that authentic scientific investigation frequently does not parallel the steps of the scientific method			

ELA3R2.2- identify the central idea and explain how relevant details support that idea in a text	ELA3C1.3- write opinions about a topic or text, include reasons supported by details from one or more sources	ELA3V1.3- use context clues, figurative language, word relationships, reference materials, and background knowledge to determine meaning of words	ELA4R2.1- explain how text features contribute to the meaning and identify text structures
ELA4R2.2- explain how relevant details support the central idea	ELA4C4.1- conduct research to answer a question, organize information about the topic, and use multiple valid sources	ELA4V1.3- use context clues, figurative language, word relationships, reference materials, and background knowledge to determine meaning of words	ELA5R2.2- explain how relevant details support the central idea
ELA5C4.1- conduct research to answer a question, organize information about the topic, and use multiple valid sources	ELA5C5.1- arrange multimedia elements to create emphasis in oral and written tasks	ELA5V1.3- use context clues, figurative language, word relationships, reference materials, and background knowledge to determine meaning of words	

Here are national standards frequently used to frame state standards.

	From molecules to organisms: Structures and processes	Biological Evolution Unity and Diversity	Energy	Ecosystems
NGSS Life Science	3- develop models to describe that plants have unique and diverse life cycles	3- use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving and reproducing	5- use models to describe that energy in animals' food was once energy from the sun	5- develop a model to describe the movement of matter among plants, animals, decomposers, and the environment
	4- construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction	3- construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all		
	5- support an argument that plants get the materials they need for growth chiefly from air and water			
C3 Framework for Social Studies	D14.3-5- explain how supporting questions help answer compelling questions in an inquiry	D2.HIS.10.3-5- compare information provided by different historical sources about the past		
	D1.5.3-5- determine the kinds of sources that will be helpful in answering compelling questions and supporting questions	D2.His.12.3-5- generate questions about multiple historical sources and their relationship to historical events and developments		
	D2.Geo.3.3-5- use maps of different scales to describe the locations of cultural and environmental characteristics	D2.His.16.3-5- use evidence to develop a claim about the past		
	D2His. 9.3-5-summarize how different kinds of historical sources are used to explain events in the past			

STEM Basics

STEM involves integrating curriculum through science, technology, engineering, and mathematics.

Science and Engineering practices, according to NGSS, involve:

- asking questions and defining problems
- developing and using models
- planning and carrying out investigation
- analyzing and interpreting data
- using math and computational thinking
- constructing explanations and designing solutions
- engaging in argument from evidence
- obtaining, evaluating, and communicating information

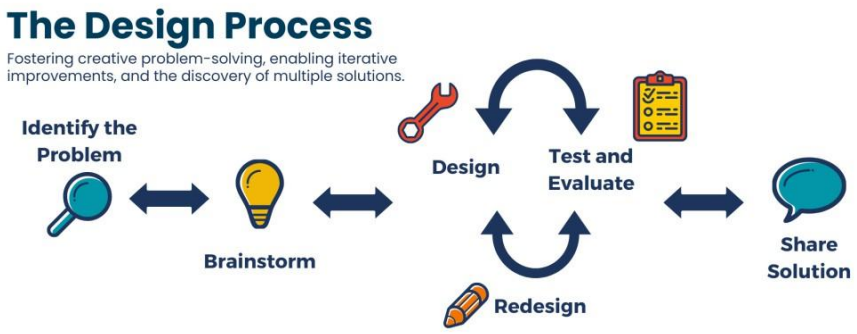
Habits of mind are an important aspect of STEM education.

Regarding technology, habits of mind include:

- being an empowered learner with the ability to choose and use technology effectively
- developing safe digital citizen habits that include responsible online interactions and safe practices
- using technology in ways that help build knowledge and understanding of the real world and authentic settings
- using a variety of technologies within a design process to identify and solve problems creatively
- leveraging the power of technology to develop and test solutions that integrate math processes
- communicating clearly and expressing self creatively through a variety of tools, platforms, and media
- collaborating with others and working effectively in teams locally and globally

Regarding engineering, habits of mind include:

- systems thinking- understanding the interconnectedness of the world and individual components within the world
- creative problem solving- developing innovative, out of the box techniques and ideas to solve a variety of problems
- adapting- being flexible with ideas and practices in regards to creative problem solving
- visualizing- creating mental models and design solutions to visualize concepts and communicate plans
- design is an important aspect of engineering, the Design Process illustration models how design, test, and redesign is a natural part of STEM inquiry



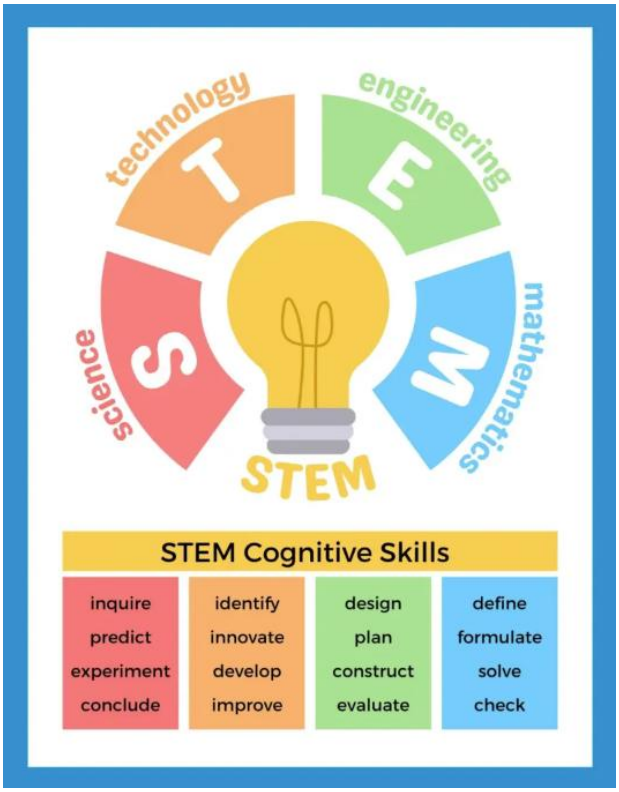
Regarding science, habits of mind include:

- thinking flexibly
- thinking about thinking- being able to explain how you know something
- questioning and posing problems- being able to recognize opportunities in the real world for solving problems
- thinking and communicating with clarity and precision- being able to explain thinking and reasoning effectively
- gathering data using the senses
- creating, imagining, and innovating- inspiring thought, design, art, and expression
- thinking interdependently- looking for connections in the real world

Regarding mathematics, habits of mind include:

- actively participating in effortful learning individually and with groups
- demonstrating understanding by representing problems in multiple ways and means
- completing tasks with mathematical fluency
- engaging in discussions that reflect on the math thinking of self and others
- using patterns and structure to help understand and connect math concepts
- assess the reasonableness of solutions
- applying math to real-world contexts

As you can see with the descriptions of the habits of mind, engaging students with STEM activities in the classroom encourages active thinking and learning. It requires students learning how to work individually and collectively.



Ideas for STEM learning opportunities are provided throughout the teacher guide with a specific culminating STEM investigation at the end.

The Learning Cycle for Science Inquiry Process

A common model of inquiry for elementary learning purposes is the 5E Learning Cycle. This process involves **engaging** student focus and imagination, students **exploring** concepts through hands-on learning experiences, the teacher and students **elaborating** on specific content being learned, students **expanding** learning through investigations that apply basic concepts they have learned, and then teachers **evaluating** the learning process and product using summative and formative assessments.

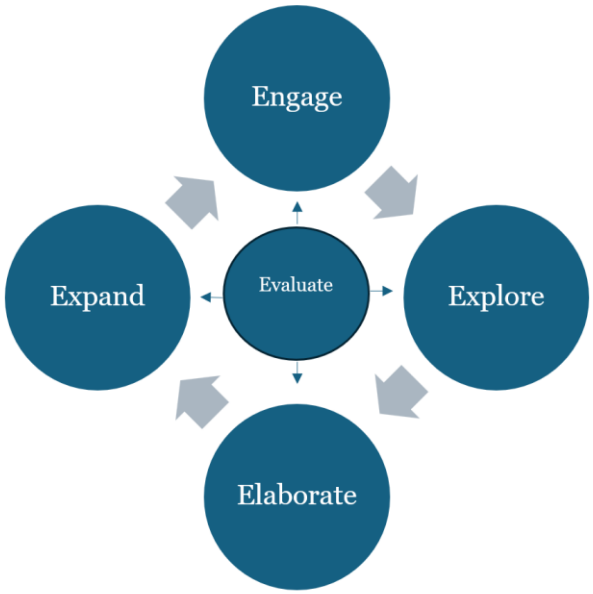
Above all, inquiry learning is active learning. Students construct their understanding of basic concepts through the use of materials and technology. The role of the teacher is that of facilitating learning through guided and open opportunities. As students progress through exploring, elaborating, and expanding their understanding of the content and concepts, they should be more and more in control of how they are learning, taking on more responsibility.

Getting a better understanding of the 5E Learning Cycle for Inquiry Purposes

Engage	
It's important to provide students with a cue to get their brains thinking and wondering. You aren't introducing anything new, just getting their brains engaged.	How could you find out what students already know? What quick activity can you use to get students thinking about the content and concepts to be learned?

Explore	
Hands-on activity(ies) that can be used to introduce content and concepts to students. This allows students to begin to construct their understanding.	What materials can students use to start learning about the content and concepts? What active learning can you use?

Elaborate	
Elaborate means to explain. The teacher and students working together figure out what has been learned through the explore activities. This basic understanding is then given formal vocabulary and direct instruction of content and concepts. The elaborate process can be done in multiple ways, but active learning is always the best method to keep students engaged and learning.	What are the specific content and concepts students need to learn about? What text can be used to help students gain formal understanding? What notes will help students gain formal understanding? What active methods can be used to encourage students to stay involved with learning?

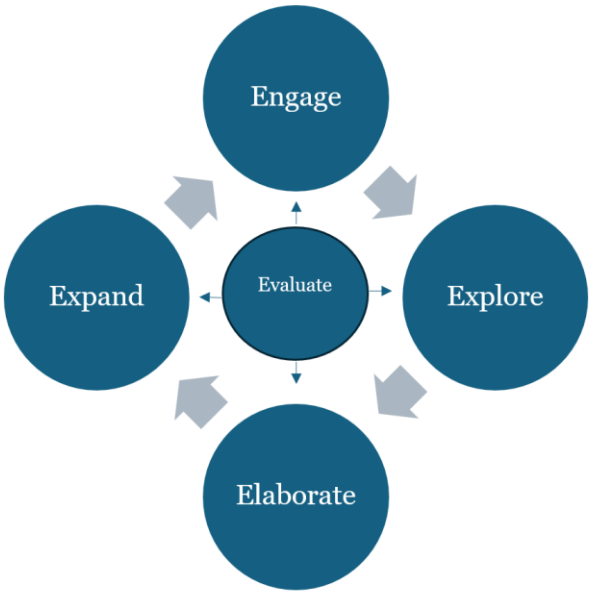


Expand

As students gain understanding of concepts and content, it is important to provide opportunities for them to apply what they are learning. Expanding should deepen student understanding and make them aware of how the content and concepts work in real-world settings.	What experiment can students design to deepen their understanding? Where can students go for a field trip to experience the content and concepts in a real-world setting? What research project can students develop to deepen their understanding?

Evaluate

The teacher role of facilitator, guide, and expert means they should have the skills to recognize when students are building understanding of content and concepts, struggling to understand, or are completely off-task or target. Evaluation does not have to be formal, but it does need to be purposeful and consistent. Evaluation should take place at all points of the cycle.	How can students reflect on their learning at each step in the cycle? What skills are part of the learning and how will the teacher monitor achievement of those skills? When should quizzes and assessments be used? What observations will help the teacher know where students are in their learning process and how will those observations best be recorded?



Different Levels of Inquiry

As students investigate learning in order to construct understanding, some of the experiences you want them to have will be fully proctored. You provide step by step directions during the experiences so that students really can gain the specific content and knowledge you want them to gain. This proctored experience is the first level of inquiry, often referred to as **direct or structured inquiry**. As students gain confidence in their ability to engage with investigations effectively and they construct the necessary understanding of the content to do more, the next level of inquiry is **guided inquiry**. You will provide students with some of the necessary aspects of their experiences, such as providing focusing questions or having specific materials to be used. Students take on responsibility for how to answer questions or how to use materials to proceed with their learning. Once again, as students gain confidence in their ability to lead investigations effectively, the final level of inquiry is **open inquiry**. While there is some structure to the content to be explored, how students go about it is entirely up to them.

All three levels of inquiry are addressed in the booklets. Remember, you want to save open inquiry opportunities for when students have the skills and content knowledge to effectively design and execute investigations. With each unit, you want to start with direct inquiry opportunities. These connect readily with the explore and elaborate phases of the 5E learning cycle for inquiry. Guided and open inquiry connect easily with the expand phase. Evaluate students' ability to understand and use the content and concepts and then lead them into guided inquiry experiences. The earlier in the year, the more direct and guided inquiry you want to use. Gradually provide students with more and more responsibility until you feel they are ready to fully take on open inquiry. If you will provide active learning supports throughout the school year, by the end of the year, students in even the youngest grades should be able to work through open inquiry at least once.

When students are involved in open inquiry, your classroom will take on characteristics that may seem different. Students are talking, building, exploring, and testing. Different groups will be working on different projects. Evaluation is integral to how you monitor the activities to make sure that learning remains focused and on target. Your job during these experiences is to ask questions, discuss, make suggestions, and celebrate successes. Students need you to be fully engaged in their learning processes even when you are not directly guiding them.

STEM and the Inquiry Process

With these concepts in mind, STEM activities in the classroom relate well with the 5E learning cycle and levels of inquiry. Through STEM, students expand on what they have learned. Integrating math, science, engineering, and technology helps students connect in multiple modes. STEM activities easily fall into the guided and open inquiry process.

Student Booklet Activities, Directions, Background notes, and anything else we can throw in

I. About Plants
   a. Cautions
      i. Plant toxicity-
         1. Some plants and seeds can be harmful when eaten or touched. Know the plants you are bringing into the classroom and allowing students to handle; consider reach- even if you don't intend for students to handle a plant, if it is within reach, they may. Toxic plants include azaleas, iris, pokeweed, hemlock, foxglove, philodendron, and caladium. Plants with toxic sap include oleander, poinsettia, and trumpet vine.
         2. School property may have harmful plants growing naturally as well. If you are planning to use the local environment, check what is in the area. Be on the lookout for poisonous plants like poison ivy. If you aren't sure, you can contact your local agriculture extension office.
         3. Store-bought seeds may be coated with insecticides or fertilizers.
      ii. Some students may have allergies relating to plants. Symptoms can include headache, nausea, dizziness, sweating, tightness in the chest, vomiting, skin itching, or dermatitis.
   b. Safety practices
      i. Have students wash their hands after completing lessons and activities that involve plants.
      ii. Use appropriate protective gear. Wear properly fitting safety goggles. Wear a lab apron or art smock made of cotton to protect clothing. Wear gloves if needed. Have students tie back hair and secure loose clothing.
      iii. Remind students to keep materials away from their mouths, noses, and eyes.
   c. Good plants to work with
      i. Green beans and peas sprout within 3 to 7 days and grow rapidly so students can clearly see roots, stems, and leaves.
      ii. Radishes sprout in a few days and complete their life cycle in 3 to 4 weeks.
      iii. Marigolds bloom quickly from seed and provide a good way to study flowers.
      iv. Fast Plants are specially bred rapid cycle plants that complete their life cycle in 35 to 40 days. Carolina Biologic is a good source to purchase Fast Plants.
   d. Timing for a study on plants
      i. Plants require sunlight. If you plan to grow in the classroom, a sunny window August to September and April to May should be good.

ii. If you want to grow outside of those times, grow lights in the classroom work well. Grow lights should be full spectrum or cool white LEDs, around 5000K-6500K. Typical lights, whether overhead or lamps, will not suffice. The lightbulbs should be about 8 inches above the seedlings and able to be lifted up as plants grow. The plants will need 12 to 16 hours of light per day, so a timer will be needed as well.

e. Another useful tool: The Interactive Science Notebook
   i. The purpose of an interactive science notebook is for students to collect, record, and organize what they are learning. It is a good opportunity for creativity. It provides a place where students demonstrate what they have learned. They can use it to review their learning and make connections between units. Encourage students to use color, to make reflections about the activities and what they are learning, they can even add information they are learning from other sources. The inquiry method encourages curiosity.

f. Yet another useful tool: the hand lens
   i. Examining the details of images is part of the process of observation. Hand lenses and the zoom tool on devices should be encouraged. Carolina Biological is a great source for hand lenses. These low-cost magnifiers have a 3x and 6x magnification optic. You can also stack them for greater magnification.



Historic Figures in STEM

About Carl Linnaeus: Linnaeus was a Swedish botanist, physician, and zoologist. He organized a method for classifying plants and animals.

Symbolism of His portrait: Linnaeus is wearing traditional Sami attire to portray himself as a bold explorer who survived a scientific expedition to the far north of Sweden. (His trip was actually to Lapland and was brief.) He holds a Sami drum linking his scientific identify to the artifacts and the knowledge he collected. He has a tiny twinflower in his buttonhole (named Linnaea borealis in his honor). He stands beside a stack of books symbolizing his ambition to catalog the natural world.

For the observe, reflect, wonder activity, print copies of page 2 so students can write directly on the paper. They can write wonder questions in their science notebook.

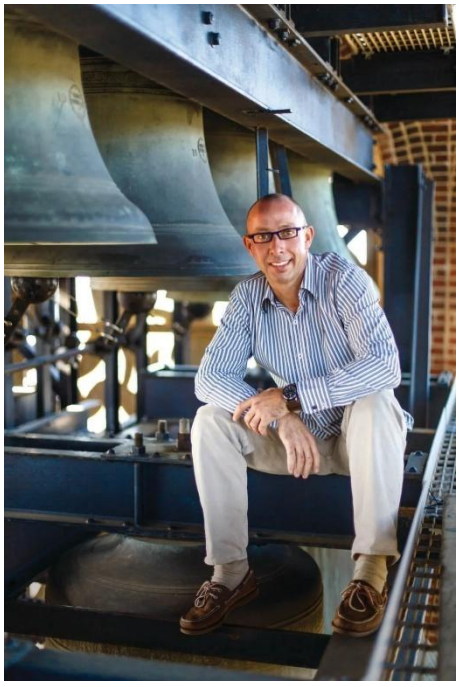
Ask students to explain what a zoologist is and does. Based on the introduction about Carl Linnaeus, they should be able to tell that a zoologist studies animals.

Historic Botanists and Architects

Students read the accounts of Marianne North and George Washington Carver on page 4, Frederick Law Olmsted, Jr and Edward Bok on page 5, and complete the graphic organizer on page 6.

Students can research any of these historic persons to learn more about their work and their contributions.

Exploring Vocabulary (page 6)



The Carillon is played by a carillonneur. The current musician with Bok Tower Gardens in Lake Wales, FL is Geert D'Hollander. In the image, he is sitting beside some of the bells that make the carillon that is housed in the tower at the gardens.



The bells are played on a board that is similar to a piano.

Bok Tower Gardens

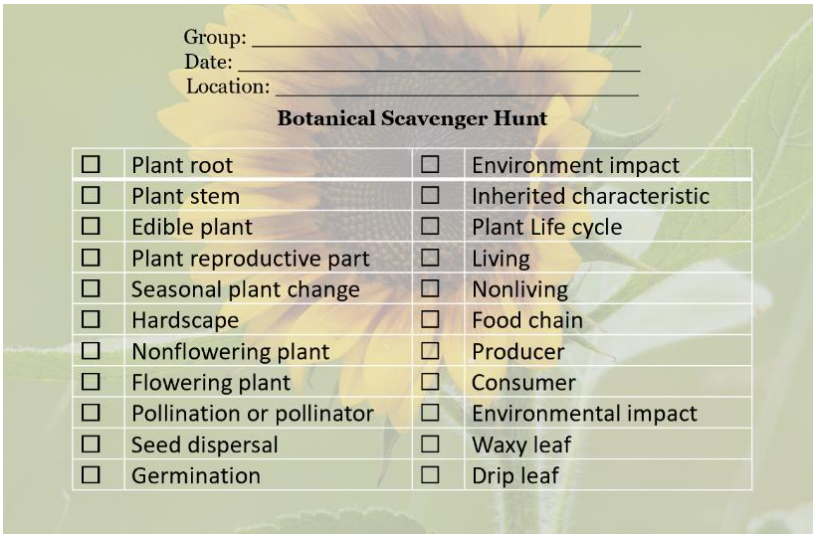
The best opportunity for learning about plants and animals is through an immersive, being there experience. Field trips to a local botanical garden, nature center, or a nearby environmental space provides opportunities for students to engage their senses as they learn, developing stronger content knowledge. Field trips should be planned, with specific goals that allow students to experience curriculum in a real-world setting.

Field trips can be used at the beginning of a unit to introduce and engage students, at the end to spark project ideas to demonstrate learning, or at a key place within the learning progression to help with student understanding of the content. However you choose to use a field trip, you should be aware of its place in a series of learning activities. Be purposeful.

Engaging activities in a natural environment

1. Forming groups: Work with the site to see if they provide docents, otherwise, plan to use parents and approved volunteers. An ideal group size is 5 students to 1 adult. Be sure the adults receive training in how to engage students during the field trip.
2. Supplies: Field bags contain a clipboard, paper, a camera or camera phone (don't allow students to carry their own phones), a hand lens, and any other supplies that might be used during the trip. Backpacks work well for this. You may also choose to include art supplies such as colored pencils. It is also a good idea to have a trash bag to pick up trash they come across and somewhere to put their own waste.
3. Schedule: Plan at least 2 activities, such as the scavenger hunt and an investigation (such as leaf studies where students measure leaves, take rubbings, discuss the various designs and formats of leaves). There should also be time for a break and breather. If you stay for lunch, that is a good time to rotate groups. A possible schedule could be groups A, B, and C start with the scavenger hunt and end at the bathrooms. Groups D, E, and F start with the investigation and visits the bathroom during their experience. Meet up for lunch and a breather, and then the groups switch for the next session. Having a plan in place maximizes opportunities for learning.
4. Before a field trip, provide an overview of the experience with students. Let them know what they will be doing and when. Talk through the expected behavior. The goal is to leave the natural environment more pristine than when they arrived.
5. After a field trip, provide a culminating activity where students express what they have learned. This can be through a presentation including the images they took or a class book that addresses the learning involved. Students should write personal reflections in their science notebook.

Example Activity: Scavenger Hunt



Group: _____
Date: _____
Location: _____

Botanical Scavenger Hunt

☐	Plant root	☐	Environment impact
☐	Plant stem	☐	Inherited characteristic
☐	Edible plant	☐	Plant Life cycle
☐	Plant reproductive part	☐	Living
☐	Seasonal plant change	☐	Nonliving
☐	Hardscape	☐	Food chain
☐	Nonflowering plant	☐	Producer
☐	Flowering plant	☐	Consumer
☐	Pollination or pollinator	☐	Environmental impact
☐	Seed dispersal	☐	Waxy leaf
☐	Germination	☐	Drip leaf

The Scavenger Hunt- Identifying characteristics and adaptations for plants and animals can be enhanced with a student scavenger hunt. By visiting the location prior to the field trip, the teacher plans the route that should be followed, identifying key elements that support the learning that should take place.

Resources

Some websites that can provide resources for building learning experiences in natural environments include the following (this list is not exhaustive):

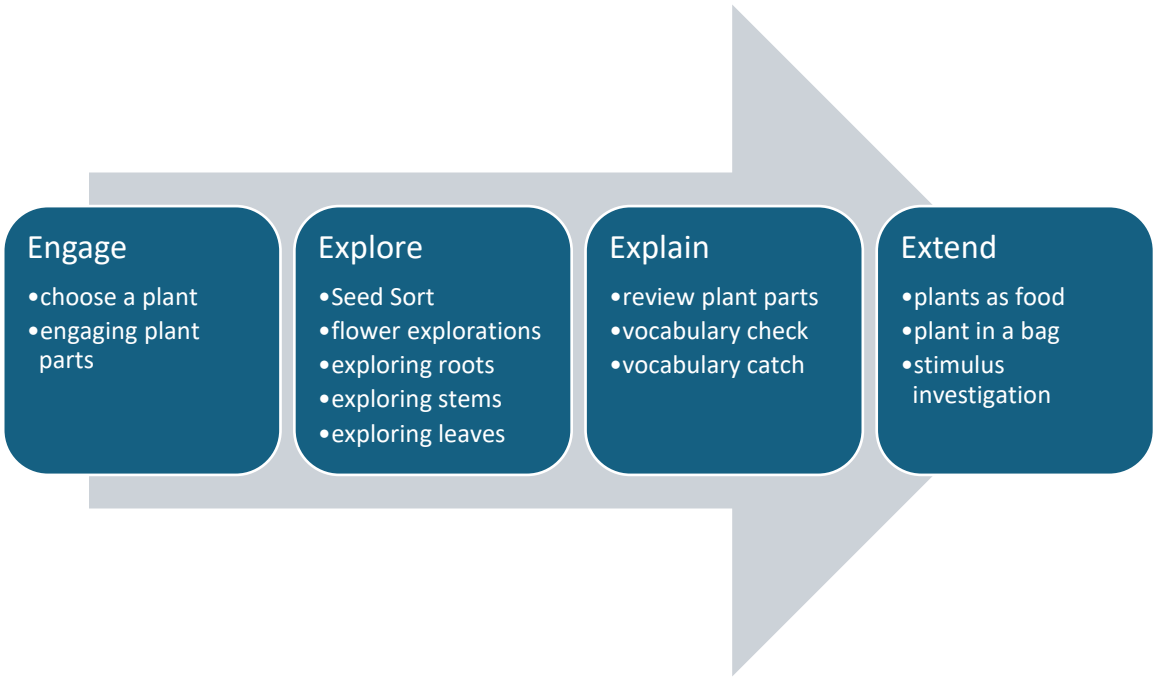
1. Bok Tower Gardens: https://boktowergardens.org/education/
2. Bronx Zoo: https://bronxzoo.com/learn/educators
3. Nature Lab with the Nature Conservancy: https://www.nature.org/en-us/about-us/who-we-are/how-we-work/youth-engagement/nature-lab/
4. The Environmental Learning Center: https://www.discoverelc.org/
5. Project WILD: https://www.fishwildlife.org/projectwild
6. Project Learning Tree: https://www.plt.org/

Exploring STEM Careers

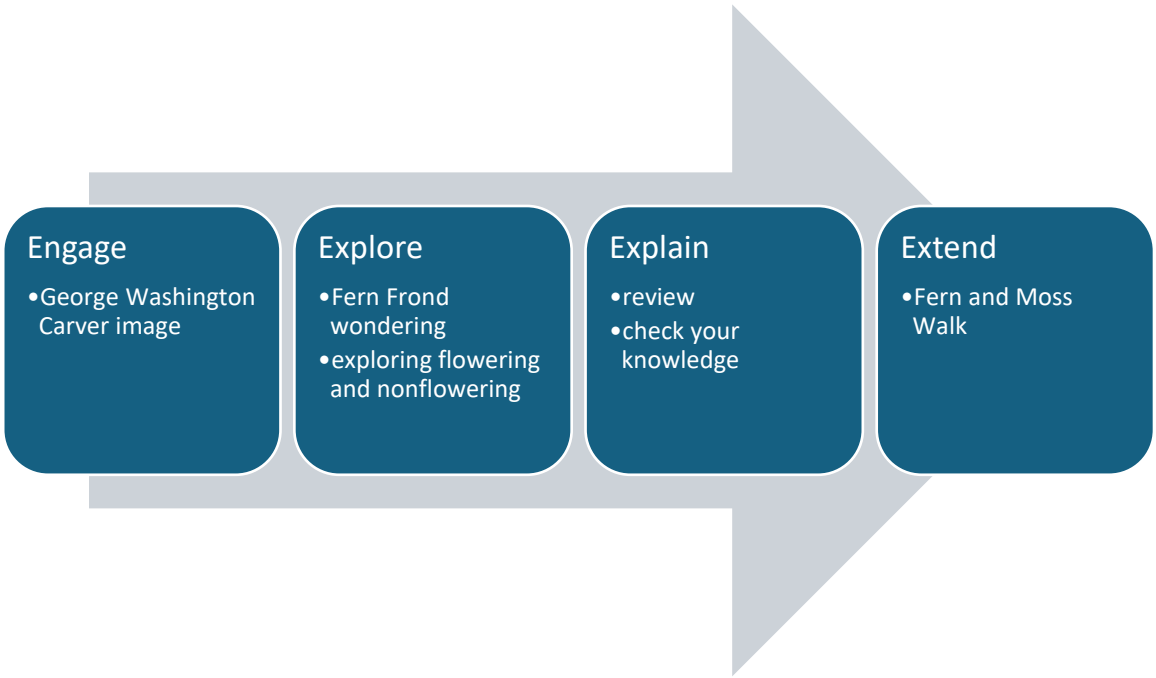
In this section, have students read and discuss the words in bold or highlighted. The drawing on page 7 is by Linnaeus. Encourage students to identify familiar plants. The book presents careers students probably never thought about, like being an architect for botanical gardens. Look in your community to see if there is anyone who could come into the classroom to talk more about STEM careers in plant science. The self-assessment is a valuable tool to help guide students toward STEM careers.

The Learning Cycle for Plant Studies

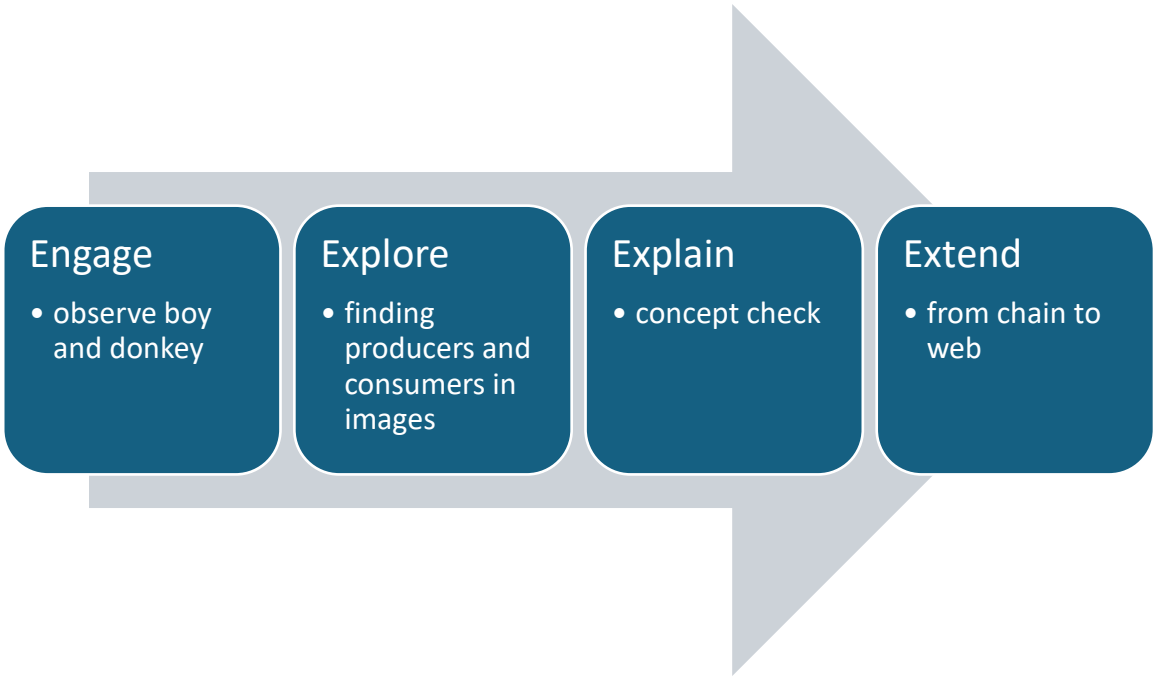
Learning Phase 1: Plant Parts and Experimenting with Plants



Learning Phase 2: Classifying Plants into Flowering and Nonflowering



Learning Phase 3: Food Chains



Learning Phase 1 Plant Parts Activities

Engage: Getting Started

The engagement activities are useful for identifying background knowledge of students and to get their attention focused for learning.

1. Let's engage with plants- Students can look at the images in their book or you can project them on the overhead. Have students express their thoughts in their science notebook. Encourage students to reflect on personal experiences with plants.



All of these are plants. Use what students say/write as a way to check their understanding of what plants are.

2. Exploring Plant Parts- The historic seed packet covers allows students to identify parts of plants they recognize. This is best viewed on personal devices. Students can use a hand lenses to look at the details. Use the observe and reflect organizer. Print a copy for students or have them draw it in their science notebook.

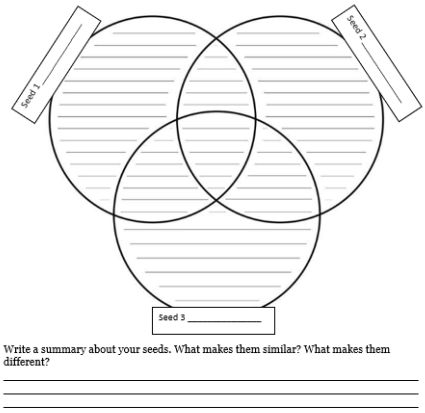


Observe	Reflect
Describe what you see. What people and objects are shown? How are they arranged? What words do you notice?	Why were these images made? What are they trying to do? What would be inside of the packets?

This activity is based on the Library of Congress teacher guide for analyzing primary sources. These are old seed packets. Students should be able to recognize different parts of plants in the images.

Explore: Constructing Knowledge about Plants

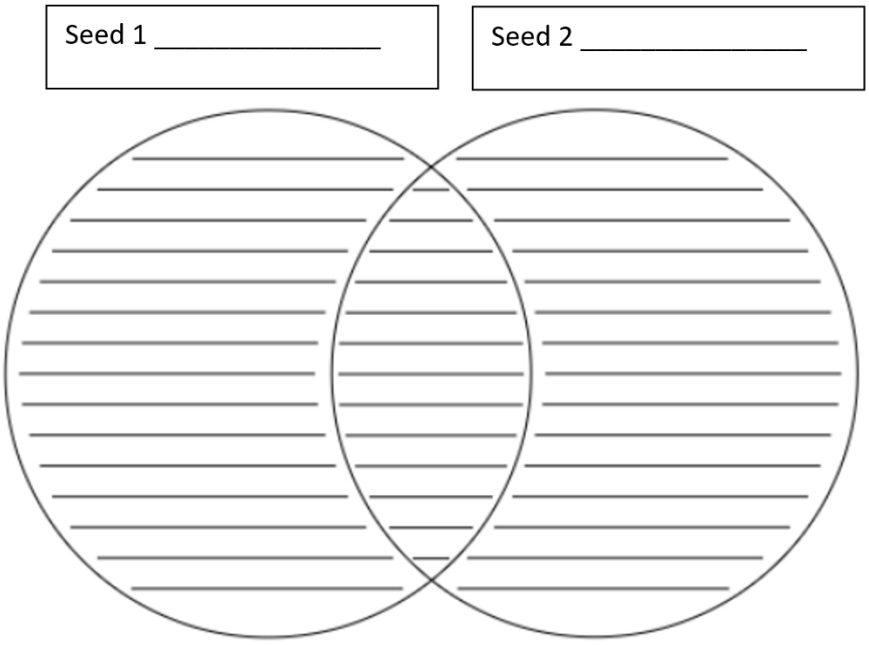
1. Seed Sort Activity



Prep for this activity: You will need 3 different kinds of seeds. Try to find tiny seeds like lavender, medium seeds like cucumber or pumpkin seeds, and big seeds like lima beans. Give each student or pair of students a paper towel, a hand lens, and one of each kind of seed. Students write the name of their seeds on the Venn Diagram. What similarities do they notice? What differences?

Students may struggle drawing the triple Venn Diagram themselves. It is helpful to print for the students and then have them tape it into their science notebook.

- For students with special needs, consider using only 2 seeds to compare and contrast.
- Follow safety procedures.
- This activity leads naturally into the Plant in a Bag activity, but seeds that have been handled are more likely to mold and spoil rather than grow. Use fresh seeds to make the plant bags.



2. Flower Explorations Activity





The first part of this activity has students exploring different kinds of flowers and then moves into plant sexual reproduction using images to identify stamen (male plant parts) and pistil (female plant parts) and the use of insects to pollinate. The standard for third to fifth grades includes pollination, fertilization, seed dispersal, and germination. All of these are introduced in this section.

Flower Dissection Lab (not included in the student book, but strongly recommend for hands-on exploring of plant sexual reproduction)

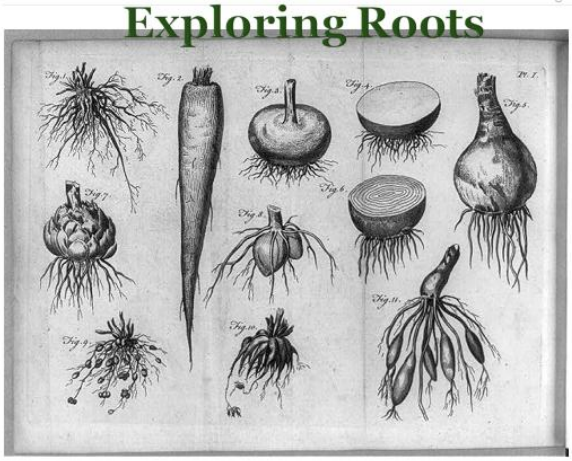
Materials needed:

- Flowers (some places will donate flowers for your classroom use) Select flowers that have clearly visible flower parts. Lilies, tulips, daffodils, hibiscus, and daisies are good examples.
- Scissors
- Tape
- Tweezers
- Science notebook
- Large Ziplock bag (especially for students who may have an allergy to pollen)
- Protective gear as needed- gloves, goggles

1. Observe the flower. Use your senses of sight and smell. Describe your flower in your science notebook. Remember, color and scent are used to attract pollinators.

2. Remove one petal at a time, working inward. How many petals does your flower have? (if using different flowers, compare—do all flowers have the same number of petals?) Label a box in your science notebook petals and tape the petals down.
3. Identify the stamen. Use the hand lens and you should be able to see pollen. Use scissors to cut the stamen from the flower. Tap the top part of the stamen with pollen onto a small box in your science notebook. This should put pollen on your paper. Label the box pollen and tape the pollen down so it doesn't blow away. Tape the stamen beside the pollen sample.
4. Next, find the pistils. Remove from the flower. Label a box in your science notebook and tape the pistils down. The ovary can be found at the base of the pistil. Explain to students that when pollen gets on the pistil, the pollen travels down the tube into the ovary and seeds form. The process of getting pollen from the stamen to the pistil is pollination. The process of pollen traveling into the ovary and forming seeds is fertilization. The seed waking up and growing into a seedling is germination.
5. If any student has allergies to pollen, you can have them cover their notebook page with a Ziplock bag.
6. Students can draw a flower diagram and label the parts in their science notebook also. While you can find lots of diagrams online, students will remember the learning better if they draw their own.

3. Exploring Roots Activity



Roots anchor (hold) plants in the earth.

What similarities do you notice in the drawings of vegetable roots?	What differences do you notice in the drawings of vegetable roots?



Roots also pull water and nutrients from the earth for the plants to use.



Just like we need to eat food and drink water to get nutrients for our bodies, plants need nutrients, too. Plants need nutrients like nitrogen, phosphorus, potassium, water, and minerals. Their roots help them absorb nutrients from their surroundings.

A GREAT EXAMPLE OF ABSORB IS TO PUT A PAPER TOWEL ON SPILLED WATER. THE TOWEL SOAKS UP THE WATER. IT ABSORBS THE WATER.

Roots can be surprising. This is a Banyon tree. It has roots that grow out from high branches and hang down. Those are called aerial and prop roots. These trees can be huge and need extra support to keep them anchored in the earth.





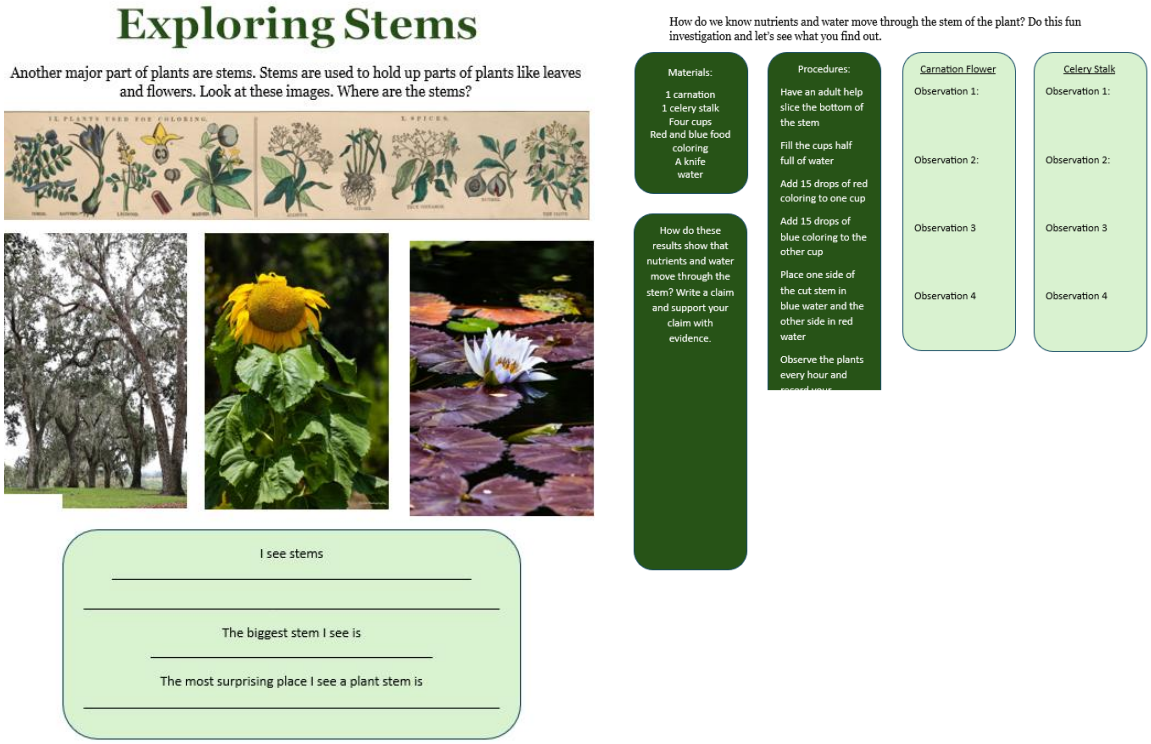




Can you find aerial roots on these plants? What nutrients do you think the roots are able to absorb from the air?

Observing roots- The images have different kinds of roots for students to compare and contrast. Aerial roots are also introduced. Students will get to learn more when they do the Plant in a Bag activity.

4. <u>Exploring stems</u>



Students observe different kinds of stems, from tree trunks to water lilies. They can make the graphic organizer in their science notebook.

Hands-on stems activity:

Materials

- White carnations work well with this
- Celery stalks that still have leaves on top
- 8 clear plastic cups (or more depending on how many colors you want to use)
- Red, yellow, blue, green food coloring (and more)
- A knife
- Water

1. Be sure to use appropriate safety precautions. Students should not handle the knife.
2. If you talk with local stores, you may be able to get carnations and celery donated.
3. By using the carnation and celery stalk, students can observe transpiration into leaves and flowers. The celery stalk also makes it easy to see the tubes called xylem that the water moves through.
4. Set up the cups. Pour water into each cup.
5. Add 15 drops of food coloring to the water in each cup. Have a set of 4 (or more if you want to use more colors) for the celery and 4 for the carnations.

6. Cut the bottom of each (to make sure the xylem are open to transpire the water) and place one in each cup.
7. This is something that will have to be observed for a couple of hours and into the next day for best results. Have students help with the setup of the experiment and then place it in a location where they can observe throughout the day.
8. In their science notebooks, students draw a picture of the setup and label the materials. Predict what they think will happen. They can also color where they think the colored water will show up in the plant. Allow students to observe and record at least 3 times and again the following morning.
9. Discuss how the color shows water moving through the stem into the leaves and flowers. Have them draw a picture and use arrows to show transpiration. Introduce transpiration and xylem. Cut the celery stalk so they can see the tiny tubes better.
10. How do these results show that nutrients and water move through the stem? Students write a claim and support it with evidence.

Having climbing plants for students to observe is another fun activity with stems. Pothos and ivy work well in the classroom.

5. Exploring Leaves

Exploring Leaves

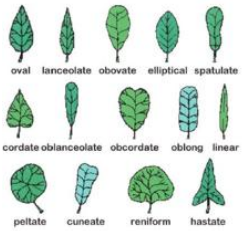
Leaves have a special plant job. They come in different shapes and sizes. Explore these leaves.



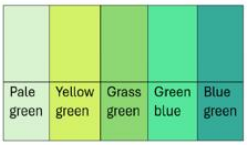
Compare and Contrast the leaves on the previous page.	
Similar shapes?	Different shapes?
Similar colors?	Different colors?
Similar features?	Different features?

Learn more about leaves using the following charts.





Trying to choose a shape? Use this graphic from Master Gardeners.



Trying to choose a color? Use this basic graphic.

Leaf Shape	Purpose of the Shape
Flat, thin leaf	good for photosynthesis
waxy surface	help reduce water loss
Large dark leaves	collect as much sunlight as possible in shady areas
hairy surface	holds moisture
small, narrow leaves	protect against water loss
thick leaves	store water

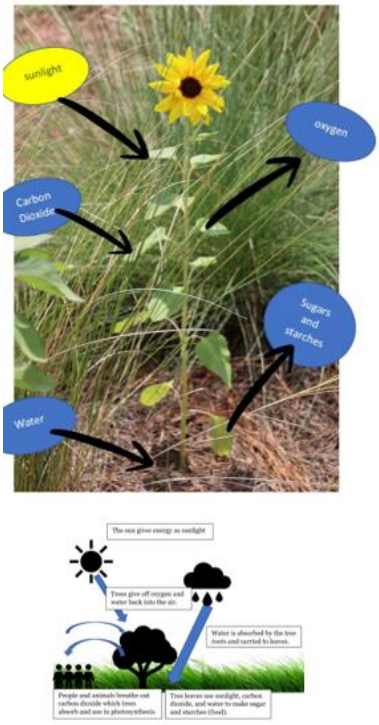
Choose a leaf from the school yard or your yard. Complete the Leaf Alert Activity Page using your leaf. You can refer to the charts for some responses.



Leaf Alert Activity Pages

Focus is on the function of shape

Exploring a Leaf	
Observe	What shapes do you notice?
	What colors do you notice?
	Draw a picture of your leaf on another piece of paper. Start with the shape. Then look for details such as veins to add. Does it have a stem? Is it one leaf or a bunch of little leaves clustered together?
Compare	What leaves are like my leaf?
	What leaves are different than my leaf?
Connect	What else has a shape like this?
	Look at what surrounds your leaf. How is your leaf part of the environment?
	Which leaf shape and purpose best fits my leaf?



The Power of Leaves

Leaves have an important job to do. Using energy from the sun, carbon dioxide, and water, leaves are able to make sugars and starches and oxygen. Sugars and starches get stored in the plant. Have you ever eaten an apple? That is sugar and starch formed in the leaves of an apple tree and stored in its fruit.

Oxygen is released into the air. This process is called photosynthesis.

Leaves also release water vapor into the air. This process is called transpiration (the same transpiration that moves water from roots, through the stem, to other parts of the plant). Try this:

1. On a plant outside, find a sturdy stem with leaves. It can even be a tree.
2. Tie a plastic bag over the leaves.
3. Wait 24 hours and check the Ziplock bag. What do you see?
4. Test out different kinds of plants. Are there plants that transpire more than others?
5. How and when could knowing this be helpful?

Leaves come in many shapes and sizes. For this activity, students use shape and color charts to compare and contrast leaves.

If used in a station, this activity would benefit by having the shape and color charts printed so students can observe the leaves while seeing the charts.

Students draw the compare and contrast chart in their science notebook and respond to each prompt.

When choosing a leaf from the school yard, be sure to follow science safety (be aware of the type of leaf selected and its condition).

For the leaf alert activity page, students draw the chart in their science notebook and use a real leaf for observation. They will also use the charts for color and leaf shapes.

Photosynthesis introduction: The Power of Leaves

The important role of leaves is to use energy from the sun, water, and carbon dioxide to produce food (usually starches and sugars). This page introduces the concept of photosynthesis. Leaves take in sunlight and carbon dioxide. Roots absorb water. Leaves make starches and sugars which can be stored in different ways in the plant, and leaves give off oxygen and water into the air. A fun investigation to do with this is to choose an easy to reach branch with leaves. Tie a plastic bag around the leaves. Let it alone overnight. The next day, there should be water in the bag.

This is a good time to explain how scientists do different types of investigations and experiments. They don't always use the scientific method. Tying the bags and observing what happens is a simple investigation. Ask students do they think all plants transpire the same amount? How could we find out? Have them come up with a procedure and a way to record results. They should write about it in their science notebook and then conduct the investigation. You will find that some plants transpire more than others.

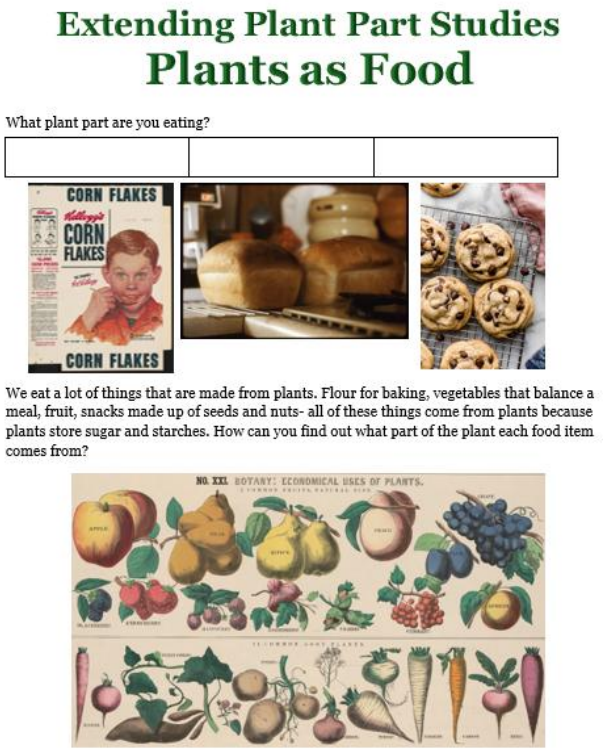
Explain: Plant Parts

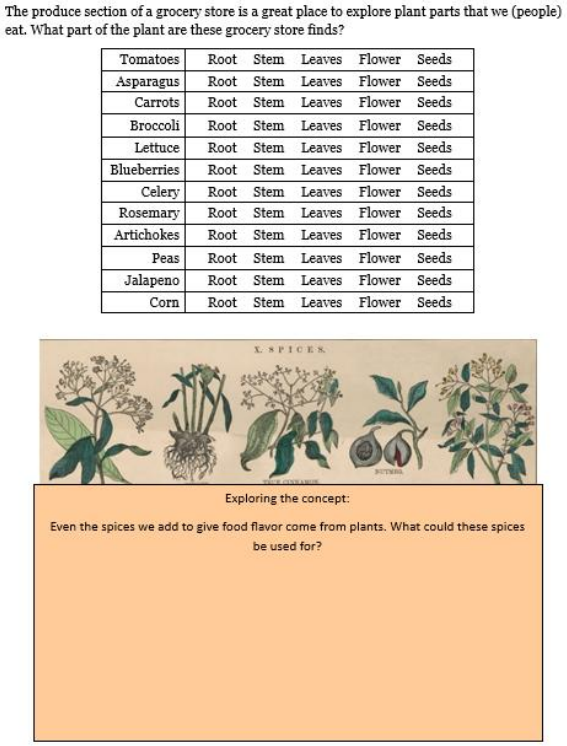
Throughout each activity, the student book provides details about what is happening and why. These work well as the foundation for explaining. You can also bring in videos, the textbook, and trade books as additional resources for explaining. Base your decisions on the needs of your students.

1. Vocabulary Check for flowers page 21
    a. Pollinators- c
    b. Pollination- j
    c. Pollen- g
    d. Stamen- i
    e. Pistil- f
    f. Ovary- a
    g. Fertilizing- e
    h. Reproduce (reproduction, reproductive)- h
    i. Produce- b
    j. Disperse (dispersal, dispersed)- d
2. Review Plant Parts page 32
    a. This is a great tool to review or assess what students have learned about plant parts. They should draw the graphic organizer in their science notebook and respond to each section.
    b. Food production can include roots (take in water needed for photosynthesis), stem (move water to the leaves), leaves (place where photosynthesis happens)
    c. Plant support- stems hold the plant up and move water throughout
    d. Transport of water and nutrients- roots (absorb water and nutrients from the soil), stem (moves water through the plant)
    e. Reproduction- flower (has pistil, stamen, and pollen needed for new seeds to form)
3. Vocabulary Catch page 35
    a. Absorb- e
    b. Germination- j
    c. Photosynthesis- d
    d. Pistil- h
    e. Pollination- c
    f. Pollinator- g
    g. Seedling- f
    h. Stamen- b
    i. Stimulus/stimuli- i
    j. Transpiration- a

Extend: Plant Part Studies

Activity 1: Plants as Food





The produce section of a grocery store can introduce students to a variety of edible plant parts. This can be a fun family science engagement activity or even a field trip if there is a grocery store that will allow you to bring a group of students. The observations on these pages should get students thinking about the plants we eat. Projects can include having students identify spices their families use when cooking. They can bring samples and make a poster that shows where the spices come from, how they are harvested, and the variety of ways they are used in cooking.

Activity 2: Plant in a Bag experiment

This investigation helps students see the growth of roots, stems, and leaves.

Materials:

- Ziplock bags
- Seeds to grow (see list of plants that grow quickly)
- Paper towels (Viva works really well)
- Hydrogen peroxide 3% to disinfect
- Water

1. Be sure to follow appropriate safety precautions during this activity. Students should wash their hands before to prevent germs and bacteria getting on the seeds.
2. The seeds need sunlight to grow. You can tape them up in a sunny window or lay them on a table in front of a window that gets plenty of light. Remember, this works best August/September and April/May. If you want to do this outside of those months or you don't have easy access to a sunny location where students can observe their seeds, use indoor plant lights.
3. Soak the seeds overnight so they should germinate more quickly.
4. Label the Ziplock bag with the date, student name, and type of seed. You can choose to have students work individually or with a partner. Each student can have two different types of seeds or you can set up groups with different seeds. This gives students the ability to see that different plants grow at different rates.
5. Soak the paper towels in water and squeeze. The towels should be damp enough to provide water for the seed but not so wet that the seed rots in the bag.
6. Lightly spray with 3% hydrogen peroxide before placing the towel neatly in the bag.
7. Place 2 seeds per bag (just in case something doesn't grow). If students are testing two different seeds, each seed needs its own bag.









8. Growth can happen as soon as one day. Keep an eye on the bags. You can make extra in case someone's seeds get moldy and don't grow.
9. As seeds begin to grow, students should carefully use a ruler to measure the root and stem growth. They should measure in cm. When leaves start opening, they can add that count to their data as well. Student books give a chart that students can use to record. They should draw the chart in their science notebooks.
10. You will need at least 2 weeks for plants to grow. Be sure to have students leave at least 5 pages for plant observations. If plants start pushing through the top of the Ziplock bag, students can repot them into cups with soil and see if they will continue to grow.
11. If the plants stay healthy, students can report and use them for the stimulus response experiments. Or you can have them grow plants in cups from seed.

Activity 3: Stimulus Response Investigation

1. This is intended to be a guided inquiry for students. As they watch their seeds grow, try to collect questions about what would happen if. For example, students might ask what happens if the seed/plant doesn't get enough light, or what if we turn the plant upside down. Use a poster to collect student questions as they are observing their seeds grow. You can also add questions if they don't think about them. What kind of soil will help plants germinate fastest? What if we water with something other than water?
2. Monitor safety throughout this investigation. Students should not use material that is harmful to them. (For example, if a team wants to investigate what happens if we water plants with something other than water, they can use common liquids they would drink instead of water. Don't use something like bleach, laundry detergent, or alcohol.
3. Students can work with partners or in groups of three. They determine the question they want to focus on. Identify the stimulus that is part of their question (sunlight, water, gravity). Having them complete a scientific method chart would be a good idea for this. They should identify their question, explain what they know so far (research), make a hypothesis based on what they know so far, list the materials and procedures, and identify variables. They should have the teacher check their work before getting started with the actual experiment.
4. Students prepare their experiment, conduct it, collect data and results, and then draw conclusions once they are finished. The conclusion should make a claim based on the initial question of the experiment. They use data to support their claim.
5. Each group should prepare a presentation to share results with the class. Taking pictures throughout would be a good idea. During presentations, students should write in their science notebooks—stimulus, description of how the stimulus was tested, and result.

Learning Phase 2: Classifying Plants as Flowering and Nonflowering

Background:

Flowering plants are characterized by flowers and seeded fruits. They produce flowers which leads to fertilization through pollination. This is a sexual reproduction process. Plants have male and female sex cells. Seeds contain genetic material from both parents, which means the offspring are not genetically identical to either parent plant.

The male sex organs are called stamen and the female organs are called pistils. The anther is the part of the stamen that contains pollen. Pollen contains the male cells. Pollen must be moved from the stamen to the stigma which is part of the pistil.

The innermost part of the flower contains the ovary. This is where eggs are located. The pollen from another flower must enter the ovary to fertilize the eggs in order for seeds to develop. Pollen travels from the stamen, to the stigma, down the pistil tube, and into the ovary.

Pollination is helped by wind or animals that move pollen from one plant to another. Many pollinators are insects like bees, butterflies, moths, and beetles. Birds, bats, and rodents can also help pollinate plants. The colors and smells of flowers often attract the specific pollinator needed.

One type of nonflowering plants includes mosses, liverworts, hornworts, lycophytes, and ferns and reproduce by spores. These plants reproduce asexually. They do not require male and female cells. Spores are microscopic specks of living material, often single-celled. Ferns produce spores on the underside of fronds. Spores are genetically identical to the parent plant. Spores get released and are carried away by wind, water, or animals. When a spore lands in a warm, moist, nutrient-rich environment, it absorbs water, breaks out of its protective outer wall, and grows into a new adult organism.

Engage: Image Analysis

Primary source analysis encourages students to use critical thinking routines. There is a lot of good research regarding the use of primary source analysis as a learning tool. For this engage activity, students study an image of George Washington Carver. The image is a woodcut print showing Carver among plants with tools he used to study and investigate them. They also observe an image of fern spores and consider what they could be. It would be best to do this observation before turning to the next page.

Explore and Explain: Nonflowering Plants

During the first learning phase, students learned about flowers and how they reproduce. Now students are introduced to nonflowering plants. This first section has images of a variety of ferns. Students observe five different ferns and look for commonalities (similar colors, leaves (fern fronds) have lots of leaflets that branch off the main stem). With the hand lens, students

should be able to see the tiny dots on the back of a frond. There is also an up-close image of spores. This part of the lesson teaches students that spores are like seeds and produce new plants.

Students observe a resurrection fern that is dormant (looks dead) and one that is vibrant green (revives after a rain).

Concept check: Ferns are nonflowering plants so they will never have flowers.

Students also observe mosses and learn that Spanish moss is not a moss at all. It is a flowering plant. Students review characteristics of flowering and nonflowering plants and then select and explain which images in a set of pictures show nonflowering plants.

In the Check your Knowledge on page 42, A, C, and F are nonflowering plants.

Extend: Fern and Moss Walk

Find a location near the school where students can look for moss and ferns in the natural environment. Moss is easily found on trees and ferns are usually part of the understory of a wooded area.

1. Provide students with a map of the area.
2. They should mark locations where moss and ferns are found on their map.
3. Use senses of sight, smell, and touch to observe the plants in the natural environment. Record in their science notebook.
4. Make a presentation that combines the map, images, and sensory data. For STEM, using a Google Maps presentation would be a good application.

Check for safety concerns, including poisonous plants growing in the area you want to explore with students, and potential allergies students may have.

If you are unable to visit a nearby nature environment, talk with a local garden center or plant nursery about bringing examples of living moss and ferns into the classroom for students to observe and investigate.

Learning Phase 3: Food Chains

Engage: Image Analysis

Observe the image of a boy and his donkey. Students can draw the graphic organizer in their science notebook. Pay attention to what is happening in the image (the boy is feeding the donkey) as this relates to the topic of this section.

Explore and Explain: Food Chains

Using images and text, students learn about producers and consumers. They observe an image of the sun that exemplifies the energy of the sun. You can also have students stand

outside on a sunny day to feel the heat from the sun. If you have any solar powered devices, students can explore that aspect of energy from the sun as well.

Activity: Botanical Artist Images- Students observe the images that show plants and animals and identify the producers and consumers in the images. You can have students draw a food chain based on each image once they complete this section of the book.

Flowers and Fruit of Mangosteen and Singapore Monkey: producers include the fruits. The monkey is a consumer.

Trumpet Flower: The producer is the flower, and the consumer is the hummingbird.

Activity: Making Food Chains- Students draw food chains.

Corn Flakes- Sun to corn to child

Boy and his donkey- sun to hay to the donkey

Cattle- sun to grass to the cattle and elephant

Fall leaves- sun to berries to the bird

Extend the Learning:

There are some great extensions for this activity, getting students to think about more complicated food chains.

Extension 1: Habitat Food Chains- With students in groups of three to four, each group chooses a habitat. They research the plants and animals in that habitat and see which group can make the longest food chain. Have groups make a poster with pictures and arrows to show the flow of energy. They present the posters to the class.

Arctic: sun gives energy to phytoplankton to zooplankton to fish to seal to orca whale

Extension 2: From Food Chains to Food Webs- With students in groups of three to four, each group makes a paper chain food chain.



Challenge them to connect another chain to their producer. For example, they could start with the sun gives its energy to the grass to mice to a snake to a hawk. Then they can connect to the grass and add to a cow to people.

STEM extension: Use the SciDraw AI app (https://sci-draw.com/food-web-maker). Describe your ecosystem with organisms and feeding relationships. The program will draw a labeled food web showing the flow of energy. Groups will present their webs to the class and describe the flow of energy.

STEM Maker Activity: Pollination Station

The goal of this activity is to design, create, and test a hand pollinator to transfer pollen from one flower to another.

Materials:

- Each group will have 2 paper plates with a picture of a flower drawn or glued to it
- Have a collection of materials available that students can choose to make their pollinators with. This can include cotton balls, balloons, foam stickers, erasers, paper towels, coffee filters, pipe cleaners, straws, craft sticks, string, aluminum foil, wire, and Q-Tip's. Students can observe the materials first to get ideas for their designs and then select the materials to make their designs.
- Tape and glue for putting their designs together. You can also use hot glue guns with close supervision.
- Make a powdery substance for pollen. Mac and Cheese dry cheese is a good option. You could also try coloring powdered milk or coffee creamer. You want something that is light so it can easily be picked up by the students' designs.

1. Consider safety, especially if you use the glue gun. Consider students' allergies as you make selections for materials students will use to make their designs.
2. Read the setup with students and discuss the problem. Have students brainstorm aloud what they know about pollinators and how they could make a hand pollinator. They can do research and collect images they want to use for inspiration.
3. Students will draw their hand pollinator first, labeling the parts based on the supplies that are available to build with. They could choose to work with partners or independently. I would not recommend groups.
4. Once they explain their design and have a blueprint to work from, give permission to proceed with building their design.
5. Once they are ready, they can test their design by putting their design. They set two plates with flower pictures beside each other and put some of the pollen powder on the first flower. They then put their design in the pollen powder and move it to the second flower and attempt to drop some of the pollen. They should take a picture of how much pollen they were able to transfer.
6. Once they see their results, they can go back to their design and decide how they can redesign for better results. They will need to draw their new design, labeling the parts and describing changes they are making. They then build the new design and retest it, taking pictures for the results.
7. Once they are satisfied with their hand pollinator, they can challenge another design and see which one is better.
8. In the student book, they learn about gardeners who use hand pollinators and why. This is a great subject to explore with research.

STEM Maker Activity 2: Nature Walk Design

The goal of this activity is for student groups to design a nature walk for someone with sensory impairment.

As more and more focus is put on the value of natural spaces for mental health and physical healing, knowledge of the restorative properties of botanical gardens is growing. Sensory gardens cam be places to relieve tension, reconnect with nature and create a sense of community while improving mental and physical health. Places like aged care facilities, hospitals, and rehab centers are tapping into nature. Continued growth in this area, including careers in research and development, means this activity is on target and relevant today and for the future.

Part of the process of this activity is to get students thinking about showing compassion and sympathy for others. They may need to research the challenges an impairment, such as blindness, could have on a person's ability to engage in a natural space.

Committees can use technology, such as Google Earth or Google Maps, to help with creating their collaborative design. The final project should be colorful and really address the supports used to counter impairment. Have them present their designs to someone.

Conclusion:

The activities in this book are intended to engage third through fifth grade students with STEM integrated with social studies through the use of primary sources and ELA with support for vocabulary and comprehension skills.

Special thanks are noted for Bok Tower Gardens. Mrs. Welsh spent time exploring the garden archives to find images and other resources useful to this project. Mr. Huggins, Mr. Lynch, and Ms. Peterson sat with us to discuss how their careers connect with STEM and what the future may look like for botanical spaces. Ms. Smith and Ms. Tyrone have assisted with making connects for this project. Their time, effort, and attention are greatly appreciated.

Special thanks are noted for Mrs. Fetterman with All Hallows Guild Archives. She provided access to archives for Olmsted and the work he did around the National Cathedral. She also took us for a walk around the grounds with more explanations.

Be sure to check out other resources available at www.Warner.edu/TPS:

- Dade Battlefield- grades 4 and 5, personal narrative about the start of the second Seminole Wars
- Explorations into the US Space program- grades 3 through 6, insight into the US Space program and its impact in Florida
- The Yamato Colony of South Florida- grades 3 through 5, shares the story of a Japanese immigrant group in south Florida in the early 1900s up to World War II
- Hope in the Face of hate- grades 5 through 8, shares survivor stories from the Holocaust with special focus on resiliency along with a brief history of the Jews and antisemitism
- Then and Now- grades K-2, presents a comparison between life in the past and the present
- European Immigration in the United States- grades through 6, presents narratives along with primary sources about immigrant groups from the Netherlands, Italy, and Germany including reasons why they immigrated and contributions they have made in the United States