Botanical Explorations Student Booklet

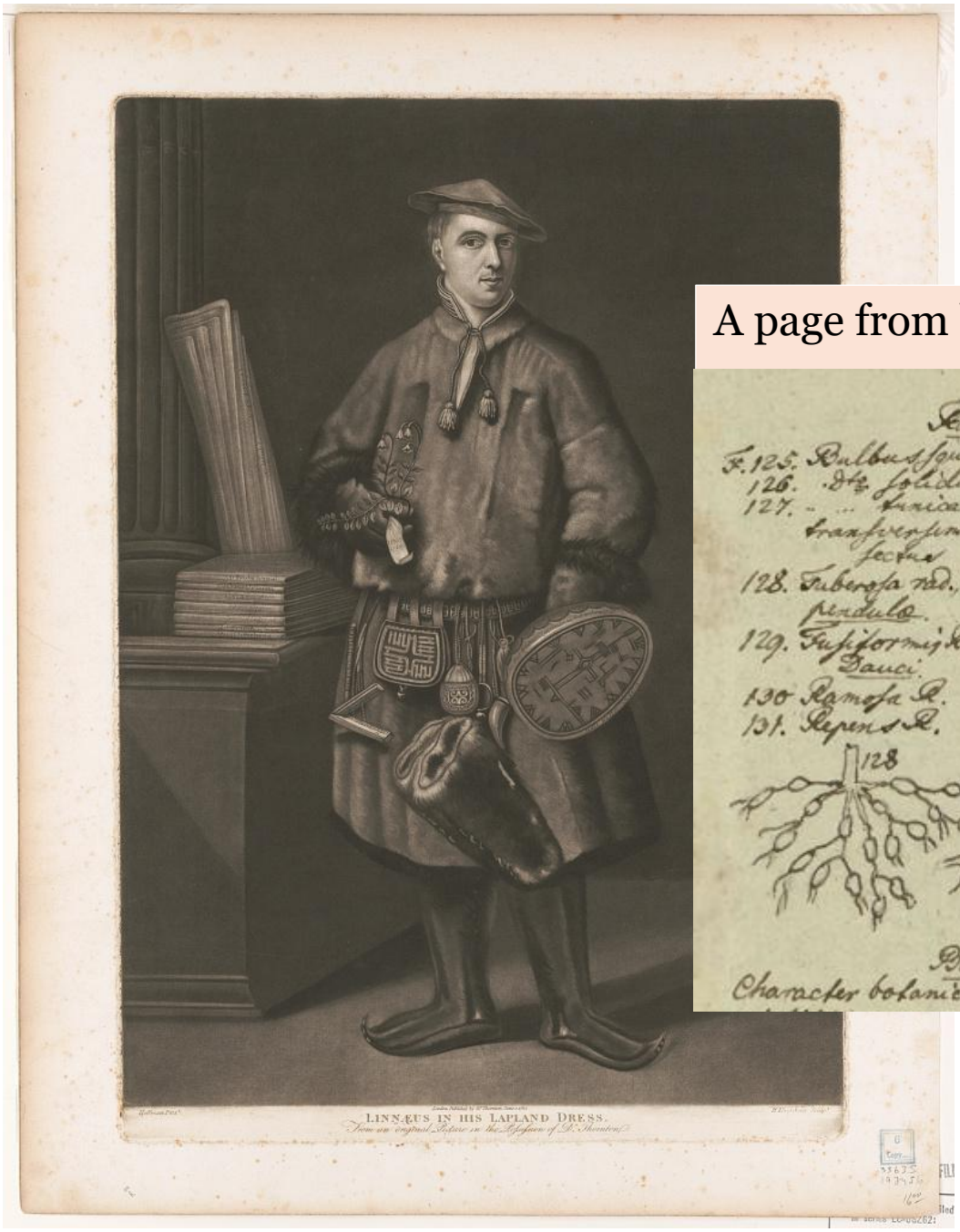


Developed by Dr. Laurie Boulden and Mrs. Katherine Lamar

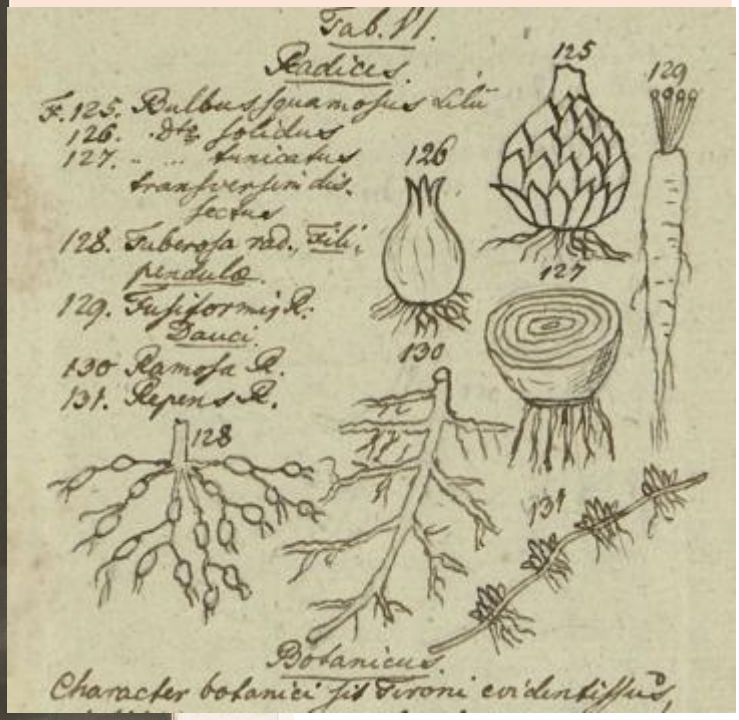
Warner University

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Historic Figures in STEM



A page from his journal...



OBSERVE	REFLECT	WONDER
Circle items on the images on page 2 that answer these questions: 1. What do you notice first? 2. What words do you see? 3. How much of the text can you read? 4. What does it say? 5. What looks strange or unfamiliar? 6. What do you see on the page besides writing? 7. What details do you see that maybe someone else would miss?	Draw 3 lines from 3 interesting details to the margin of the page. Write your thoughts. Answer the following questions: 1. What is this person's name? 2. What type of person is in the image? 3. Is this person a botanist or an architect? 4. What can you learn from examining this image?	What would you ask the person in the image? Listen to the teacher read the CONTEXT. What else do you wonder now?

Botanist –

a person who studies plants.

Architect –

a person who designs spaces

Historic Botanists

Botanical Artist



Marianne North

(1830 - 1890)

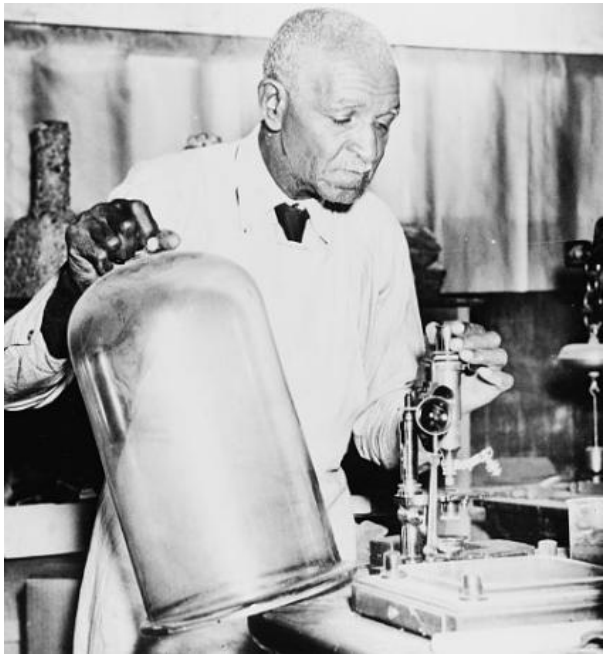
Focus: Wild Plants

Job: Painter of Flowers, Explorer

Bio: She traveled all over the world painting beautiful scientifically accurate images of plants. She was **independent**, doing things for herself. She often traveled alone. 800 of her oil-on-cardboard paintings are displayed at Kew Gardens, United Kingdom. Below is her "Night Flowering Lilly and Ferns, Jamaica".



Botanical Scientist



George Washington Carver

(1864-1943)

Focus: Crops

Job: Professor of Agricultural Science, Inventor

Bio: He experimented with peanuts, sweet potatoes, soybeans, pecans, and crop rotation. He helped improve farming. Under his gifted **leadership**, his students and he created hundreds of ways to make the crops more useful. He helped the peanut become a fashionable American food.



Historic Architects

Architect of Nature & Landscapes

Architect of Interior Design & Culture

Frederick Law Olmsted, Jr.
(1870-1957)

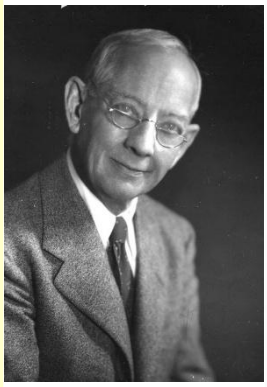
Focus: Outside

Job: Landscape architect, National Park **Conservationist**

Bio:

He designed **public spaces**, educating young architects, and promoting national parks like Yosemite. He helped protect the Everglades, creating a national park. He designed the White House grounds and Jefferson Memorial.

Quote: "Protect and perpetuate whatever of beauty and inspirational value [is] inherent in that landscape."





Collaboration:

Bok Tower Gardens

(1927-1929)

Both architects worked together to create the Gardens with its singing tower – a **carillon** with **humungous** bells whose beautiful melodies can be heard up to a mile away.

Edward W. Bok
(1863-1930)

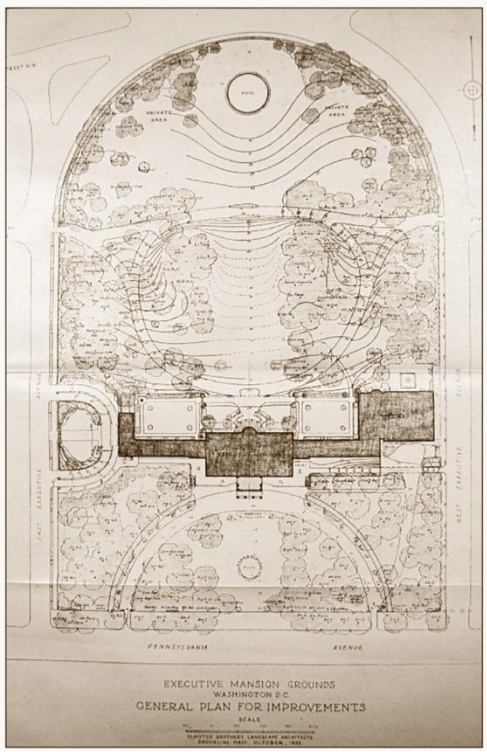
Focus: Inside

Job: Cultural architect, Editor of "*Ladies Home Journal*" magazine, author who won the Pulitzer Prize

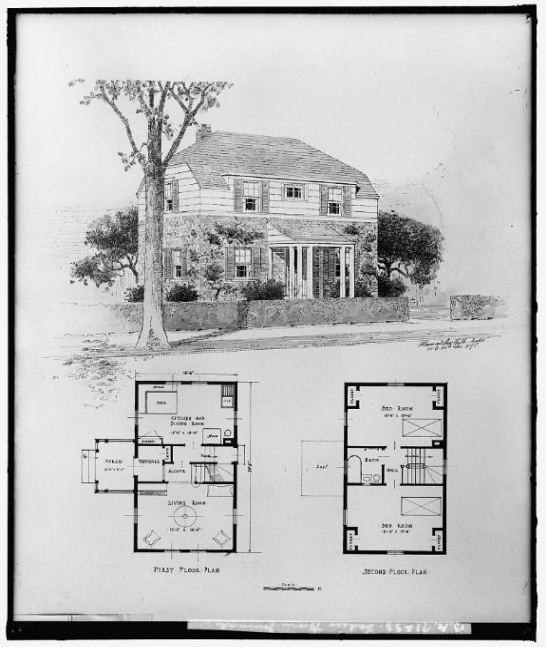
Bio:

He **emigrated** from Holland. Under his gifted **leadership**, his magazine reached over 1 million subscribers. His choices affected home fashions and introduced the term "living room." He published affordable blueprints for homes that shaped the design of modern **suburbs**. He promoted women's **suffrage** – a woman's right to vote for herself.

Quote: "Make the world better and a bit more beautiful because you have lived in it"







Analyzing Historic People

1. Florida, Georgia, and Texas lead in peanut production. Whose **contributions** are responsible for these crops?

2. What is a difference between a **Botanical Artist** and a **Botanical Scientist**?

3. What is a difference between **a Landscape Architect** and **a Cultural Architect**?

INSTRUCTIONS:

Use the VENN DIAGRAM below.
Choose one Botanist and one Architect.
Record at least 2 similarities (center) and 3 differences.

Accurate – true

Carillon – a musical instrument with at least 23 tuned bells arranged in a series, the bells are cast from bronze

Conservationist – person who protects nature

Contributions – gifts, what a person gives

Crop – plant grown by people in big amounts

Culture – the common language, art, and way of life a group of people has

Emigrate – move to and settle in a new place

Humungous – the largest carillon bell weighs over 22,000 pounds

Leadership – the skills and personality required to lead and guide an organization

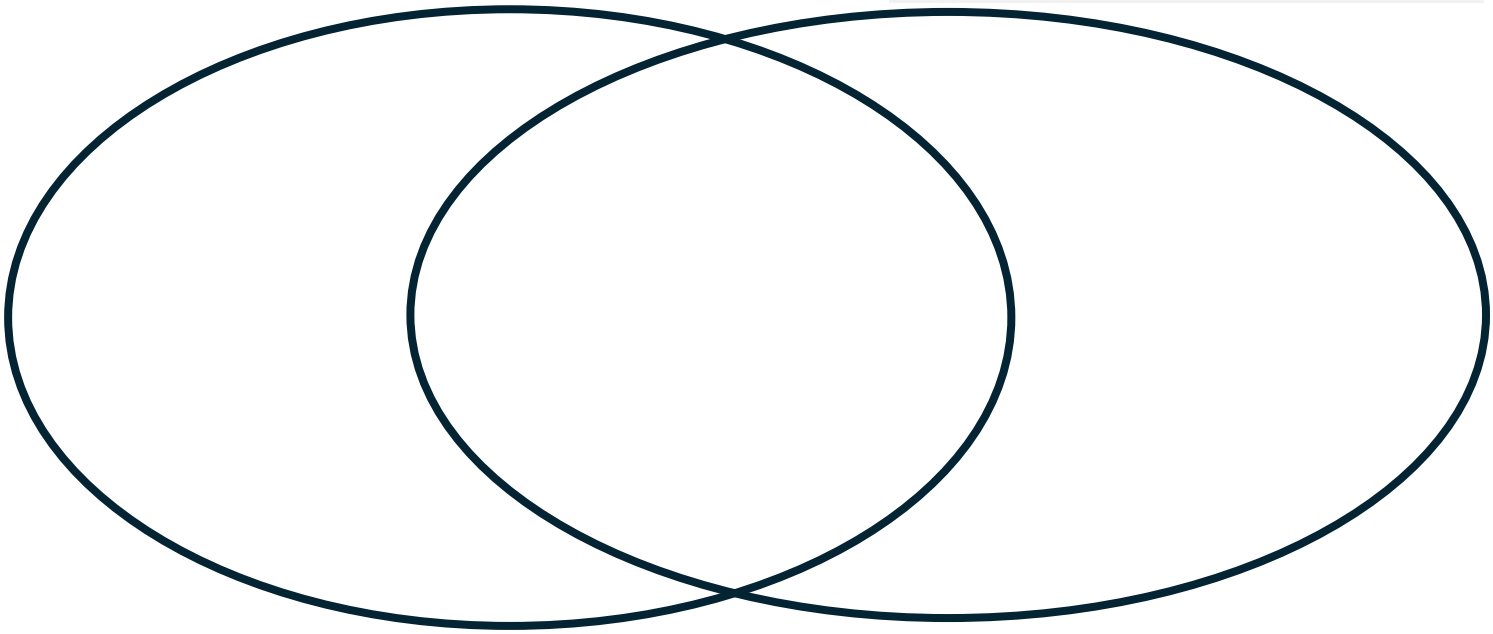
Public Space – somewhere everyone can go

Suburbs – the edge of a town where people live

Women's Suffrage – the fight for women to have the right to vote took place between 1848 and 1920, leading to changes to the 19th Amendment of the United States

Botanist

Architect



Exploring STEM Careers

What is STEM?

STEM is an **acronym**- each letter stands for a specific word.

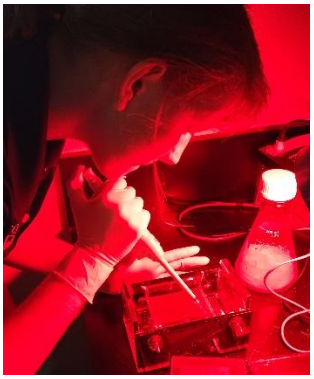


S- science

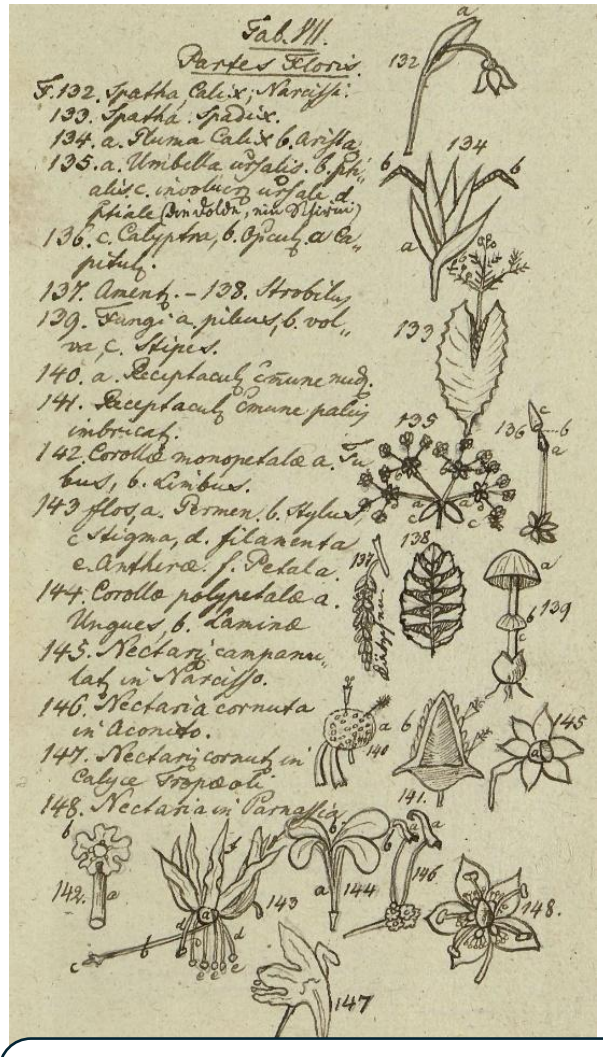
T- technology

E- engineering

M- mathematics



Many jobs involve **two or more** of these parts of STEM.



Why focus on STEM activities?

STEM activities help you learn problem solving and research skills. You can be curious and explore. You can ask questions and seek answers. STEM learning sparks your imagination as you make new discoveries and come up with more questions. Most importantly, STEM helps your brain get smarter as you work with partners to solve problems and challenges. These activities can prepare you for a career later.

How can plants be a part of STEM?

This book is called *Botanical Explorations*. **BOTANY** is root word of **Botanical.** It means "having to do with plant science". Plants are important for life. People have wanted to find out which plants were good for food and how plants could be used in the home since ancient times. The scientist, Carl Linnaeus, explored the world, collecting plants and coming up with ways to organize them by similar traits. Here's an example of Linnaeus' work.

Use a hand lens to explore this page of drawings and names. Describe 4 details that capture your attention.

1. 3.

2. 4.

What are some plant-focused STEM careers?

BOTANIST

A botanist *(-ist* is a suffix that means *person*) studies botany.

Botanists work with plants: studying plants, conducting experiments on plants, or even comparing plants in different parts of the world.

HORTICULTURIST:

A person who is involved with growing fruits, vegetables, flowers, or ornamental plants.

PLANT BIOPHYSICIST:

A person who studies the structures and functions of plants

using computers and technology.

ECOLOGIST:

A person who studies the environment and the living things that are part of it.

ARBORIST:

A person who studies and cares for trees. They can prune and remove trees safely.

To **prune** is to cut off branches so that the tree will grow better in the future.

Which career MOST interests you?

Where do people in plant-focused STEM careers work?

Botanical gardens are one place where careers relating to plants are needed. A botanical garden uses horticulturists, botanists, arborists, landscape architects and designers, groundskeepers, and nursery specialists. Botanical gardens require people with STEM jobs to accomplish their mission. A well-known botanical garden in Lake Wales, Florida is Bok Tower Gardens.



This building is a nursery.

I think the purpose of a **nursery like this is** to…

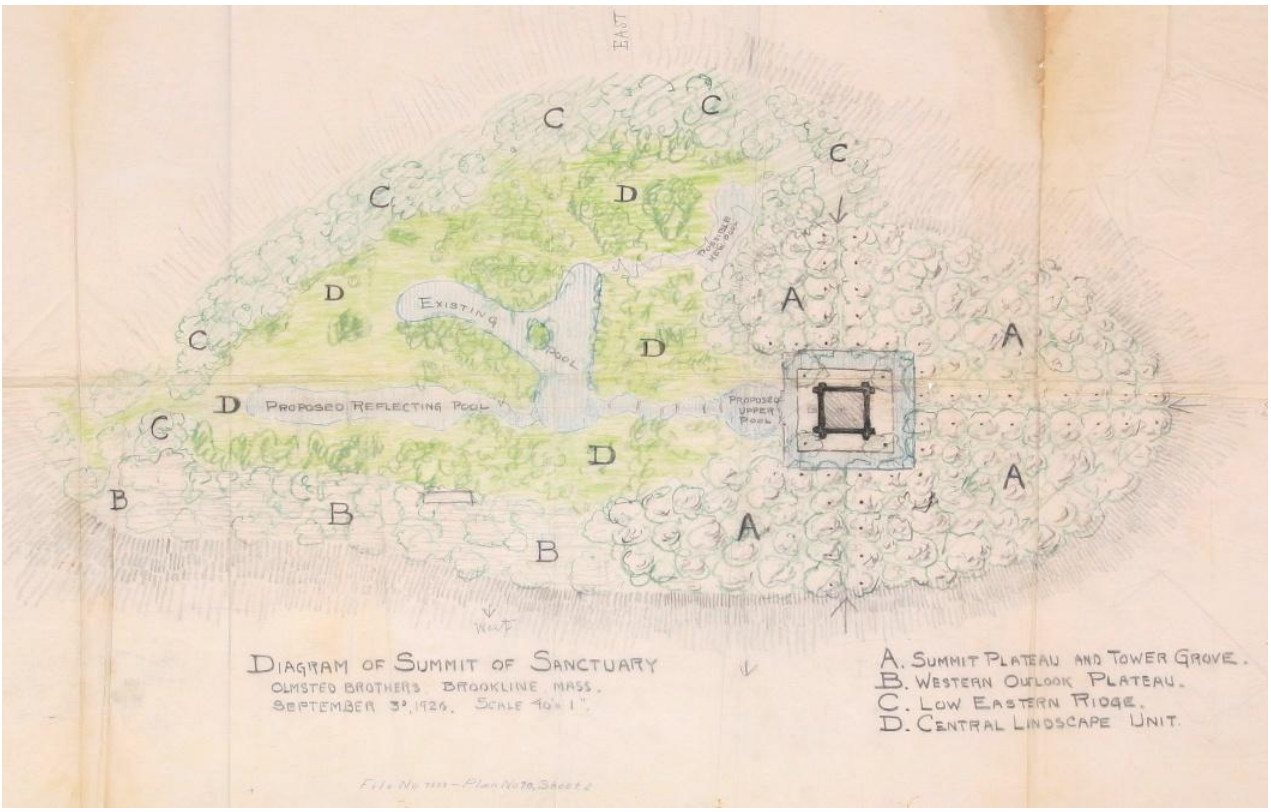
What do people in these careers do BESIDES care for plants?

Frederick Olmsted, Jr. was a landscape architect that worked with Edward Bok to build Bok Tower Gardens.

Olmstead designed and built **softscapes.** Softscapes are the plans for where plants and trees should be placed in an area.

Olmsted also designed and built **hardscapes**. Hardscapes are walls, buildings, paths and **terraces** (flat raised areas, like big steps).

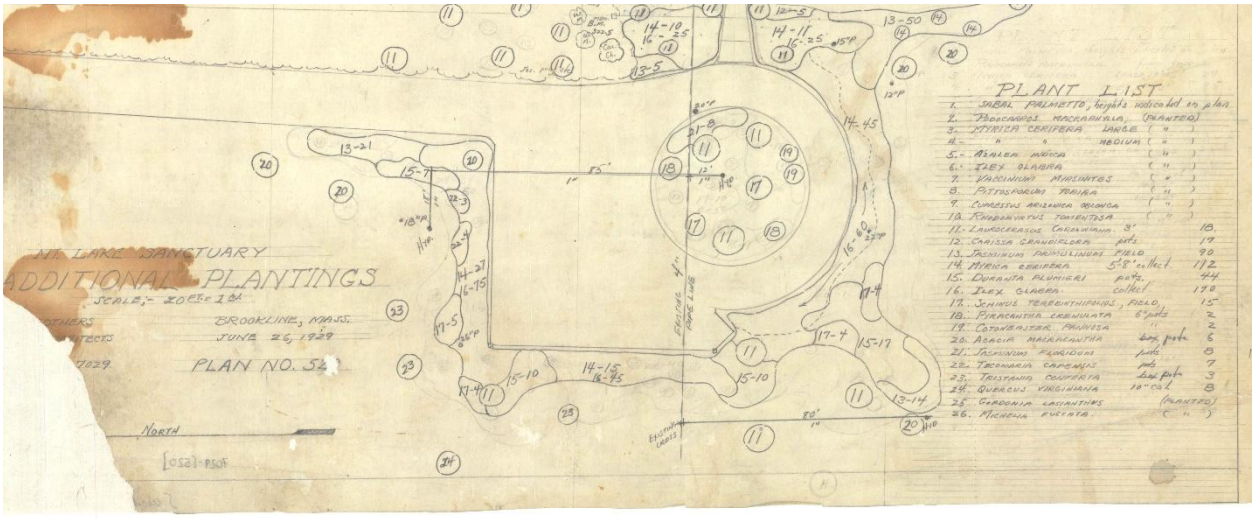




This is a map made by Olmsted. Which of the following would be involved in designing the map?

A. **SCIENCE**: observing, experimenting, researching, knowing how things work in nature
B. **TECHNOLOGY**: inventing, using tools (like computers) to solve problems
C. **ENGINEERING**: designing, building, and improving systems
D. **MATH**: using numbers, equations, measurements, and graphs to solve problems

Which part of STEM do you think would be the MOST important in designing the map? Explain.



This is another map of Bok Tower Gardens by Olmsted.
What additional information does this map provide?

Olmsted was famous. He helped design and build botanical spaces in Washington, DC, the capital city of the United States. The grounds around the **Capitol Building** (where lawmakers meet), The National Cathedral (a large church), and the National Botanical Gardens were all designed by Olmsted. Below is the domed Capitol Building framed by plants. Olmstead designed a place where guests to the Capitol could rest.

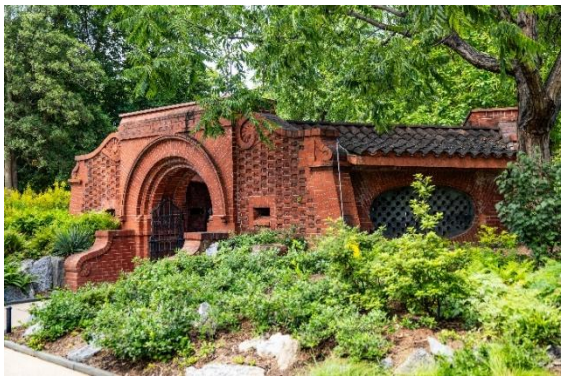
Circle the **softscape** of lawn, trees, bushes and flowers that you see.





Is this building on the right an example of **hardscape** or **softscape**?

Would you rather design **hardscapes** or **softscapes?**



The top is an **historical image** of the National Cathedral and grounds.

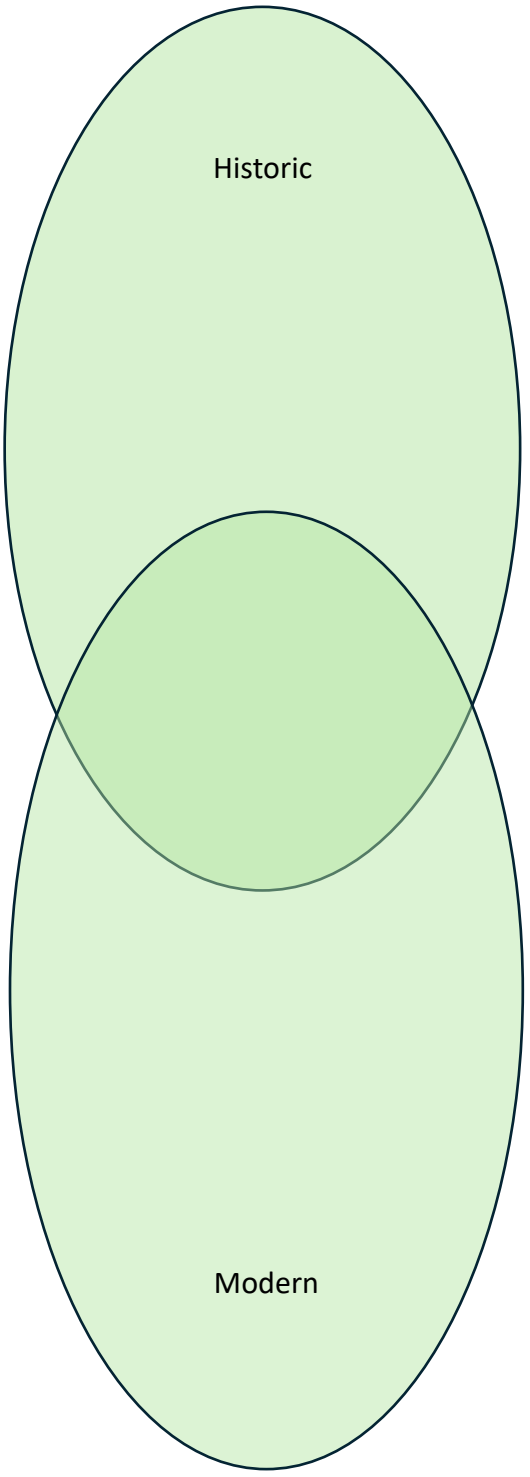
The bottom is a modern image from 2026.

Use the VENN Diagram to answer the question.

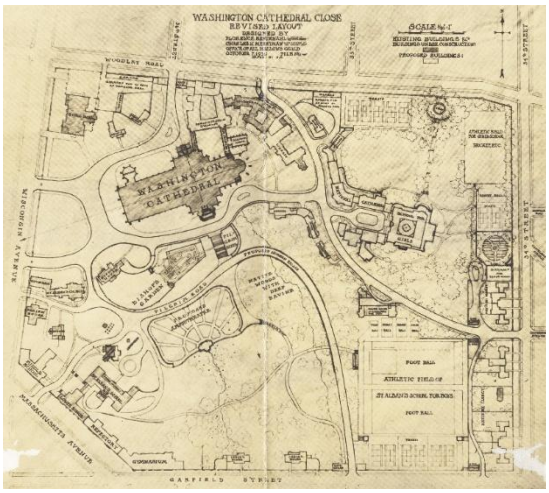
What is similar between the images? What has changed over time?











What do you study to be a horticulturalist?



A meeting with three horticulturists at Bok Tower Gardens reveals what is involved in becoming a horticulturist and working in a botanical garden.

All three have **advanced college degrees**. That means they studied in college for more than 4 years and got 2 or more college degrees. First, they studied botany, microbiology, and horticulture for 4 years. After they graduated, they kept going and earned Master's Degrees in natural resource management, ornamental horticulture, cell and molecular biology, and organismal botany. Organismal botany is the study of plants as an important part of the environment.

What does a horticulturalist in a botanical garden do?

Part of their job involves being **plant detectives**. They map plants in the garden, starting in the nursery then going out to the grounds. They keep track of any changes that occur over time. They search for unknown plants that could be brought in by animals or carried on the wind. They help preserve rare plant species and restore habitats.

Another part of their job **is communicating with other gardens around the world**. The gardens help each other monitor changes in weather and climate, disease control, and rare plant conservation. They talk about how to use new technology like using drones to update maps.

Microbiology- the study of living things that can only be seen through a microscope
Ornamental- plants in a garden not intended for food production (farming)
Preserve- doing something to save rare plants
Habitats- a specific environment and its expected weather and climate, such as rainforest, grasslands, and deserts



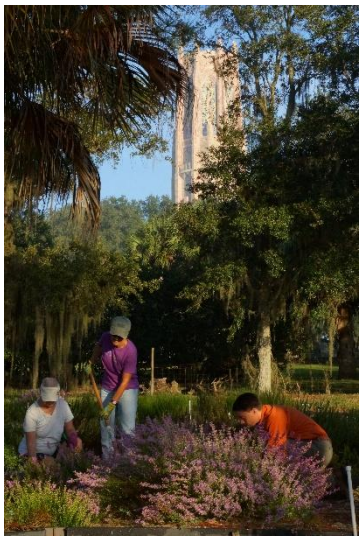
The images below are of gardeners at Bok Tower Gardens adjusting plants in the 1920s and 100 years later.

What do you think it would be like working in the garden?

What supplies and tools would you need to have?

How have those tools changed over time?





Should I consider seeking a plant-focused STEM career?

If you are interested in this STEM field, many local schools have an **Agricultural Program** that focuses on farming animals and plants. Many botanical gardens and environmental centers offer summer programs. Fill in the survey below to figure out if it is for you!

A Lot	A Little	Not Really	I enjoy…
			… being outside.
			… working with my hands.
			… interacting with plants (smelling, eating, watering, etc.).
			… changing the environment around me.
			… making things grow OR making them more beautiful.
			… being a detective.
			… making and coloring maps.
			… studying really small things OR really tall things.
			… the idea of using drones, chain saws, and different tools.
			… figuring out how different things affect each other.
			… solving problems as a team.

(Circle One) Based on this survey, a plant-related STEM career ***MIGHT BE*** ***MIGHT NOT BE*** for me.

Let's Engage with Plants

Observe each image. Mark all images that are plants. Explain your reasoning.

☐ 

☐ 

☐ 

☐ 

☐ 

☐ 

Exploring Plant Parts



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?

Seed Sort Activity



Write a summary about your seeds. What makes them similar? What makes them different?

_____

_____

_____

Draw what might happen to a seed if you plant it in soil.

Flower Explorations







Flowers come in a variety of shapes, sizes, number of petals, and colors.

Observe these examples. What similarities do you notice? What differences?

Use a hand lens to observe closer. What tiny details can you see with the hand lens?







Observe these examples. What similarities do you notice? What differences?

Use a hand lens to observe closer. What tiny details can you see with the hand lens?

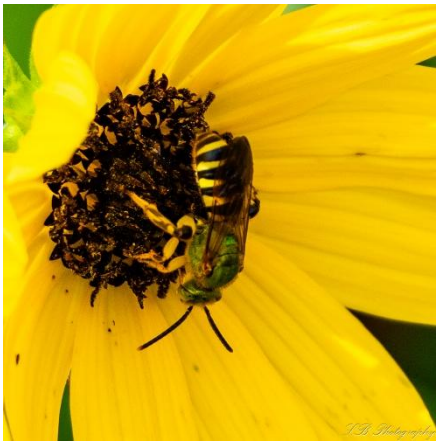
The main purpose of flowers is to attract pollinators to fertilize the plant. What do you notice on these flowers?











What part of the flower do they seem to be focused on?

Let's take a closer look at why that is.

George Washington Carver uses a microscope to study plants. What might he see under the microscope?





With this flower, you can really see what the center of the flower looks like. The female part of the flower is slightly longer than the male. How many female parts does this flower have?

The male parts have a yellow pad at the end where pollen is formed. How many male parts does this flower have?

The female part of the flower is called the pistil. The male part is called the stamen. A flower needs both parts in order to reproduce (produce seeds to make new plants).



Here's another flower where we can easily see the reproductive parts. Again, the female part (pistil) is slightly longer than the male parts (stamen). The ends of the stamen on this plant are dark.

How many male parts does this flower have?

How many female parts?

Let's talk fertilizing the flower. Fertilization is the process where pollen (the male part of a plant) enters the ovary (a female part of the plant) and cause seeds to form. When you eat an apple, what do you find inside? Seeds. The fruit is the ovary part of the plant where seeds form. Pollen can be dispersed (carried to the female parts) by wind, insects, and animals such as birds.



What do you notice about the center of this flower? Can you identify the stamens and the pistil?

How many pistils?

How many Stamen?

How is the flower in the bottom image similar to the other flower examples?

How is the flower in the bottom image different from the other examples?



How many pistils does this flower have? _____

How many stamens can you count? _____



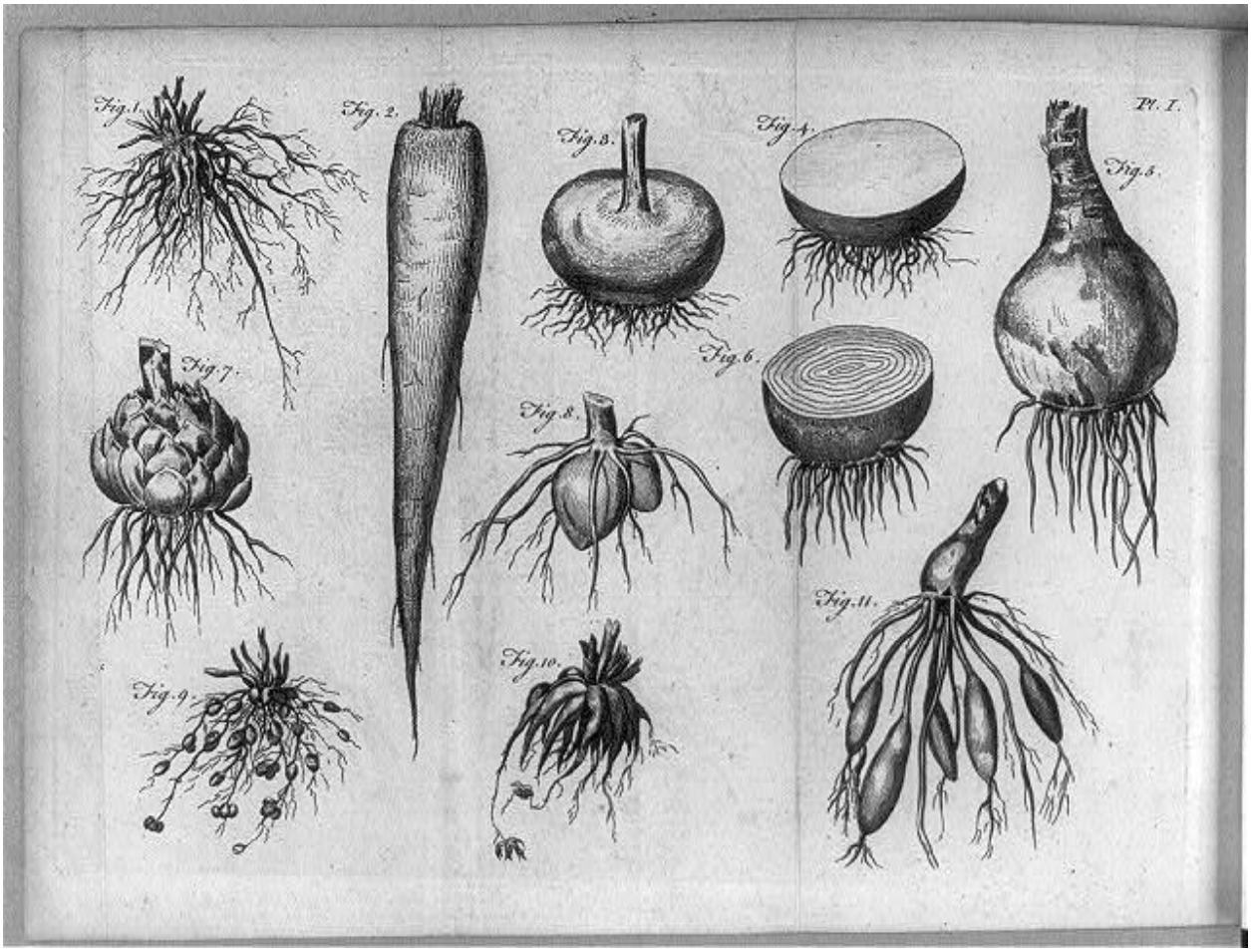
In this image, look closely at the bee. Little bits of pollen are sticking to the bee. The male part of a flower makes the pollen. The female part uses the pollen to produce seeds. This is the process of pollination.

Seeds formed in flowers help plants reproduce. You can see seeds beginning to form in the center of this flower. Some flowers, like this sunflower, will produce lots of seeds. Others, produce just a few seeds.



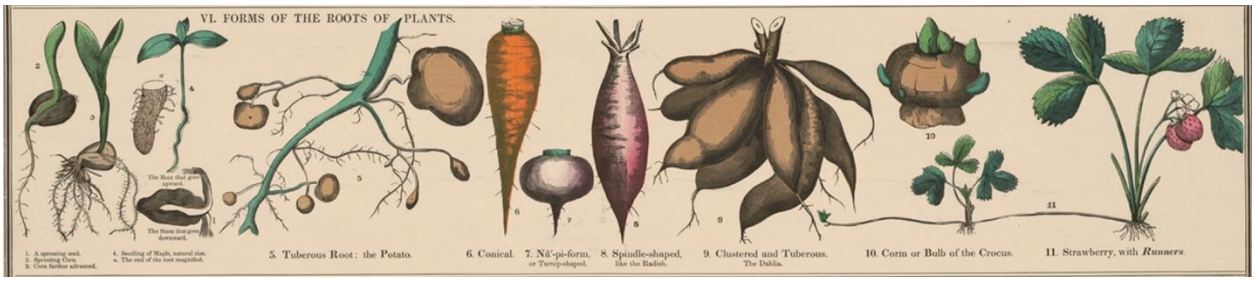
Vocabulary Check		
1. Pollinators		A. The female part of a flower where seeds form
2. Pollination		B. To make
3. Pollen		C. Something that moves pollen from the stamen to the pistil, usually an animal or wind
4. Stamen		D. To be moved from one place to another by animals or wind
5. Pistil		E. The process where the female part of the flower uses pollen to produce seeds.
6. Ovary		F. The female part of the flower that takes in pollen
7. Fertilizing		G. Male cells needed for a flower to be pollinated
8. Reproduce		H. The process where a plant makes seeds (offspring)
9. Produce		I. The male part of the flower that carries pollen
10. Disperse, dispersed		J. The process where pollen is moved from the stamen to the pistil

Exploring Roots



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?

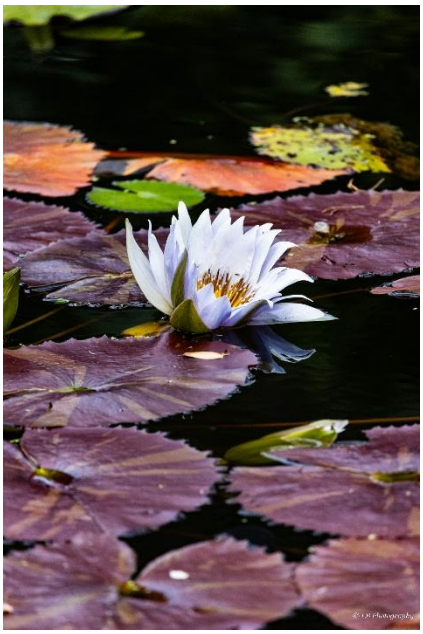
Exploring Stems

Another major part of plants are stems. Stems are used to hold up parts of plants like leaves and flowers. Look at these images. Where are the stems?









I see stems

_____

_____

_____

The biggest stem I see is

_____

PLANT INQUIRY

How do we know nutrients and water move through the stem of the plant?

Do this fun investigation and let's see what you find out!

Materials:

1 carnation
1 celery stalk
Four cups
Red and blue food coloring
A knife
water

Procedures:

Have an adult help slice the bottom of the stem.

Fill the cups half full of water.

Add 15 drops of red coloring to one cup.

Add 15 drops of blue coloring to the other cup.

Place one side of the cut stem in blue water and the other side in red water.

Observe the plants every hour and record your findings

Carnation Flower	Celery Stalk
Observation 1:	Observation 1:
Observation 2:	Observation 2:
Observation 3	Observation 3
Observation 4	Observation 4

How do these results show that nutrients and water move through the stem?

Write a claim.

What evidence supports your claim?

Exploring Leaves

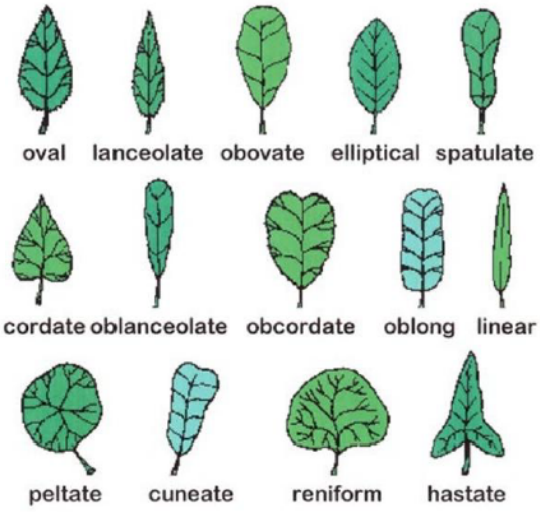
Leaves have a special plant job. They come in different shapes and sizes. Explore these leaves.



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

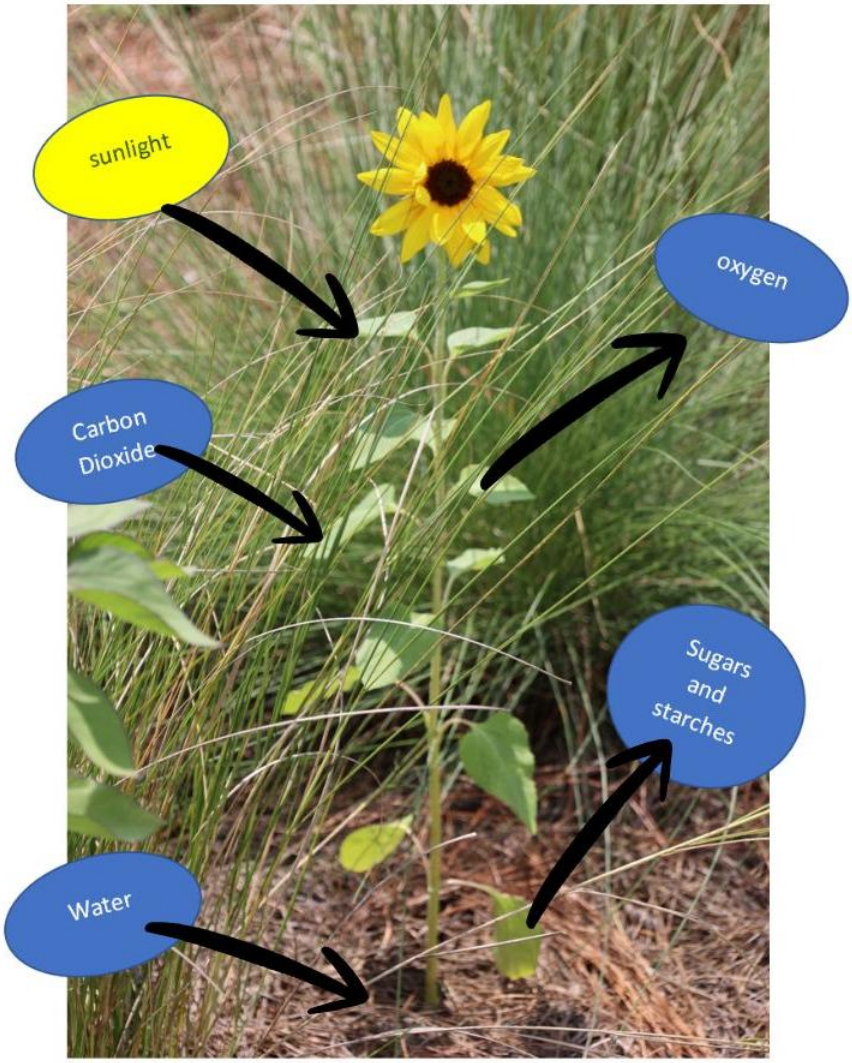
Choose a leaf from the school yard or your yard. Complete the Leaf Alert Activity Page using your leaf. You can refer to the charts for some responses.



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?



What plant part are you eating?

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 transpiration. Try this:

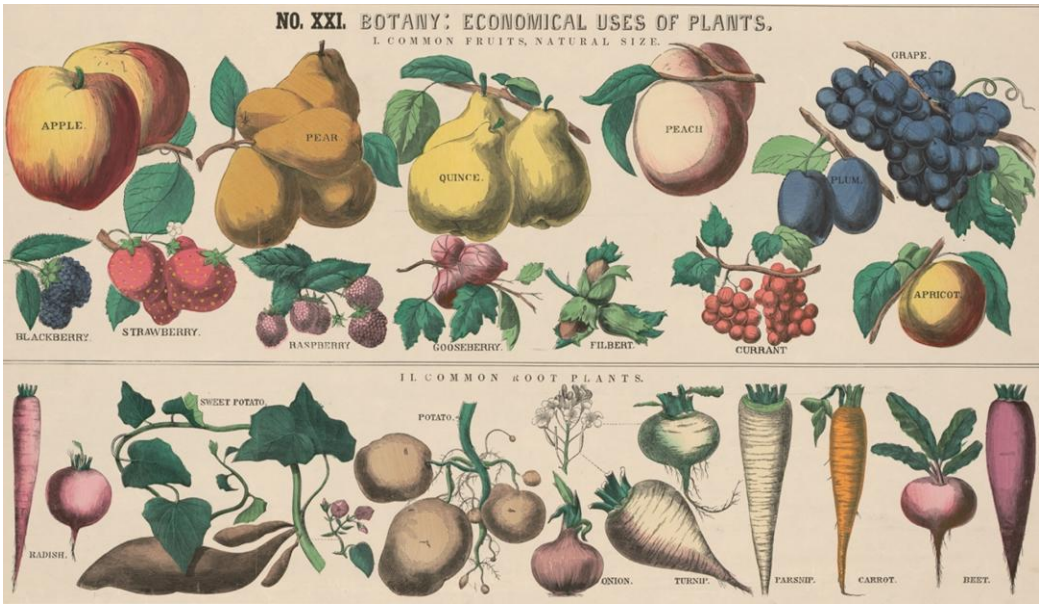
1. On a plant outside, find a sturdy stem with leaves.
2. Tie a plastic Ziplock bag over the leaves.
3. Wait 24 hours and check the Ziplock bag. What do you see?
4. Test out different kinds of plants. Are there plants that transpire more than others?
5. How and when could knowing this be helpful?







We eat a lot of things that are made from plants. Flour for baking, vegetables that balance a meal, fruit, snacks made up of seeds and nuts- all of these things come from plants because plants store sugar and starches. How can you find out what part of the plant each food item comes from?



The produce section of a grocery store is a great place to explore plant parts that we (people) eat. What part of the plant are these grocery store finds?

Tomatoes	Root	Stem	Leaves	Flower	Seeds
Asparagus	Root	Stem	Leaves	Flower	Seeds
Carrots	Root	Stem	Leaves	Flower	Seeds
Broccoli	Root	Stem	Leaves	Flower	Seeds
Lettuce	Root	Stem	Leaves	Flower	Seeds
Blueberries	Root	Stem	Leaves	Flower	Seeds
Celery	Root	Stem	Leaves	Flower	Seeds
Rosemary	Root	Stem	Leaves	Flower	Seeds
Artichokes	Root	Stem	Leaves	Flower	Seeds
Peas	Root	Stem	Leaves	Flower	Seeds
Jalapeno	Root	Stem	Leaves	Flower	Seeds
Corn	Root	Stem	Leaves	Flower	Seeds



Exploring the concept:

Even the spices we add to give food flavor come from plants. What could these spices be used for?

Let's Review Plant Parts

Which plant part(s) have something to do with each of the following? (Hint: There might be more than one connection you can make!)		
Roles	**Plant Structure(s)**	**Your explanation**
Have a role in food production		
Have a role in plant support		
Have a role in transport of water and nutrients		
Have a role in reproduction		

Let's Experiment

The best way to learn all about plants is growing and exploring how they respond to stimuli.

Before we can see how plants will respond to stimuli, we need to grow some first.

Stimuli is a form of the word stimulus. A stimulus is something that triggers or signals for something to happen. If someone taps on your shoulder, you turn around to look at them. The tap is the stimulus. Turning to look is your response. The stimulus is the cause and the response is the effect. Let's try a few "shoulder taps" on plants and see what happens.

Materials:

You will need 2 Ziplock bags, 2 paper towels, water, a spray of hydrogen peroxide, 2 lima bean seeds, and 2 sunflower seeds.

Steps:

1. Soak the seeds overnight so they are ready to germinate.
2. **Wash your hands with soap and water before you touch your supplies.**
3. Label your Ziplock Bags. Write lima bean seeds on one bag and sunflower seeds on the other bag. Also write the start date.
4. Wet your towels and wring them out really well. Place each towel neatly in a Ziplock bag. Have an adult lightly spray each towel with hydrogen peroxide.
5. Place two lima beans in the lima bean bag and two sunflower seeds in the sunflower bag. Seal the bags nice and tight. This will keep the water from evaporating. Next, place your bags near a sunny window. You can tape them to the window if possible.

Hydrogen peroxide is a chemical that is often used for leaning and getting rid of germs. A light spray won't harm your seeds. It will help protect them from any harmful germs that may keep your seed from growing. Germination is a fancy word for starting to grow. Wait until you see what part of your plant grows first!

Observe:

Check the bags carefully every day. What do you observe?

The next page provides a format you can use to record your observations.

Plant in a Bag

Date:			
Seed:			Draw your plant
☐ dormant	☐ germination	☐ seedling	
	Measuring Growth	Describing Growth	
Root growth			
Stem Growth			
Leaf Growth			
Seed:			Draw your plant
☐ dormant	☐ germination	☐ seedling	
	Measuring Growth	Describing Growth	
Root growth			
Stem Growth			
Leaf Growth			

Draw or copy and paste this chart in your science notebook.

Use a new chart each day you collect data.

WEEKLY ANALYSIS: Each week, answer these questions.

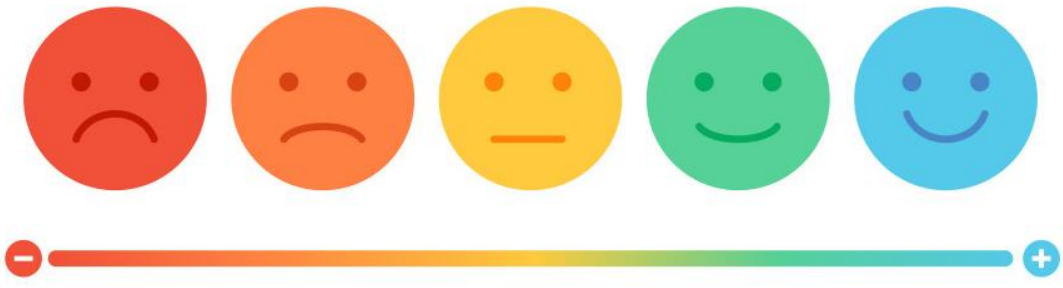
- Which plant is growing faster?
- What part of the plants has grown more?
- How are the lima and sunflower plants similar?
- How are the lima and sunflower plants different?

* When your plants reach the top of the Ziplock bag, it is time to plant them in soil. *Follow the directions of the adult helping with the investigation.*

Vocabulary Catch

Check your Understanding	
1. _____ Absorb	a) Release of water and oxygen from the leaves
2. _____ Germination	b) Male part of a flower that makes pollen
3. _____Photosynthesis	c) Process of a flower getting pollen so it can make seeds to reproduce
4. _____Pistil	d) Process used by leaves to produce food in the form of sugar and starches
5. _____Pollination	e) To soak up
6. _____Pollinator	f) A young plant
7. _____Seedling	g) Something that helps a flower get pollinated, usually an insect, animal, or wind
8. _____Stamen	h) Female part of the flower
9. _____Stimulus/stimuli	i) Something that triggers or signals something to happen
10. _____Transpiration	j) When the seed begins to grow

How well do you know your vocabulary? Rate yourself.



Stimulus Investigation

Which stimuli is our group investigating? What question will guide us?	
How will we set up our investigation?	
What data and observations will we collect?	
How should we record our data and observations in our science journal?	
How will we share our results with the class?	

Reflecting on Plant Investigations

What have you learned?	What questions do you still have?

Engaging with Plant Identification

Learning Phase 2



Observe	Reflect and Infer	Question
Describe what you see. What do you notice first? What people and objects are shown? What details stand out to you?	What type of image is this? Why do you think it was made? What's happening in the image? What tools do you think were used to make this image?	What do you wonder about? Who is this? When is this? What other questions can you come up with?



George Washington Carver (1864-1943) worked with plants. He needed to understand how plants are classified. Let's explore a type of plant classification: flowering and nonflowering plants.

Something is going on with this plant! What do you see? What do you think it could be? Share your ideas.

Flowering and Nonflowering Plants

Not all plants have flowers that make seeds. Some nonflowering plants reproduce with spores. Let's explore more.



Use a hand lens to look closely at these images. What common characteristics do you notice?





Look at the back of these fern fronds. What do you notice? Each dot is a spore, capable of growing a whole new plant, just like a seed does.



Reproduce means making a copy of something or having babies or new plants. The ability to reproduce is one of the characteristics of living things.



Here is a closeup of spores on a fern.

Each leaf of a fern is called a frond.

There are many kinds of ferns. This is called a resurrection fern. When it is dry, it looks like this. How would you describe it?



After it rains, look at how this plant transforms. What changes do you notice?



Concept Check: Why won't you find flowers on a resurrection fern?

Vocabulary Exploration:

Resurrection means to come back from the dead. Why do you think someone decided to call this plant resurrection fern?

Here is another group of nonflowering plants. Mosses are curious. They don't really have roots. They cling to the surface of rocks and trees and absorb nutrients with tiny hairs called rhizoids. Mosses grow in different places, from cold mountains to hot deserts.



How is moss similar to ferns? How is it different?



Like other plants, mosses come in a variety of shapes. Use your hand lens to observe these images. What similarities do you notice? What differences?







Ever heard of a moss that hangs in trees? Spanish moss is often thought of as a moss, but guess what? It isn't! It isn't even a nonflowering plant. Spanish moss is a flowering aerial plant called an epiphyte.



Another type of epiphyte you may be familiar with is the orchid. It is a flowering plant.

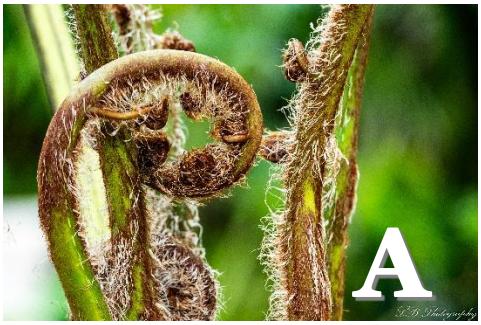





COMPARE & CONTRAST:

Flowering Plants	Both	Nonflowering Plants
Flowers contain pistils (female parts) and stamens (male parts) to assist with pollination and germination	Use sunlight, water, and carbon dioxide to make food for the plant …and anyone who eats the plant	Do not make flowers or fruit
Make enclosed seeds, usually in the fruit of the plant	Are made of cells which give plants structure and support	Make spores to reproduce
Flowers are scented and colored to attract pollinators	Can be found in a variety of environments and weather/climate conditions	Mosses and ferns are examples

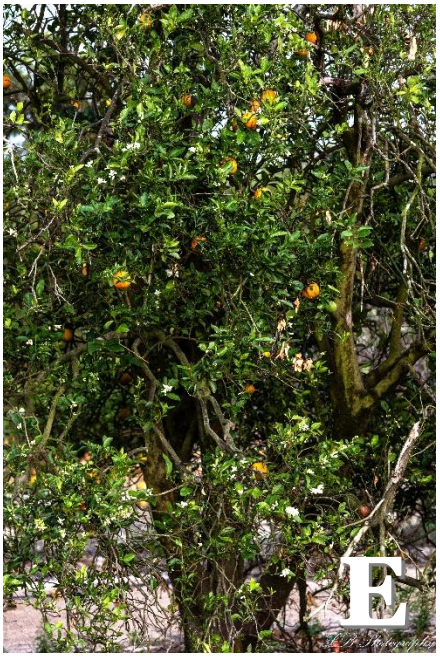
Test your knowledge. Circle the nonflowering plants.









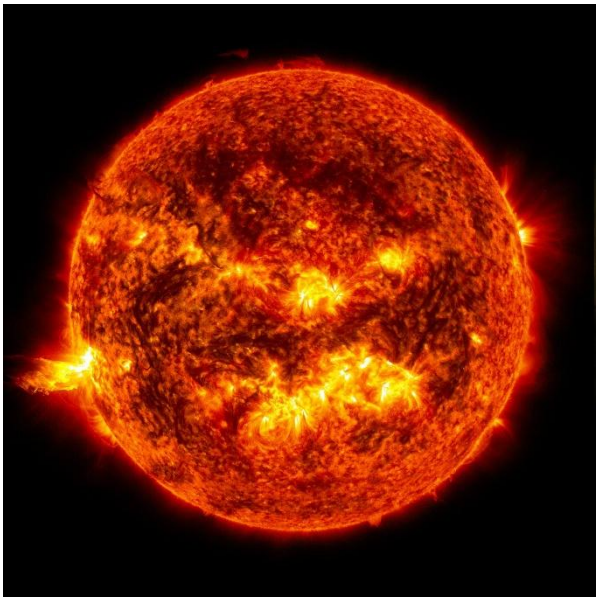




Learning Phase 3

All Part of the Food Chain

Earlier in the book, we learned that plants use energy from the sun, water, and carbon dioxide to make (or produce) starches and sugars. When anything eats a plant, it consumes the plant. Plants are producers, because they make their own food. Animals are consumers because they eat plants (or other animals who eat plants) to get their food. Animals are not able to produce their own food the way that plants do.



A food chain starts with the sun, because that is where energy comes from. Here is an image of the sun made by NASA (National Aeronautics and Space Administration). It is the government organization that explores space.

What do you see in the image that demonstrates the sun is energy?

Look at the image by botanical artist and biologist Marianne North. What producers and consumers can you identify?

Producer	Consumer



Painting no. 577: 'Flowers and Fruit of the Mangosteen, and Singapore Monkey'.



Another botanical artist, Mark Catesby, made this illustration. What is the producer and what is the consumer?

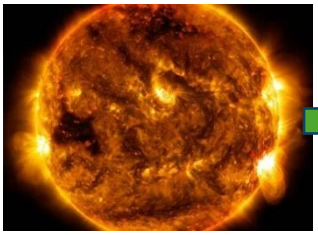
producer		consumer	



What are the consumers and producers in this image?

producer		consumer	

We can make a chart that shows how energy moves from the sun, through producers, and on to consumers. This is a food chain.







The sun gives energy to the sunflower which makes sunflower seeds. The squirrel eats sunflower seeds from the bird feeder.

You are part of a food chain as well.
Draw a food chain for eating corn flakes for breakfast.



Concept Check: What producers are in each image? What consumers are in each image? What part of the food chain is not seen in the image but it has to be part of each food chain?







Image 1	Image 2	Image 3

STEM Maker Activity 1: Pollination Station



As we have learned, animals help plants reproduce by spreading flower pollen and moving plant seeds from one place to another. Pollinators are animals of all types that visit flowers and take away their pollen. Bees, butterflies, moths, wasps, flies, bats, and birds are just a few different types of pollinators. May of these animals are threatened or endangered partly because of loss of habitat and pesticide (poisons) use. Sometimes, when natural pollinators are hard to come by, gardeners will pollinate plants by hand.

The Problem:

You are a gardener in a greenhouse and you want to have your flowers pollinated, but you don't want to let bees or other insects into the greenhouse. Your challenge is to build a device that can be used to pollinate the plants in the greenhouse.

The Goal:

Design, create, and test a hand pollinator to transfer "pollen" from one "flower" to another.

Brainstorming Discussion:

Think about how flowers get pollinated. How does pollen get from one flower to another?

How do animals, like insects, manage it? Do they use their legs or another body part? How do they carry pollen without dropping it? How does pollen get from one flower to another?

Names of pollinators: _____
Tally (*number of images I observed to get ideas*): _____

Materials:

- 2 paper plates with a large flower drawn on each
- Powdery substance like dry mac and cheese powder
- Design materials like cotton balls, pom-poms, balloons, foam stickers, erasers, paper towels, coffee filters, pipe cleaners, straws, craft sticks, string, aluminum foil, wire
- Tape, glue, and/or hot glue gun *with close adult supervision*
- Paper and pencils for sketching designs

DESIGN, BUILD & TEST:

1. **Sketch:** After researching and exploring the materials available for your design, sketch a few ideas.
   Engineers create blueprints before they start building to help them plan.

2. **Construct:** Based on one of your sketches, build a device using the available materials that will pick up and carry pollen from one plate flower to another. *Engineers construct designs.*

3. **Test Checklist:** *Engineers are scientists who test their designs.*

   - Once you have built a design, place your two flower plates beside each other.
   - Put a small amount of pollen powder in the center of one flower.
   - Gently press your hand pollinator into the pollen. Be light like a butterfly or bee.
   - Gently touch your hand pollinator to the center of the second flower.

OBSERVE:

Observe your result and draw a picture.

How much pollen was transported from one flower to another?

_____

REDESIGN, REBUILD & RETEST:

1. **Redesign:**
    a. What improvements can you make to your design to transport more pollen?

    b. Look at the supplies. Is there something that would be more successful?

    c. Make changes to your design on paper.

2. **Rebuild:** Build your redesign.
3. **Retest**: Repeat the test.

OBSERVE:

Observe your result and draw a picture.

Compare the results of the first and second test.

Which transported the most pollen? _____

Summarize your findings **HERE** in 2 sentences.

SHARE YOUR RESULTS:

Share your summary and your designs with another person or group.

Get their signatures here:

CHALLENGE:

Who in your group can build the best hand pollinator using the following **resource?** (https://tulsastem.org/design-a-hand-pollinator/)

DID YOU KNOW:



Some gardeners and botanists use hand pollination

(also called **purposeful pollination**):

1. to control what plant breeds can mingle
2. to create new varieties of plants or
3. to improve the quality of existing plants.

They brush pollen (top) from one flower onto another flower to get a new color, or a stronger scent, or even better-tasting fruits.



This frilly daffodil (right) was developed through **purposeful pollination**.



This botanist (left) wants to make a stronger plant.

What do you think he will do?

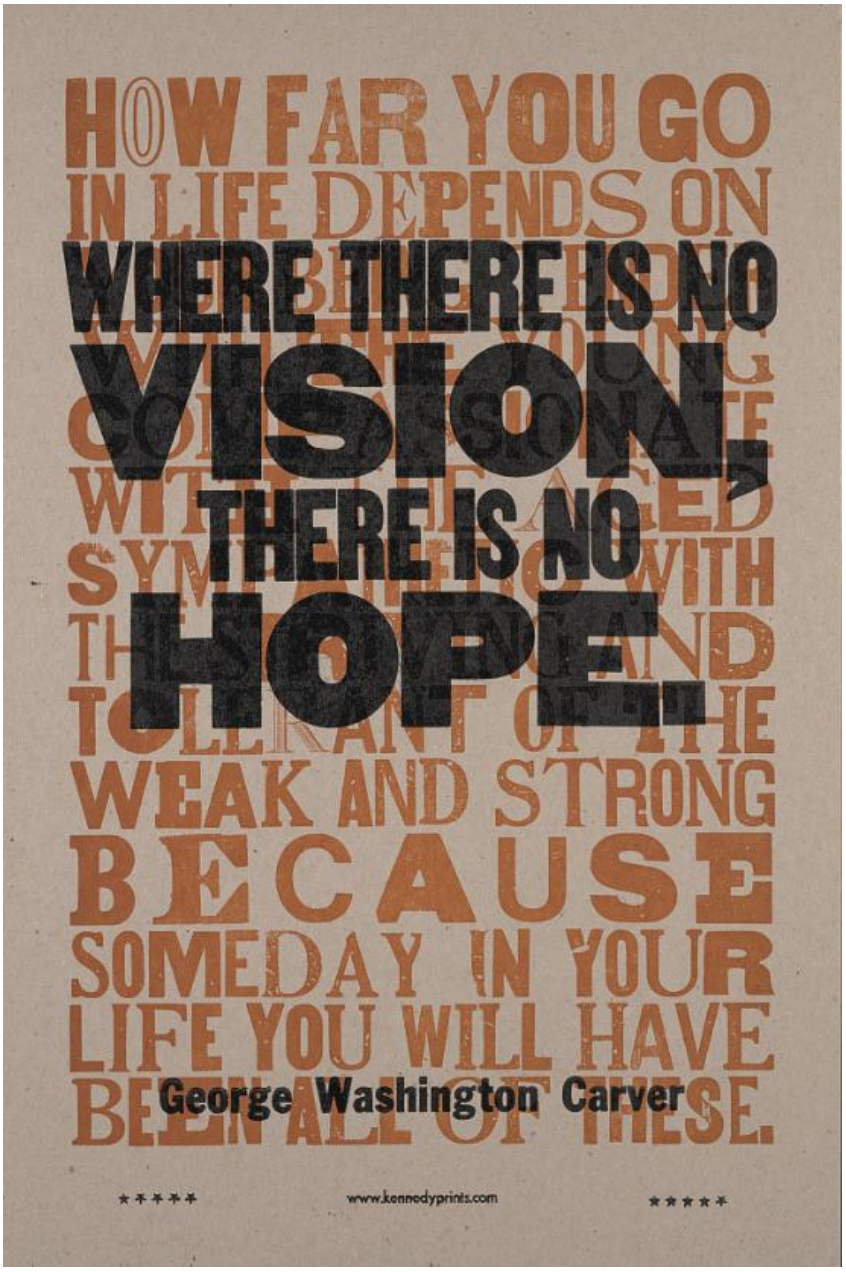
STEM Maker Activity 2: Nature Walk Design

Group Project:

Design a nature walk for someone with sensory impairment [deaf, blind, wheelchair bound, etc.]. Follow the same step-by-step "path" Bok and Omstead Jr. did as they developed Bok Tower Gardens!

STEP 1: CONCEPT

Analyze this poster that quotes George Washington Carver:



1. A **CONCEPT** is a big idea that everyone can understand, that can be summarized in **one word**.

   Concepts include *power, love, freedom, systems, truth, life, revolution, survival, legacy*, and *fun*.

   Circle 2 CONCEPTS in this poster.

2. What do you think is the most important CONCEPT in this poster?

3. In your own words, what is the MESSAGE of this poster?

4. A CONCEPT I want to connect to my nature walk design is:

5. What did the ARTIST do to get the MESSAGE across in a creative way?

6. **Who** do you think **George Washington Carver** wanted to hear this MESSAGE?

7. As you design your nature walk,
which **sensory impairment** do you want to keep in mind MOST?

8. What MESSAGE do you want to send with your design?

   Include your chosen CONCEPT in the message.

Compassionate – being kind and supporting one who is hurt or confused

Sympathetic –caring

Striving – trying very hard

9. Circle three CONCEPTS hidden within the following quote:

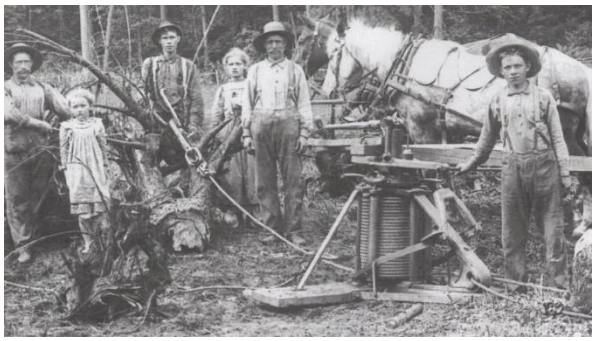
"How far you go in life depends on your being
tender with the young, compassionate with the aged,
sympathetic with the striving, and tolerant of the weak and
strong. Because someday in your life
you will have been all of these."

– G.W. Carver

10. How will your NATURE WALK design "show compassion" or "be sympathetic"?

STEP 2: SCOUT LOCATIONS

Edward Bok identified Lake Wales, Florida as the perfect location for his Gardens.

<table>
<tr><td>This is an image of natural Florida.</td><td>Attach or sketch a picture of a real place near you where you could create a nature walk.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>What tools would be needed to change this land into a garden with a “singing Tower”?</td><td>Describe the location in relation to streets and geographical features so that a friend could find it on a map.</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2">The area of Bok Tower Gardens is
250 square acres.

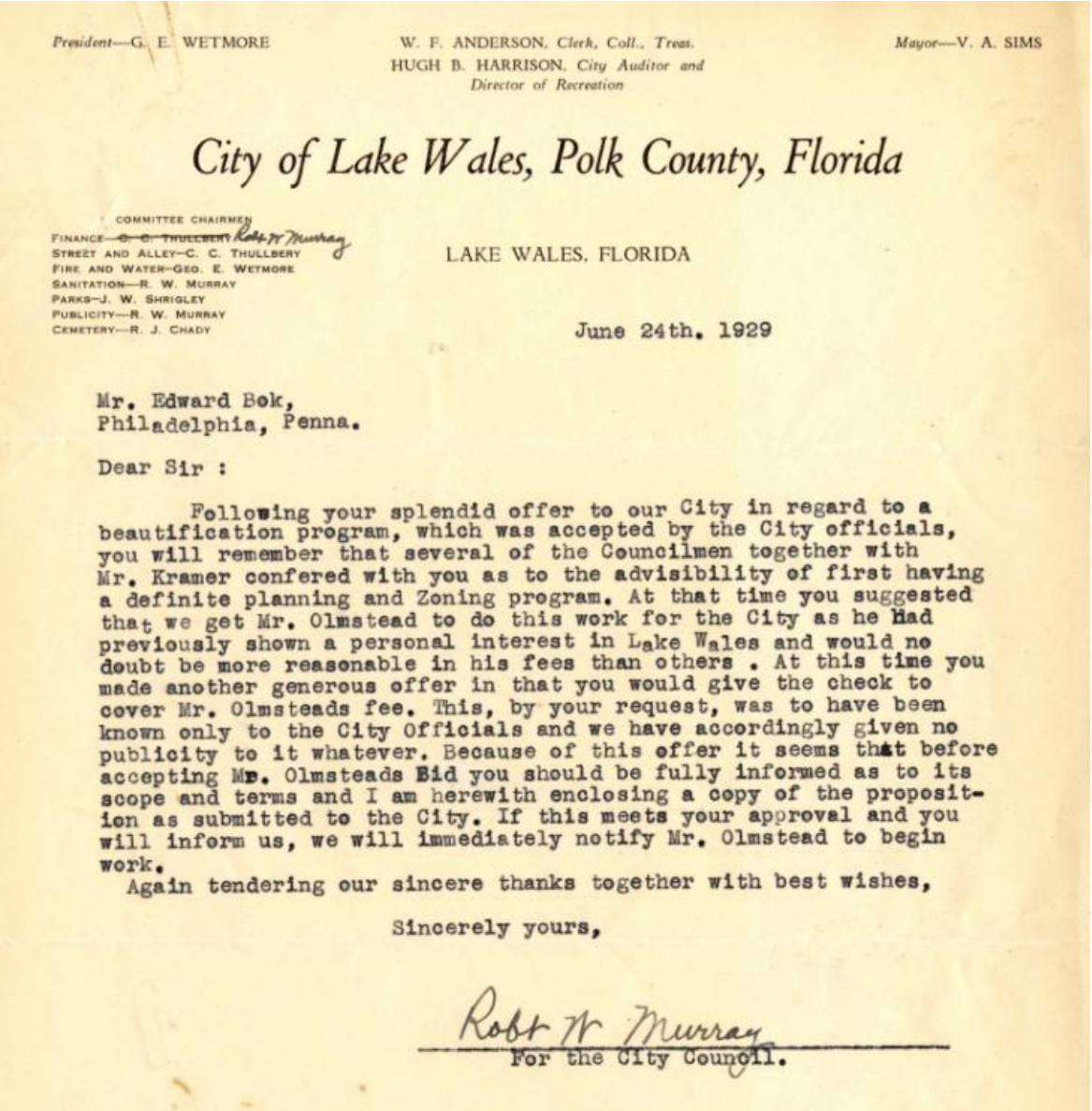
That is about the size of 190 football fields or a smaller than the nearby town of Lake Wales.

It would take about 4-8 hours
to walk across it.</td><td>Describe the size of your location.</td></tr>
<tr><td></td></tr>
</table>

STEP 3: ASSEMBLE PARTNERS

Analyze this letter to Mr. Edward Bok.

Circle details that are interesting or that you have questions about.



President—G. E. WETMORE

W. F. ANDERSON, *Clerk, Coll., Treas.*
HUGH B. HARRISON, *City Auditor and Director of Recreation*

Mayor—V. A. SIMS

City of Lake Wales, Polk County, Florida

COMMITTEE CHAIRMEN
FINANCE—~~C. C. THULLBERY~~ Robt W Murray
STREET AND ALLEY—C. C. THULLBERY
FIRE AND WATER—GEO. E. WETMORE
SANITATION—R. W. MURRAY
PARKS—J. W. SHRIGLEY
PUBLICITY—R. W. MURRAY
CEMETERY—R. J. CHADY

LAKE WALES, FLORIDA

June 24th. 1929

Mr. Edward Bok,
Philadelphia, Penna.

Dear Sir :

Following your splendid offer to our City in regard to a beautification program, which was accepted by the City officials, you will remember that several of the Councilmen together with Mr. Kramer confered with you as to the advisibility of first having a definite planning and Zoning program. At that time you suggested that we get Mr. Olmstead to do this work for the City as he had previously shown a personal interest in Lake Wales and would no doubt be more reasonable in his fees than others . At this time you made another generous offer in that you would give the check to cover Mr. Olmsteads fee. This, by your request, was to have been known only to the City Officials and we have accordingly given no publicity to it whatever. Because of this offer it seems that before accepting Mr. Olmsteads Bid you should be fully informed as to its scope and terms and I am herewith enclosing a copy of the proposition as submitted to the City. If this meets your approval and you will inform us, we will immediately notify Mr. Olmstead to begin work.

Again tendering our sincere thanks together with best wishes,

Sincerely yours,

Robt W Murray
For the City Council.

1. Who PARTNERED to make the "beautification program" a reality?

2. Are all PARTNERS in the same state? How do you know?

CREATE YOUR COMMITTEE:

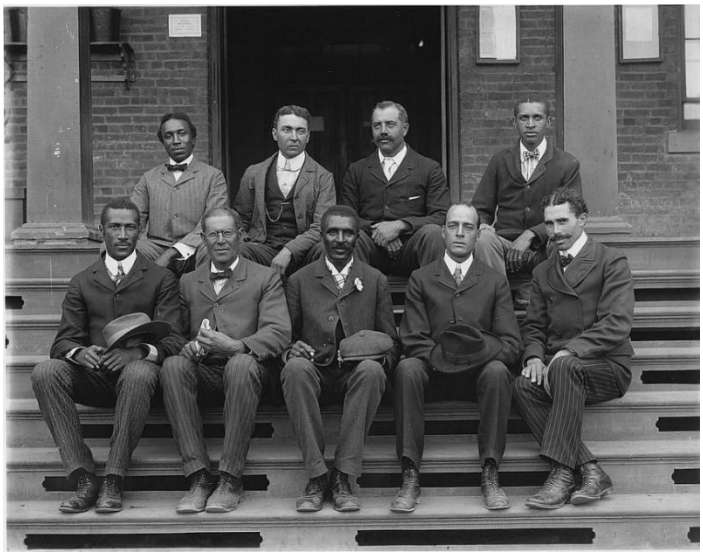
OPTION 1

The teacher partners students based on similar CONCEPTS, MESSAGES, or LOCATION.

OPTION 2:

Students look for 1-2 partners they can collaborate with to design the nature walk. Look for partners who choose a similar CONCEPT, share a similar MESSAGE, or can agree on a perfect LOCATION. You don't have to agree on everything; just one important thing.

COMMEMORATIVE PHOTO





To the left is George Washington Carver and other professors he worked with at his university. On the right is Edward Bok and the gardeners he worked with at Bok Tower Gardens. *Attach a photograph of your group that imitates one of the images above. List each partner's name and location.*

3. What is the name of your committee?

4. Which location have you chosen?

5. What is the message you want your design to send?
   Underline the most important CONCEPT within your message

STEP 4: Create A Collaborative Design

This is an example from Bok Tower Gardens. Work together to create your own design.

Create a key showing features designed with disabilities in mind.

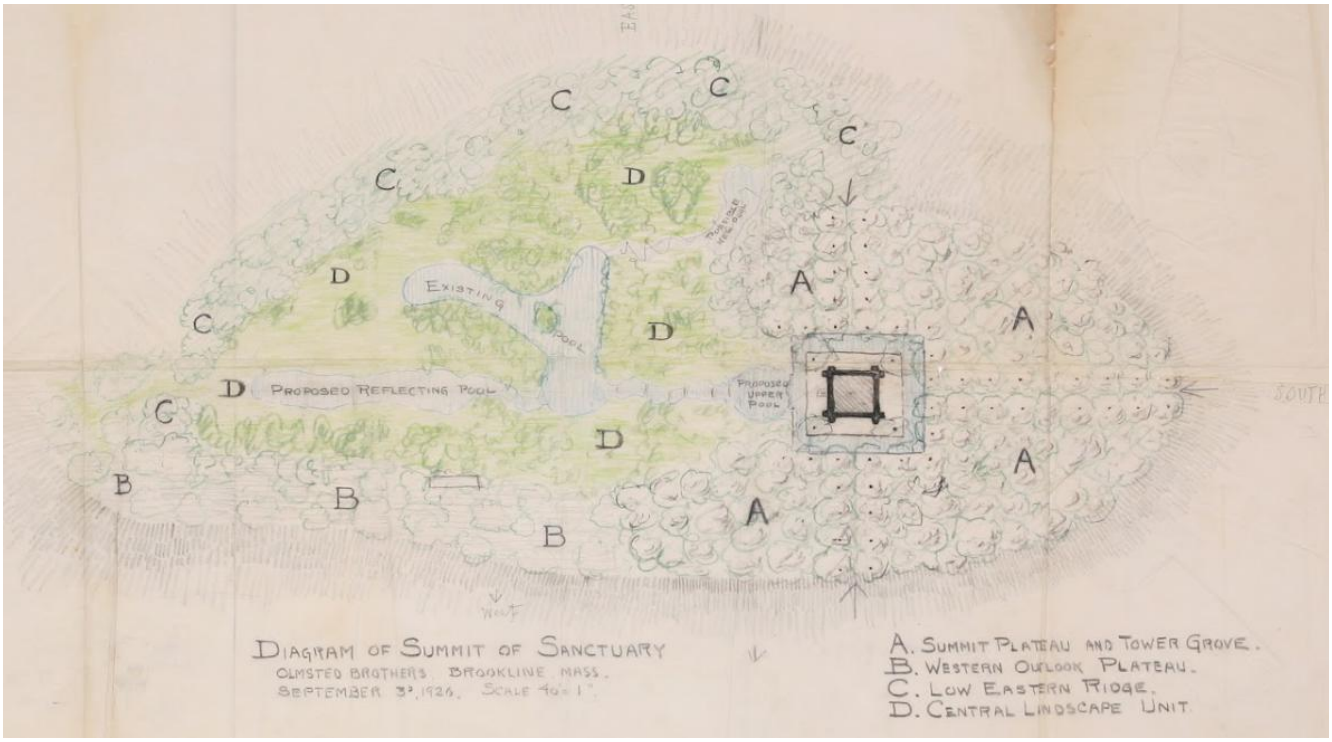


Image References

Title page: Bok Tower Garden image by Laurie Boulden

Page 2 Portrait: Linnaeus in his Lapland Dress, Library of Congress, 2003666985

Page 2: Botanical Notebook of Linnaeus image, Library of Congress, 2021668119

Page 4 upper left: Maryanne North, 1877, in A Guide to the Marianne North Gallery, Kew Botanical Gardens

Page 4 upper right: George Washington Carver working in a laboratory, 1937, Library of Congress, 2006675174

Page 4 lower left: Night Flowering Lilly and Ferns, 1877, in A Guide to the Marianne North Gallery, Kew Botanical Gardens

Page 4 lower right: George Washington Carver in his laboratory at Tuskegee Institute, 1923, Library of Congress, 2006675173

Page 5 upper left: Frederick Law Olmsted, Jr.

Page 5 upper right: Edward W. Bok, Bok Tower Gardens Archives

Page 5 lower left: Executive Mansion Grounds General Plans for Improvement, Olmsted Group

Page 5 lower middle: Bok Tower Gardens Postcard, Bok Tower Gardens Archives

Page 5 lower right: House Blueprint, Bok Tower Gardens Archives

Page 7 upper Left: Bok Tower Garden image by Brendan Huggins

Page 7 upper right: Bok Tower Garden image by Brendan Huggins

Page 7 lower: Image 229 of Botanical Notebook of Linnaeus, Library of Congress, 2021668119

Page 8: Man and Woman with Plants in Greenhouse, Library of Congress, 2016889731

Page 9 upper: Bok quote at Bok Tower Garden image by Laurie Boulden

Page 9 lower: Olmsted Map of Bok Tower Garden, Bok Tower Garden Archive Collection

Page 10 upper: Olmsted Map of Bok Tower Garden, Bok Tower Garden Archive Collection

Page 10 Center: Park around the Capitol Building, Washington, DC image by Laurie Boulden

Page 10 lower right: Granite Lamp Piers and Bronze Fountains at the Capitol Building, image by Laurie Boulden

Page 10 lower left: Summerhouse at the Capitol Building, image by Laurie Boulden

Page 11 top: 1932 Early Photograph of the National Cathedral, All Hallows Guild of the Washington National Cathedral

Page 11 bottom: 2026 image of the National Cathedral and grounds, image by Laurie Boulden

Page 12 top: Olmsted Woods Contemplative Circle at the National Cathedral, image by Laurie Boulden

Page 12 middle: National Cathedral Map Close by Olmsted, All Hallows Guild of the Washington National Cathedral

Page 12 middle: Page 12c: Robert (Bobby) Williams, cousin, receiving college degree (1970) Library of Congress CN2015651225

Page 12 bottom: Bethune-Cookman College Students using Microscopes, Library of Congress, 2017845273

Page 13 left: Gardeners raising a Palm, Bok Tower Garden Archive Collection

Page 13 right: Glen and Volunteers in beds, 2014, image by David

Page 14 upper: six flower images by Laurie Boulden

Page 14 seed bag 1: Cole's, 1896, Garden, Farm & Flower Seeds, Pella IO, 009551

Page 14 seed bag 2: Alneer Brothers, 1896, Illustrated catalogue of Everything for Flower and Vegetable Garden, Rockford, IL, SIL-SIL08-10893-a-000002

Page 14 seed bag 3: Buist, Robert, Co., 1896, Garden Guide and Almanac no 1896, 1898, Philadelphia, PA, SIL-SIL08-09480-b-000002

Page 14 seed bag 4: Conard and Jones Co. 1897, Fall Catalog of Bulbs, Roses, and other Beautiful Flowers for Winter and Spring Boom, West Grove, PA, 009665

Page 16: six flower images by Laurie Boulden

Page 17 top: five Flower images by Laurie Boulden

Page 17 bottom: George Washington Carver working in a Laboratory, 1937, Library of Congress, 2006675174

Page 18: two flower images by Laurie Boulden

Page 19; two flower images by Laurie Boulden

Page 20: two flower images by Laurie Boulden

Page 22 top: Composite of 11 illustrations of Vegetable Roots, 1760, Library of Congress, 2005680733

Page 22 bottom: part of School and Family Charts by Marcius Willson and NA Calkins, 1890, Library of Congress, 2018757055

Page 23 top: Food Pyramid illustration

Page 23 middle: two images by Laurie Boulden

Page 23 bottom: two images by Laurie Boulden

Page 24 top: part of School and Family Charts by Marcius Willson and NA Calkins, 1890, Library of Congress, 2018757055

Page 24 middle: Three images by Laurie Boulden

Page 26: Ten images by Laurie Boulden

Page 27: part of School and Family Charts by Marcius Willson and NA Calkins, 1890, Library of Congress, 2018757055

Page 28: Graphics by Master Gardeners

Page 30 top: Image with Graphics by Laurie Boulden

Page 30 lower left: Kellogg's Corn Flakes artwork by Norman Rockwell, 1950-1960, Library of Congress, 2026163518

Page 30 lower middle: bread image

Page 30 lower right: chocolate chip cookie image

Page 31 top: part of School and Family Charts by Marcius Willson and NA Calkins, 1890, Library of Congress, 2018757055

Page 31 bottom: part of School and Family Charts by Marcius Willson and NA Calkins, 1890, Library of Congress, 2018757055

Page 37 top: Alabama biochemist, 1947, Library of Congress, 97514531

Page 37 bottom: image by Laurie Boulden

Page 38: Seven images by Laurie Boulden

Page 39: Two images by Laurie Boulden

Page 40: five images by Laurie Boulden

Page 41 top: three images by Laurie Boulden

Page 41 middle 1: Watercolor Orchids by Marianne North, Kew Gardens source

Page 41 middle 2: Orchideae- Denusblumen, 1904, Library of Congress, 2015648955

Page 42 top: Two images by Laurie Boulden

Page 42 middle left: Large Ferns beside railroad track, 1895, Library of Congress, 2004707866

Page 42 middle right: image by Laurie Boulden

Page 42 bottom: Two images by Laurie Boulden

Page 43 top: Sun Emits a Solstice SME, June 20, 2013, image by NASA

Page 43 bottom: Flowers and Fruit of the Mangosteen and Singapore Monkey by Marianne North, Kew Gardens source

Page 44 top: Catesby, Mark, Hummingbird and Trumpet Flower in The Natural History of Carolina, Florida, and the Bahama Islands, 1754, Library of Congress, 11000175

Page 44 upper middle: Catesby, Mark, Birdweed in The Natural History of Carolina, Florida, and the Bahama Islands, 1754, Library of Congress, 11000175

Page 44 lower middle left: Sun Emits a Solstice SME, June 20, 2013, image by NASA

Page 44 lower middle and right: images by Laurie Boulden

Page 44 bottom: Kellogg's Corn Flakes young girl artwork by Norman Rockwell, 1950-1960, Library of Congress, 2026163519

Page 45 top left: Son of Pomp Hall feeding his Father's Mule, 1940, Library of Congress, 2017785260

Page 45 top middle: Good Friends, 1907, Library of Congress, 2020681873

Page 45 top right: Bird with Autumn Foliage, 1873, Library of Congress, 2016652302

Page 46: Watercolor Amazon Water Lilies by Marianne North, Kew Gardens source

Page 49 top: pollinating a flower by hand

Page 49 middle: narcissus

Page 49 bottom: Walter T. Watanabe Cross Pollination Experiments, 1942, Library of Congress, 2021647205

Page 50: Where there is no vision, there is no hope, 2012, Library of Congress, 2023633852

Page 53: Edward Bok letter to City of Lake wales, 1929, Bok Tower Gardens Archives

Page 54 left: George Washington Carver, full-length portrait, seated on steps, 1902, Library of Congress, 2024671560

Page 54 right: Edward Bok with Garden Staff, Bok Tower Gardens Archives

Page 55: Olmsted drawing of Bok Tower Garden, Bok Tower Gardens Archives

Special Appreciation

Bok Tower Gardens:

Mrs. Diana Welsh, Collections Manager

Brendan Huggins, Director of Horticulture

Patrick Lynch, Plant Records Curator

Cheryl Peterson, Rare Plant Conservation Manager

Danielle Smith, Director of Visitor Engagement

Melissa Tyrone, Director of Philanthropy and Membership

Southwest Florida Historical Society

All Hallows Guild with the National Cathedral in Washington, DC

Mrs. Nancy Fetterman, All Hallows Guild Archivist