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A Visit to Rock City Gardens

Rock City Gardens is a self-guided interactive tour. Students will be able to investigate the different types of rocks found at Rock City. By the end of your visit to Rock City Gardens your students should be able to:

- Identify igneous and sedimentary rock.
- Explain the formation of sandstone.
- Explain the formation of mountains.
- Understand the role of water in erosion.
- Explain different ways erosion occurs.
- Identify various plants and trees.
- Identify plant parts, processes and reproduction methods.
- Develop an awareness of our impact on the environment.

To accomplish this task, teachers may use the information in the Resource Guide to prepare students for their visit. Teachers may want to form small groups of students assigned to investigate together. Students may want to take a small notebook with them to record their observations so that they can be discussed back in the classroom.

Teachers may also want to provide a student in a small group with a Rock City Rockquest Guide to help students know what to look for at Rock City Gardens.

Educational Curriculum Standards - Rocks

A field trip to Rock City Gardens combined with a study of the provided educational guide meets the following educational standards.

National Standards

National Science Standards K-4

Content Standard		Topic
A. Science as an Inquiry	A1	Abilities necessary to do scientific inquiry
D. Earth and Space Science	D1	Develop an understanding of properties of earth materials
	D3	Develop an understanding of changes to the earth and sky

National Science Standards 5-8

Content Standard		Topic
A. Science as an Inquiry	A1	Abilities necessary to do scientific inquiry
D. Earth and Space Science	D1	Develop an understanding of the structure of the earth system
	D2	Develop an understanding of earth history

National Social Studies Standards

Content Standard		Topic
Civics	C.K-4.5	Understand important responsibilities of Americans
	C.5-8.5	Understand the roles of a citizen
Geography	G.K-12.3	Understand the physical processes that shape the pattern of the earth's surface
	G.K-12.5	Understand how human actions modify the physical environment

National Language Arts Standards

Content Standard		Topic
Reading for Perspective	NL-ENG.K-12.1	Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among texts are fiction and nonfiction, classics, and contemporary
Applying Language Skills	NL-ENG.K-12.1	Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information)

Tennessee Standards

Tennessee Science Curriculum Content Standards K-8

Standard	Learning Expectation	Topic
9.0 Earth Features (Earth Science)	1.9.1, 2.9.2, 3.9.1,	Identify the earth's major geological features
	4.9.1, 5.9.1	Recognize that the earth's geological features change
	4.9.2, 5.9.2	Know that the earth is composed of different layers
10.0 Earth Resources (Earth Science)	K.10.1, 2.10.1, 3.10.1	Recognize that there are a variety of earth materials which have basic observable and measurable properties
	4.10.3, 5.10.3	Realize the difference between renewable and non-renewable resources

Tennessee Science Curriculum Content Standards 9-12

Standard	Learning Expectation	Topic
3.0 The Rock Cycle (Geology)	3.1	Identify and differentiate between the three rock classes
	3.2	Examine the processes responsible for forming the three rock classes
5.0 Plate Tectonics (Geology)	5.4	Describe the processes associated with volcanoes, earthquakes, and mountain building.
6.0 Personal and Civic Responsibility (Environmental Science)	6.1	Evaluate and articulate his/her own personal views concerning the environment
	6.2	Recognize his/her rights and responsibilities as a citizen in maintaining a healthy environment

Tennessee Social Studies Curriculum Content Standards

Standard	Learning Expectation	Topic
3.0 Geography	K.3.2, 1.3.2, 2.3.2, 3.3.2, 4.3.2, 5.3.2, 8.3.3	Recognize the interaction between human and physical systems
	7.3.6, 9.3.6, 10.3.6, 11.3.6, 12.3.6	Understand how physical processes shape the earth's natural landscapes and affect environments
	7.3.8, 8.3.8, 9.3.8, 10.3.8, 11.3.8, 12.3.8	Understand how human activities impact and modify the physical environment
4.0 Governance and Civics	K.4.3, 1.4.3, 2.4.3, 3.4.3, 4.4.3, 5.4.3, 8.4.5	Understand the rights, responsibilities, and privileges of citizens

Tennessee Language Arts Curriculum Content Standards

Standard	Learning Expectation	Topic
1.0 Language Arts	K.0.1, 1.0.1, 2.0.1, 3.0.1, 4.0.1, 5.0.1, 6.0.2, 7.0.2, 8.0.2	Develop the reading and listening skills necessary for word recognition, comprehension, interpretation, analysis, evaluation, and appreciation of print and non-print texts

Georgia Standards

Georgia Science Performance Standards

Concept	Performance Standard	Topic
Earth Science	SKE2	Students will describe the physical attributes of rocks and soils
	S3E1	Students will investigate the physical attributes of rocks and soils
	S5E1	Students will identify surface features of the earth caused by constructive and deconstructive forces
	S6E5	Students will investigate the scientific view of how the earth's surface is formed
	S6E3	Students will recognize the significant role of water in earth processes
Physical Science	SKP1	Students will describe objects in terms of the materials they are made of and their physical properties
Life Science	S3L2	Students will recognize the effects of pollution and humans on the environment
	SHS	Students will use process skills in laboratory or field investigations, including observation, classification, communication, and analyzing data

Georgia Social Studies Performance Standards

Concept	Performance Standard	Topic
Government and Civic Understanding	SSKCG1	The student will demonstrate an understanding of good citizenship
	SS5CG1.d	Explain the responsibilities of a citizen

Georgia Quality Core Curriculum Standards

Concept	Topic	Standard
Inquiry	Reference Skills	Uses books and other media to obtain information related to science concepts
	Activities/Tools	Actively engages in the learning process via hands-on/minds-on science activities and experiences
Earth and Space Science	Earth Materials: Physical Geology	Classifies rocks according to the manner in which they are formed. Knows the primary groups of rocks (igneous, metamorphic and sedimentary) and knows that characteristics of rock types are a direct result of how they are formed
	Earth Processes: Physical Geology	Recognizes changes that occur on the earth's surface as a result of erosion and deposition. Describes examples of erosion and describes examples of deposition
	Earth Processes: Physical Geology	Explores and discusses change in the earth's surface due to plate tectonics
	Geology	Recognizes that constructive and destructive earth forces (e.g., continental drift, earthquakes, volcanoes, plate tectonics, weathering, and erosion) change the earth's surface
	Composition of the earth	Describes the rock cycle and the importance of heat and pressure
	Formation of earth's features	Describes the theory of plate tectonics
	Human Interactions with the Environment	Recognizes the effects human beings have on pollution and the environment
Civics	Citizenship	Recognizes rights, duties and responsibilities of a U.S. citizen
Language Arts	Reading	Demonstrates comprehension when reading
	Reading	Reads a variety of materials for information and pleasure

Alabama Standards

Alabama Science Course of Study Content Standards

Concept	Standard
Earth and Space Science	Identify components of earth's surface including soil, rocks, and water Identify evidence of erosion and weathering of rocks Identify/describe geological features of earth Classify rocks and minerals by characteristics including streak, color, hardness, magnetism, luster, and texture Describe factors that cause changes to earth's surface over time
Geology	Explain natural phenomena that shape the surface of the earth including rock cycles, plate motions and interactions, erosion and deposition, volcanism, earthquakes, weathering and tide Identify natural surface openings including lava tubes, solution cavities, and caves
Alabama Social Studies Course of Content Standards	
Concept	Standard
Geography	Identify human made and natural resources in the world Describe physical characteristics including landforms, bodies of water, soil, and vegetation of various places on earth Describe processes that shape the physical environment, including long range effects of extreme weather phenomena and human activity
Political Science	Identify ways to take personal action to protect the environment Identify individual and civic responsibilities of citizens

North Carolina Standards

North Carolina Competency Goals

Science	<p>Competency Goal: The learner will make observations and use student-made rules to build an understanding of solid earth materials</p> <p>Objective: Describe rocks and other earth materials in more than one way</p> <p>Competency Goal: The learner will conduct investigations and use appropriate technology to build an understanding of the composition and uses of rocks and minerals</p>
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Science (cont.)	<p>Objective: Describe and evaluate the properties of several minerals</p> <p>Recognize that minerals have a definite chemical composition and structure, resulting in specific physical properties</p> <p>Explain how rocks are composed of minerals</p> <p>Show that different rocks have different properties</p>
	<p>Competency Goal: The learner will make observations and conduct investigations to build an understanding of landforms</p>
	<p>Objective: Identify and analyze forces that cause change in landforms over time</p> <p>Investigate and discuss the role of the water cycle and how movement of water over and through the landscape helps shape land forms</p> <p>Discuss and analyze how humans influence erosion and deposition in local communities, including school grounds</p>
	<p>Competency Goal: The learner will build an understanding of the geological cycles, forces, processes, and agents which shape the lithosphere</p>
	<p>Objective: Evaluate the forces that shape the lithosphere including: crustal plate movement, folding and faulting, deposition, volcanic activity, and earthquakes</p> <p>Describe the processes which form and the uses of earth materials (rock cycle, minerals, characteristics of rocks)</p> <p>Evaluate ways in which human activities have affected earth's pedosphere and the measures taken to control the impact</p>
Earth/ Environmental Science	<p>Competency Goal: The learner will build an understanding of lithospheric materials, tectonic processes, and the human and environmental impacts of natural and human-induced changes in the lithosphere</p> <p>Objective: Investigate and analyze the importance and impact of the economic development of earth's finite rock, mineral, soil, fossil fuel and other natural resources to society and our daily lives</p>
	<p>Competency Goal: The learner will build an understanding of the hydrosphere and its interactions and influences on the lithosphere, the atmosphere, and environmental quality</p> <p>Objective: Evaluate erosion and depositional processes</p>

Educational Curriculum Standards - Plants

A field trip to Rock City Gardens combined with a study of the provided educational guide meets the following educational standards.

National Science Standards

Content Standard	Topic
A. Science as an Inquiry	A1 Abilities necessary to do scientific inquiry
C. Life Science	C1 Characteristics of organisms
	C2 Understanding of life cycles of organisms
	C5 Develop an understanding of diversity and adaptations of organisms

Tennessee Science Curriculum Content Standards

Standard	Learning Expectation	Topic
1.0 Cell Structure and Function	1.1.1, 2.1.1, 3.1.1	Recognize that living things are made up of smaller parts
	1.1.2, 2.1.2, 3.1.2	Recognize that smaller parts of a living thing contribute to the operation and well being of the entire organism
2.0 Interactions Between Living Things and Their Environment (Life Science)	1.2.3, 2.2.3, 3.2.3	Examine interrelationships among plants, animals and their environments
	4.2.2	Recognize that organisms are able to change their environment
3.0 Food Production and Energy for Life	3.0	Study the basic parts of plants, investigate how plants produce food, and discover that plants and animals use food to sustain life
	2.3.1, 3.3.1	Recognize the basic requirements of all living things
	3.3.2	Recognize the basic requirements of all living things
	7.3.3	Describe the movement of oxygen and carbon dioxide between living things and the environment
4.0 Heredity and Reproduction	3.4.1	Recognize that living things reproduce
	2.4.3, 3.4.3	Recognize that the appearance of plants and animals change as they mature
	4.4.3, 5.4.3	Investigate the life cycles of different organisms

Georgia Science Performance Standards

Concept	Performance Standard	Topic
Life Science	S1L1	Students will investigate the characteristics and basic needs of plants and animals
	S2L1	Students will investigate the life cycles of different organisms
	SHS	Students will use process skills in laboratory or field investigations including observation, classification, communication, and analyzing data

Alabama Science Course of Study Content Standards

Concept	Standard
Life Science	Identify the relationship of structure to function in plants, including roots, stems, leaves, and flowers Describe the life cycle of plants, including seed, seed germination, growth, and reproduction
Botany	Identify types of roots, stems, and leaves Describe plant responses to various stimuli Describe the structure and function of flower parts Identify life cycles of ferns

North Carolina Competency Goals

Science	Competency Goal: The learner will conduct investigations and make observations to build an understanding of the needs of living organisms
	Objective: Investigate the needs of a variety of plants
	Competency Goal: The learner will conduct investigations and build an understanding of plant growth and adaptations
	Objective: Observe how the quantities and qualities of nutrients, light, and water affect plant growth
	Investigate and describe how plants pass through distinct stages in their life cycle (growth, survival, reproduction)
	Observe and discuss how bees pollinate flowers
Competency Goal: The learner will investigate the cycling of matter	
Objective: Examine evidence that green plants make food	
Evaluate the significance of photosynthesis to other organisms	

Geology of Rock City

Lookout Mountain is a **landform** with amazing geological phenomena. The top of Lookout Mountain is where you will find Rock City Gardens. Rock City Gardens is an amazing journey through time. The massive rocks of the garden tell the story of Lookout Mountain that many people do not know.

About 300 million years ago the area that is now Lookout Mountain was a shallow sea. The skeletons of the small creatures that lived in the seabed accumulated on the bottom, along with pebbly sand and shale, and were compressed in layers to form **limestone** rock. Limestone rock is a type of **sedimentary rock**. Sedimentary rocks have layers called **strata** that are compressed to form a solid rock. The process that forms a limestone rock is called **lithification**. This limestone rock is still at the heart of Lookout Mountain.

The beaches became something different. Ocean waves and currents deposited sand on the beaches. Over time the sand was compressed to form **sandstone**. Sandstone is a sedimentary rock that is made of tiny grains of quartz.

The sandstone that was formed can be seen on top of Lookout Mountain at Rock City Gardens. In the **Grand Corridor** at Rock City you have a chance to examine the sediments that make up the sandstone rocks. The grains that make up the rocks are different sizes but some of them are easily seen.

At the same time the sandstone of Rock City was forming, Lookout Mountain itself was being born. Tectonic movements of the earth's plates caused a series of powerful earthquakes. The plates pushing against each other buckled, pushing rock upwards to form what is called a **folded mountain**. You know these folded mountains as the **Appalachian Mountain chain**. The limestone of the sea formed the heart of Lookout Mountain and the sandstone beaches are at the top.

The sandstone atop Lookout Mountain has undergone **erosion**. Erosion is the process through which rocks are broken down and carried away. Water, wind, plants, or ice can do this. Water can break down a rock as it flows over it or as waves wash upon the rocks. As the water passes the rocks, it carries it away bit by bit. Wind erosion is more common in dry areas like deserts. Wind blows dust and sand at rocks and the abrasive actions sculpt the rocks into amazing shapes. Plants can erode rocks as their roots work their way down into the cracks of the rocks breaking them apart. Ice is a very powerful force of erosion. Glaciers gouge out valleys and can completely remove a hill as they travel through an area. Ice can form in saturated pore spaces and crack the rocks. The rocks at Rock City have most likely been eroded by water that was flowing through the area millions of years ago. Also the roots of the plants on the trail are contributing to this erosion. A great example of an eroded rock at Rock City is the **Mushroom Rock**. Looking at Mushroom Rock you can see the layers in the rock that characterizes it as a sedimentary rock made of sandstone. This is an example of the strength of sandstone.

You can also examine **igneous rock** at Rock City. Igneous rocks are formed when molten magma from deep inside the earth moves up towards the cooler regions. The magma cools and crystallizes to form the igneous rock. Sometimes the magma is erupted from a volcano as lava and cools on the earth's surface to form extrusive rock. The rock could also cool inside the earth to form intrusive rock. There are no volcanoes on Lookout Mountain. The igneous rocks are seen at the **Seven States Flag Court**. The pedestals for the flagpoles are made of an igneous rock called granite.

Crystals and Coral at Rock City Gardens

Walking through *Fairyland Caverns* you will see **crystals** across the ceiling. The crystals you will see are not natural to the area but were brought in. Crystals are solids that form in a regular repeated pattern and have the same arrangement of particles over and over throughout the entire structure.

Only if a mineral is allowed to grow without interference from other minerals will it form crystals. Minerals "grow," or crystallize, from many types of solutions. Crystals may be formed from evaporating seawater, or from magma when lava cools. While growing, minerals may develop a distinct shape. You can examine the crystals in the Fairyland Caverns ceiling and count the faces of the crystals that are primarily either quartz or fluorite.

Crystals have:

1. An orderly and symmetrical atomic structure (repeated pattern of particles)
2. A definite chemical composition (growing without interference)
3. A definite shape with faces (flat sides)

As you are walking through Fairyland Caverns looking at the ceiling you will also find coral. This coral was brought to Rock City Gardens. Any coral that originally occurred at Rock City was broken up into bits millions of years ago to make the sandstone rocks that surround you. Coral looks like rock but it is actually a living animal. The **coral** you are looking at on the ceiling is actually the hard skeleton of what was once a living coral polyp. The coral grows over thousands of years as the hard skeletons build up. The skeletons are actually made of limestone - the same type of rock you will find at the heart of Lookout Mountain.

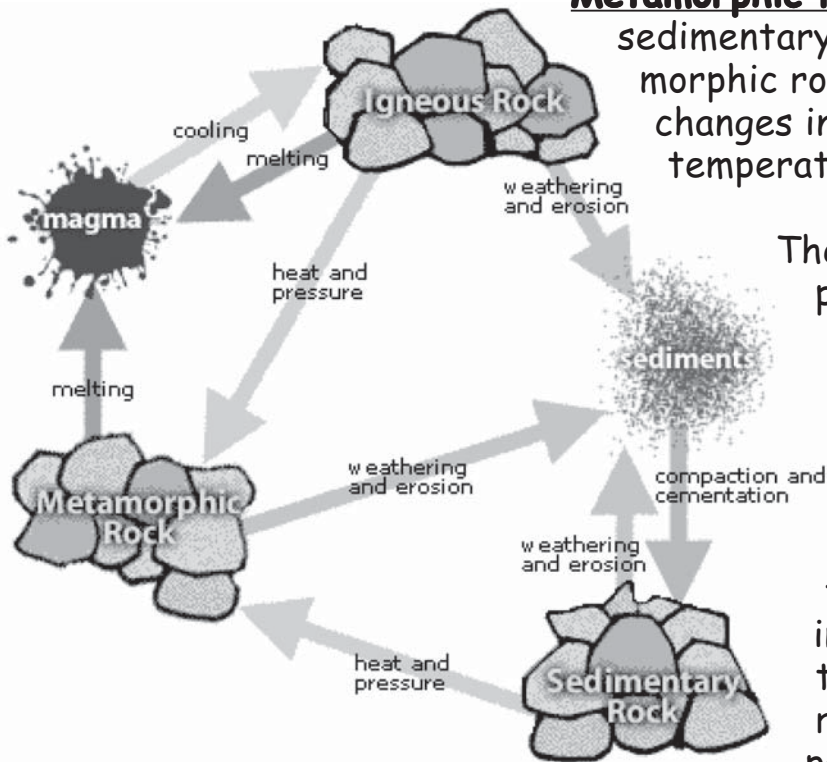
You will also see rocks that seem to glitter. These silvery rocks are made up of thin sheets of material called mica. Aren't they pretty?

Rock Cycle

Igneous Rocks are formed when molten magma from deep inside the earth moves up towards the cooler regions. The magma cools and crystallizes to form igneous rock. Sometimes the magma is erupted from a volcano as lava and cools on the earth's surface. The rock could also cool inside the earth.

Sedimentary rocks are formed when sediments are deposited in layers, or **strata**. These layers are pressed down until the particles become cemented together. **Sandstone** rock is a type of sedimentary rock and contains the mineral **quartz**. Rock City Gardens has boulders and rocks made of sandstone rock. Sedimentary rocks like sandstone form layers that are visible and may contain fossils. While at Rock City you can examine the different sediments of quartz that formed the sandstone.

Metamorphic rocks are formed from sedimentary, igneous, or other metamorphic rocks. The rocks are formed by changes in pressure or changes in temperature.



The **rock cycle** is a continuous process that changes old rocks into new rocks. The chart shows how the cycle works. Rocks are added to the earth's surface by tectonic movement and volcanic action.

The rocks that are exposed to the surface are broken down into rock particles by weathering and erosion. Glaciers, rivers, and wind transport the particles. They are deposited as

sediment in lakes, river deltas, deserts, and the ocean floor. Some of the sediments become **sedimentary rock**. The rock is then either pushed up to the surface or forced deep into the earth. The rocks that are forced deep become **metamorphic rock**. The rock can then be pushed up to the surface or melted to form magma. The rock that becomes magma cools and solidifies to become **igneous rock**. The rocks eventually work their way to the surface and can be broken down again to repeat the cycle.

Environmental Education: Soil Erosion

At Rock City Gardens you have a wonderful chance to examine the effects of **erosion** on the sandstone boulders that are around you. The erosion that carved out the rocks is a natural process that has occurred since the earth's beginning. At Rock City Gardens you can stand on *Lover's Leap* and see ridges that have been carved into the side of the mountain by erosion.

Not all erosion happens the way it should. Soil erosion is a natural process where soil is moved by wind or water. In recent years, accelerated soil erosion has become a problem. Deforestation is a major cause of soil erosion. Trees have deep roots that hold the soil in place. When the trees are removed, the soil is loosened and can easily be washed away. Extensive farming also causes soil erosion. Land that has been farmed too much is easily eroded away and loses nutrients. After land has been farmed too much, even if it is not eroded away, it is no longer able to sustain plant life. Building homes and roads also damages soil. During construction the land is left bare to rain and wind, making it easier to become eroded.

Soil erosion (and degradation) can leave devastating effects. Excessive rain in areas that have been eroded can result in landslides or mudslides. Farmers lose land that is used for producing food. Silt and mud can be washed down streams and build up downstream causing problems for people in that area. Silt and mud can be washed into the ocean where it settles on the bottom. Organisms that live in the ocean are killed by the change in their environment.

Farmers can help to prevent soil erosion by not over-using or over-grazing land. They can also use crop rotation, allowing plants to decay in soil as a natural fertilizer. Plants play a very important part in the prevention of soil erosion. Keeping natural plants in their area and allowing trees to remain is a good way to prevent soil erosion. Plant roots hold the soil in place but they also add their organic material to the soil, which helps to keep it healthy and productive.

Even in your hometown there are probably places that have experienced soil erosion. You can help prevent it at your home by planting plants in barren areas. You can help prevent it by not allowing barren spots with no grass. You can also help by making sure that during a rain shower any areas of exposed soil are protected and not washed away.

Rock City Geology Vocabulary

Coral A polyp found in the ocean. Coral creates hard skeletons that over years build up to make a coral reef.

Crystals A solid substance with a regular pattern and symmetrical faces (or sides.)

Erosion The process by which weathered materials are carried away by wind, water, or glaciers.

Igneous Rock Rock formed by the solidification of molten magma.

Landform A feature on the earth's crust. Examples of landforms are mountains, valleys, plains, and plateaus.

Lithification The process of pressing layers of sediment until they become solid rock.

Metamorphic Rock Rock formed when other types of rock (sedimentary and igneous) are exposed to heat and pressure.

Quartz A crystal that is not easy to break down. It is made of oxygen and silica. **Sand** is very small pieces of eroded quartz.

Rock Cycle A continuous process that changes old rocks into new.

Sandstone A type of sedimentary rock made mostly of quartz.

Sedimentary Rock Rock formed from sediments that have been pressed together over time to make solid rock.

Strata Layers of sediment that are pressed together to make sedimentary rock.

Plants at Rock City

Plants are an important part of our lives. Plants produce oxygen that we breathe; they are also an important food source for people. There are more than 350,000 types of plants in many different shapes and sizes.

Plant Parts

- **Roots** anchor a plant and are used to absorb water and minerals from the soil. There are different types of roots. A **taproot** grows straight down. **Fibrous roots** spread out under the plant to gather water. At Rock City Gardens you will see fibrous roots growing above ground over rocks and boulders as they search for water.
- **Stems** hold the plant upright, allowing it to reach out toward the light. The stem also moves water and minerals up from the roots to other parts of the plant. The trunk of a tree acts as the stem. You will see some trees at Rock City Gardens that have twisted or leaned their trunks in the direction of light through boulders.
- **Leaves** make food for the plant and allow it to breathe. A plant will turn its leaves toward light so that it can absorb it. You will notice how some trees at Rock City have limbs that reach out and above the boulders to allow their leaves to absorb the sunlight easier. In the autumn a tree will shed its leaves because of the cold and dry season. The tree survives on the food that it has stored.
- **Flowers** are used for plant reproduction. Most trees have flowers, too, but they are not as "showy" or pronounced as on most plants.

Plant Processes

- The roots of a plant take in water and minerals from the soil. Water and minerals are transported through the stem all the way to the leaves.
- Plants absorb carbon dioxide from the air. (Carbon dioxide is what humans and other animals breathe out.) The carbon dioxide enters the plant through the leaves.
- Green **chlorophyll** in the leaf of a plant absorbs sunlight a plant needs. Plants use the sunlight in a chemical process to turn water, minerals, and carbon dioxide into sugars the plant can use for survival. The plant releases water and the oxygen that humans and other animals breathe in.
- Plants use the sugar for growth and reproduction.
- The process that plants go through to make sugar is called **photosynthesis**. The formula for photosynthesis is:
Chlorophyll + carbon dioxide + water + sunlight = sugar

Plant Reproduction

Flowering Plants

Plants have several different ways of reproduction. Some very simple plants simply divide and copy themselves in **asexual reproduction**. Most plants use **sexual reproduction** that requires both male and female parts. The male part of a plant is **pollen**. Pollen is found at the end of a stalk called a **stamen**. The female part is called an **ovule**. After fertilization the ovule will become a seed. For this to happen, the pollen must reach the ovule. Plants rely on insects (like bees), birds, animals, wind or water to do this. (Bees in a flower brush against the pollen on a stamen and it sticks to them. They carry it to another flower and brush against the female **stigma** of a flower. The stigma has a tube called a **style** that the pollen travels down. It is connected to the ovule that is waiting for the pollen to produce a seed.) **Pollination** is the movement of pollen from the stamen of a flower to the stigma of another flower. **Fertilization** occurs when the pollen reaches the ovule. After fertilization plants can produce seeds. Some plants produce seeds inside a fruit. Some plants produce seeds in a nut. Some plants like dandelions produce their seeds and release them into the wind.

Cones

Conifers are cone-producing plants (like pine trees). They do not produce flowers like most plants. Conifers have male pinecones and female pinecones. The female cone is sticky. The male cone releases pollen into the wind that sticks to the female cone. Pine trees and other conifers rely on wind for pollination. After fertilization a cone grows with seeds inside. The cone swells and releases the seeds into the wind. It can take over two years for a coniferous tree to produce seeds.

Spores

Ferns, mosses, liverworts, and hornworts produce spores. Ferns do not have pollen like other plants. Ferns have a very strange life cycle. A fern starts out as a **gametophyte**. It is a tiny plant and is both male and female. The male part "swims" to the female part so a fern plant can grow. A fern plant produces **spores** on the bottom of its leaves. The spores are released with the wind and a new generation starts.

When you visit Rock City Gardens you have a chance to examine plants. Look for flowers with pollen used for reproduction. Examine the ferns you will see and check for spores. You might see spores, flowers, and nuts. Also watch for birds. Birds are an important part of plant reproduction because they carry seeds away so that the plants can grow in a whole new place.

Rock City Gardens Plant Vocabulary

Asexual Reproduction Reproduction that does not need both male and female plant parts

Chlorophyll A special green pigment in plants that traps sunlight that it needs to produce sugar

Conifers Plants that produce seeds in cones (like pine trees)

Fertilization Occurs when pollen meets the ovule of a plant

Fibrous Roots Roots that spread out under a plant

Gametophyte A tiny plant in the life cycle of a fern that is both male and female

Ovule The female part of a plant that after fertilization becomes a seed

Photosynthesis Process that plants use to produce sugar from sunlight, water, and carbon dioxide

Pollen Male part of the plant that has to be moved to the ovule to produce seeds.

Pollination Occurs when pollen is transferred to the stigma of a flower. (Usually helped by birds, bees, wind, and water)

Roots Part of the plant that absorbs water and minerals from the soil. They also hold the plant in place

Sexual Reproduction Reproduction with both male and female parts needed

Spores In plants like ferns used to grow the gametophyte that is used in reproduction

Stamen Male part of the flower where you find pollen

Stems Part of the plant that holds it up. Also used to transfer water and minerals from the roots to other parts of the plant

Stigma Sticky tip of the style of a flower that catches the pollen

Style Long tube that leads to the ovule. The pollen sticks to the stigma and travels down the style during pollination

Taproot A root that grows straight down instead of spreading out

History of Rock City Gardens

Before it was a tourist attraction, the area where Rock City is located was the home of Native Americans. A missionary to the Native Americans named Reverend Daniel S. Buttrick made an entry into his journal in 1823. In his entry he states, "I ascended Lookout Mountain to visit a citadel of rocks." No doubt he is referring to what is now known as Rock City Gardens.

During the Civil War a Union officer made a diary entry saying that one could see seven states from the summit at "the Rock City." A Confederate nurse made the same speculation in her own diary. In the latter part of the 1800's Rock City was known to hikers and geologists but was not a tourist attraction.

Garnet and Frieda Carter

- In 1883 Garnet Carter was born in Sweetwater, Tennessee. He moved with his family to the Chattanooga area atop Lookout Mountain when he was 11.
- In 1924 Garnet Carter took part in developing a community called Fairyland atop Lookout Mountain.
- Carter created the world's first miniature golf course atop Lookout Mountain because the community's golf course was taking a long time to be built.
- Carter franchised his "Tom Thumb Golf" all over the United States.
- Frieda Carter wanted to develop her homestead at the Rock City. She took a ball of string and marked a trail winding through the giant rock formations all the way out to Lover's Leap.
- Garnet Carter liked Frieda's idea so well that he helped her, and Rock City Gardens was born.

Rock City Gardens was opened to the public on May 21, 1932 but was not a huge success. Rock City was very hard to find on top of Lookout Mountain. Garnet Carter hired a sign painter named Clark Byers to paint signs on the roofs of barns. The slogan SEE ROCK CITY was born. The barns told the mileage to Rock City, the best highway, or some simply bore the slogan. The signs could be found as far north as Michigan and as far west as Texas. By the end of the 1930's the signs paid off, and more people than ever visited Rock City Gardens.

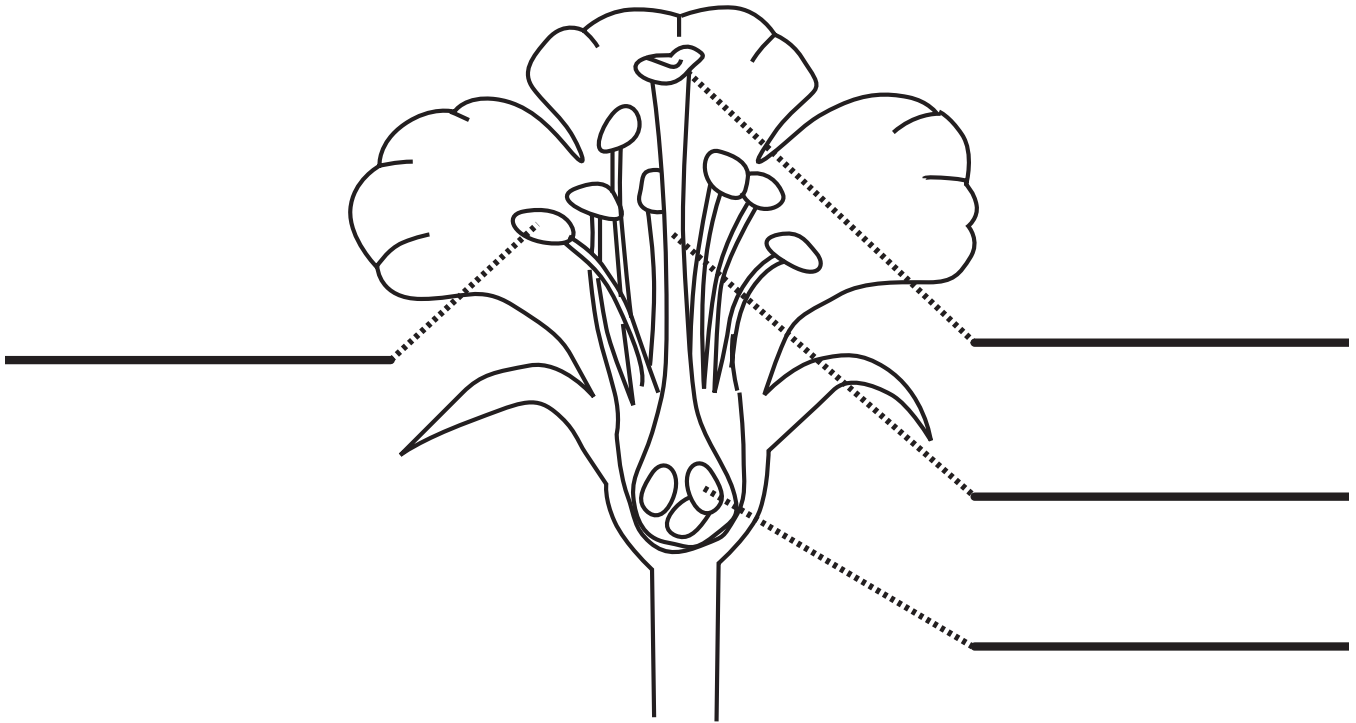
Rocks Multiple Choice Quiz

1. Which of these is a landform?
a) house b) mountain c) mall d) river
2. Erosion is caused by:
a) wind b) water c) ice d) all of the above
3. Rocks formed by volcanic action are:
a) sedimentary b) igneous c) metamorphic d) sandstone
4. Sandstone is made of:
a) quartz b) coral c) mud d) diamonds
5. Lookout Mountain is a part of which mountain chain?
a) Rocky b) Appalachian c) Sierra Nevada d) none of the above
6. The process of pressing sediment together until they become solid rock is:
a) stratification b) lithification c) sedification d) sandstone
7. Soil erosion can be prevented by:
a) digging deep trenches into the ground b) planting trees
c) leaving bare ground d) overgrazing land
8. The boulders at Rock City Gardens are made up of what type of rock?
a) limestone b) metamorphic c) granite d) sandstone
9. The coral found at Rock City Gardens are from animals that live where?
a) Lookout Mountain b) the ocean
c) Tennessee River d) coral are not animals
10. Rock City Gardens was at one time a/an :
a) ocean bottom b) beach c) coral reef d) volcano

A Garden of Knowledge Plant Quiz

1. The _____ of a plant will eventually become a seed.
2. The two different types of roots are _____ which grow straight down, and _____ which spread out.
3. Plants are very important because they release _____ that humans and other animals need to breathe.
4. Plants that produce cones instead of flowers are called _____.
5. A fern starts out as a _____, a plant that is both male and female.
6. The male part of a flower is moved by wind, water, bees, and animals. It is called _____.
7. During pollination, the pollen sticks to the stigma of a flower. The stigma is attached to a long tube called a _____.
8. The green substance in a plant's leaves is called _____.
9. Water and minerals move from up from a plant's roots through the _____.
10. Ferns have _____ on the bottom of their leaves that are released into the wind instead of seeds.

Label the Parts of a Flower



(Hint: Stamen, Stigma, Ovule, and Style)

Plant Hunt

Most of the following plants are labeled and are in order starting at the Grand Corridor and ending at Fairyland Caverns.

1. This shrub is named after John Fothergill, an English physician. It is in the same family as Sweet Gum Tree and Witch Hazel shrub. It blooms in March to April with white, fragrant bottlebrush looking blooms. Hint - don't take too many steps. Can you name this shrub?
2. The original seedling was found growing at Forest Nursery, McMinnville, TN. The new foliage starts out as red-purple. Then it changes to green as the season gets warmer. The flowers are purple to pink, blooming in March to April. This small tree's parents are native to the eastern United States. Can you name this tree?
3. A slow-growing evergreen tree that has red berries. These berries mature in October and are used as Christmas greenery. It is native to the southeast and mid-west United States. Can you name this tree?
4. How many different labeled ferns can you count in the Grand Corridor? What are the names of all these ferns? Hint - be sure to look up.
5. The fall leaf color is usually red to purple on this tree. The bark looks like an alligator hide. This tree is referred to as our "million Dollar Tree". Hint - it starts in the Grand Corridor but you can't see the top until you cross over the trail at Gnome's Overpass. Can you name this tree?
6. This shrub seems to grow out of rocks after Needle's Eye. Its bark is exfoliating or peeling off. The flowers are white, appearing in June, unless we have had a very cold winter. Hint - the foliage looks like a red oak leaf. Can you name this shrub?
7. This shrub has about 150 different species and more cultivars. The flowers are fragrant and open from pink buds to white blooms in late April. Hint - this shrub is native to Korea. Can you name this shrub?
8. This shrub grows smaller than most of its family members and stays compact. The white flowers are slightly fragrant. A U.S. National Arboretum introduction named it after the Eskimos. Can you name this shrub?
9. I am a large tree with warts growing on my trunk. I produce thousands of small black fruit in September and October. The birds love my fruit. Hint - I am a common tree. Can you name this tree?

10. This small tree has definite horizontal branching with stems purple in color. The flowers bloom May - June and are yellow to white in color. Native to northeast down to southeast United States. Hint - related to the flowering dogwood. Can you name this tree?
11. This shrub can grow 15' tall and 15' wide. It flowers in October - November with a fragrant smell. It has thorns, which are quite sharp, and the leaves are dark green above and silvery underneath. Can you name this shrub?
12. This large tree likes its feet to be wet but can stand dry sites as well. It looks like an evergreen tree in full leaf. The foliage turns brown in winter and falls off. Hint - you can see the fruit hanging from large trees just about year round. Can you name this tree?
13. This tree in its youth develops corky wings along the young stems and trunks. The older trees lose these corky wings and develop fruits that are prickly to pick up. They are like walking on marbles when they drop. Hint - you can see the fruit hanging from large trees just about year round. Can you name this tree?
14. This shrub is a coarse textured evergreen plant. The flowers appear March - April and are yellow and fragrant. The fruit, which is bluish in color, matures in July - August and can be damaged by temperatures around 10 degrees. The birds eat the seeds and spread them everywhere. Hint - each leaf has between 5 to 7 prominent thorns. Can you name this shrub?
15. This small tree is a member of the rose family and has over 600 types. The range in flower color is from white to red and appears from April to May. The fruit ranges in color from red, yellow and green in the fall. Hint - if you have bitten into the fruit, you know what bitter means. Can you name this small tree?
16. This shrub has over 900 species, is evergreen and the most abundant plant we have at Rock City Gardens. A poll of gardeners asked what their favorite shrub is - this plant came in number one. It blooms from April - June all colors. Hint - you can see this plant just about anywhere in the gardens. Can you name this shrub?
17. This large tree likes to grow on rocky places and poor soil. Many forms of wildlife eat the large acorns. The bark has more tannin than any other trees in the family. Hint - what do you roast over an open fire at Christmas time? Can you name this tree?

- 18.** This fast growing tree can grow 8' during one season. The leaves on seedlings often reach 2' long. The older tree leaves reach a normal size of 5" to 10" long. Cold weather can kill the flower buds. The flower buds persist through winter, looking like grape clusters. One large tree can produce 20 million seeds. The wood is prized by the Japanese for pots, bowls, spoons, furniture and coffins. The flowers appear in May with a violet to pale blue color. This tree is often found along highway cuts. It is also used to reclaim strip-mined land. Hint - you can find one near the bird viewing deck. Can you name this tree?
- 19.** This shrub grows quickly but can also die quickly during a cold winter. It is fragrant and will flower from June through September if the spent blooms are cut. Hint - the butterflies love this shrub. Can you name it?
- 20.** This shrub looks like it belongs in a southwest desert. It blooms on a 3' stalk and is white from May - June. Look above Shelter Rock and you can see a colony of these plants. Hint - sometimes referred to as the sword plant. Can you name this plant?
- 21.** This plant is considered a small tree or large shrub and is one of the first flowering trees in the woods. It likes to grow on rocky soil and its flowers are white in March - April. The black fruit is liked by birds and other wildlife. Hint - it is also called a Sarvis tree. Can you name this tree?
- 22.** The history of this tree makes a good story. In 1770, John Bartram found this small tree along the banks of the Altamaha River in Georgia and collected a few for his garden. He sent some to Ben Franklin in Philadelphia. The tree has not been seen in the wild since 1790. So if you have one of these trees, you have one that came from Bartram's original collection. The tree has a beautiful 3-3 1/2" white flower that appears in July - August. Hint - Bartram was a great admirer of Ben Franklin. Can you name this tree?
- 23.** This small tree or large shrub blooms red after the leaves have come out. The flowers bloom in May and are about 4"-8" long. Hint - the Ohio State football team is called what? Can you name this plant?
- 24.** This shrub is a graft, but the root stock has taken over from the graft. The original plant was named Arnold Promise. This plant flowers in February. Hint - a witch would like this shrub. Can you name this shrub?

- 25.** This is a large evergreen tree with needles about 1/4 - 1/2" long. It can grow in shade or also sun if water is supplied. Its native range is from Nova Scotia south to the mountains of Georgia. Hint - what country is Nova Scotia in? Can you name this evergreen tree?
- 26.** This large tree loses its leaves in the winter. Its flower is red in March before the leaves appear. It is one of the first trees to color in fall. The colors vary from tree to tree ranging from yellow to orange to red. Hint - this tree and its cousin, the Sugar Maple, are the brightest leaf colors in the fall. Can you name this tree?

Rock City History Review

Garnet Carter was born in Sweetwater, Tennessee in _____ .
His wife was _____ . Garnet Carter invented
Tom Thumb Golf, which was the world's first _____
_____. Frieda Carter used a ball of _____
to mark her winding pathway through Rock City. Rock City Gardens was
opened to the public May 21, _____. Garnet Carter hired a man named
_____ to paint signs
on barns along the roads advertising Rock City. He painted three words, most
often they are _____ !
Since then millions of people have made their way to Rock City Gardens.

Grow Your Own Crystals

Gather these things:

- String (kite string works well)
- A pot (medium to large size)
- Candy thermometer
- Metal bowl or pan
- 2 cups water
- 5 cups sugar
- Spoon
- Foil

Stretch the string across the top of the metal pan or bowl. You will need to let it droop into the liquid, but don't let it touch the bottom. Tape the ends to the outside of the pan or bowl to keep it from touching the bottom.

Put water and sugar in the pot and stir until the sugar dissolves. Place candy thermometer in water and cook until the liquid reaches 250 degrees. DO NOT stir after you have started cooking the liquid.

Carefully pour the VERY hot liquid into the pan or bowl that you have prepared with the string. Make sure that the string is at least 3/4 of an inch under the surface of the liquid. Cover the pan or bowl with foil and don't disturb it for a week. In 7 days, lift out the string and it will be covered with Rock Candy.

Make sure to have an adult's help during the cooking and while working with the hot liquid!

Erosion Experiment

What you need:

A plastic container with a wide neck and a screw on or clip on top, pieces of rock/building material of various sorts

What do you think?

Which type of rock do you think is the toughest? Which will break up fastest? Try to work it out first - then do the experiment.

What to do:

Lay out the rocks and look at them. Put them all in the plastic container together and shake it hard for 15 seconds. Pour them out and see which ones have changed the most. Do this several times to find out which rocks are the best survivors. If you have some kitchen scales, you could try weighing the different bits of rock at each stage to measure how they get broken down.

What happens?

Which rock broke? Why do you think some rocks break more easily? Take your rocks out and examine them. Try other rocks as well.

Make Your Own Sandstone

What you need:

- Sand
- Water
- Milk Carton with top cut off
- Sunshine

What to do:

Fill your milk carton with sand and water. Pack it in very tightly and place in the sun to dry. After a few days, carefully remove the milk carton and you will have a block of sandstone. Careful, it is fragile!

How A Stem Works

What you need:

- 2 glasses of water
- Food coloring
- A fresh piece of celery with its leaves on top
- A white carnation
- Knife (adults only please)

What to do:

1. Add a few drops of food coloring to each glass of water.
2. Put the celery in one glass and the carnation in the other.
3. Set the glasses in the sunlight and leave alone for 24 hours.

What happens?

Look at your celery and carnation after they have been sitting in the sun. They have changed to the color of your food coloring! That is because the stem of the celery and carnation were pulling up the water from the glass to the rest of the plant. An adult should cut the stem of the plants so that you can find the tubes that the plants used to carry the water.

Rock City Marigold Gardens

- Concept:** To observe how plants grow and change.
To understand basic needs of all plants.
- Problem:** How are beautiful flowers like those at Rock City Gardens produced?
- Materials:** One egg carton, potting soil, Rock City Marigold seeds, water, sunny window sill.
- Procedure:** Fill each section of your egg carton with potting soil. Carefully open your seed packet (Marigold seeds are tiny, so be careful!) Plant five or six seed in each cup of dirt. Cover seeds with 1/4" to 1/2" of dirt. Water each section with a teaspoon of water. Place your Rock City garden on your window sill.
- Conclusion:** With proper care, your seeds should grow and blossom. The care involved promotes responsibility on the part of the student. If all needs of the seeds are met, they will grow.

Try these fun activities with your garden!

1. To teach students that plants need sunlight, try placing half of the plants in the shade and the other half in the sunlight. Students can see the difference in how well that plants grow.
2. Show students that plants need soil by planting some seed in sand, some in clay, and some in potting soil. Watch and see which ones grow best.
3. Dig up a plant that has just sprouted and have the students draw a picture of the sprout and roots. Wait another week and make a picture of another sprout. Wait until a bud forms on the plant and make another diary. Keep a record of the growth on the bulletin board.
4. Plants need leaves to survive. After the plants have grown leaves take one plant and remove all but about two or three leaves. Have the students watch and see that the plant with more leaves grows better.

Plants Are A-maze-ing!

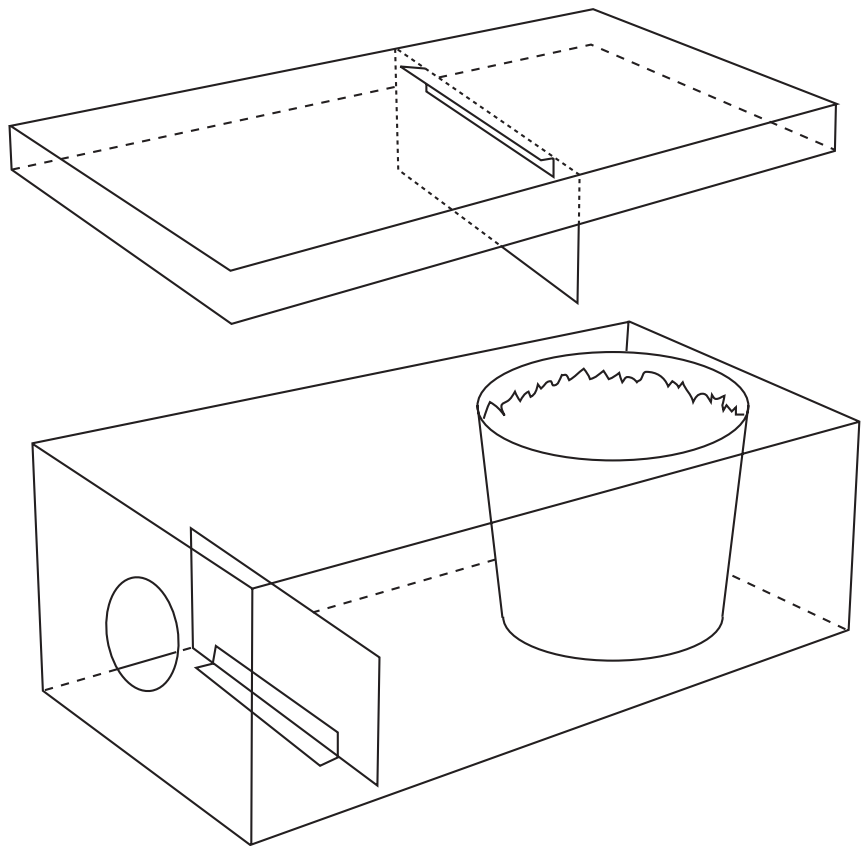
You will see some plants in Rock City have grown in strange ways to reach the sunlight they need in this activity you can see that in action.

Materials:

- Shoe box with lid
- Sprouting potato
- Small pot that will fit in shoe box with lid closed, filled with moist potting soil
- Two pieces of cardboard
- Tape

What to do:

1. Plant the potato halfway in the pot of moist soil.
2. Put the pot in one end of a shoe box.
3. Cut a hole about 1" in diameter at the other end of the box.
4. Tape one piece of cardboard coming from the shoe box lid (leave a 2" space underneath so that it doesn't touch the bottom of the box) and one at the bottom of the box (leave a 2" space at the top).
5. Put the top on the box and place next to a window with the hole facing the window.



In a few days the plant should grow through the maze toward the light.

Quiz, Review and Plant Hunt Answers

Rocks Multiple Choice

1. B - mountain
2. D - all of the above
3. B - igneous
4. A - quartz
5. B - Appalachian
6. B - lithification
7. B - planting trees
8. D - sandstone
9. B - the ocean
10. B - beach

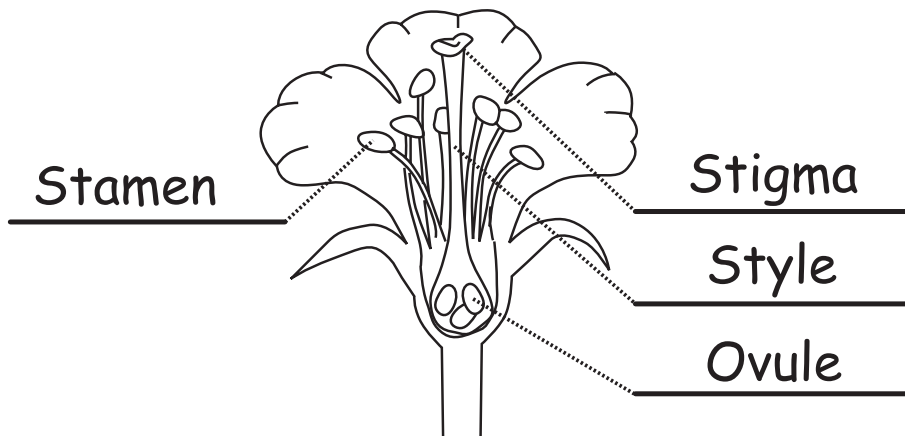
A Garden of Knowledge

1. The ovule of a plant will eventually become a seed.
2. The two different types of roots are taproots which grow straight down, and fibrous roots which spread out.
3. Plants are very important because they release oxygen that humans and other animals need to breath.
4. Plants that produce cones instead of flowers are called conifers.
5. A fern starts out as a gametophyte. A plant that is both male and female.
6. The male part of a flower is moved by wind, water, bees, and animals. It is called pollen.
7. During pollination, the pollen sticks to the stigma of a flower. The stigma is attached to a long tube called a style.
8. The green substance in a plant's leaves is called chlorophyll.
9. Water and minerals move from up from a plant's roots through the stem.
10. Ferns have spores on the bottom of their leaves that are released into the wind instead of seeds.

Plant Hunt

1. *Fothergilla gardenii* - Dwarf Fothergilla
2. *Cercis Canadensis* 'Forest Pansy' Eastern Redbud
3. *Ilex opaca* - American Holly
4. Labeled Ferns: 1) Autumn Fern 2) Christmas Fern 3) Cinnamon Fern
4) Japanese Painted Fern 5) Royal Fern 6) Tassel Fern
7) Boston Fern 8) Resurrection Fern
5. *Nyssa sylvatica* - Black Gum or Sour Gum
6. *Hydrangea quercifolia* - Oakleaf Hydrangea
7. *Viburnum carlesii* 'Cayuga" Korean Spice Viburnum
8. *Viburnum utile* - Eskimo Viburnum
9. *Celtis occidentalis* - Common Hackberry
10. *Cornus alternifolia* - Pagoda Dogwood
11. *Elaeagnus pungens* - Thorny Elaeagnus
12. *Taxodium distichum* - Common Bald Cypress
13. *Liquidambar styraciflua* - American Sweetgum
14. *Mahonia bealei* - Leatherleaf Mahonia
15. *Malus* sp. - Flowering Crabapple
16. *Rhododendron* sp. - Rhododendron or Azaleas
17. *Quercus prinus* - Chestnut Oak
18. *Paulownia tomentosa* - Princess Tree
19. *Buddleia davidii* - Butterfly Bush
20. *Yucca filamentosa* - Adam's Needle Yucca
21. *Amelanchier laevis* - Serviceberry
22. *Franklinia olatamaha* - Ben Franklin Tree
23. *Aesculus pavia* - Red Buckeye
24. *Hamamelis vernalis* - Vernal Witch Hazel
25. *Tsuga Canadensis* - Canadian Hemlock
26. *Acer rubrum* - Red Maple

Label the Parts of a Flower



Rock City History Review

Garnet Carter was born in Sweetwater, Tennessee in 1883. His wife was Frieda Carter. Garnet Carter invented Tom Thumb Golf, which was the world's first miniature golf course. Frieda Carter used a ball of string to mark her winding pathway through Rock City. Rock City Gardens was opened to the public May 21, 1932. Garnet Carter hired a man named Clark Byers to paint signs on barns along the roads advertising Rock City. He painted three words, most often they are SEE ROCK CITY! Since then millions of people have made their way to Rock City Gardens.