




OKLAHOMA
CareerTech

Introduction to Agriscience

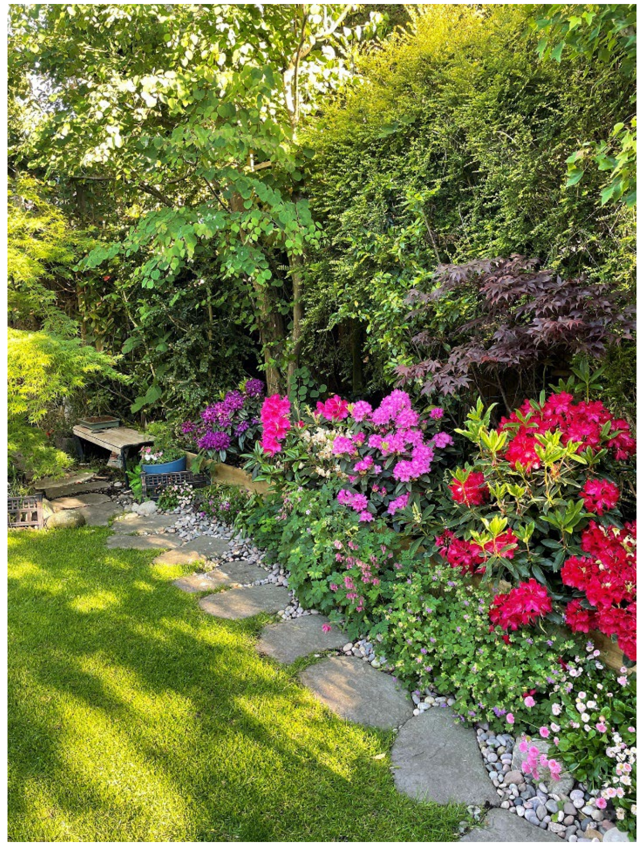
Unit 4
Plant and Soil Science

Student Edition

CIMC

AG3001

Unit 4
Plant and Soil Science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People in many professions need a good knowledge of plants and soil because they are important for so many of our everyday needs, such as food, shelter and transportation. Outdoor activities such as golfing, hiking, or bike riding involve plants and soil. Outdoor sports such as football, tennis, and baseball also depend upon plants and soil. Hundreds of activities that people enjoy every day rely upon plants and soil that have been modified for that specific use. Like the farmer or rancher, people who design parks, playing fields, golf courses, or hiking trails need a good knowledge of plant and soil management.

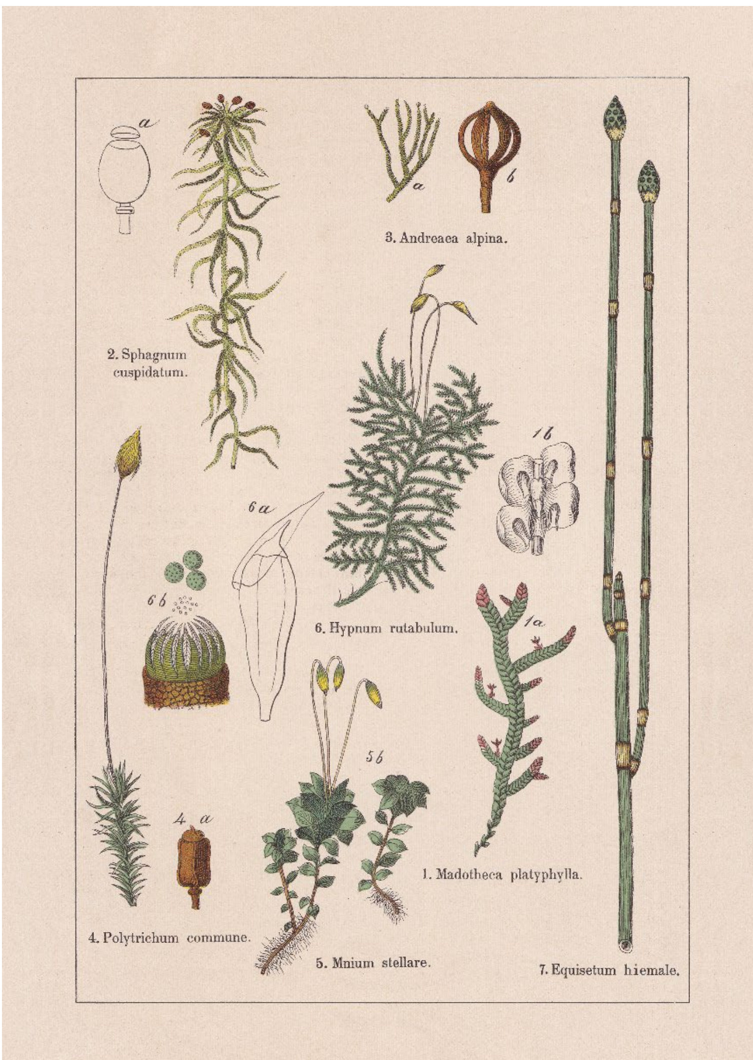
When scientists began to study plants and soil to determine how they work together to provide humans and animals with a food source, there became a need to name plants, as well as soil, according to a variety of characteristics. Naming and classifying plants, along with determining how plants grow and how soil is formed, has led to advancement in plant growth and production.

OBJECTIVES

1. Determine how plants are taxonomically named.
2. Discuss how plants are classified.
3. Examine the processes that occur within a plant leaf.
4. Determine the requirements for plant growth.
5. Identify types of plant growth media.
6. Discuss soil formation and major components.
7. Read the soil textural triangle.

KEY WORDS

annual
biennial
chlorophyll
climate
deciduous
dormant
evergreens
hydroponics
loam
minerals
organic matter
parent material
peat moss
perennial
perlite
photosynthesis
pine bark
respiration
sphagnum
topography
transpiration
vermiculite



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Plant Taxonomy

Like animals, plants are scientifically classified and named using the same taxonomic system. This hierarchical system has seven levels of classification. The top level is the kingdom. All plants belong in the kingdom *Plantae*. The lowest two levels of classification, genus and species, give the plant its individual scientific name. This is also called its botanical name, or simply its Latin name, because the taxonomic names are all in Latin.

The Father of Taxonomy

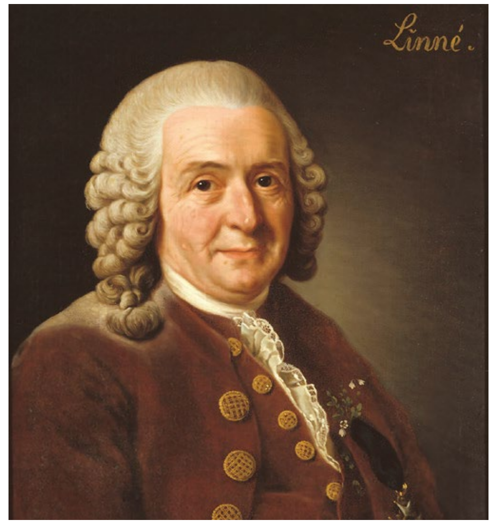

Photo courtesy Wikimedia Commons

Carl Linnaeus lived in Sweden in the 1700s. He is widely known for beginning the taxonomic system in use today for classifying plants and animals. The system that Linnaeus developed continues to undergo revisions, as scientists learn more about plant and animal species.

This is the system that Linnaeus developed:

Kingdom
Phylum/Division
Class
Order
Family
Genus
Species

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Latin names for plants are important for precise identification. Every plant has a unique Latin name. Many plants are known by more than one common name, or one common name may apply to more than one plant. For example, Purple Coneflower is commonly known throughout the Great Plains. However, Mexican Hat is a plant that is quite different in its growing habits and appearance, but it is sometimes called "Coneflower."

Of course, people in the United States normally don't speak Latin, so it may seem like a chore to memorize the scientific plant names. Luckily, the English language is based in large part on Latin. Therefore, a Latin word is often quite similar to an English word. Also, the species names given to plants are frequently descriptive of the plant itself. For instance, the species name may describe the plant's color, leaf shape, or the terrain where it grows.

Latin Words That Describe a Plant's Color

Cardinalis or rubra	Red
Rosea	Pink
Citrina	Yellow
Purpurea	Purple

Latin Words That Describe a Plant's Location

Canadensis	From Canada
Alpina	From the mountains
Riparia	From the riverbanks
Occidentalis	Western

Latin Words That Describe the Shape, Location, or Color of a Plant's Leaves or Flowers

Dendron	Tree
Phyllus, phyla	Leaf, leaves
Flora, florum, florus	Flower
Caulis	Stem of a plant

Latin Words or Prefixes That Describe the Size or Other Characteristics

Fragrans	Fragrant
Giganteum	Large
Arborea	Tree-like
Elegans	Elegant, slender
Compactus	Compact, dense
Armatus	Armed
Diversi	Varying
Plumosus	Feathery
Macro	Large
Micro	Small
Nana	Dwarf
Edulis	Edible

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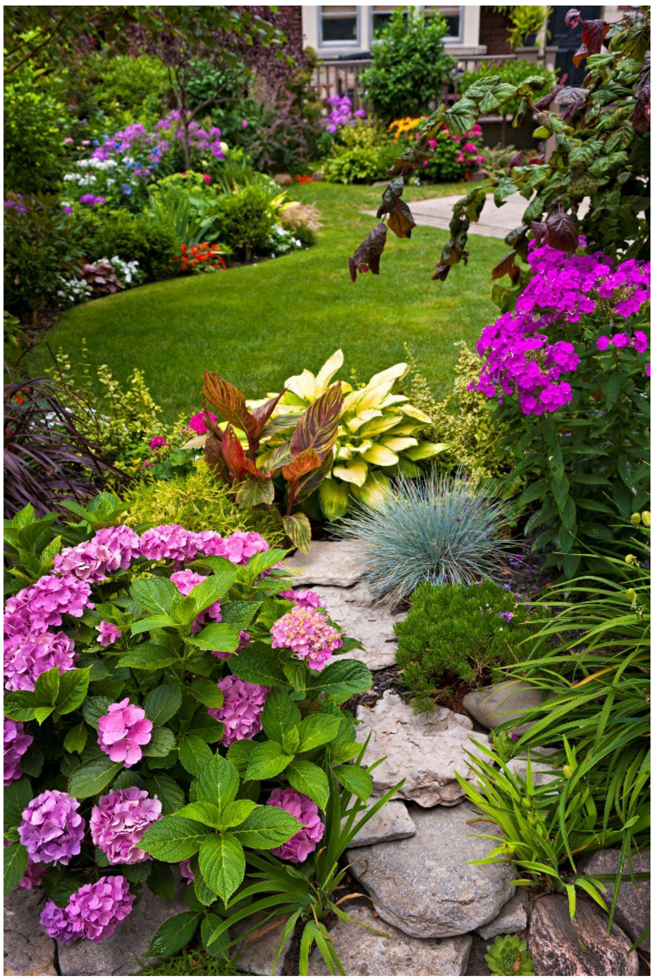
You may come across the Latin word *grandiflora*, derived from the Latin root words *grandi* (large, showy) and flora (flower). It means “large, showy flowers.” Similarly, the word *microphylla* means “small leaves.” When using Latin (scientific) names, the genus name is always capitalized and the species is not capitalized. The entire name is italicized.

> EXAMPLES: *Helianthus annuus* (annual sunflower); *Buchloe dactyloides* (buffalograss).



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Classifying Plants

Although plants are scientifically classified and named, they can also be grouped based on their longevity or structures. These common classifications are important to know because they affect decisions about what plants should be grown in a particular location or for a particular purpose. Some plants such as grasses and trees can live longer than others, like marigolds or periwinkles. Can you imagine the grass in yards dying in the fall and having to be replanted every spring? Grasses are one plant that will come back year after year without replanting.

Longevity

Plants are often grouped according to the length of their life cycle. A plant’s life cycle is the time between germination and death, assuming proper living conditions. Plants are grouped into three categories: annual, biennial and perennial.

Annual plants complete their entire life cycle, including reproduction, within one growing season (usually, the spring, summer, and fall months). Many ornamental flowers are annuals because producing many flowers quickly is how the plant best reproduces.

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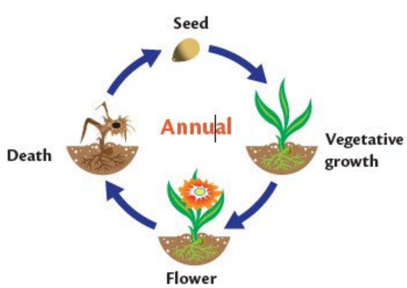
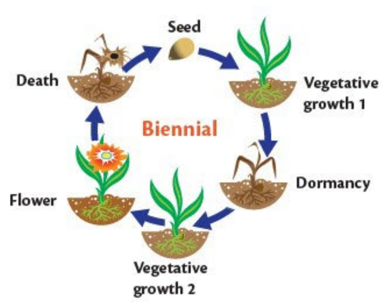
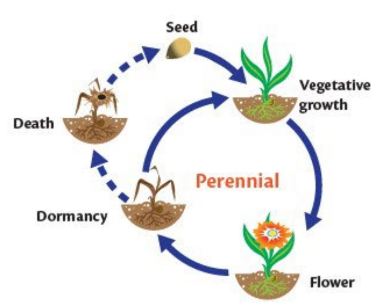
Biennial plants need two growing seasons to complete their life cycle. These plants germinate and grow during the first growing season, overwinter, and reproduce or set flowers during their second growing season.

Perennial plants grow season after season. They may flower the first growing season, as in the case of some grasses, or not for many years, as is characteristic of some trees, but they may reproduce each season thereafter. Trees and many shrubs are perennials. While perennial plants live through all seasons of the year, they still experience different amounts of growth during each season. During the cold winter season, most are ***dormant***, meaning they either slow their growth or stop growing completely. Some plants lose their leaves as part of this dormant period. The leaves die during the autumn, sometimes turning beautiful red, orange, and yellow colors, and then fall from the tree or shrub. These plants are called ***deciduous***. Other plants keep their leaves and green color throughout the year. These plants are called ***evergreens***. Their leaves do drop, but only a few at a time.

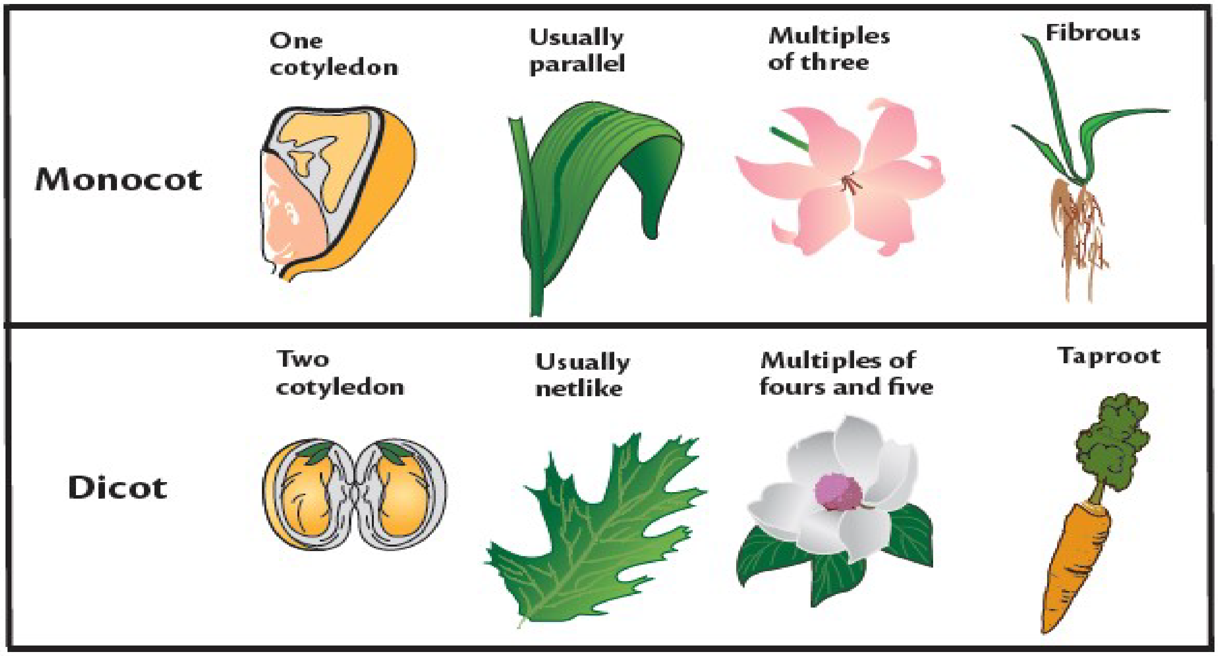






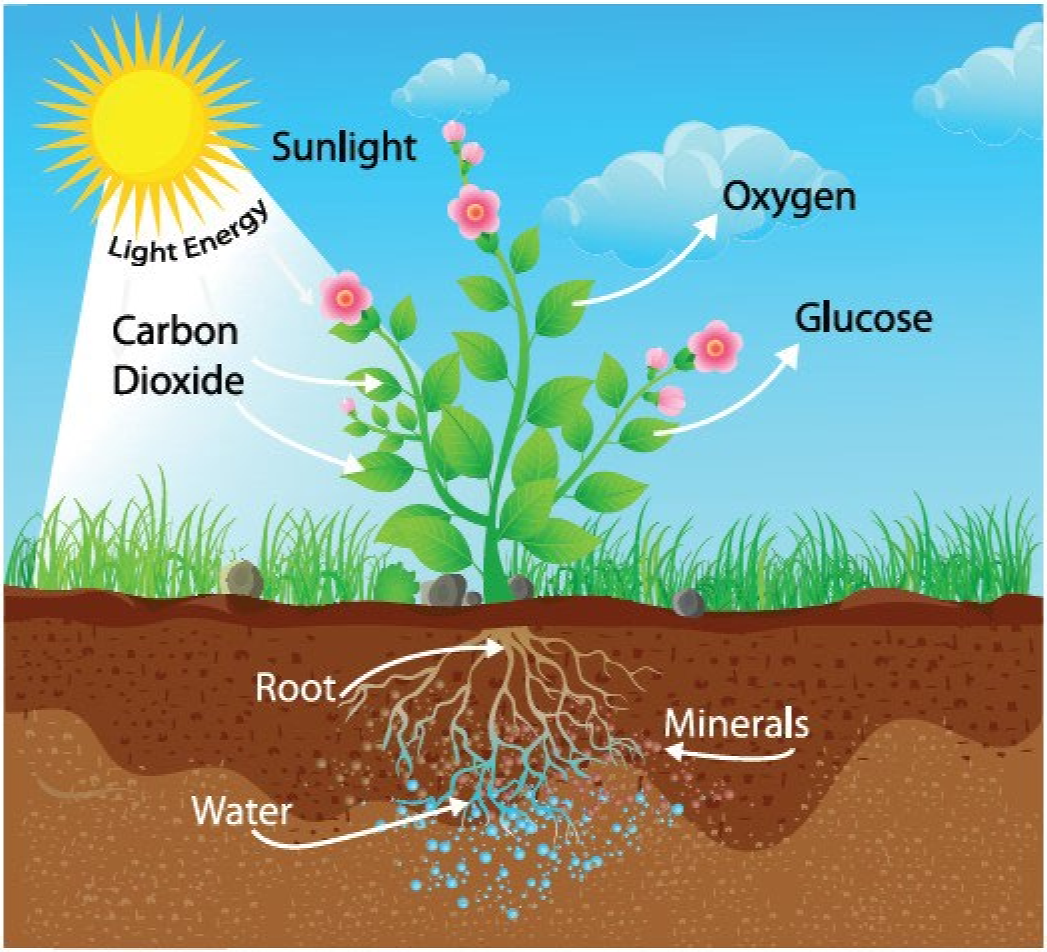
Structures

Plants can also be grouped according to common structures or parts. The two principal categories are monocots and dicots. The word “mono” means one and “cot” means leaf, which indicates that when a monocot sprouts it has only one seed leaf. A dicot has two seed leaves because the word “di” means two. Monocots tend to be simpler in their structural design, while dicots tend to be more complex. These differences can be seen in the roots, seed leaves, leaf veins, and floral parts.



Leaf Processes

How do plants obtain food? If they don’t eat like humans and animals, how do they obtain nutrients to grow? Plants are unique because they can manufacture food within their leaves and store it for future use. This process of food production is called ***photosynthesis***, which involves carbon dioxide, water, light energy, and ***chlorophyll***, or the green pigment in the leaves. During photosynthesis, light energy is taken in by chlorophyll-containing cells in leaves along with carbon dioxide from the air. Water is taken in by the leaves or roots. The leaf cells then use these ingredients to manufacture food for the plant through a chemical reaction, which also results in oxygen that is released into the atmosphere. The newly manufactured food is distributed throughout the plant or stored.



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When the plant is ready to use the food in the form of sugar produced through photosynthesis, the plant goes through a process like humans called ***respiration***. During respiration the plant uses oxygen taken in through the leaves and water from the roots to convert the stored sugar into usable energy. Humans undergo this same process when breaking down food. Once food has been changed into energy, plants just like humans expel carbon dioxide into the atmosphere.

Do plants sweat? Sure, they do. Plants lose water via openings in the skin of the leaf through a process called ***transpiration***. Unlike humans, plants can control when they sweat. On hot, sunny days, plants will close the openings of the leaf to prohibit water from exiting. On cooler days, the openings will reopen because there is less chance for water to evaporate from the leaves due to the heat.

Each of these three processes is important in ensuring the health of the plant. Without the ability to make, store, and process food, along with being able to release or retain water, plants would not be able to function. This is much like when humans are unable to digest what they have eaten.

Plant Growth Requirements

SAE IDEA:
Exploratory
Take photos to use for plant or insect identification.

Growth is the process by which plants become larger by increasing the size and the number of cells, which is reflected in an increase in the number of leaves, stems, and roots. Plant growth is a progressive development from seed germination through flowering and fruiting. Many factors influence the various stages of plant growth.

Plants are living organisms that have certain requirements for successful growth. While these requirements may differ drastically from one species to another, the basic factors remain the same. Water is essential, even for plants that are adapted to very dry climates. Like humans and other animals, a plant's structure consists mostly of water. Plants receive hydrogen from water as a nutrient.

Light is required for the process of photosynthesis to take place. In fact, "photo" means light, and "synthesis" means combining different parts into one whole. Outdoor plants get the light they need from the sun. The amount of light they receive can trigger reactions in the plant, such as growth when days get longer in the spring, or dormancy, a period of rest, when days get shorter in the fall. The amount of sunlight needed for growth varies greatly depending on the plant species.

Air supplies the carbon dioxide that plants use in photosynthesis. Plants absorb this compound from the atmosphere, as well as from air trapped within the spaces between

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SAE IDEA:
Research
Investigate the best types of artificial lights for plant growth.

soil particles. Nutrients for plants come from air, water and minerals. Carbon, hydrogen and oxygen are supplied by the air and water. There are 14 additional "essential nutrients" that plants must have to thrive. These are supplied in mineral form and absorbed from the soil by the plant's roots. Without the proper nutrients, the plant will not thrive and may not be able to reproduce. Most soils do not have the proper amounts or balance of these nutrients, so growers usually add what is needed in the form of fertilizers.

Temperature is another important factor that affects a plant's growth. The temperature of both air and soil affects the plant. Most agricultural plants prefer a temperature between 60° and 90°F. Other plants around the world are adapted to warmer or colder temperatures.

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Soil is a necessity for most plants, although in some cases plants do grow without soil. For most plants, soil provides an anchor for the roots. It is also the source of mineral nutrients for the plant. While most agricultural plants rely on soil as their growth medium, plants grown in nurseries may be placed in "soilless media" made from organic and mineral materials. Another way of growing plants without soil is called ***hydroponics***, which is a growing method that uses a mineral nutrient water solution without soil. There is even a plant class that anchors to surfaces without soil and obtains their nutrients almost entirely from air and water. Whether or not soil is used, a plant must have a source of mineral nutrients.

Plant Growth Media

Dirt is what most people think of when they picture a plant's growing media, but in fact, dirt is considered a bad word in the world of soil science. Plants often require different growing conditions, which will affect the type of growth media. Some growth media is considered organic, or all-natural, while other growth media is composed mainly of minerals. This type of media is inorganic. Some media occurs naturally on the earth and is referred to as soil.

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Organic Media

Leaf mold, compost, and sawdust are common and popular organic materials used for home gardens and greenhouses, but they are not used in commercial greenhouses or nurseries because they contain seeds and toxins. Some commonly used organic materials include peat moss, sphagnum (sfag-num) moss, and pine bark. These are safer because they generally do not include the seeds and toxins found in materials such as leaf mold or compost.

Peat moss is partially decomposed plant matter. The benefit to peat moss is its high water and nutrient retention capabilities. Peat forms under water and is preserved by water. It is collected from marshes, bogs, and swamps. As with any crop, the peat harvest can be plentiful or scarce according to climate conditions.

Sphagnum is a type of peat moss. It is dehydrated stems and leaves of acidic bog plants, which are shredded and used to cover planted seeds. Sphagnum moss also has good water retention, absorbing 10 to 20 times its dry weight in water. Another benefit to sphagnum is its ability to control disease.

Pine bark when used is broken into small pieces of 1/4 inch or smaller. The bark absorbs nutrients and releases them slowly. Most tree bark mixtures use pine, although some use oak bark. Redwood and fir barks are less popular. Nurseries use tree bark more frequently than greenhouses do because they tend to decompose slowly.

Inorganic Media

For a material to be considered organic, it must have once been living. Although materials such as perlite and vermiculite are found in nature, they are considered inorganic since they did not originate from a plant or animal.

Perlite is volcanic rock that has been crushed and heated to 1800º F. It is used to improve aeration in growth media and can hold three to four times its dry weight in water. One disadvantage to perlite is its inability to hold nutrients.

Vermiculite is a heated mica compound. Mica is a mineral formed as sheets in rocks and is apparent by its shiny luster. It is used to improve moisture retention and it absorbs and gradually releases nutrients.

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Natural Soils

The uppermost layer of soil, consisting of air, water, minerals, and organic matter is called topsoil. It is the most important layer or natural soil for plant production. Topsoil is typically a combination of sand, silt, and clay particles with the ratios of each varying from location to location. If a soil has approximately equal parts of sand, silt, and clay it is considered a ***loam***. A loam soil has the optimum characteristics for plant growth. It allows water to drain but not so quickly that it is unavailable for plants to use. It also allows air to move throughout the soil, allowing aeration of the roots.

Another natural soil that can be used is masonry or plaster sand, which consists of sharp, coarse particles. Disadvantages of this type of soil are that it must be cleaned and sterilized before use, does not hold water, and contains very few nutrients.

Formation and Major Components of Soil

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Every building needs a solid foundation, and that foundation is generally placed on soil. Builders need to understand soil properties when they design and construct houses, apartment buildings, office buildings, roads, railroad tracks, bridges, airport terminals, or anything that people live in, work in, and travel on. If a construction project is built on inadequate soil that doesn't give good support, the building will settle and cause cracked walls, broken pipes, and other damage. Soil is also used as a building material. One common example is adobe, which is used extensively in Mexico and the Southwest United States.

One essential use for soil is in waste disposal facilities. These range from the home septic system to large landfills. In either case, as waste material moves through soil, organic elements are broken down and incorporated into the soil. A serious problem with waste disposal is the movement of hazardous material, such as harmful bacteria and toxins, through the soil and into the water table. Engineers must study and analyze potential waste disposal sites to make sure that contaminants cannot leach out of the soil and into areas where they would pose a health risk.

SAE IDEA:
Entrepreneurship
Grow and sell red worms used to produce compost.

If you ever consider soil, you might think of it as something lifeless that simply sits there, never changing. In fact, soil is constantly forming, changing, and aging. Soil formation is a process that is affected by five factors: parent material, climate, topography, living organisms, and time.

Formation

The ***parent material*** of a soil is the original matter from which the soil particles are formed. Most soils are mineral in origin, meaning the parent material is rock. Some examples are sandstone, marble and granite. Other soils are organic in origin, meaning the soil is made mostly from living organisms that have decayed. The parent material of organic soils is plant life.

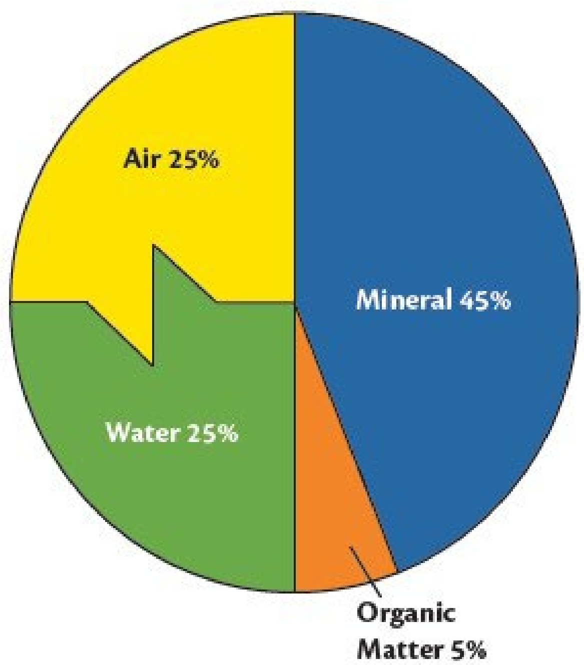
Weathering, in the form of temperature and rainfall, helps to initially break apart the parent material into smaller particles. ***Climate*** conditions, such as humidity and wind, also create changes in already formed soil by affecting the amount of organic matter the soil holds. Rainfall also serves to move materials through the soil.

SAE IDEA:
Placement
Be a sales associate at a garden or farm supply store.

The soil's location affects its development, as well as exposing it to different forces. ***Topography*** is the variation of the earth's surface, such as elevation and slope. If soil is located on a slope, gravity and water will cause the soil to move downhill and accumulate at the base of the slope. Soil in a sunny location will tend to be drier than soil that is shaded. All organisms that live on or in the soil affect its formation. These include plants, insects, microbes, and animals — including humans. Like people, soils change and age over time. Soil may become deeper, thinner, or more or less productive as time allows other factors to affect it.

Composition

Soils contain four components: minerals, water, air, and organic matter. ***Minerals*** are the small rock particles in the soil. These contain various nutrients that are important for plant growth, such as calcium and iron. About 45 percent of an average soil is mineral matter.



Organic matter, or humus, in soil is made of decaying material from living organisms such as plants, worms, insects and animals. While minerals are considered inorganic matter, organic matter is anything that is, or once was, living. Organic matter supplies additional important nutrients for growing plants. About 1 to 5 percent of the average soil is organic matter.

Air and water fill the small spaces between particles in soil. These spaces are called pores and make up about 50 percent of the average soil. For ideal plant growing conditions, the soil would have nearly equal amounts of air and water. A dry soil will have mostly air in its pores, while a very wet soil will contain more water than air.

Soil Textural Triangle

A simple way to classify soils is by texture. This method is commonly used by growers to determine how well crops may grow in a certain soil. With this method, soils are classified by the size of the mineral particles. Particle size is important because it affects how well the soil holds and drains water, as well as the nutrients necessary for plant growth. There are three main soil particles: sand, silt, and clay. Soil is rarely composed 100 percent of a particle. Soils in different areas are a variant mixture of each of the soil types.

Sand

Sand is the largest particle of the three types. Sand particles are between 0.05 and 2.0 millimeters in diameter. Soil with a sandy texture feels gritty when rubbed between your fingers. The large particles allow water to drain through the soil quickly. Sandy soil is not usually good for growing crops because nutrients are also washed away easily.

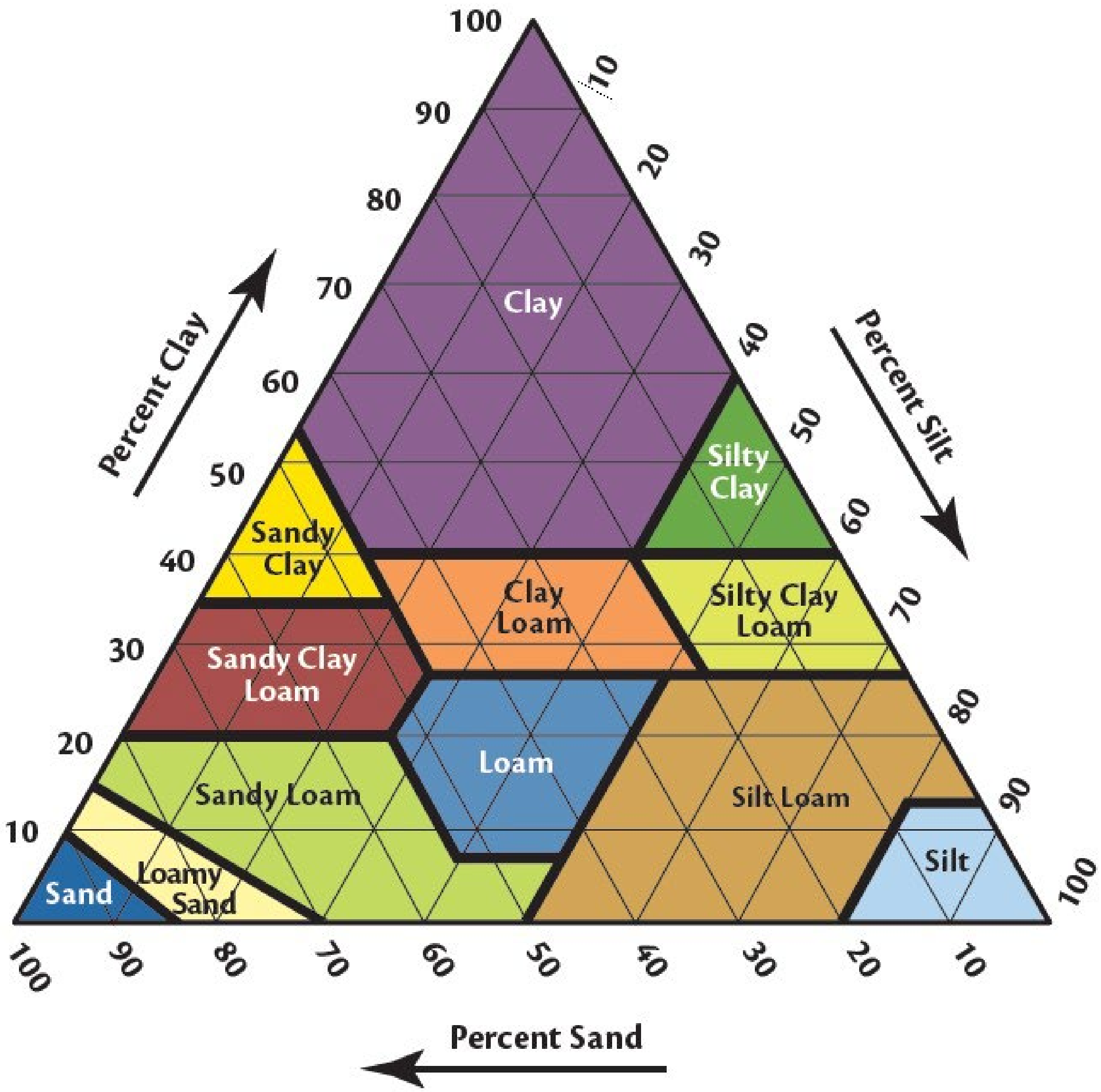
Silt

Silt is finer than sand, with particles between 0.002 and 0.05 millimeters in diameter. Silt feels powdery to the touch. Silt's finer texture holds water and nutrients in the soil well, making it a better texture for growing crops.

Clay

Clay is the smallest soil particle, measuring less than 0.002 millimeters in diameter. Clay tends to be very hard when dry and sticky when wet. Wet clay stains the fingers when handled. Clay soils are heavy and hard to work and do not allow water to penetrate or drain well, making them less desirable for growing most crops.

To determine the texture of a soil, one must first know the percentages of two soil types. For example, if a soil consists of approximately 30 percent clay and 20 percent sand, then that would mean the remaining amount, or 50 percent, is silt. The actual soil texture can be determined by where the lines of each percentage intersect. The lines for each soil type run the same direction in which the percentage numbers appear. If the lines intersect on a texture division line, either soil texture can be used.



UNIT SUMMARY

Plants and soil have been a part of the Earth for thousands of years. They provide a food source and circulate the oxygen we breathe. Without the soil, many of the plants we enjoy would not be able to grow, and without many plants, humans and animals would not be able to survive. Plants have been named using a taxonomic system identifying it first as part of the plant kingdom and continuing through the system to the lowest levels of classification, genus and species. Besides scientific classification, plants can also be grouped by their growing cycle and structures. Plants perform many processes including photosynthesis, respiration, and transpiration. Each of these processes plays a vital role in growth and health of the plant.

All plants need water, light, air, proper temperature, and a growing medium such as soil to grow. Without these requirements, plant health can suffer. Many of the requirements can be obtained from the growth media or soil. Not all plants grow in soil; many are planted in potting soil or mixes that contain organic and inorganic materials. Soil is formed over many years from the weathering of rocks with the help of climate and topography. Every soil is composed of different materials depending upon where it was formed. The soil texture is important because it shows how much sand, silt, and clay are in a soil. The proper mixture of these three minerals will greatly impact soil health and plant growth.

UNIT REVIEW

1. Why are plants given a scientific name along with a common name?
2. What language is used to scientifically name plants?
3. Give five Latin words and what they mean.
4. What is the difference between an annual, biennial and perennial plant?
5. What do the prefixes “mono” and “di” mean?
6. How do monocots and dicots differ?
7. Describe each of the three processes that occur in the leaf.
8. Which of the three plant processes described also occurs in humans? Explain.
9. What are the six requirements for plant growth?
10. What is hydroponics?
11. What is organic media?
12. Give two examples of organic media.
13. How is inorganic media different from organic media?
14. Describe how soil is formed.
15. Name the four components of soil and their average percentages.
16. What is the difference between sand, silt, and clay?
17. Explain how a soil textural triangle is read.