CHAPTER 7 Plant Taxonomy

Chapter Outcomes

After studying this chapter, you will be able to:

- Discuss the historical origins of the plant classification system.
- Describe the hierarchical orders of plants.
- Interpret a plant identification key.
- Describe the purpose of herbaria.
- Explore careers related to plant taxonomy.

Words to Know

angiosperm
binomial nomenclature
class
classification
common name
cotyledon
cultivar
dichotomous key
Dicotyledoneae (dicots)
domain
ecologist
family
genus
gymnosperm
herbarium
International Code of Botanical Nomenclature
Monocotyledoneae (monocots)
morphology
order
phylum
scientific name
species
specific epithet
taxonomy
variety

Before You Read

As you read the chapter, put sticky notes next to the sections where you have questions. Write your questions on the sticky notes. Discuss the questions with your classmates or teacher.





G-WLEARNING.COM

While studying this chapter, look for the activity icon to:

- **Practice** vocabulary terms with e-flash cards and matching activities.
- **Expand** learning with the Corner Questions and interactive activities.
- **Reinforce** what you learn by completing the end-of-chapter questions.

Have you ever compared the leaves of hickory, pecan, and walnut trees, **Figure 7-1**? Have you noticed the similarities among the flowers of an apple, pear, and peach? If you observed that these plants resemble each other, it is because they belong to the same plant families. Plants and all living organisms are organized by their relationships to each other. This system of grouping like organisms together is called ***classification***. The science of naming and classifying organisms is called ***taxonomy***. Taxonomy provides a useful framework for understanding the features of similar plants, including their growth habits, their physical makeup, and their response to environmental conditions. Familiarity with closely related plants helps growers and gardeners know what to expect when growing a new plant for the first time. Taxonomy also allows horticulturists to easily communicate throughout the world by using universal specific names and minimizing confusion that comes from common names.

History of Plant Taxonomy

"What is a weed? A plant whose virtues have never been discovered."
—Ralph Waldo Emerson

The earliest record of categorizing plants into groups belongs to Theophrastus (370–285 BCE), an assistant to Aristotle. Theophrastus divided plants by their growth characteristics into trees, shrubs, half-shrubs, and herbs. He observed a wide range of plant features including the seed structure, germination, and plant habitat range. He described several "plant families" including the parsley (Apiaceae) family, **Figure 7-2**. He noted the umbrella shape of the flower clusters among parsley, fennel, and chervil. His categorization essentially remains the same in today's modern classification.

In the middle of the eighteenth century, a Swedish naturalist, Carl Von Linné (1707–1778), suggested a classification based solely on the flower structures of plants. Better known as Carolus Linnaeus, the Latinized version of his name, he published *Species Plantarum* in 1753 and described more than 1300 plants placed into "classes." The plants were catalogued using the number of stamens, stamen characteristics, and the relationship of stamens to other floral parts. This system forms the basis for plant classification today.

A Sergio Schnitzler/Shutterstock.com B Nataly Lukhanina/Shutterstock.com C J. William Calvert/Thinkstock

Figure 7-1. Look closely at the leaves of these trees. A—Pecan. B—Walnut. C—Hickory. What similarities and differences do you see?

A Lena Kozlova/Thinkstock B Ngarto Februana/Thinkstock C wdhackett/Thinkstock

Figure 7-2. Members of the parsley family have similar umbrella-shaped flowers. A—Dill. B—Carrots. C—Queen Anne's lace.

Horticulturists and gardeners generally refer to plants using a ***common name*** (a word or term in everyday language). For example, in the United States, the linden tree is a common landscape feature. In the United Kingdom, the same tree is called a lime tree, **Figure 7-3**. The use of common names can lead to confusion and potential misunderstandings when communicating about living organisms. Carolus Linnaeus pioneered the consistent use of ***binomial nomenclature*** (a two-word naming system) to describe plant species. Prior to this system, different botanists might give a plant species different names. The binomial language developed by Linnaeus provides a methodical and consistent way to describe different plant species. For example, a red maple within this system has the name *Acer rubrum*. Plant names must adhere to specific rules and are governed by the ***International Code of Botanical Nomenclature***. This code is a set of rules that guides the naming or renaming of plant species.

filmfoto/Thinkstock

Figure 7-3. Common names make it challenging to communicate correctly about plants. What kind of plant do you envision when someone says "lime tree?" In Great Britain, this name is used for what in the United States is called the linden tree. Can you think of any other plants that go by multiple common names?

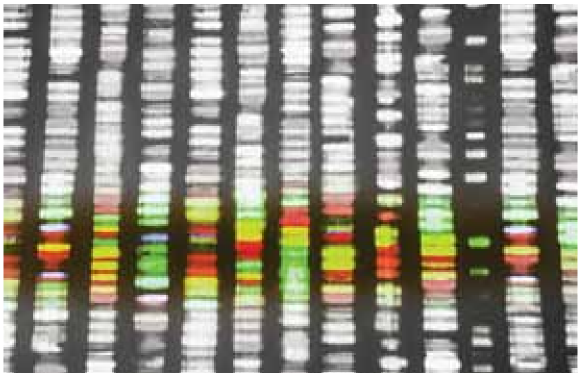
A System of Botanical Classification

Considered the father of taxonomy, Linnaeus set the stage for scientists to name plants using a binomial nomenclature and also to organize plants in a hierarchical way that shows the relationships between plant species. While much of taxonomy uses ***morphology*** (the physical form and structure of an organism) to classify plants, many new technologies have emerged in recent years to shift the approach some taxonomists use to organize plant species. Advances in physiological, biochemical, ecological, and molecular techniques make taxonomy a dynamic and changing field.

Floral morphology of plants has determined how plants are classified since the early days of Theophrastus. It remains an important tool for botanists and horticulturalists to determine plant species. Observations of floral characteristics as well as close examination of leaf shape, margins,

"A practical botanist will distinguish at the first glance the plants of the different quarters of the globe and yet will be at a loss to tell by what marks he detects them."
—Carolus Linnaeus

arrangement, and other key features aid in identification. If a new species is found, these characteristics help determine where the plant fits in the current classification scheme. These same features are used to readily identify plants in the horticultural trade.



Gio.tto/Shutterstock.com

Figure 7-4. Molecular techniques, such as the DNA barcoding shown in this picture, provide new insights into plant relationships.

Molecular tools developed in the past few years provide easier and quicker means for classifying known and unknown plant specimens. New techniques like DNA analysis help scientists see similarities and differences at a much deeper level than just visually inspecting the plant, **Figure 7-4**. These techniques offer a way to genetically fingerprint a specimen and to examine evolutionary relationships among specimens. These new tools have shifted some taxonomic rankings among horticultural plants. For example, maples used to be in their own family, Aceraceae. Now they belong to a broader family, Sapindaceae, which also includes the horse chestnut and lychee. In plant breeding, these same tools can protect patenting rights for a breeder.

Domain

For years, living organisms were separated into only two broad categories: prokaryotes (single-celled organisms without membrane-bound organelles) and eukaryotes (single-celled and multicellular organisms made of cells with membrane-bound organelles). These two divisions did not accurately reflect significant differences among prokaryotes. Through molecular techniques, scientists have now arranged organisms into three ***domains***, which are the highest and most inclusive taxonomic ranking for all living organisms. These domains include Eubacteria (meaning true bacteria), Archaea, and Eukaryotes. **Figure 7-5** shows an example of a specific plant's classifications.

Plant Classification Structure

Classification Level	Classification Level
Kingdom	Plantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Gentianales
Family	Apocynaceae
Genus	*Asclepias*
Species	*tuberosa*
Common Name	Butterfly milkweed
Scientific Name	*Asclepias tuberosa* L.

Goodheart-Willcox Publisher

Figure 7-5. The hierarchical structure of plant classification goes from most inclusive in domain to least inclusive in species.

Corner Question

How many plant species have been identified across the world?

Domain is considered the highest rank of classification, with each further subdivision becoming less inclusive and of lower rank order. The ranks include domain, kingdom, phylum, class, order, family, genus, and species. These ranks are discussed in the following sections.

Kingdom

There are six kingdoms, with plants belonging to the Plant kingdom. The Plant kingdom, also called Plantae, includes living organisms that are multicellular, have cell walls, and are autotrophic (able to make their own food supply). The Plant kingdom contains more than 400,000 species. These species include the angiosperms, gymnosperms, ferns, club mosses, hornworts, liverworts, mosses, and green algae. ***Angiosperms*** are flowering plants that have their seeds enclosed in fruit. ***Gymnosperms*** are nonflowering plants that produce seeds.

Phylum

After kingdom, plants are further separated into a rank called ***phylum***. Plants can be roughly divided into four major groups: nonvascular plants, seedless vascular plants, gymnosperms (nonflowering seed plants), and angiosperms (flowering seed plants), **Figure 7-6**. Within each of these categories, a phylum more specifically defines the group. The rank phylum was called "division," and although this term may still be used today, it is generally agreed by scientists in the field of plant taxonomy to use the term "phylum."

Nonvascular Plants

Mosses are part of a group of nonvascular plants. They lack a vascular system for transporting water and nutrients throughout their structure.

A Artush/Shutterstock.com **B** Jon Bilous/Shutterstock.com **C** MIMOHE/Thinkstock

Figure 7-6. A—The phylum Bryophyta includes mosses, a group of plants that require moist environments for growth and reproduction. B—The phylum Pterophyta is comprised of various fern species, a rich source of shade-loving horticultural plants. C—The gingko tree is an important street and landscape tree and is considered a "living fossil."

They are small in size; lack roots, stems, and leaves; and produce spores rather than seeds. Mosses (phylum Bryophyta), liverworts (phylum Hepatophyta), and hornworts (phylum Anthocerotophyta) make up the group of nonvascular plants. Mosses can be considered a niche market of horticultural plants. They can also be viewed as a weed in the landscape.

Seedless Vascular Plants

Seedless vascular plants are more complex than their nonvascular counterparts. They have a vascular system comprised of xylem and phloem, allowing for movement of water and solutes. They have true roots, leaves, and stems, and their spore-producing structures permit wide dispersal. Like the mosses, hornworts, and liverworts, the seedless vascular plants also require water in or on the soil for sperm to swim to the eggs for fertilization to occur. This group consists of ferns (phylum Pterophyta) and their allies, the club mosses (phylum Lycophyta), horsetails (phylum Sphenophyta), and whisk ferns (phylum Psilotophyta). The fern (phylum Pterophyta) has the most horticultural value, with many species considered important in the ornamental landscape field.

Gymnosperms

Nonflowering, seed-producing plants are called gymnosperms. The word *gymnosperm* means naked seed. These plants do not produce a seed within a protective structure of a fruit. Gymnosperms are wind pollinated and most (all except one species) have separate male and female reproductive structures called cones. Gymnosperms contain four phyla: the conifers (phylum Coniferophyta), the cycads (phylum Cycadophyta), ginkgoes (phylum Ginkgophyta), and the gnetophytes (phylum Gnetophyta). Conifers contain numerous species of high economic importance in landscape horticulture, including pines, spruces, firs, cedars, junipers, and hemlocks. Ginkgo has only one living species, *Ginkgo biloba* L. It has male and female gametophytes on separate trees that do not produce cones.

Did You Know?

The ginkgo tree, *Ginkgo biloba* L., is called a "living fossil" because nearly identical plants have been found fossilized and dated to nearly 200 million years old. The fossil records suggest that the gingkoes were once a widespread, abundant, and diverse group. The specific epithet, *biloba*, means "two lobes," which describes the leaves well.

Angiosperms

Most seed plants are flowering plants, called angiosperms, and have their seeds enclosed in a fruit. They are vascular plants with complex cellular structures. This group ranges in incredibly diverse sizes, from small perennials to soaring trees. The group hosts flowers of every hue and shape. Angiosperms include flowering annuals and perennials, fruits and vegetables, and woody ornamentals. Angiosperms are in the phylum Anthophyta.

Class

Class is the taxonomic rank that separates or identifies plants within a phylum. Plants in the seeded vascular plant phyla are ranked into two primary classes, Angiospermae (angiosperms) and Gymnospermae (gymnosperms). The class Angiospermae includes all flowering plants. The class Gymnospermae includes all nonflowering, seed-bearing plants (ginkgoes, cycads, gnetophytes, and conifers). Filicinae is another class that includes ferns and fern allies.

Within the Angiospermae class, plants can be placed into subclasses of ***Dicotyledoneae (dicots)*** or ***Monocotyledoneae (monocots)***, **Figure 7-7**.

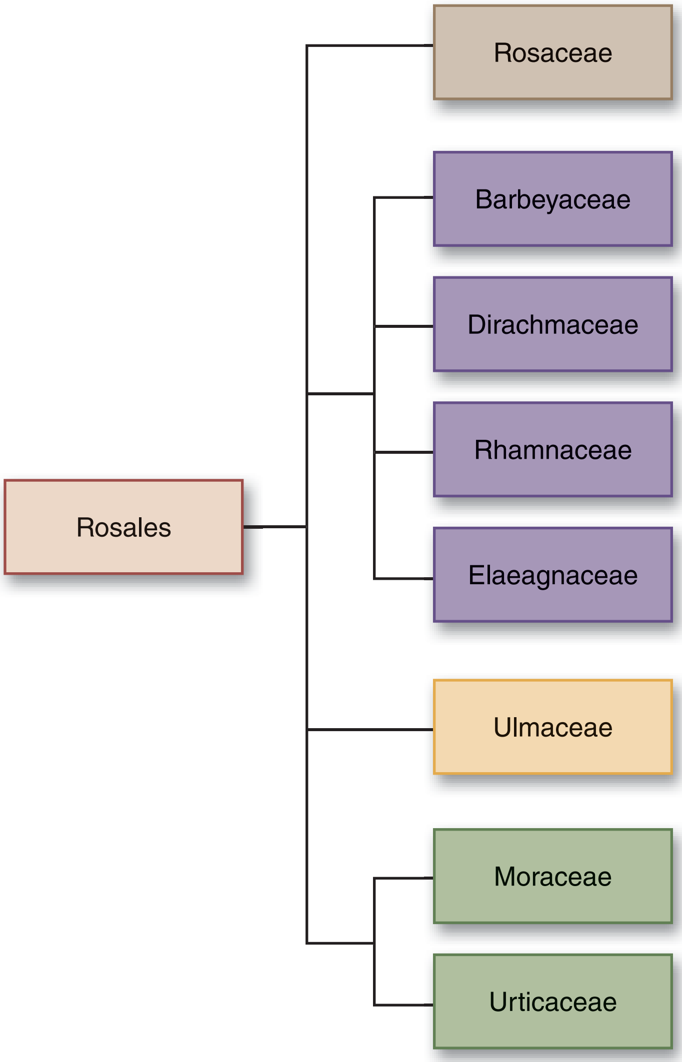
A Nadalina/Shutterstock.com B Elnur/Shutterstock.com

Figure 7-7. A—Dicots form a subclass with distinct characteristics and include beans, petunias, and geraniums. B—Monocots form their own subclass and include plants such as lilies, grasses, and orchids. Can you see the differences between dicots and monocots?

Dicot members generally have two ***cotyledons*** (first leaves) in their seeds, net-veined leaves, and flower parts in multiples of fours and fives. Dicots also usually have a vascular cambium and vascular bundles arranged in a ring. Members of this subclass are vast and include beans, roses, magnolias, and geraniums. Monocots have only one cotyledon in the seed, parallel-veined leaves, and floral structures in multiples of three. All roots in monocots are fibrous. They have vascular bundles scattered or in rings of two or more. They usually lack a cambial layer. Monocots include grasses, lilies, orchids, agaves, and palms.

Order

Order is a taxonomic ranking that separates or identifies plants within a class. Most horticulturists and gardeners do not reference the rank order to understand key characteristics that assist in managing plant growth. Rather, order is a category that provides an understanding of evolutionary relationships among plants. Orders end in *ales*. Rosales is an example of an order. The Rosales order is a broad umbrella for plants such as roses (Rosaceae), nettles (Urticaceae), elms (Ulmaceae), and mulberries (Moraceae). **Figure 7-8** shows a phylogenetic tree, which illustrates the genetic relationships of families within an order.



Goodheart-Willcox Publisher

Figure 7-8. A phylogenetic tree shows the evolutionary relationships among plants, helping give order to a huge number of plant specimens.

STEM Connection

Changing Names of Plants

You may have noticed that the scientific names of the plants that you memorized now have different names. Science is a dynamic and fluid field with new information being discovered every day. In plant taxonomy, the relationship between species continues to unfold as more molecular tools evolve to unfold these stories. DNA research has revealed that long-held beliefs about the relationships of one species to another may no longer be true. This means that plants that once belonged in the same genus or even same family may be reclassified. Early taxonomists using keen powers of observation of the physical characteristics of plants were fairly correct in their organization, so many of these plant shifts are not dramatic.

For example, the Japanese maple (*Acer palmatum*) was part of the Aceraceae family until it became part of the broader Sapindaceae family.

Jason Vandehey/Shutterstock.com

This new knowledge is particularly important for taxa that are found to be unique or rare. Resources can be used to protect these species before they are extinct. In other cases, distribution of a new species may be limited and can be a source for further research into understanding the particular local environment that shaped the development of a species.

"Nature uses only the longest threads to weave her patterns, so that each small piece of her fabric reveals the organization of the entire tapestry."
—Richard P. Feynman

Family

A ***family*** is a taxonomic rank that separates or identifies plants in an order. It is one of the most useful rankings in horticulture for plant growth and management. Plants in the same family can be defined as having similar floral structures. The rank of family provides horticulturists a very useful understanding of how to manage these plants, include controlling pests, promoting growth and development, and planning crop rotation. Members of the same family often attract similar insect pests and diseases, need similar nutrient management, and have about the same growth requirements. Family names of plants always end in *aceae*. For example, the cabbage family is Brassicaceae. Most members of this family have similar physical traits, **Figure 7-9**. Cabbage family members also produce similar chemical sulfur compounds and have other genetic similarities. There are more than 600 plant families that include angiosperms, gymnosperms, ferns and their allies, and mosses and liverworts.

KPG Payless2/Shutterstock.com

Figure 7-9. Look closely at the flower of this broccoli. If you were to compare this to any other member of the cabbage family, you would find them to be similar.

Genus

Plants in a ***genus*** are a subset of organisms within a family that share similar characteristics. The first letter of a genus name is always capitalized and the genus (and specific epithet) of all species is always either italicized or underlined. For example, *Betula* or <u>Betula</u> is the proper way to denote the birch genus. The genus name is used in addition with the specific epithet to comprise a ***scientific name***.

Corner Question

What do you think the specific epithet "alba" means?

Species

A ***species*** is the lowest and least inclusive ranking of plant classification and is the basic unit of biological classification, **Figure 7-10**. A species has historically been defined as organisms capable of interbreeding and producing fertile offspring. This definition remains a primary tool, although advances in DNA comparisons and other molecular techniques, morphological traits, and ecological niches can also contribute to a definition of a species. The presence of a unique trait or local adaptation may not warrant a new species, but might create a subspecies and possibly a variety. A subspecies is subordinate to species and has enough variation, usually due to geographic isolation, to warrant a taxonomic ranking.

Laborant/Shutterstock.com

Figure 7-10. The hollies are part of a large genus. This English holly is its own species, ***Ilex aquifolium***.

The ***specific epithet*** is the second half of a binomial name of a plant species. Together, the genus name and the specific epithet form the scientific name of a species. The specific epithet can describe a character trait, identify the person who discovered the plant, or honor a location where it was found. For example, the paper birch species, *Betula papyrifera*, **Figure 7-11**, has a specific epithet, *papyrifera*, that describes the papery texture of its bark. The specific epithet never stands alone because many species may have the same specific epithet. The paper mulberry, for example, also has the specific epithet *papyrifera*, but is defined by its species name, *Broussonetia papyrifera*. The specific epithet is always written in lowercase and either italicized or underlined in the same manner as the genus name.

J.L. Levy/Shutterstock.com

Figure 7-11. Paper birch has a specific epithet of ***papyrifera***, a Latin derivative for paper. Many plants have descriptive specific epithets.

Variety

A variety is a more specific and distinct subset of a species than a subspecies. A ***variety*** is a form of a species that is slightly different but not different enough to warrant a new species and hold horticultural value, such as leaf color or pattern or thornlessness. A naturally occurring variation of Japanese maple is *Acer palmatum* var. *atropurpureum*, with *atropurpureum* as the variety. Thornless honeylocust, *Gleditsia triacanthos* var. *inermis*, is another example of a variety. The species *Gleditsia triacanthos* has long thorns, but the variety *Gleditsia triacanthos* var. *inermis* has none.

Cultivar

Many gardeners confuse cultivar with variety. A ***cultivar*** is a name for a plant that has been bred or selected for horticultural purposes. The word is derived from the words "cultivated" and "variety." The first letter of a cultivar is typically capitalized and the name is enclosed in single quotes. For example, the eggplant cultivar 'Fairy Tale' is written as such.

Plant Keys

You might easily be able to identify a plant as a member of the oak family, Fagaceae. However, it can be much more challenging to identify the plant as an individual species. Plant keys enable horticulturists to identify plants based on specific characteristics through a process of elimination. A ***dichotomous key*** is a tool that gives users paired choices, called couplets. The user makes a choice, which leads to another set of paired statements. The user continues selecting characteristics that fit the plant being identified. When all choices have been exhausted, the plant species remains. The example in **Figure 7-12** is a sample of a key for identifying maple species. Many online plant keys also exist to help users properly identify their plant species by entering or defining characteristics present in their specimen.

Herbaria

An ***herbarium*** is a repository for collected plant specimens. Plants are pressed and mounted to archival-quality paper and stored in cabinets that preserve them. Not all plant material lends itself well to being pressed.

STEM Connection Virtual Herbarium

Many herbaria are now creating digitized collections of their specimens, essentially building an electronic repository to plant researchers across the globe. Specimens are photographed to make high-resolution images that can be made available to wide audiences and used in biodiversity research projects. The digitized images reduce specimen wear and tear and provide a long-term record of the specimen. For each specimen, there is a visual image of the plant or fungi material along with all of the information including the collection information, such as the collector, the location, the date, and botanical nomenclature.

- I. Leaves entire
  - A. Leaves with obtuse base and three equal triangular lobes—*Acer buergerianum* (trident maple)
  - B. Leaves with truncate or cordate base and three or more lobes
    - i. Leaves with mostly three lobes
      - a. Leaves with silvery underside and red petioles—*Acer rubrum* (red maple)
      - b. Leaves with green underside without red petioles—*Acer tataricum* subsp. *Ginnala* (amur maple)
    - ii. Leaves with more than three lobes
      - a. Fruit mature in late spring and buds red
        - 1. Leaves with sinuses that are U-shaped and entire—*Acer saccharinum* (silver maple)
        - 2. Leaves with sinuses that are V-shaped and toothed—*Acer rubrum* (red maple)
      - b. Fruit matures in early fall, buds not red
        - 1. Petiole sap milky, buds green and mostly glabrous—*Acer platanoides* (Norway maple)
        - 2. Petiole sap not milky
          - i. Leaves with five to eleven lobes; double serrate margin—*Acer palmatum* (Japanese maple)
          - ii. Leaves with mostly five lobes; coarsely toothed margin
            - a) Leaves pale green, tips horizontal not drooping—*Acer saccharum* (sugar maple)
            - b) Leaves dark green, leaf tips drooping—*Acer saccharum* subsp. *nigrum* (black maple)
- II. Leaves compound
  - A. Leaves with 3 to 6 leaflets, greater than 8^2 long and green stems—*Acer negundo* (box elder)
  - B. Leaves with 3 leaflets, less than 8^2 long and stems pubescent or flaky—*Acer griseum* (paperbark maple)

Goodheart-Willcox Publisher

Figure 7-12. This is an example of a plant key used to identify maple species.

Photograph by University of South Florida Herbarium Credit line

Figure 7-13. This is an herbarium specimen of a pitcher plant, *Sarracenia rubra* C. Walter subsp. *gulfensis* D. E. Schnell and is useful for researchers and in education.

Formaldehyde may be used to preserve bulky items such as fruits or fleshy flowers. All plant material is labeled with essential data, including the plant species name, location, date, and altitude where it was found, and any special environmental conditions, **Figure 7-13**. Specimens are generally organized by their taxonomic relationships, with similar species clustered close to other members of their family.

Herbaria specimens play a central role in documenting plant diversity throughout the world. Herbaria provide a reference collection that enables plant identification, research, and education. Many herbaria may specialize in collecting local flora, creating an inventory of plant species, and showing changes in species over time. Herbaria are similar to libraries and usually allow a loan of specimens for educational or research purposes.

Careers in Plant Taxonomy

New discoveries are being made every day. Because of new techniques in classifying plants, various careers are available in the field of plant taxonomy. To work in the field of taxonomy, you must be able to do extensive research and work well with fellow employees. You may work all over the world to do research, or you may be associated with a specific herbarium. Jobs in this field include herbarium directors or curators and ecologists.

Herbarium Director/Curator

An herbarium director or curator is responsible for the maintenance of the collection of herbaria. Many herbaria are associated with universities, colleges, or botanical gardens. Many directors will remain active in research projects involving local or international flora. The director may mount many of his or her own specimens and supervise staff or students to perform these tasks as well. The tasks require demonstrated abilities to interact and collaborate broadly in research and teaching. Many herbaria provide unique opportunities for outreach education and teaching of undergraduate plant taxonomy courses. For this kind of position, a higher level degree with significant experience is typically recommended and required.

Corner Question

What is a flora?

Ecologist

Ecologists are scientists focused on understanding ecosystems as a whole. This includes the distribution of organisms and the relationships between these organisms and their environment. Many ecologists have a specific focus, such as ecology of desert plants or tropical plants. Ecology involves fieldwork, such as surveying populations and recording data, and policy and management work. The exact purview of an ecologist varies significantly by the employing organization. For example, the national parks system may want an ecologist to assess the environmental impacts of installing a hiking trail through a sensitive area. Many ecologists will use mapping tools including GPS and GIS and write reports that can impact decision making. A degree in ecology, plant biology, or related field is a minimum requirement for many jobs.

Career Connection

Dr. Andrea Weeks, George Mason University

Plant Taxonomist

Dr. Andrea Weeks' earliest memories are rooted in playing outside. Growing up on a farm, she was always fascinated by plants. She would capture twirling maple fruits as they descended from the trees and plant them in rows. In middle school, Andrea started her own business of drying flowers and peddling them to local craft stores. Her interest in the intersection of wild and cultivated plants grew and in her first year of college she found herself enrolled in a plant systematics course that encapsulated everything she loved: plant taxonomy, evolutionary processes, and phylogeny.

From then on, Andrea began to find opportunities and courses in college that let her pursue her interest in understanding plants. From applied internships that put her to work in greenhouses to research positions that led her to the lab to explore plant breeding, tissue culture, and other molecular work, she began to craft a path that would lead her to her career as an associate professor of plant systematics and director of the Ted R. Bradley Herbarium at George Mason University in Virginia.

As a professor, she teaches students and conducts her own research and outreach programs within the field of plant systematics. Her research has focused on the evolutionary biology of plant members within the frankincense and myrrh families and explores how all the species are related and how and when they evolved. As part of her efforts as the director for the herbarium at George Mason, Andrea spearheaded a citizen science project that engaged the public to participate in digitizing old herbarium specimens, making centuries of biological observations of plants widely available and accessible to everyone. Biologists can use this legacy data to begin to understand how plant populations have changed and moved over time and to help answer big questions relating to climate change, among other ideas.

Andrea continues to love her work for the ability to be creative in asking and answering questions in the field of plant biology. She finds it exciting to contribute to the growing body of knowledge about plants in general.

CHAPTER 7

Review and Assessment

Chapter Summary

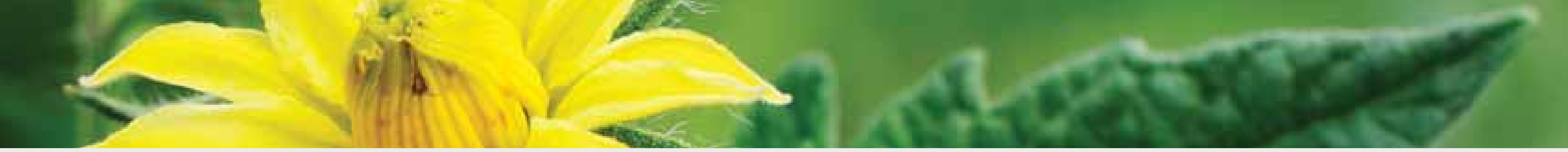
- Classification provides an organized framework to understand relationships that plants have to each other. This information is useful for managing plant growth and development.
- The early roots of plant classification began with Aristotle's assistant, Theophrastus, who used visible plant characteristics to cluster plants into families.
- Carolus Linnaeus is considered the father of taxonomy and pioneered the consistent use of a binomial nomenclature for naming plant species.
- Plant taxonomy uses the physical features of a plant as well as molecular, physiological, biochemical, and ecological techniques to classify plants.
- The hierarchical system for organizing plants begins with the least inclusive rank of domain and increasingly becomes less inclusive with kingdom, phylum, class, order, family, genus, and species.
- There are six kingdoms, with plants belonging to the Plant kingdom. The Plant kingdom includes living organisms that are multicellular, have cell walls, and are autotrophic.
- Angiosperms and gymnosperms are important phyla and consist of species that have tremendous horticultural value.
- Class is the taxonomic rank that separates or identifies plants in a phylum. Within the Angiospermae class, plants can be classified as dicots or monocots.
- Order is a taxonomic ranking that separates or identifies plants in a class. Order is a category that provides an understanding of evolutionary relationships among plants.
- The rank of family separates or identifies plants in an order. This rank provides useful information in managing plants, including strategies for controlling pests and diseases, promoting growth and development, and planning crop rotation.
- Plants in a genus are a subset of organisms within a family that share similar characteristics. A species is the lowest and least inclusive ranking of plant classification and is the basic unit of biological classification. A variety is a subset of a species.
- A scientific name for a plant contains both a genus name and a specific epithet. The specific epithet reflects a characteristic of the plant or honors a person or place.
- Cultivars are plants that have been bred or selected for a particular characteristic. A plant species may have several cultivars.
- Plant keys enable users to identify plants based on specific features through a process of elimination. Choices are made based on plant characteristics until all choices are eliminated and the plant species remains.
- Herbaria are repositories for holding collected plant specimens that can be used for research or education.

Words to Know

Match the key terms from the chapter to the correct definition.

A. angiosperm
B. binomial nomenclature
C. class
D. classification
E. common name
F. cotyledon
G. cultivar
H. dichotomous key
I. Dicotyledoneae
J. domain
K. ecologist
L. family
M. genus
N. gymnosperm
O. herbarium
P. International Code of Botanical Nomenclature
Q. Monocotyledoneae
R. morphology
S. order
T. phylum
U. scientific name
V. species
W. specific epithet
X. taxonomy
Y. variety

1. A form or subclassification of a species that is slightly different but not different enough to warrant a new species.
2. A name for a plant that has been selected or bred for horticultural purposes.
3. The physical form and structure of an organism.
4. A seed producing plant that lacks a protective cover for the seeds.
5. The process of systematically identifying and organizing plant species.
6. A subset of organisms within a family that share similar characteristics.
7. Plants with two cotyledons in their seeds.
8. A word or term for plants that is used by gardeners in everyday language.
9. The first leaf that emerges from a seed.
10. A flowering plant that has seeds enclosed in its fruit.
11. The science of naming and classifying organisms.
12. A two-word naming system, such as that used for plant species.
13. The second half of a scientific name for a plant species, usually descriptive of a plant feature or in honor of someone's name or a place.
14. The taxonomic rank that separates or identifies plants in an order.
15. A taxonomic ranking that separates or identifies plants in a kingdom.
16. The taxonomic rank that separates or identifies plants within a phylum.
17. A repository of collected plant material.
18. The highest and most inclusive taxonomic ranking for all living organisms.
19. A scientist focused on understanding ecosystems as a whole.
20. A set of rules that guides the naming or renaming of plant species.
21. Plants with one cotyledon in their seeds.
22. A taxonomic ranking that separates or identifies plants in a phylum.
23. A tool used to identify plants by pairing choices against each other until all choices have been exhausted and the plant species remains.
24. A two-word name that includes a genus and specific epithet for a plant species.
25. The lowest and least inclusive ranking of plant classification.



Know and Understand

Answer the following questions using the information provided in this chapter.

1. What is plant taxonomy, and why is it used for growers and gardeners?
2. Describe the system for categorizing plants used by Theophrastus.
3. Describe the system for categorizing plants used by Carolus Linnaeus.
4. What problems can result from using common names for plants?
5. Why is the system of binomial nomenclature developed by Linnaeus a better way to name plants than using common names?
6. What are some features of morphology used the identify plants in the horticultural trade?
7. How have molecular techniques changed how plants can be identified?
8. What three categories are used to group all organisms? What are the other ranks or classifications below the domain level?
9. How many kingdoms are used in taxonomy, and what kingdom do plants belong to?
10. What are the four major groups of plants for the phylum rank?
11. What are characteristics of a nonvascular plant such as moss?
12. Seedless vascular plants in what phylum have the most horticultural value?
13. What are some types of conifers that are important in landscape horticulture?
14. What features define the subclasses of Dicotyledoneae (dicots) and Monocotyledoneae (monocots)?
15. List some of the ways that plants within a family are similar.
16. What is a genus? How should a genus name be formatted in writing?
17. What is a species?
18. How does a dichotomous key help correctly identify plants?
19. What role do herbaria play in documenting plants?
20. With what are ecologists generally focused?

Thinking Critically

1. You are hiking in the woods near your home, and you come across a plant that you have never seen before. You think it may be a new plant species. What steps would you take to determine whether this plant is indeed a newly discovered specimen? If it is not a new species, what else might it be?
2. Imagine you are outside on an autumn day and come across two different types of leaves that have fallen. How would you research to find out what kind of plants or trees they came from?

STEM and Academic Activities

1. **Science.** What defines a subspecies? Visit your local herbarium or library and find a plant species that also has a subspecies. What are the characteristics that differentiate the two?
2. **Science.** Research the soil conditions and climate in your area. Find out what flowering and foliage plants grow well in these conditions. Choose another location in the country that you find interesting and do similar research on soil and climactic conditions. Do the same plant species grow in these areas? Why or why not? Are there plants within similar families or different families?

3. **Math.** Find a native plant species in your area. Research the population levels of your plant species. Find out additional population data for your plant species in other areas where it grows. Create a chart that compares plant populations. Do you see differences in their numbers? Why or why not?
4. **Language Arts.** Plants are identified by their unique features. Find a horticultural plant you think is interesting. Write a plant description that would help someone identify it. Use the botanical terms to properly describe the plant characteristics.
5. **Language Arts.** Many poems have been written about the beauty of plants. Plant taxonomy requires the close observation of a plant's features, which can inspire writers to create prose describing their virtues. Write a poem that uses descriptive language about a plant.

Communicating about Agriculture

1. **Speaking.** Working in groups of three, create flash cards for the key terms in this chapter. Each person in the group chooses six terms and makes flash cards for those six terms. On the front of the card, write the term. On the back of the card, write the pronunciation and a brief definition. Use your textbook and a dictionary for guidance. Take turns quizzing one another on the pronunciations and definitions of the key terms.
2. **Reading and Speaking.** Create an informational report on taxonomy as it relates to plants. Explain how the hierarchy system is set up for the Plant kingdom. Explain how the original ranking system was modified due to molecular research. Choose one plant family and list all of its plants and flowers. List the common characteristics that link these plants together. Include drawings or photographs of the most common family members. Present your report to the class.
3. **Listening.** As classmates deliver their presentations, listen carefully to their arguments. Write down any questions that occur to you. Later, ask questions to obtain additional information or clarification from your classmates as necessary.

SAE Opportunities

Teddy Leung

1. **Exploratory.** Visit an herbarium and examine different herbarium specimens.
2. **Exploratory.** Go to your local public garden or arboretum. Find a plant specimen you enjoy and try to identify what it is. Use a dichotomous key to aid in identification.
3. **Exploratory.** Create an herbarium specimen for a plant that you have to know about for a career development event (CDE). Create a classroom collection of specimens to help CDE teams learn about plant material.
4. **Exploratory.** Job shadow a plant taxonomist. Many states have a bio blitz, an event where volunteers can go out and inventory flora in a particular area.
5. **Placement.** Contact your local college or university to see if they have a taxonomist that uses molecular techniques in his or her research. Try to obtain an internship for the summer or for three or four weeks to gain laboratory experience in plant taxonomy.