Red Seal Landscape Horticulturist Identify Plants and Plant Requirements

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Line F Apply Horticultural Practices: F2 - Level 1, 2, 3 and 4

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Sample APA-style citation:

This textbook can be referenced. In APA citation style, it would appear as follows:

Nakano, M. (2020). *Red Seal Landscape Horticulturist Identify Plants and Plant Requirements*. Victoria, B.C.: BCcampus. Retrieved from https://opentextbc.ca/plantidentification/

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Ebook ISBN: 978-1-77420-083-4

Print ISBN: 978-1-77420-082-7

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This book was produced with Pressbooks (https://pressbooks.com) and rendered with Prince.

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Acknowledgements

This textbook represents a commitment to excellence in horticulture education at Kwantlen Polytechnic University. It is a living record of Horticulture Faculty and Staff contributions to the Hort 1155 Introduction to Plant Materials Lecture Notes, 1993 – 2019. I would like to thank Aaron Roth for his dedication to the KPU Plant Database, referenced in the text. I am grateful to BCcampus for the opportunity to acknowledge my colleagues with this first open education resource for all students of plant identification.

I wish to thank Karen Meijer-Kline, KPU Library for support with the formatting and references.

Michelle J. Nakano

February, 2020

About This Book

Red Seal Landscape Horticulturist Identify Plants and Plant Requirements is an adaptation of KPU HORT 1155 Introduction to Plant Materials Lecture Notes. It is an editable, open access learning resource with interactive web-based experiences customized for horticulture students studying plant identification.

This edition supports student achievement of the Level 1, 2, 3, and 4 learning goals for Red Seal Landscape Horticulturist Line F2:

- Identify plant and plant requirements for a range of plants commonly used in horticulture
- Employ correct naming and plant identification terminology
- Identify morphological characteristics, growing requirements, use and availability
- Use a dichotomous key for plant identification
- Explain plant hardiness
- Identify weedy and invasive plants
- Identify plant and plant requirements for a range of woody and non-woody plants
- Use botanical terms to identify and describe plants
- Identify and describe plants according to cultural and maintenance requirements
- Recognize plants suitable for common tropical, floral and interior landscape situations
- Identify plants suitable for planting in difficult situations
- Describe native plants common to the horticulture industry
- Describe seasonal plants common to the horticulture industry in BC
- Describe plants suitable for green infrastructure projects
- Describe plants suitable for edible landscapes

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1. https://opentextbc.ca/plantidentification/
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Part 1 – Plant Identification

1.

Introduction to Plant Identification

Learning Objective

- Describe the development of plant identification.

All living organisms on Earth rely on the process of photosynthesis for food energy and oxygen. Humans depend almost entirely on plants for clean air and a livable climate as well as for food, medicines, materials, and well being. Around the world, groups of people with their own distinct history, culture, and society have learned to identify plants and their properties. For Indigenous peoples, the accumulated traditional knowledge of plants has allowed them to thrive in diverse environments for thousands of years.

Traditional knowledge passed among generations through the oral traditions of hunter-gatherers influenced the naming and grouping of plants. With the settlement of agricultural communities and the domestication of plants about 10,000 years ago, written records documented their use. Early systems of plant classification emerged in Eastern and Ancient Egyptian cultures and botany, the scientific study of plants developed in Ancient Greece.

Taxonomy, a branch of botany, is defined as the systematic classification, naming, and identification of plants. This orderly system arranges related plants with similar characteristics into groups called taxa and uses a convention called bionomial nomenclature to give a unique name to one group of plants. In addition to classification by morphology (external form) and anatomy (internal structures), botanists now use genetic sequencing and biochemistry to decode the evolutionary history of relationships among plants. As a discipline, taxonomy has continued to develop over centuries of botanical study and this knowledge is available to students of plant identification.

The ability to identify plants and their requirements has always been an essential skill for horticulturists who manage plant growth and health. However, with more than 300,000 known species in the world, the plant kingdom – Plantae, is both diverse and complex. No two species of plants will be exactly alike, and while some common characteristics may be easily seen, others are so different that few if any relationships can be observed. Furthermore, the progression of evolution never stops and relationships among plant groups continue to change over time. To address this challenge, this book introduces students of plant identification to a systematic approach to classifying, naming, and identifying unknown species.

REVIEW

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2.

Introduction to Taxonomy

Learning Objectives

- Describe the scientific system of plant classification and naming.

A working knowledge of taxonomy is useful for classifying, naming, and identifying unknown plants. Theophrastus (370-285 BC), a Greek philosopher, first used taxonomy to describe and group plants according to their morphology (shape), growth, and reproductive traits. In the 18th century, a scientist named Carl Linnaeus applied binomials (two-term names) and classified known plants into a hierarchical system of classification.

CLASSIFICATION AND NAMING

The most effective classification systems are hierarchical and comprised of a nested series of categories or ranks. A good analogy is a computer filing system. Certain kinds of information reside at each level (drive, library, directory or folder, sub-directory, document, etc.), with file names (or labels) that signify the sort of information found there. Every level in the hierarchy is more inclusive than the one below it and the more of the filing system that is investigated, the more related information is uncovered.

Similarly, the categories used in plant classification provide an organizational framework into which the names of naturally occurring plants are slotted. In this framework, species of plants that are most similar to each other are grouped together. Groups or taxa (plural) are arranged in a hierarchical sequence of taxons (singular), from least inclusive rank at the bottom to most inclusive rank at the top as shown below in the plant classification hierarchy. In other words, the taxa “family” may include numerous plant genera, and within a genus (singular of genera) there may be any number of species, whereas within a given species, a subspecies may describe only a few populations or individuals.

Within taxa – family, genus, species, etc., there are identifiable characteristics common to each group. For example, plants in the cypress family typically have broad, flattened, scale leaves, while plants in the pine family exhibit needle-like leaves. Once organized into a sensible system that recognizes similarities or relatedness, the grouping becomes easier to understand and remember. That is, once characteristics for a given group are known, they can be used to match unknown plants with known taxons.

Plant Classification Hierarchy of Taxons

- Family
- Genus (plural = genera)
- Species
- Subspecies or Variety
- Forma

Other Classification terms

- Hybrid
- Cultivar
- Common Names
- Plant Groups

REVIEW

Identify the hierarchy of plant taxons.

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3.

Introduction to Taxons

Learning Objectives

- Identify characteristics of taxons.

The plant family taxon is a grouping of plants consisting of one or more related genera that are more like each other than to other genera, and that includes the entire surviving lineage of the ancestral population. Family names always end with the suffix -aceae, except in a few notable cases where use of traditional names is also acceptable. Newer family names are based on the “type-genus” concept which means that for every family there is a genus that best represents the characteristics of the family. For example, *Brassica* (the cabbage genus) is the base for the family Brassicaceae, as is *Rosa* (the rose genus) for the family Rosaceae.

Older family names are still used since many are somewhat descriptive and may be more familiar than their newer counterparts. For example, Cruciferae (from the Latin crucifer, a cross) refers to the four-petal arrangement of flowers characteristic of the mustard family. The revised family names for some familiar plant groups are listed in Table 3.1.

Table 3.1: Revised family names

Traditional Name	New Name	Common Name
Compositae	Asteraceae	Aster
Cruciferae	Brassicaceae	Mustard
Graminae	Poaceae	Grass
Labiatae	Lamiaceae	Mint
Umbelliferae	Apiaceae	Carrot

Because of new discoveries and technological advancements for determining plant genetics and other markers, some genera and family names have been reclassified under new names, as shown in Table 3.2.

Updates to plant information publications and online resources takes time and overlaps in established and reclassified family names can be expected.

Table 3.2: Reclassified family names

Family Name	Reclassified Name	Common Name
Aceraceae	Sapindaceae	Soapberry
Asclepiadaceae	Apocynaceae	Dogbane
Taxodiaceae	Cupressaceae	Cypress

TAXONOMIC EXAMPLE

The list of ten Pacific Northwest native conifers can be grouped into three families. Within each family, there are a different number of genera, as represented by the common names. Within each genus, unless a monospecific (single) genus as with *Taxus* and *Pseudotsuga*, there are a number of different species.

Pinaceae – pine family

Douglas fir (*Pseudotsuga*, 1 species)

hemlock (*Tsuga*, 2 species)

larch (*Larix*, 3 species)

true fir (*Abies*, 3 species)

spruce (*Picea*, 4 species)

pine (*Pinus*, 7 species)

Cupressaceae – cypress family

arborvitae (*Thuja*, 1 species)

yellow cedar (*Cupressus*, 1 species)

juniper (*Juniperus*, 3 species)

Taxaceae – yew family

yew (*Taxus*, 1 species)

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4.

Introduction to Binomial Nomenclature

Learning Objectives

- Employ correct naming and plant identification terminology.

For an orderly system of classification, botanists give each group of plants a name that is recognized by people who know binomial nomenclature, regardless of where they are or the language they speak. This way every plant species will have a unique botanical name based on the binomial system of nomenclature. For example, one of the best-known trees of the Pacific Northwest, the Douglas fir, recognizes botanist Archibald Menzies in its scientific name *Pseudotsuga menziesii*. While the common name recognizes fellow botanist David Douglas, Archibard Menzies is credited with the first botanical description of the plant.

A plant name or binomial is made up of two names: a genus name and a (usually) descriptive specific epithet (species name), both commonly of Latin or Greek origin. For example, of the many species within the group known as pines (genus = *Pinus*) there is only one named *Pinus contorta* (contorta = twisted). This species is characterized by often having contorted or twisted young shoots. The "species name" is the binomial; for instance, the species to which we belong is *Homo sapiens*.

GENUS

A genus (plural = genera) is defined as an assemblage consisting of one or more related species that are more like each other than to other species, and that includes the entire surviving lineage of the ancestral population. Evidence for these relationships is deduced from the fossil record and from comparative techniques in morphological, chemical and molecular (DNA sequencing) analysis.

A genus name can be descriptive of the plant, such as *Equisetum* (common horsetail) which is from two Latin words *equus* (horse) and *saeta* (bristle). The genus can be the actual Latin or Greek name such as *Erysimum* which is derived from the Greek name for the same plant *erysimon*. It can also be derived from the plant founder's name such as *Davidia*, which is from Father David, a famous French plant explorer who lived in China for many years.

SPECIES

The species is the basic life-unit in biology and can be defined as consisting of one or more related species that are more like each other than to other populations and that presumably come from a single ancestral population. The species name may be an adjective that indicates a distinguishing characteristic of the species, e.g., *Quercus alba* – white oak, or a noun that honors a person or indicates the species habitat. Species is abbreviated sp. (a single species) or spp. (more than one species).

SUBSPECIES

Subspecies (ssp. or subsp.) and variety (var.) names are also multinomials. For example, lodgepole pine is known by the botanical name *Pinus contorta* var. *latifolia*, or sometimes, *P. contorta* ssp. *latifolia*. In other words, a northern variant of *Pinus contorta* with needles more flattened (lati = broad and folia = leaf) than the typical, coastal variety (*P. contorta* var. *contorta*). Note that "variety" is used here at the same rank as "subspecies" while some botanists consider the "variety" as a lower rank. These terms are used to describe naturally occurring plants.

FORM

The rank form or forma (f. or fa.), is used to represent individuals which differ in some specific way from other individuals within the same natural populations. For example, one can find numerous red bract forms throughout populations of the more commonly white bract *Cornus florida* (Eastern flowering dogwood). These red bract dogwoods are correctly known as *Cornus florida* f. *rubra* (rubra = red). Other common, naturally-occurring mutations in other plants include: weeping habit (f. *pendula*), dissected leaves (f. *dissecta*), and white flowers (f. *alba*).

HYBRIDS

Hybrids are the offspring of successful mating between plants belonging to different taxa. Known interspecific hybrids (between species in the same genus) are designated by a multiplication sign, as *Platanus* × *acerifolia* (*P. occidentalis* × *P. orientalis*). Intergeneric hybrids result from crossing plants belonging to separate genera; an intergeneric hybrid name is always preceded by a multiplication sign, as ×*Solidaster* (*Solidago* × *Aster*).

CULTIVARS

Cultivars are horticultural races or strains of plants which originate under cultivation or may originate in nature as a mutation and subsequently persist under human cultivation. The word cultivar (cv.) comes from "cultivated variety," a somewhat confusing derivation, since the "variety" represents a naturally occurring entity, while the cultivar does not.

As cultivars do not persist in nature, it is not a botanical designation; however, where used, the cultivar

is considered part of the botanical name and must be appended to it. Cultivar names are distinguished in text using single quotation marks, as *Chamaecyparis pisifera* ‘Filifera Aurea’ (filaments or threads of gold).

COMMON NAMES

Common names are the local, familiar names given to plants. The same common name may be used for several completely different plants. For example, the common name “cedar” is a name given to a variety of plants with aromatic wood (recalling the “cedar” of antiquity, *Cedrus* spp.) or to plants that are reminiscent of other plants called “cedars,” for example. In the Pacific Northwest, cedar refers to *Thuja* (western red cedar) and to *Cupressus* (yellow cedar).

Similarly, a single species may have numerous common names, particularly if known from a variety of locations. For example, yellow cedar is also known as Nootka cypress and Alaska cedar. Clearly, there is potential for much confusion with common names. In text, common names are written out in lower case, except where they include proper names; e.g., Douglas fir, Japanese painted fern, etc. Common names are not botanical names. While botanical names are often, at least initially, difficult to remember and pronounce, they are universally recognized and considerably more accurate than common names.

5.

Conventions for Binomial Nomenclature

Learning Objectives

- Describe conventions for writing botanical names.

Botanical nomenclature is the scientific system of naming plants. The naming of plants is governed by two sets of published rules: The International Code of Nomenclature for algae, fungi, and plants and the International Code of Nomenclature for Cultivated Plants. These rules establish a worldwide standard of reference for naming plants. By convention, when written in text a botanical name is always italicized or underlined, and the first letter of the genus name is always capitalized.

The following summarizes the basic rules regarding the writing of botanical names for plants:

- The generic epithet of a botanical name is always capitalized (e.g., *Salvia, Impatiens),* and is underlined or italicized except where it is also used as a common name, as in salvia or impatiens. Within text or in a list – but only where unambiguous – the genus name is often abbreviated to the first letter, for example, *Rosa rugosa, R. moyesii*, *R. acicularis*.
- The specific epithet of a botanical name is always lower case, and is underlined or italicized in text, as Gaultheria shallon or *Gaultheria shallon*. If only the genus of a plant is known, the specific epithet is abbreviated as sp. (designating a single species) or spp. (more than one species).
- Hybrids, produced from breeding 2 or more different species (interspecific), are noted by a multiplication sign between the genus and specific epithet, for example, *Forsythia* × *intermedia*.
- Hybrids produced from crosses between genera (intergeneric), are noted by a multiplication sign before the genus, for example, ×*Solidaster luteus* which has the following parentage, (*Solidago canadensis* × *Aster ptarmicoides*).
- Subspecies are abbreviated ssp. or subsp. The subspecies epithet is not capitalized but is underlined or italicized, for example *Acer glabrum* ssp. *douglasii*
- Variety or more officially, varietas, is abbreviated var. The variety epithet is not capitalized but is underlined or italicized, as in this example, *Clematis montana* var. *rubens*

- Form or more officially, forma, is abbreviated f. (or sometimes fa.). For example, *Cornus florida* f. *rubra*.
- Cultivars usually have vernacular names, are not italicized or underlined, and all words are capitalized and usually in single quotes. For example, *Astilbe chinensis* 'Pumila' or *Ilex aquifolium* 'Ferox Argentea'.
- Group: This describes a group of unnamed tree seedlings, for example *Picea pungens* Glauca Group describes all the un-named seedlings with blue foliage that are available in the nursery trade. Groups names are not italicized or underlined, and all words are capitalized but are not in single quotes.
- The ™ designation indicates that the originator of the new plant, for example, *Pyrus calleryana* Aristocrat™, has applied for a trademarked name. The ® indicates that the plant name is a registered trademark, such as in *Pyrus calleryana* Chanticleer®. The trademark name is often the "selling name" of the plant, which may differ from the cultivar name. eg. *Weigela florida* 'Alexandra' is sold under the moniker Wine & Roses® weigela.

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6.

Nomenclature Review

Learning Objectives

- Apply the conventions for writing botanical names.

TRUE OR FALSE

Apply binomial nomenclature conventions to each of the plant names.

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7.

The Meaning of Plant Names

Learning Objectives

- Describe the meaning of botanical names.

Botanical names often provide a helpful description of a plant. The origins of Latin and Greek names may be classical, mythological, or commemorative, or they may relate to a place, area, or season. Descriptors for plant surface characteristics or color, habitat, growth habit, and size and shape are other common sources for specific epithets. Familiarity with their meaning is helpful for remembering plant names. References such as the *Dictionary of Plant Names* by Allen J. Coombes (1994) or *The Names of Plants* (1996) contain interesting information on the origin and meaning of plant names. Information is also available online at these links to *Califlora: Plant Name Meanings and Derivations* [New Tab][1] and *The Meaning of Latin Plant Names* [New Tab].[2]

PRACTICE

Identify the meaning of each of the specific epithets using the links above to online resources.

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1. http://www.calflora.net/botanicalnames/index.html
2. http://theseedsite.co.uk/latin.html

8.

Plant Growth

Learning Objectives

- Identify common classifications of plant growth.

Water movement is the most basic classification of plant growth. All plants need water to survive and, based on how they move water, are categorized as either vascular or non-vascular. Vascular plants, such as trees, have a water conducting system, allowing them to supply aerial tissues with water and to grow well above the ground. Non-vascular plants rely on their closeness to water and their own physical absorption to support green tissues above ground. Mosses and liverworts are examples of non-vascular plants.

Reproduction is another classification of vascular plants that is based on whether they reproduce themselves asexually or sexually. Vascular plants are subdivided into two major categories, pteridophytes, and spermatophytes. Pteridophytes (Greek for “fern plant”) include ferns and horsetails that reproduce asexually by spores. Spermatophytes (Greek for “seed plant”) include conifers and flowering plants that reproduce sexually by seed.

Conifers, from the Latin for “cone-bearing” are woody plants that bear their female and male reproductive structures in separate cones or strobili rather than in flowers. Coniferous trees and shrubs typically bear both female and male cones on the same plant. Pollen produced by male cones is transported on wind currents to the female cones wherein seed development is completed. Conifers belong to the group of seed producing plants called gymnosperms. Gymnosperm literally means ‘naked seed’ as seeds are held on the surface of a cone scale or at the end of a small structure. This is the main differentiation between conifers and the flowering plants (angiosperms) which bear their seeds in an enclosed ovary of a flower that becomes the fruit.

Angiosperms are the largest and most diverse group in the plant kingdom. Some angiosperms produce flowers and fruit over many years (polycarpic), while some die after flowering and bearing fruit only once (monocarpic). In addition to the presence of flowers and fruit, angiosperms are classified according to two major groups of plants that are each derived from a common ancestor species (clade), the monocotyledons and eudicotyledons. This classification is based on the number of cotyledons or seed leaves produced at seed germination. Monocotyledons (meaning “single seed-leaf”) include grasses, lilies, orchids, and palms. They develop from a seed with a single seed leaf. Some basic recognizable patterns of monocotyledons include leaf veins arranged in parallel lines; flower parts numbered in 3’s

and a herbaceous plant structure. Eudicotyledons (meaning “true dicots”), are an evolutionary line that includes plants such as maples, oaks, roses, buttercups, mints, and sunflowers that develop from seed usually with a pair of seed leaves. Some basic recognizable patterns of dicotyledonous plants include leaves with netted venation; flower parts numbered in 4’s or 5’s and woody or herbaceous plant structure.

Type of growth, such as tree versus shrub or woody versus non-woody (herbaceous), is often the first visual recognition of a plant. Plant growth may also be categorized by some aspect of their biology or ecology such as: terrestrial or aquatic habitat (e.g., duckweed), adaptations such as twining stems for climbing (wisteria) or underground storage bulbs (e.g., daffodil), or whether they exhibit seasonal loss of leaves (deciduous) or if they remain evergreen.

Plant growth varies from trees with well-defined trunks, to multi-stemmed shrubs and climbers to spreading ground covers and clumping herbaceous plants. The above ground plant structure is typically formed by stems that are either woody or herbaceous. Woody plants such as cedars, oaks, and maples produce more or less permanent structures capable of extension and annual thickening (secondary growth). Non-woody or herbaceous plants such as dandelion, (eudicot) and grasses (monocot), and ferns, (pteridophyte) are limited to only extension growth and do not produce permanent above ground structures.

The herbaceous growth habit is common among vascular plants, and many specific plant groups are distinguished on that basis. Herbaceous plants are characterized by a lack of woody tissue, such as bark. Their stems will eventually die back to a live root crown and root structures. Deciduous herbaceous perennials wither and die back to some kind of long-lived, resistant organ (a fleshy crown, bulb, tuber, rhizome, etc.) and enter a state of dormancy when conditions are not suitable for continued growth. In comparison, evergreen herbaceous plants have leaves that persist over one or more seasons of growth.

Not all herbaceous plants are seed plants; spore producing plants such as ferns and horsetails are also considered herbaceous. The ability of some perennial plants to propagate themselves non-sexually by means of vegetative reproductive structures such as underground creeping stems (rhizomes) and tubers and bulbs is a competitive advantage over sexually reproduced plants and provides an effective adaptation for spreading.

Plants with a climbing growth habit may be woody or herbaceous. Vines (herbaceous) and lianas (woody) have various specialized adaptations for climbing on, through, and over host plants and surrounding objects to gain access to light. Self-clinging climbers attach themselves to supports by aerial (adventitious) roots or by modified leaf structures called tendrils. Tendril climbers twine around or adhere themselves to supports by contact sensitive tendrils with adhesive discs at the tips. Climbers with twining stems or curling leaf stalks coil around supports in a clockwise or counterclockwise spiral habit. Scrambling (scandent) or trailing climbers with long arching stems attach loosely, if at all to supports. Some species, such as roses, are equipped with stem modifications of hooked thorns that allow them to scramble through other plants.

REVIEW

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9.

Introduction to Plant Classification

Learning Objectives

- Recognize and describe patterns used to classify plants.

Classifying unknown plants as identical with or similar to plants within a particular taxonomic group involves observation and comparison. The ability to accurately distinguish and categorize the similarities and subtle differences among plant species relies on at least three interrelated skills: pattern recognition, description, and classification.

Pattern recognition includes awareness of visual indicators such as shape, size, habit, etc. as well as other sensory input such as smell, touch, sound, etc. Much pattern recognition depends upon our ability to describe what is perceived. Frequently, people don't remember those things they can't describe in words. In contrast, those things, which are related to other more familiar things, are more easily recalled: for example, "it feels like velvet," "it smells of lemons," or "it appears to be bigger than a breadbox".

Descriptions allow people to identify and catalog those patterns. "Striped," "spotted," "rough" and "smooth" are simple descriptors. It is not difficult to remember such patterns. Other, more complex descriptors are needed for characterizing complex organisms. The "trick" is in recognizing the patterns that indicate important relationships. There is a significant amount of vocabulary involved in describing plants, and the student of plant identification must learn to apply both plant morphology (the study of shape) and the descriptive terminology.

Classification is an effective method for organizing data. People naturally classify things according to various categories. Based on their usefulness, some plants may be considered more desirable than others. For example, plants considered to be undesirable for health or economic reasons are often categorized as weeds. Additional categories used for plant classification include their utility (medicinal plants), cultural tolerances (house plants), growth form (trees), leaf shape (needle vs. broad leaves), their assumed evolutionary relationships and genetic sequences (phylogenetics), among others.

REVIEW

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10.

Classify Plants by Life Cycle

Learning Objectives

- Describe characteristics of plant life cycle classifications.

A plant will go through a sequence of stages from seed germination to seed production as a mature plant. For some plants, this sequence, or life cycle may take a few weeks while others continue to grow and flower repeatedly over many years. Plant life cycles are classified as annual, biennial, or perennial. Annuals complete their life cycle of germination from seed, growing, flowering, fruiting and dying within a single season of growth. Biennials require two seasons to complete their life cycle. In the first season, foliage production and storage of food reserves takes place followed by flowering, seed production and death in the next. Perennials typically flower annually once established and may live for several to a great number of years.

TYPES OF ANNUALS

While the annual life cycle is completed within a single season of growth, the term annual or bedding plant may also be used to describe any plant that is grown outdoors in the spring and summer for one growing season.

Annual flowers differ in their tolerance to cold weather and frost. Hardy annuals are the most cold tolerant; they will take light frost and some freezing weather without being killed. In most cases, hardy annuals can be planted in the fall or in the spring before the last frost date. Examples of hardy annuals include *Lathyrus* (sweet pea), *Viola* (pansy), and *Tagetes* (marigold) cultivars. Most hardy annuals are not heat tolerant and usually decline and die with the onset of hot summer temperatures. Another type of hardy annual is the winter annual that germinates in the fall, overwinters as a rosette of leaves, and flowers in late winter and early spring. Species of *Stellaria* (chickweed) and *Cardamine* (snapweed) are examples of winter annuals.

Half-hardy annuals will tolerate periods of cold damp weather, but will be damaged by frost. Most half-hardy annuals can be seeded outdoors in early spring since they do not require warm soil temperatures to germinate. Seeds or plants are normally planted after the last spring frost. Examples of plants grown

as half-hardy annuals are *Cosmos* (cosmos) and *Tropaeolum* (nasturtium). Some half-hardy annuals may decline in the midsummer heat but may re-bloom in late summer or fall.

Because most tender annuals are native to warm tropical regions of the world, they are sensitive to cold soil temperatures and are easily damaged by frost. Most seeds will not survive freezing soils temperatures and will not germinate when soil temperatures are below 15°C. It is recommended to wait two to three weeks after the last spring frost to sow seeds or transplant outdoors. Tender annuals include species of *Begonia* (begonia)and *Impatiens* (impatiens).

While some plants may be perennial in tropical regions, they are categorized as cool- or warm-season annuals when planted in colder regions. Cool-season annuals, such as *Pelargonium* (geranium), *Petunia* (petunia), and *Antirrhinum* (snapdragon), grow best when temperatures are in between 20° and 25° C. during the day. Best flower production is in the spring and fall; flower production tends to decline in the middle of a hot summer. Warm-season annuals, such as *Zinnia* (zinnia) perform well when day time temperatures are between 26° and 32°C. and night time temperatures are between 15° and 20°C.

BIENNIALS

The life cycle of biennial plants is completed over two growing seasons. During the first season, they produce only leaves—usually in a rosette. Following a winter cold period, they flower in the second growing season, produce seeds, and then die. Popular biennials include *Digitalis* (foxglove) and *Oenothera* (evening primrose). Cultural practices are basically the same as for annuals, except that the plants are alive for two growing seasons.

Biennials present the obvious disadvantage of producing only foliage the first year. One solution is to sow biennial seeds in mid-summer so that the plants will develop during the summer and fall. After exposure to the winter cold, they will develop flowers in the spring.

PERENNIALS

Perennial plants can be either short-lived or long-lived herbaceous or woody plants. Short-lived herbaceous plants such as *Gaillardia* (blanket flower) may live for only a few years, or they can be long-lived like *Paeonia* (peony). Woody plants also classify as perennials, though they are rarely referred to as such. Woody species have stems that continue to grow, developing a permanent structure that the plant cannot ‘replace’ once removed. Some woody plants live tremendously long lives, such as the 9500 year old *Picea* sp. (spruce) in Sweden and British Columbia’s 1000 year old *Thuja plicata* (western red cedar). Perennials that flower and fruit only once and then die are termed monocarpic**.** However, most perennials are polycarpic, flowering over many seasons in their lifespan.

COMMON HARDY HERBACEOUS PLANT FAMILIES INCLUDE:

Asteraceae – sunflowers

Brassicaceae – mustards

Crassulaceae – sedums

Liliaceae – lilies

Lamiaceae – mints

Poaceae – grasses

Ranunculaceae – buttercups

REVIEW

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11.

Introduction to Dichotomous Keys

Learning Objectives

- Describe the characteristics of dichotomous keys.

A dichotomous key is a useful tool for the identification of things not known to the observer; for example, unfamiliar plant species. The typical dichotomous key, as shown in the example below, is made up of a series of descriptions, features or characteristics, arranged in pairs (couplets) of contrasting alternative choices (e.g., hairy vs. not hairy, bigger than a breadbox vs. not bigger than a breadbox, etc.). Each couplet is worked through sequentially until the correct determination is made.

Starting at the first couplet, choose which of the two alternatives best suits an object or thing, and proceed to the couplet number or answer indicated by that choice. The number of things being considered is reduced at each successive step in the key so that by a process of elimination the correct determination is made.

EXAMPLE DICHOTOMOUS KEY

Example objects to identify: **apple tree, water-lily, fir tree, dandelion, astroturf, seaweed**.

- 1.a. found in water …….. go to 2
- 1.b. found on land …… go to 3
- 2.a. grows in salt water …… seaweed
- 2.b. does not grow in salt water …….. water-lily
- 3.a. a real plant …… go to 4
- 3.b. not a real plant …….. astroturf
- 4.a. grows more than 50 m tall …….. fir tree
- 4.b. grows less than 50 m tall …….. go to 5
- 5.a. produces yellow flowers …….. dandelion
- 5.b. does not produce yellow flowers …….. apple tree

Or, the couplets may be grouped like this:

- 1.a. found in water …….. 2
- 2.a. grows in salt water …….. seaweed
- 2.b. does not grow in salt water …….. water-lily
- 1.b. found on land …….. 3
- 3.a. real plant …….. 4
- 4.a. grows more than 50 m tall …… fir tree
- 4.b. grows less than 50 m tall ……. 5
- 5.a. produces yellow flowers …….. dandelion
- 5.b. does not produce yellow flowers ……. apple tree
- 3.b. not a real plant ……. astroturf

Dichotomous keys may be simple or complex depending on what is being identified. For example, distinguishing obvious visible characteristics, such as structures for water movement in woody or herbaceous plant growth is straightforward. However, it should be noted that leaves, flowers, and fruit will not typically be available at the same time and return visits may be needed. Furthermore, differentiating minute plant parts such as reproductive structures requires the use of a hand lens or low magnification microscope for inspection and a thorough understanding of the descriptive terminology used in a dichotomous key.

An example of a dichotomous key for plant identification is available online at this link to *Oregon State University Dichotomous Key* [New Tab].[1]

1. https://oregonstate.edu/trees/dichotomous_key.html

12.

Key to Plant Classification

Learning Objectives

- Use a dichotomous key for plant classification.

Dichotomous keys help improve pattern recognition and understanding of the descriptive terminology used to classify important distinctions among plants. The following dichotomous key can be used outdoors to classify a range of plants by type, growth habit, and reproductive method.

PRACTICE

Use a dichotomous key for plant classification**.**

Key to Plant Classification

- 1.a. Plants rely on their closeness to water and absorptive green tissues above ground…… Non-vascular plant (go to 2)
- 1.b. Plants have a water conducting system that supplies above ground tissues with water and allows growth above ground …….. Vascular plant (go to 2)
- 2.a. Plants, (conifers and flowering) that reproduce by seed …….. Spermatophyte (go to 3)
- 2.b. Plants that reproduce by spores …… Pteridophyte (go to 4)
- 3.a. Spermatophyte that flowers and develops seeds within ovaries that mature into fruits …….. Angiosperm (go to 4)
- 3.b. Spermatophyte that flowers and develops seeds ‘naked’ in cones (conifer) ……. Gymnosperm (go to 5)
- 4.a. Plants with primary growth tissue only, lacking woody tissue like bark …… Herbaceous (go to 6)
- 4.b. Plants with secondary growth tissue, like bark ……. Woody (go to 5)

- 5.a. Woody plants with one or few main stems ……. Tree (go to 7)
- 5.b. Woody plants with multiple stems emerging from base …….. Shrub (go to 7)
- 6.a. Non-woody tissue does not persist over one or more seasons; withers and dies back to fleshy crown, bulb, tuber, or rhizome …….. Deciduous herbaceous (go to 8)
- 6.b. Non-woody tissue and leaves persist over one or more seasons of growth …… Evergreen herbaceous (go to 8)
- 7.a. Trees or shrubs that lose their leaves every autumn…….. Deciduous (go to 8)
- 7.b. Trees or shrubs that are never entirely leafless ……. Evergreen or semi-evergreen (go to 8)
- 8.a. Herbaceous angiosperm that produces a single seed leaf; leaves have parallel venation; flower parts are in 3's …… Monocotyledon
- 8.b. Woody or herbaceous angiosperm that produces a pair of seed leaves; leaves have netted venation; flower parts are in 4's or 5's …….. Eudicotyledon

13.

Introduction to Plant Morphology

Learning Objectives

- Describe the morphological characteristics of herbaceous and woody stems.

Plant identification relies on knowledge of taxonomy and understanding of stem, leaf, bud, flower and fruit morphology. Morphology is the Greek word for "the study of shape," and plant morphology is the study of the external plant structures and shapes. While the original botanical resource, *Species plantarum* was published by Carolus Linnaeus in 1753, one of the most comprehensive references currently available for plant morphology is Huxley, A. (ed.) *The New Royal Horticultural Society Dictionary of Gardening*. London, Macmillan Press, 1992.

A working knowledge of morphological descriptors for plant identification enables the use of dichotomous keys as well as herbarium samples and digital databases. A herbarium is a collection of pressed and dried plants that is systematically arranged for research and plant identification purposes. Media 13.1: *Plant Collecting & Herbarium Research Pt 1* [New Tab][1] shows the procedure for collecting and preparing plants for herbarium samples.

1. https://youtu.be/Y4OzLI1qYh8

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Media 13.1: Plant Collecting & Herbarium Research Pt 1.

Information about an institutional herbaria is available at this link to the *University of British Columbia Beaty Biodiversity Museum* [New Tab].[2]

Digital databases and apps typically use the morphology of stems, leaves, flowers, and fruit to identify unknown plants . Examples of regional databases are available at these links to the *Kwantlen Polytechnic University Plant Database* [New Tab],[3] *Oregon State University Landscape Plants* [New Tab],[4] and *University of British Columbia E-Flora BC* [New Tab].[5]

STEM MORPHOLOGY

A morphological description usually starts with the structure of a plant. Plant stems with vascular tissue support leaves and reproductive structures such as flowers. Depending on the type of plant, stems may be woody or herbaceous, and solid or hollow in cross section.

Herbaceous (non-woody) stems with solid or hollow stems are typical of forbs (eudicots), grasses, and grass-like plants called rushes and sedges (monocots). The stems are generally filled with a soft spongy tissue called pith, that stores and transports nutrients. The culm (stem) of a grass plant (*Poa* spp.) is

2. https://beatymuseum.ubc.ca/research-2/collections/herbarium/
3. https://plantdatabase.kpu.ca/
4. https://landscapeplants.oregonstate.edu/
5. http://linnet.geog.ubc.ca/biodiversity/eflora/index.shtml

hollow with pith only at the jointed nodes. The base of the leaf circles around the stem forming a series of overlapping sheaths. Sedges (*Carex* spp.), differ from grasses and rushes in that the stems are triangular (V-shaped) in cross section at the base ("sedges have edges"), have a solid pith, and are not jointed. Rushes differ from grasses in that stems are not jointed (no nodes) and are typically filled with pith. Some rush genera, such as *Luzula* spp. can look very grass-like with leaf blades while in *Juncus* spp. the leaves may be reduced to just a rounded sheath. Examples of these morphological characteristics are available at this link to *Grasses, Sedges and Rushes* [New Tab].[6]

In contrast to herbaceous stems that die at the end of the growing season, woody stems are permanent structures that grow in length and girth (diameter) each year and produce bark as a protective covering. The general features of the woody stem illustrated in Figure 13.1 will be characteristic for a particular plant species.

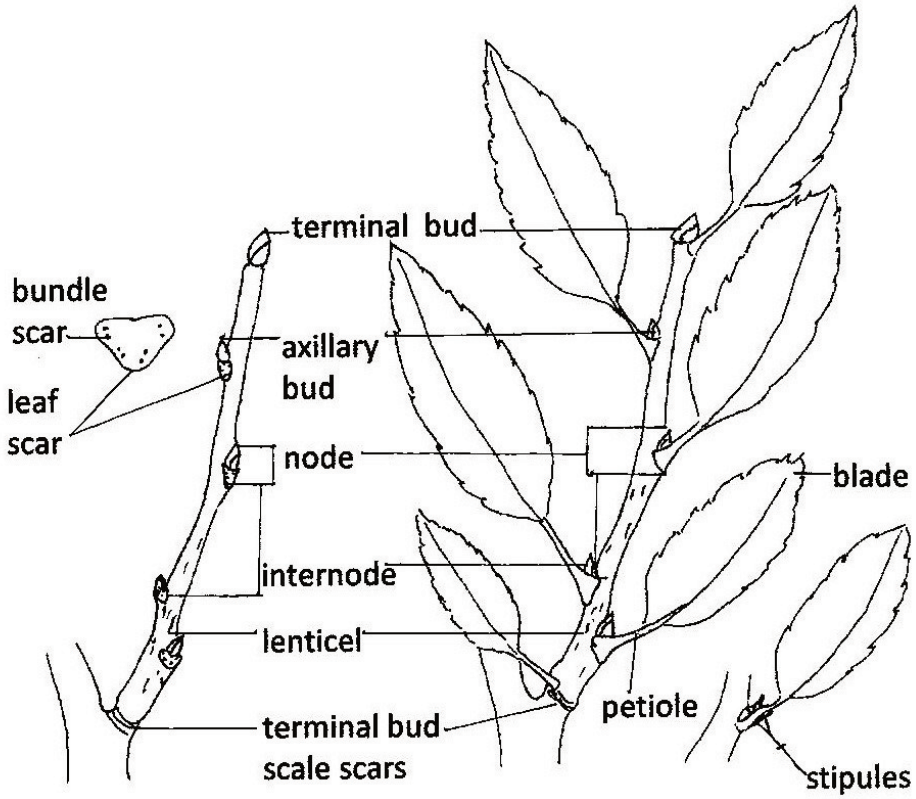

Figure 13.1 External features of a woody stem.

The shape, size and arrangement of buds and lenticels (small openings in the outer bark that allow for the exchange of gases), are often identifiable in trees and shrubs, as shown in Figure 13.2 and Figure 13.3. The thickness, texture, pattern, and color of the bark of many woody plants is both a distinctive species characteristic for identification and an attractive feature for landscape use.

6. https://www.minnesotawildflowers.info/page/grasses-sedges-rushes

Figure 13.2 Buds on Prunus tree.

Figure 13.3 Bark and lenticels on Prunus tree.

Examples of the morphology of herbaceous stems and woody stems and buds are available at this link to *Stems – External KPU.ca/Hort* [PDF] [New Tab].[7]

Stem modifications include underground, above ground, and aerial structures that are characteristic to different plant species. Underground structures for spreading and food storage include rhizomes, corms, tubers, and bulbs. Stolons, runners, suckers, and offsets that grow almost parallel to or just above the ground enable plant spread. Aerial modifications include stem tendrils and thorns for climbing and protection. In xeric (dry) conditions, the stem may take over photosynthesis in order to reduce water loss from leaves (*Cactus* spp.). Examples of different types of stem modifications are shown at this link to *Modifications – Stem KPU.ca/Hort* [PDF] [New Tab].[8]

7. http://www.horticulturebc.info/labreviews/pdfs/Stems%20-%20External.pdf
8. http://www.horticulturebc.info/labreviews/pdfs/Modifications%20-%20Stem.pdf

TRUE OR FALSE

Search the botanical names for plant information available at this link to the *KPU Plant Database* [New Tab][9]

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Video Attributions

- "Plant Collecting & Herbarium Research! Pt 1" by Science IRL. Standard YouTube Licence.

9. https://plantdatabase.kpu.ca/

14.

Plant Morphology – Leaves

Learning Objectives

- Describe the morphological characteristics of plant leaves.

Leaves are specialized structures for photosynthesis that provide plants with energy. Leaves arise at nodes just below an axillary bud on woody stems and are usually petiolate, that is composed of a blade and stalk-like petiole. Petioles may have stipules, two small leaf-like flaps that are attached at the base. In some cases, stipules on leaves and stems may become modified into spines, thorns, or prickles. Some leaves are sessile, that is, they lack petioles and have blades directly attached to the stem. When a bud is located in the axil of a single leaf and the stem, as shown in Figure 14.1 the leaf is classified as simple.

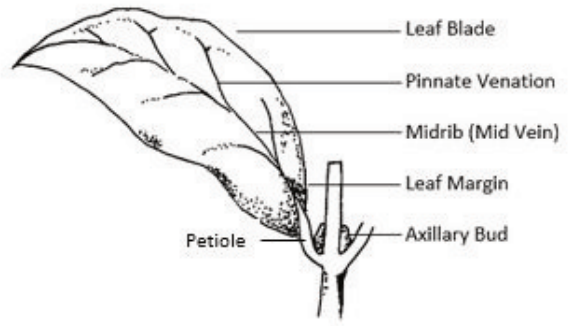

Figure 14.1 Parts of a simple leaf

However, when a bud is located in the axil of a structure with more than one leaf (leaflet) on attached to the axis (rachis), the leaf is classified as compound. As shown in Figure 14.2, even or odd numbers of leaflets may be pinnately compound that is, arranged along a central axis (feather-like), or palmately compound from one point on the tip of the petiole, (like fingers on an out-stretched hand). Compound leaves may undergo double (bipinnate) or triple (tripinnate) compounding into finer segments or leaflets.

Figure 14.2 Types of compound leaves.

Phyllotaxy, the arrangement of a leaf or bud in relation to another leaf or bud along a plant stem is a useful basis for classifying plants. Figure 14.3 illustrates common leaf arrangements where leaves and buds on a stem are opposite (directly across from each other on the stem), alternate (spaced alternately along the stem axis), whorled (three or more leaves and buds are positioned at a node), or basal (emerging from the base). Leaf arrangement may also be described as spiral, clustered, decussate (alternating pairs at right angles), and imbricate (overlapping scales).

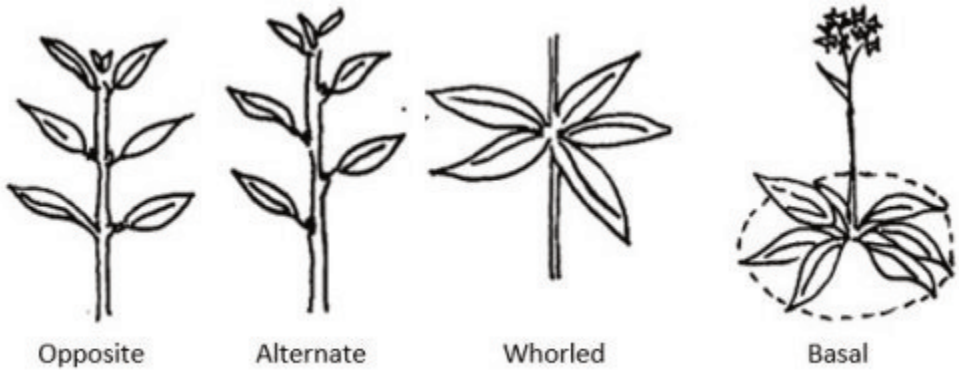

Figure 14.3 Common types of leaf arrangements.

Leaf venation refers to the patterns of veins within the leaf blade. In eudicot plants, leaf venation is typically either pinnate or palmate and may have multiple branching that gives an overall netted appearance. In contrast, monocots will have parallel leaf venation. Additional morphological features for description include leaf shape, tip and base features, and margins (edges). Leaf surface characteristics vary and some may be smooth (glabrous) or with hairs (hirsute or pubescent), wrinkles (rugose), pustules (verrucose) or other interruptions of the surface. Additional leaf surface terms are defined at this link to *Leaf* [New Tab].[1]

Figure 14.4 and Figure 14.5 illustrate components of a leaf morphology chart commonly used for plant identification. More detailed information about the external characteristics of leaves is available at this link to *Leaf Morphology* [New Tab].[2]

1. https://en.wikipedia.org/wiki/Leaf#Surface
2. https://commons.wikimedia.org/wiki/Leaf_morphology#shape

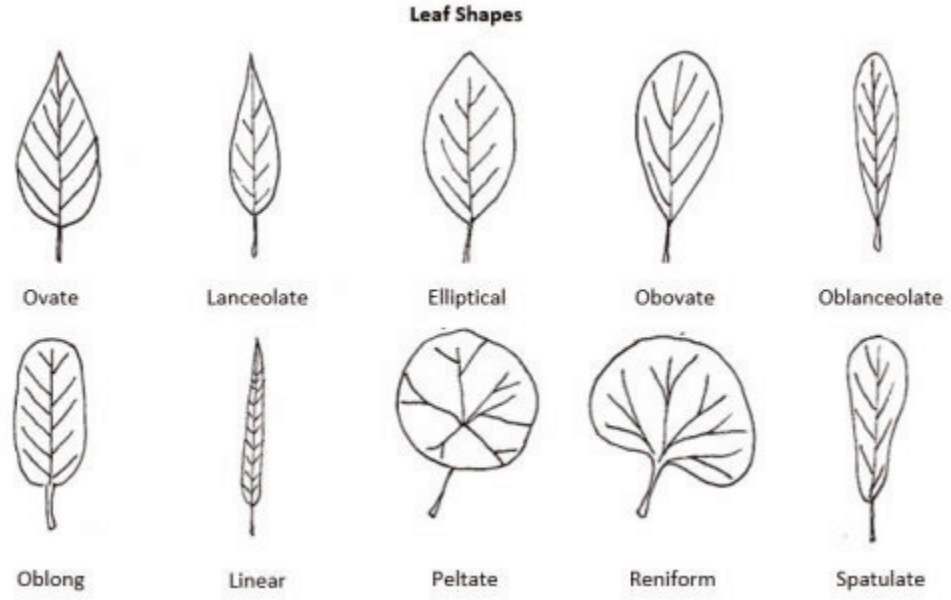

Figure 14.4 Leaf morphology chart with narrow to broad examples.

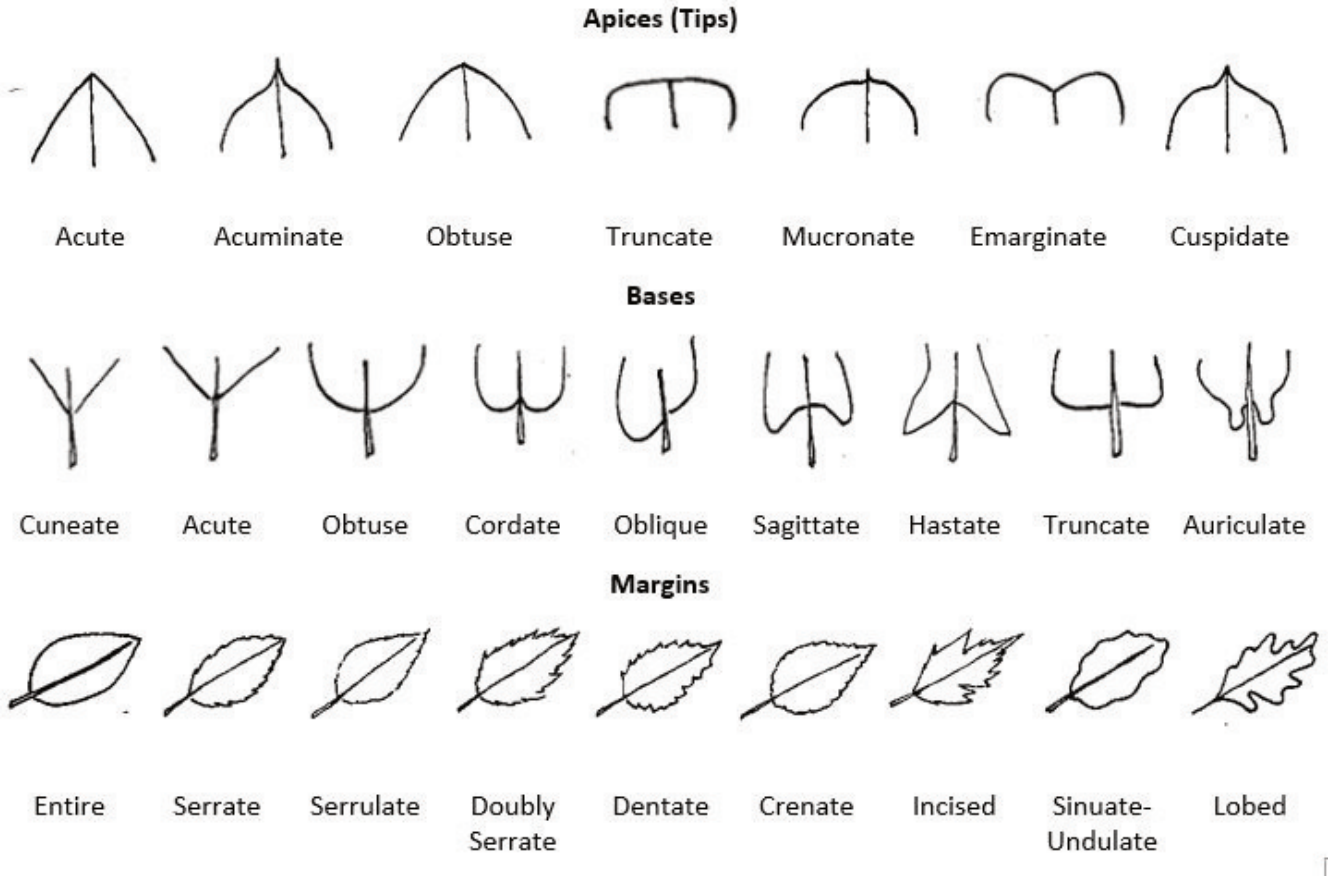

Figure 14.5 Leaf morphology chart of tips, bases, and margins.

REVIEW

Use morphological descriptors for leaf parts. Click the image hot spots.

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15.

Plant Morphology – Conifers

Learning Objectives

- Use a dichotomous key to identify conifers.

Both evergreen and deciduous leaves exhibit characteristic broad blades in angiosperms, and narrow needle, scale-like, or awl-shaped leaves in the conifers. Figure 15.1 illustrates the different types of conifer leaves. Leaves may be borne singly on the shoot as in *Picea* spp. (spruce), in tufts or clusters as in *Larix* spp. (larch), or in fascicles (bundles) of 2-5 as in *Pinus* spp. (pines). The awl-shape and scale-like foliage of *Juniperus* spp. exhibits leaf dimorphism where a juvenile leaf form differs from the mature leaves of the same plant.

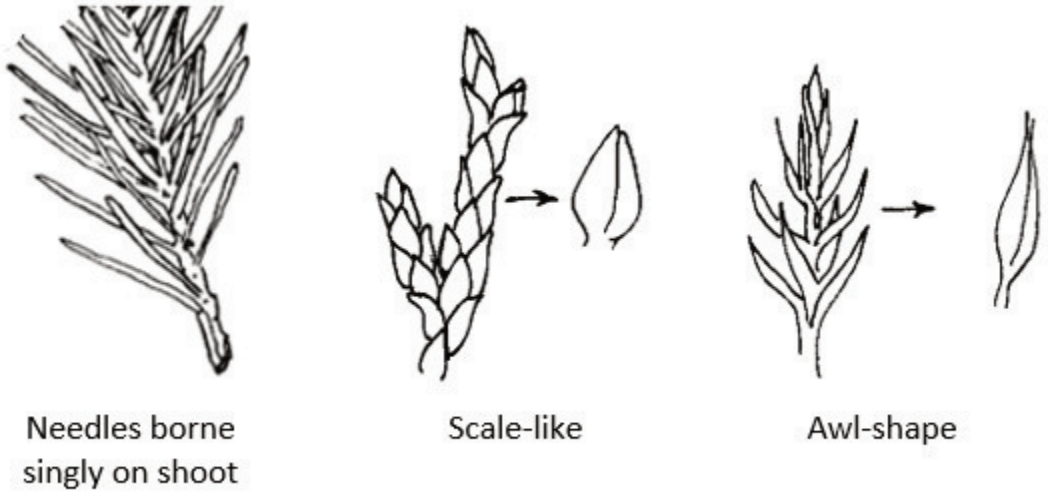

Figure 15.1 Types of conifer leaves.

DICHOTOMOUS KEY FOR SOME COMMON CONIFERS

Click the links for plant images.

- 1.a. leaves long, needle-like …….. go to 2

- 1.b. leaves lanceolate, awl or scale-like, overlapping, not needle-like …… go to 5
- 2.a. needles in bundles or tufts …….. go to 3
- 2.b. needles borne singly …… go to 7
- 3.a. needles in bundles of 2 to 5 ……. go to 4
- 3.b. needles deciduous, many in a tuft …….. *Larix decidua* [New Tab][1]
- 4.a. 5 needles per bundle …… *Pinusstrobus* [New Tab][2]
- 4.b. 2 needles per bundle ……. go to 10
- 5.a. scales imbricate (overlapping) cones small, upright… *Thujaplicata* [New Tab][3]
- 5.b. scales imbricate, cones spherical or oval, opening along sutures at maturity ……. go to 6
- 6.a. cones small, spherical; cone scales with a prominent point ……. *Cupressusnootkatensis* [New Tab][4]
- 6.b. cones larger, oval, cone scales thick, deeply pitted …….. *Sequoiadendrongiganteum* [New Tab][5]
- 7.a. needles stiff and sharp, 4-sided …… go to 8
- 7.b. needles flat and pliable ……. go to 9
- 8.a. needles extremely sharp, new growth coated with bluish wax…….. *Piceapungens* Glauca Group [New Tab][6]
- 8.b. needles not extremely sharp, not coated with bluish wax …… *Picea abies* [New Tab][7]
- 9.a. needles dull green, 2 cm long, borne on short pegs that persist after the needles fall ……..*Tsuga heterophylla* [New Tab][8]
- 9.b. needles shining green, 2 cm long, not borne on pegs …….. *Pseudotsugamenziesii* [New Tab][9]
- 10.a. needles < 7 cm long …….. go to 11
- 10.b. needles > 7 cm long ……. *Pinusnigra* [New Tab][10]
- 11.a. needles dark green, 3-6 cm long, cone scales with a small recurved prickle …….. *Pinus contorta* [New Tab][11]

1. https://plantdatabase.kpu.ca/plant/plantImages/91?image=l
2. https://plantdatabase.kpu.ca/plant/plantImages/1608?image=h
3. https://plantdatabase.kpu.ca/plant/plantImages/178?image=h
4. https://plantdatabase.kpu.ca/plant/plantImages/760?image=l
5. https://plantdatabase.kpu.ca/plant/plantImages/157?image=f
6. https://plantdatabase.kpu.ca/plant/plantImages/123?image=l
7. https://plantdatabase.kpu.ca/plant/plantImages/119?image=t
8. https://plantdatabase.kpu.ca/plant/plantImages/182?image=f
9. https://plantdatabase.kpu.ca/plant/plantImages/137?image=h
10. https://plantdatabase.kpu.ca/plant/plantImages/122?image=h
11. https://plantdatabase.kpu.ca/plant/plantImages/120?image=t

- 11.b. needles bluish green 5-7 cm long, slightly twisted, cone scales without a prickle …… *Pinus sylvestris* [New Tab][12]

12. https://plantdatabase.kpu.ca/plant/plantImages/124?image=h

16.

Plant Morphology – Flowers and Fruit

Learning Objectives

- Describe the morphological characteristics of flowers and fruit.

The most significant patterns, in terms of evolutionary relationships, involve reproductive structures, such as the number and arrangement of flower parts, or the structure of cones. While the size and shape of vegetative structures such as leaves and stems are relatively plastic or changeable, the basic patterns of reproductive structures change little over time. Although access to flowers and fruit may be seasonal, digital resources and herbarium samples allow the identification of patterns and relationships within plant taxa.

FLOWER AND INFLORESCENCE MORPHOLOGY

Flower shape, color, and markings are all valuable features for plant identification. Figure 16.1 illustrates some flower shapes that are commonly used for identification purposes.

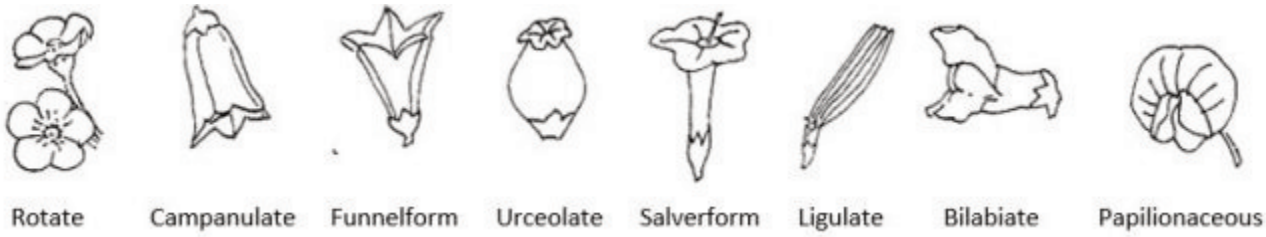

Figure 16.1 Flower corolla shapes.

A typical angiosperm flower is borne on a peduncle (stalk) and is composed of the receptacle, sepals (calyx), petals (corolla), stamens, and pistil (carpel). Flower parts may be fused or separate and usually exhibit radial (star-shaped) symmetry or bilateral (two-mirror image halves) symmetry as shown in Figure 16.2.

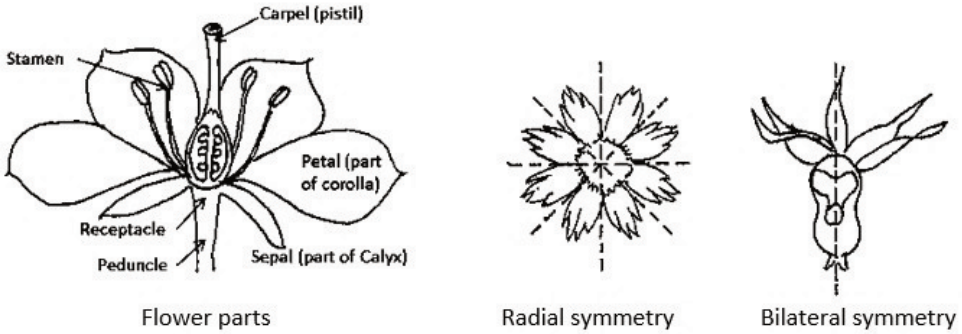

Figure 16.2 Flower parts and symmetry.

In addition to their shape, flowers are often differentiated by further dissections of their structure. For example, complete flowers must have all four main flower parts: sepals, petals, stamens (male) and pistils (female), while incomplete flowers will be missing one or more of these parts. Most flowering plants have perfect flowers that contain both male and female reproductive parts. However, some have imperfect flowers that contain only the male or female part (stamen or pistil) and may or may not contain sepals or petals. A species may have individual plants that are dioecious, producing either male or female flowers or cones on separate plants. Plants that are monoecious produce both female and male flowers and cones on one plant. Flower parts and structures can be examined at this link to *Flower Morphology KPU.ca/Hort* [PDF] [New Tab].[1]

Angiosperms produce flowers which are arranged on a structure called an inflorescence. An inflorescence may support a solitary flower or display individual flowers (florets) to pollinators or expose flower parts to pollen carried on air currents. Figure 16.3 illustrates types of inflorescence commonly found in both woody and herbaceous plants.

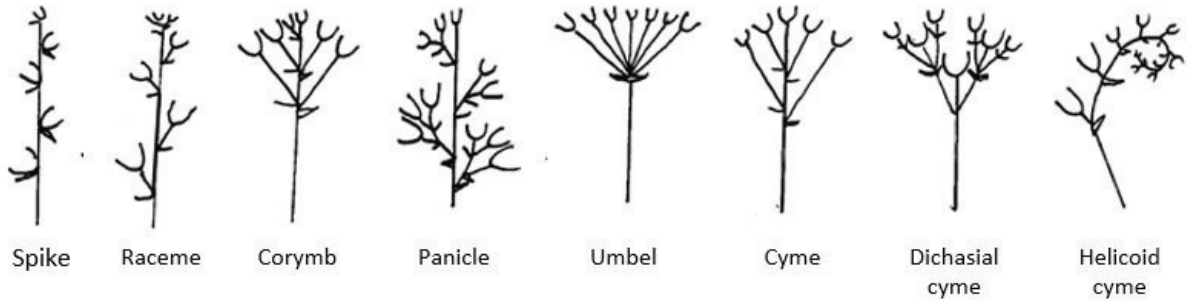

Figure 16.3 Inflorescence types.

Representative characteristics of flowers and inflorescence can be examined at this link to *Inflorescence Types KPU.ca/hort* [PDF] [New Tab].[2]

1. http://www.horticulturebc.info/labreviews/pdfs/Flower%20Morphology.pdf
2. http://www.horticulturebc.info/labreviews/pdfs/Inflorescence%20Types.pdf

FRUIT MORPHOLOGY

For the majority of angiosperms, when a flower is pollinated, the pollen joins with an egg to produce a seed. The seed develops within the ovary which is part of the pistil, a female reproductive organ of the flower. The expanded and ripened ovary is referred to as the fruit. Commonly, the enlarged ovary becomes the edible portion of the fruit.

Fruits are classified into one of three main groups: simple, aggregate, or multiple, as shown in Figure 16.4 and Figure 16.5. Simple fruits, which form from a single, ripened ovary, may be either fleshy or dry. Fleshy fruits include the berry (grape), pepo (pumpkin), hesperidium (orange), drupe (plum), and pome (apple). Aggregate fruit develop from a single flower with numerous pistils. Once fertilized, the individual pistils develop into tiny fruitlets clustered on a single receptacle, as in a raspberry or blackberry. Multiple fruits, such as pineapples, form when numerous fertilized flowers in a single inflorescence develop together into a larger fruit.

Dry fruits, are either dehiscent (split open at maturity) or indehiscent (remain closed at maturity). Dry fruits that split at maturity include the legume (pea), silique (mustard), follicle (milkweed), and capsule (cotton). Dry fruits that do not split at maturity include the achene (sunflower), nut (pecan, almond), grain (corn), samara (ash), and schizocarp (geranium, carrot).

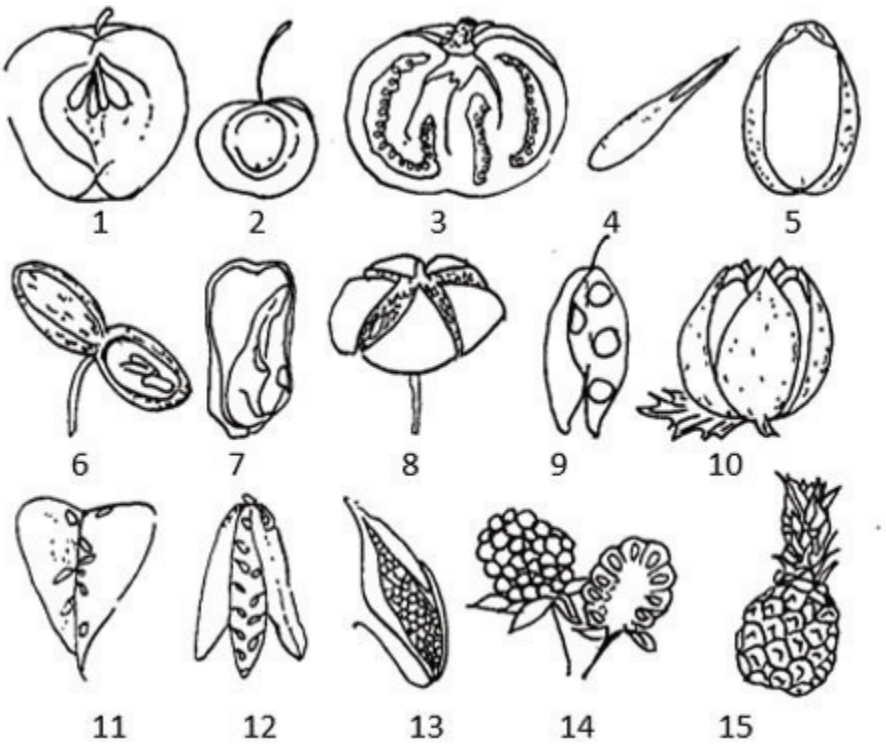

Figure 16.4 Fruit morphology chart.

Figure 16.5 Key to fruit types.

In addition to an important feature for identification purposes, many fruit types have decorative value and may provide long season interest in the landscape. The morphology of different fruit types can be examined at this link to *Fruit Types KPU.ca/Hort* [PDF] [New Tab].[3]

For the majority of gymnosperms, the cone is the reproductive structure. Most familiar is the female cone, which is constructed of many small, rounded, scale-like structures attached to a central stem. The pollen bearing male cone is characteristically smaller than the female cone. Typically, a naked seed will develop on each of the scales of a female cone. Examples of recognizable cone characteristics for some closely-related conifers are available at this link to *Conifer Cones – Tree Guide UK* [New Tab].[4]

REVIEW

Match the flower and inflorescence types.

An interactive or media element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/plantidentification/?p=64

REVIEW

Select and place the correct term next to the plant that has that fruit type. Search the type of fruit for each plant at this link to the *KPU Plant Database* [New Tab][5].

3. http://www.horticulturebc.info/labreviews/pdfs/Fruit%20Types.pdf
4. https://www.treeguideuk.co.uk/mini-guides/conifer-cone/
5. https://plantdatabase.kpu.ca/

An interactive or media element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/plantidentification/?p=64

17.

Plant Family Characteristics

Learning Objectives

- Describe key morphological patterns characteristic to plant families.

Plant families are separated according to structural differences in flowers, fruit, and seed. Genera that share similar structures are grouped within a particular family. While some plant families, such as Orchidaceae (orchid) and Asteraceae (sunflower family) have several hundred members, others such as Ginkgoaceae (ginkgo) have a single member. As the group with the greatest number of closely related plants, the family taxon provides a starting point for narrowing the search for an unknown plant. In addition to shared morphological characteristics, the family taxon provides information about evolutionary adaptations for growth conditions as well as methods for propagation. One of the most comprehensive references for angiosperms is Flowering Plant Families of the World by V. H. Heywood (2007). The morphological characteristics for some families and genera commonly found in landscapes and gardens are summarized below. Images of the representative genera are available at this link to the *KPU Plant Database* [New Tab][1] .

ASTERACEAE – ASTER, SUNFLOWER FAMILY

One of the largest families of flowering plants is the aster or sunflower family, Asteraceae. Most of its members are evergreen shrubs or subshrubs or perennial rhizomatous herbs, but tap-rooted or tuberous-rooted perennials, and biennial and annual herbs are also frequent. Common genera of this family include:

- *Achillea* (yarrow)
- *Dahlia* (dahlia)
- *Jacobaea* (dusty miller)
- *Leucanthemum* (daisy)
- *Symphyotrichum* (aster)
- *Taraxacum* (dandelion)

1. https://plantdatabase.kpu.ca/

Key identifying characteristics for Asteraceae include an inflorescence that is a composite head with disc florets, (ray florets may or may not be present), and an achene-like cypsela (fruit) with a fringe of hairs or papus. The leaf arrangement may be alternate or opposite, though rarely whorled. Leaf blades are often lobed or toothed and pinnately or palmately veined.

CARYOPHYLLACEAE – PINK, CARNATION FAMILY

The pink or carnation family, Caryophyllaceae is a large family of temperate eudicots that are mostly annual, biennial, or perennial herbs and a few subshrubs with woody stems. Many members are flowering ornamentals and some, such as *Cerastium* may be weedy. Common genera include:

- *Cerastium* (snow-in-summer)
- *Dianthus* (pinks, carnations)
- *Lychnis* (campions)
- *Silene* (catchflies)

Species in Caryophyllaceae are relatively uniform and recognized by non-succulent stems, swollen stem nodes, and opposite leaves (rarely whorled). Leaf blades are typically simple, lanceolate with entire margins, and without stipules. Flowers are often white or pink, with 4 or 5 petals, and 5 sepals. Petals may be entire, fringed, or deeply cleft and sepals may be free or united. There are usually 5-10 stamens or more and the carpels are united in a common superior ovary. Flowers are terminal and bloom singly or branched in cymes. In some species such as *Silene* spp., the calyx may be cylindrical and inflated. The fruit is a capsule with many seeds.

ERICACEAE – HEATHER FAMILY

One of the most common groups of plants in the British Columbia and the Pacific Northwest (PNW) is the heather family, Ericaceae. Family members are mostly temperate woody shrubs and trees, and rarely herbs. Species of *Arbutus*, *Arctostaphylos* and *Gaultheria* are indigenous to the PNW. Some common genera in the Ericaceae family include:

- *Calluna* (heather)
- *Erica* (heather or heath)
- *Pieris* (lily-of-the-valley shrub)
- *Rhododendron* (including azaleas and rhododendrons)
- *Vaccinium* (huckleberries and cranberries)

For the most part, ericaceous plants have urn-shaped flowers borne in racemes or panicles. *Rhododendron* is an exception; they have relatively open, bell-shaped flowers in short racemes (trusses). Other shared characteristics include: fine, off-white shallow roots, an affinity for acid soils, leathery leaves arranged alternately or appearing terminally whorled, rough or peeling bark, and dense wood.

While many members are deciduous, genera in this family are among the most recognizable of broadleaf evergreens, both in and out of flower.

LAMIACEAE – MINT FAMILY

The mint family, Lamiaceae is easily recognized because its members exhibit square stems, opposite, often decussate (4-ranked) leaf arrangement, and distinctive two-lipped flowers held in verticillasters (pairs of axillary cymes arising from opposite leaves or bracts and forming a false whorl). The fruit is a nutlet. Family members may be annual or perennial, and are often subshrubs (woody base with soft wooded stems) or entirely herbaceous. Many are highly aromatic, vigorous growers and adapted to propagate easily from stem-cuttings. There are a number of broadleaf evergreen members in Lamiaceae, as listed below:

- *Ajuga* (carpet-bugle)
- *Lamium* (dead nettle)
- *Lavandula* (lavender)
- *Rosmarinus* (rosemary)
- *Salvia* (sage)
- *Thymus* (thyme)

LILIACEAE – LILY FAMILY

Members of the the lily family, Liliaceae are typically perennial herbaceous monocots that grow from bulbs or rhizomes. Leaves are basal, alternate, and sometimes whorled in arrangement with parallel venation. The inflorescence is a raceme or solitary flower. Flowers are radially symmetrical with parts occurring in 3's, and separate but undifferentiated sepals and petals (tepals) that may be spotted or striped. The fruit is a capsule. Some of the genera in the lily family include:

- *Erythronium* (fawn lily)
- *Fritillaria* (chocolate lily)
- *Lilium* (lily)
- *Tulipa* (tulip)

RANUNCULACEAE – BUTTERCUP FAMILY

The buttercup family, Ranunculaceae is composed of herbaceous annuals or perennials, woody shrubs, and lianas. Leaves are typically alternate, sometimes opposite in arrangement, and simple or compound with lobed or dissected margins. The inflorescence is a cyme or solitary flower. Flower sepals and petals are often similar, separate and radially symmetric. Flowers may have few to many petals, often with many stamens and carpels, and produce follicle fruit. Examples of genera in the buttercup family are:

- *Aquilegia* (columbine)
- *Clematis* (leather flower)
- *Delphinium* (larkspur)
- *Helleborus* (hellebore)
- *Ranunculus* (buttercup)

ROSACEAE – ROSE FAMILY

The rose family, Rosaceae is a large and important family of woody and herbaceous, deciduous and evergreen plants. It is valued for its bush and tree fruits and for many popular horticultural ornamental plants. A few commonly grown rosaceous plants include:

- *Cotoneaster* (cotoneaster)
- *Fragaria* (strawberry)
- *Malus* (crabapple)
- *Spiraea* (spirea)

Common features of these genera include simple rotate flowers with 5 separate petals, sepals, and stamens, and simple or multiple fleshy or achene fruits. Leave are alternate or basal in arrangement, simple or compound, sometimes toothed and often with stipules. Spines, thorns, and prickles are prevalent in the rose family.

SAPINDACEAE – SOAPBERRY FAMILY

The soapberry family, Sapindaceae is a large family of about 140 genera of trees and shrubs, lianas, and vines. Family members such as maples and buckeyes are valued for lumber and ornament. A few examples of sapindaceous plants include:

- *Acer* (maple)
- *Aesculus* (buckeye, horse chestnut)
- *Koelreuteria* (golden rain tree)

Some genera in Sapindaceae, including *Acer* (maple) are lactiferous, i.e. containing a milky sap. Maples and buckeyes include mostly deciduous trees and shrubs with petiolate, opposite leaves that are often simple, lobed or dissected, or pinnate, ternate, or palmately compound. Leaf venation is palmate or pinnate and leaflet margins may be entire, crenate, serrate, or dentate. The flowers are unisexual or bisexual in racemes, panicles or corymbs. The fruit is typically a distinctive samara in the maples, while the buckeyes produce globular dehiscent capsules with poisonous nuts.

There are several hundred plant families and comprehensive information about additional families is available at this link to the *Digital Atlas of Ancient Life Overview of Angiosperm Phylogeny* [New Tab][2].

REVIEW

Identify the family name for each plant genus.

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/plantidentification/?p=66

2. https://www.digitalatlasofancientlife.org/learn/embryophytes/angiosperms/angiosperm-phylogeny/

II

Part 2 Plant Requirements and Use

18.

Plant Habitats

Learning Objectives

- Identify plants used in all segments of horticulture.

The horticultural use of plants for decoration, food, medicine, and materials spans the history of human development on earth. While early European explorers to North America described the new world as untouched wilderness, generations of Indigenous residents used plants for decoration and ritual and managed growing conditions for food for thousands of years. The relationship between people, plants, and the environment on the Pacific coast of North America is described at this link to the *Garry oak ecosystem* [New Tab].[1]

The early European plant explorer, Archibald Menzies has been credited as the first discoverer, describer, and collector of a number of plants whose provenance is the Pacific Northwest. Provenance refers to the populations of plants that occur naturally in local regions. For example, *Pseudotsuga menziesii (*Douglas fir) and *Arbutus menziesii (*Pacific madrone) both occur naturally in the Pacific Northwest. A plant's nativity or provenance can be determined either geographically or politically. *Acer saccharum (*sugar maple), is native to central eastern North America, in other words, a Canadian native, but not a Pacific Northwest native. Similarly, *Artemisia tridentata (*big sagebrush) and *Rhus glabra (*smooth sumac) are native to interior British Columbia, but only to the dry interior valleys, not to the coast.

NATIVE PLANTS

Plants that occur naturally in a place are considered native or indigenous to a place. Native plants have undergone genetic adaptations that have allowed them to evolve within the physical, chemical, and biological conditions of local ecosystems. As such, they function as part of a biodiverse community of organisms that includes plants, animals, and microorganisms adapted to local environmental conditions.

In North America, an indigenous designation is usually applied to plants that were present before first contact with Europeans. Thus, *Plantago* spp. (plantains), although widespread here, are not considered

1. http://www.goert.ca/about/why_important.php

native since they were brought here as a result of immigration by early European settlers. However, the influences of climate change and globalization will likely redefine what it means to be indigenous.

Native gardening with indigenous plants that are appropriate to the conditions and geography of a given area can simulate the biodiversity of a natural habitat. Native plant gardens locally frequently include plants that are not native to the Lower Mainland of British Columbia, but also include plants native to other parts of the Pacific Northwest. For instance, *Quercus garryana (*Garry oak), also discovered and described by Archibald Menzies, is now grown in gardens in the Lower Mainland, but is only found naturally in rain shadow climates, such as on southern Vancouver Island.

While not all native plants may be garden worthy for ornamental impact, those chosen from the regional locality of a garden will often blend appropriately and will be among the best adapted to local moisture, soil, and climatic conditions. Although native plants are not immune to pest and disease problems, the majority of locally native plants seem to attract fewer problems than many exotics do. Efforts to restore natural habitats using provenance-specific plants grown from locally sourced seed perform better than non-natives when established in these areas. However, changing climate patterns and the impacts of urbanization will likely have consequences for plant provenance.

Natural Habitats

Natural habitats provide the resources that enable indigenous plants to persist and thrive in existing growing conditions. Examples of natural habitats commonly used as horticultural garden themes include alpine, woodland, Mediterranean, and bog. The growth characteristics of plants native to these habitats have been shaped by differences in elevation, temperature range, precipitation, soil types and geology, and biological and chemical factors. Over time, indigenous species successfully adapted to the habitat conditions by developing specialized features for survival. Some features associated with alpine, woodland, Mediterranean, and bog plants are described below. Additional information about how evolution and natural habitats have influenced plant adaptations is available at this link to the *Missouri Botanical Garden* [New Tab][2].

Alpine plants

True alpine plants are well adapted to the harsh environments of high elevations. Above tree line, low temperatures, high sunlight, constant wind, dryness, and a short growing season are typical. Plant adaptations include growth low to the ground, a compact cushion or mat habit, and thick, waxy evergreen or pubescent (hairy), or curly leaves. Alpines, such as *Campanula* spp. (bell flower) flower in late spring and early summer and may have deep or extensive roots or below ground storage organs to persist in thin, low nutrient mountain soils. Although well adapted for extreme temperatures, alpine plants are typically intolerant of constant wetness around the roots and warm and humid summer conditions. Information about these specialized plants is available at this link to *Alpine plant* [New Tab].[3].

2. http://www.mbgnet.net/bioplants/adapt.html
3. https://en.wikipedia.org/wiki/Alpine_plant

Woodland understory plants

The temperate woodland habitat is characterized by distinct growing seasons, a dormant period, relatively consistent precipitation, and rich soils. Trees dominate this habitat forming an overhead canopy that shades and cools the understory and forest floor to varying degrees. Woodland understory plants include layers of woody shrubs and herbaceous plants that are adapted in size, form, shade tolerance, and slow growth or dormancy when light and water are limited**.** Understory plants such as *Hydrangea quercifolia* (oakleaf hydrangea) flower in late winter to early summer, before the leaves of deciduous shade trees fully emerge. Depending on the amount of light available, some understory plants have distinctive leaf color and patterns of ornamental interest in gardens. Information on gardening with woodland understory plants is available at this link to *In the Shade: Gardening with Native Plants from the Woodland Understory* [New Tab].[4]

Mediterranean plants

Mediterranean plants, such as *Cotinus coggygria* (smoke bush) and *Lavandula* spp. (lavender) are adapted to short, mild, and wet winters and long, warm, and dry summers. Some are short, dense, and shrubby evergreens that are suited to well drained soils, drought, and fire. Leaves may be leathery or reduced in size, and aromatic with thick, waxy or hairy coverings to reduce water loss, and bluish-grey (glaucous) or light in color to reflect excessive light. Some examples of naturally occurring vegetation are listed at this link to the *Mediterranean climate Wikipedia* [New Tab].[5]

Bog plants

Bogs and freshwater habitats are typically oxygen and nutrient poor with acidic pH conditions. *Quercus palustris* (pin oak) is an example of a tree that naturally grows in these conditions. Bog plants are adapted to growing in standing water while marginal plants such as *Iris siberica* (Siberian iris) and *Typha* spp. (cattail) thrive in waterlogged soils and shallow waters with short term dryness. Some bog and marginal plants such as *Juncus effusus* ‘Spiralis’ have striking foliage and make good choices for planting areas with limited or poor drainage. The bog habitat is described at this link to *Bog* [New Tab].[6]

4. https://wildseedproject.net/2016/03/in-the-shade-gardening-with-native-plants-from-the-woodland-understory/
5. https://en.wikipedia.org/wiki/Mediterranean_climate#Natural_vegetation
6. https://en.wikipedia.org/wiki/Bog#Habitats

19.

Plant Use Categories

Learning Objectives

- Describe horticultural plant use categories.

Horticulture production provides plant resources for a wide range of functional, cultural, and aesthetic garden purposes. Ornamental plants are used for environmental enhancement, food production, and re-vegetation of damaged ecosystems, as well as for their visual and sensory appeal in landscapes and gardens. An overview of the ornmental horticulture sector in Canada is available at this link to the *Canadian Ornamental Horticulture Alliance* [New Tab][1]. Some common categories of plant use include bedding plants and cut flowers, trees and shrubs, and ground covers and climbers.

BEDDING PLANTS AND CUT FLOWERS

Bedding plants, such as *Lobelia erinus* (lobelia) and *Petunia* × *hybrida* (petunia) are grown in greenhouses and nurseries for seasonal interest in gardens and landscapes. They are typically tender and half-hardy annuals, biennials, and some perennials that grow quickly and provide a vibrant display of color in beds, containers, and hanging baskets. Cut flowers produced by the floral industry include both herbaceous and woody flowering plants and cut greens for specialty services.

TREES AND SHRUBS

Trees such as *Acer rubrum* (red maple) and *Quercus rubra* (red oak) grow from single stems while some like *Acer circinatum* (vine maple) have two or three main stems. This distinguishes trees from shrubs with several or many stems branching from or near soil level. Whether deciduous or evergreen, trees are generally larger than shrubs however, their shape and height can vary from dwarf cultivars 1 meter high, to grafted standards on 2 meter rootstocks and specimens of 90 meters or more. Tree selection must account for mature height and spread to ensure adequate space in the landscape. Trees with year-round interest in form, foliage, flower, fruit, and bark are commonly grown in open sites as specimen plants. They may serve as a focal point for an entrance or as a special accent in the garden. On large sites, trees are often planted in groups to form woodlands or hedging. Strategic planting of trees in urban

1. https://coha-acho.ca/our-sector/

environments can channel air movement, shade and cool microclimates, and provide barriers for noise and security, as well as frame or screen views.

Shrubs such as *Cornus alba* 'Elegantissima' (silverleaf dogwood) and *Hibiscus syriacus* (hardy hibiscus) are valued for their ornamental features and varied growth forms. Shrub sizes range from 0.15 meter to about 6 meters. Deciduous and broadleaf evergreens, variegated foliage, fragrant and showy flowers and fruits, as well as decorative stems and buds provide year round interest and variety in mixed borders and container planting. Shrubs are commonly massed for effect, planted in small groups in mixed plantings, or used as screens and hedging. The wide selection of shrubs produced by nurseries provides for most garden conditions.

GROUNDCOVERS

Groundcover plants such as *Ajuga reptans* (bugleweed) are adapted with creeping and carpeting habits and are often used under woodland and shrub plantings, and for covering and stabilizing some slopes. Plant runners (stolons) that root where they touch the ground and spreading underground stems (rhizomes) that send up new shoots and form colonies stabilize and cover bare soil reducing erosion, evaporation, and weed growth.

CLIMBERS

Climbing plants, whether woody or herbaceous, deciduous or evergreen provide strong vertical elements and year round garden interest. Where space is limited, climbers such as *Hydrangea anomala* ssp. *petiolaris* (climbing hydrangea) may be the best option for screening and climate control. It is important to match the vigor, method of attachment, height, and spread of a climber with an appropriately sturdy support and adequate light exposure for flowering and fruiting.

20.

Plant Growth Characteristics

Learning Objectives

- Recognize and describe plant growth characteristics.

Plant form and growth habit are among the most noticeable and important features for identification purposes as well as for landscape plant selection. Plant form, the three-dimensional shape or silhouette outline of a plant, is determined by the habit or branching pattern. For example, plants with an excurrent growth habit have single, undivided trunks and lateral branches that typically produce an overall cone or pyramid-shaped form. This plant form and growth habit is characteristic of many gymnosperms such as *Thuja plicata* (western red cedar) and *Pseudotsuga menziesii* (Douglas fir). In contrast, decurrent, or sometimes called deliquescent growth habit exhibits several roughly equal branches arising from the trunk or stem that become the main structural system of the plant. This habit results in the typical rounded or spreading form of deciduous trees such as *Acer macrophyllum* (big leaf maple) or *Acer platanoides* (Norway maple) as well as many shrubs. Depending on the branching pattern, additional descriptive terms such as upright or horizontal, arching or weeping, open, twiggy or dense may be used for shrubs as well as for trees.

REVIEW

Describe plant form and habit. Click the image hotspots.

An interactive or media element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/plantidentification/?p=76

STEM, BARK, AND BUD MORPHOLOGY

In addition to plant form and habit, the winter identification of deciduous trees and shrubs depends on the morphology of stems, bark, and buds. Stem color, surface texture and the presence of lenticels, small cork-like spots for gas exchange between plant tissues and air are characteristic for some species of *Prunus* (cherry). A cross section taken through a stem or shoot reveals soft plant tissue, the pith. The

color and texture of the pith may be used for distinguishing between similar plant types, such as species of *Cornus* (dogwood). Pith may be brown or white, variably shaped, and uniformly solid, chambered or hollow as illustrated in Figure 20.1.

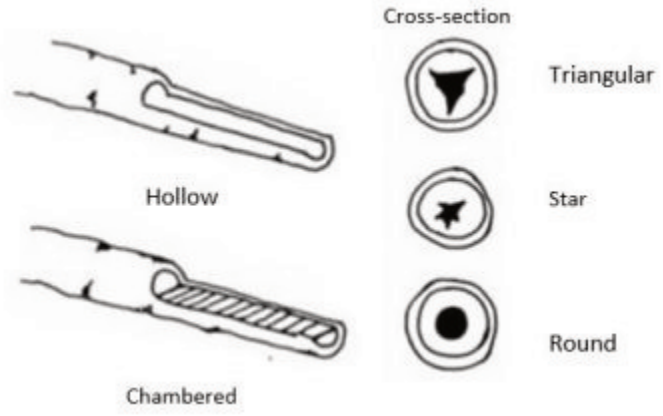

Figure 20.1 Pith types found in plant stems.

Bark, the dead outer protective tissue of woody plants can vary greatly in appearance, thickness, and texture as a tree or shrub matures. In addition to plant identification, plant bark may have highly ornamental value in the landscape. Color change, peeling and exfoliation, and smooth, or furrowed (grooved), ridged or plate-like are some common descriptors used for bark. For example, Figure 20.2 shows the bark of *Platanus* × *acerifolia*.[1] In addition to its ornamental value, the bark is a key identification feature for this tree.

Figure 20.2 Bark of Platanus x acerifolia (London plane tree).

Buds, condensed shoots containing a new leaf, leaf cluster, or flower are located in leaf axils and at tips of stems. In general, a flower bud appears somewhat larger and rounder than a vegetative bud. While bud shape, size, color, and surface texture vary by species, bud arrangement will be alternate, opposite

1. https://search.creativecommons.org/photos/86b35ef4-ee15-4ac5-89ab-85e3d34145dc

or whorled on the stem. Bud scales, the protective covering of buds may be single, few, or many, and imbricated (overlapping) or not as shown in the Figure 20.3. The shape of a leaf scar, where a leaf falls off a twig, and the arrangement of vascular bundles within the leaf scar may also provide distinct identification characteristics as in *Juglans* spp. (walnut).

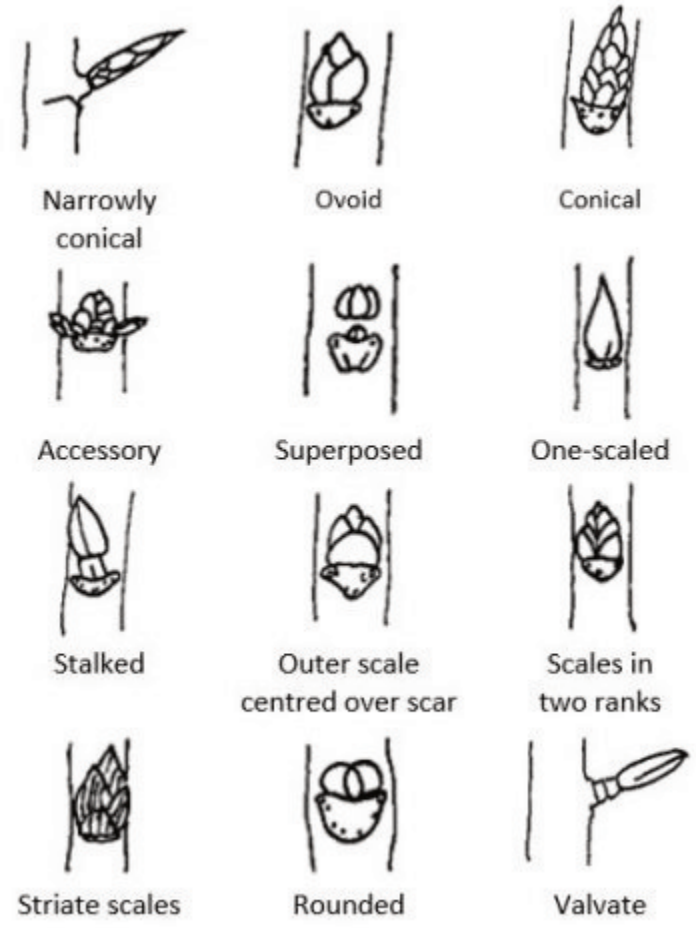

Figure 20.3 Bud types found in woody plants.

The dichotomous key below differentiates bud characteristics for some common deciduous trees and shrubs. Plant information is available at this link to the *KPU Plant Database* [New Tab].[2]

Dichotomous Key to Buds of Common Deciduous Trees and Shrubs

- 1.a. buds opposite or whorled on the stem …… go to 2
- 1.b. buds not opposite on the stems …….. go to 7
- 2.a. leaf scars oval or round, vein scars forming a ring ……. *Catalpa speciosa* [New Tab][3]
- 2.b. leaf and vein scars not as above ……. go to 3
- 3.a. buds valvate, appressed, brownish black ……

2. https://plantdatabase.kpu.ca/
3. https://plantdatabase.kpu.ca/plant/plantImages/23?image=o

Cornuskousa var. *chinensis* [New Tab][4]

- 3.b. buds acute or swollen, red or green …… go to 4
- 4.a. buds small or narrow, with few obvious scales, the scales more or less valvate (i.e., meeting at the edges) ……. go to 5
- 4.b. buds large, with several imbricate (overlapping) scales ……. go to 6
- 5.a. buds conical, the outer scales shiny red, the bud with a short fringe of hairs at its base…… *Acer circinatum* [New Tab][5]
- 5.b. buds conical, the outer bud scales green or red, hairs extending half the height of the bud……. *Acer palmatum* Atropurpureum Group [New Tab][6]
- 6.a. buds brown large, ovoid, and varnished with sticky gum …….. *Aesculushippocastanum* [New Tab][7]
- 6.b. buds smooth, leaf scars small, with a single vein scar…… *Syringa vulgaris* [New Tab][8]
- 7.a. buds narrowly conical and bud scales imbricate …. *Fagus sylvatica* [New Tab][9]
- 7.b. the bud scales imbricate or valvate, or the buds covered by a single scale …… go to 8
- 8.a. buds stalked …….. *Alnusrubra* [New Tab][10]
- 8.b. buds not stalked …… go to 9
- 9.a. twigs yellow, the buds flattened, appressed to stems and covered by a single, silky-downy bud scale……. *Salix sepulcralis* var. *chrysochoma* [New Tab][11]
- 9.b. twigs not yellow, buds not covered by a single scale …… go to 10
- 10.a. lateral buds superposed, slightly hairy; leaf scars v-shaped, prominent; pith chambered ……. *Juglansnigra* [New Tab][12]
- 10.b. buds not superposed; leaf scars not v-shaped; pith not chambered …….. go to 11
- 11.a. buds 2 mm long, rounded to shortly acute, with several reddish-brown scales …….. *Cotinuscoggygria* [New Tab][13]
- 11.b. buds 2 mm long, ovoid to acute, with several rows of imbricate scales …… go to 12
- 12.a. buds of 2 sizes, bud scales glabrous, leaf scars triangular with 3 vein scars

4. https://plantdatabase.kpu.ca/plant/plantImages/23?image=o
5. https://plantdatabase.kpu.ca/plant/plantImages/2?image=o
6. https://plantdatabase.kpu.ca/plant/plantImages/6?image=o
7. https://plantdatabase.kpu.ca/plant/plantImages/9?image=o
8. https://plantdatabase.kpu.ca/plant/plantImages/171?image=o
9. https://plantdatabase.kpu.ca/plant/plantImages/61?image=o
10. https://plantdatabase.kpu.ca/plant/plantImages/199?image=o
11. https://plantdatabase.kpu.ca/plant/plantImages/153?image=o
12. https://plantdatabase.kpu.ca/plant/plantImages/89?image=o
13. https://plantdatabase.kpu.ca/plant/plantImages/1651?image=o

…… *Prunus* ‘Kanzan’ [New Tab][14]

- 12.b. buds of 1 kind; buds scales fringed with hair; leaf scars with 5 or more vein scars ……. *Quercusrobur* [New Tab][15]

14. https://plantdatabase.kpu.ca/plant/plantImages/135?image=o
15. https://plantdatabase.kpu.ca/plant/plantImages/142?image=o

21.

Characteristics of Weedy Species

Learning Objectives

- Describe the characteristics of weedy species.

Whether a plant is classified as a weed or not depends on its location and relationship to human activities. Plants in gardens, agricultural, and natural settings that are considered undesirable or out of place due to appearance, contamination, or competition with desirable plants are often classed as weeds. Aquatic and terrestrial weedy species transported or migrated beyond their natural range that become established in a new area may pose significant impact or injury to economic, environmental, or human health. These are categorized as invasive, noxious, or nuisance species by governing authorities. Examples of species monitored for management in British Columbia are listed at this link to *Invasive Terrestrial Plants* [New Tab].[1]

Common characteristics of weedy species include aggressive growth, competition with other plants for light, water, nutrients, and space, an ability to grow in a wide range of soils and adverse conditions, and resistance to control measures. Some cultivated plants such as *Lythrum salicaria* (purple loosestrife), *Vinca minor* (periwinkle) and *Lamiastrum galeobdolon* (yellow archangel) can overwhelm and displace other plants and ecosystems. A number of unwanted horticultural plants are identified in this link to the *Field Guide to Noxious Weeds and Other Selected Invasive Plants of British Columbia* [PDF] [New Tab].[2]

When environmental conditions in a site change there will always be a change in the plant make up. For instance, where the ground is fully covered with vegetation there will be no bare soil available for weeds to inhabit. Disturbances in vegetation cover and changes in environmental conditions due to natural events or human activities and management practices create opportunities for species with adapted life cycles and growth characteristics to become established, reproduce, and colonize a site.

Knowledge of family characteristics and life cycles is important for proper landscape and garden plant selection. Species characteristics such as generalist pollination requirements, diverse seed and vegetative dispersal methods, the ability to adapt quickly to new environmental conditions may indicate the potential for invasive growth. Combinations of these

1. https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species/plants/terrestrial
2. https://www.bcinvasives.ca/documents/Field_Guide_to_Noxious_Weeds_Final_WEB_09-25-2014.pdf

characteristics are commonly exhibited in the Asteraceae (aster), Brassicaceae (mustard), Polygonaceae (knotweed), Fabaceae (pea), and Euphorbiaceae (spurge) families, as well as others.

Weeds are typically classified according to their life cycle. Depending on the degree of disturbance to a site, herbaceous plant species with annual and biennial life cycles will be the first to colonize followed by perennial herbaceous and woody plants. Annual weeds such as *Galium aparine* (cleavers) that produce high numbers of seed occur most frequently in regularly cultivated and disturbed areas such as vegetable gardens or annual borders. Their rapid growth can smother slower-growing plants and compete for moisture and light. An advantage for winter annuals such as *Capsella bursa-pastoris* (shepherd's purse) and *Cardamine oligosperma (snapweed)* is that they germinate in the fall, overwinter as a rosette of leaves, and flower and produce many seeds in late winter and early spring. Biennial weeds such as *Echium vulgare* (blueweed) usually produce only a rosette of leaves in the first growing season. Energy stored in the roots over a winter cold period enables the plant to bolt (flower), produce seeds, and then die in the next season. Removal of the rosette before flowering stops the biennial life cycle.

Herbaceous perennial weeds such as *Cirsium vulgare* (Canada thistle), *Heracleum mantegazzianum* (giant hogweed), and *Equisetum arvense* (horsetail) and woody species such as *Buddleja davidii* (butterfly bush) and *Rubus armeniacus* (Himalayan blackberry) survive adverse conditions by storing food reserves in roots, rhizomes, and tubers or bulbs in some species. Important control measures include early identification and removal before establishment.

In situations where weed populations remain below established thresholds of impact or injury for a given site and use, there are ecosystem benefits. For instance weed cover can provide protection from soil erosion, produce pollen, nectar, and habitat for beneficial organisms and wildlife, serve as indicators of soil conditions, and contribute organic matter for soil enhancement, as well as provide food and medicinal products for human use.

PRACTICE

For each plant, access the correct common name and family name available at this link to the *KPU Plant Database* [New Tab].[3]

An interactive or media element has been excluded from this version of the text. You can view it online here:

https://opentextbc.ca/plantidentification/?p=78

3. https://plantdatabase.kpu.ca/plant/search.gsp

22.

Plant Hardiness

Learning Objectives

- Explain plant hardiness zones.

Over the course of their evolution, plant species adapt to the climate variations of a region. Therefore, the ultimate deciding factor in whether a plant will survive in a given location (with adequate supplies of light, moisture, and nutrients) is quite simply the lowest temperature it will have to endure. Although several factors such as length of frost free period, rainfall, snow cover, wind, and soil type affect the hardiness of a plant, in temperate climates the minimum temperature during the winter is the most important element in plant survival.

PLANT HARDINESS ZONES

Average annual minimum temperatures are determined for locations throughout North America. Plotting areas with similar average minimum temperatures yields a temperature zone map. Zones numbered 0 to 9 relate to the average annual minimum temperature calculated for that zone. The zones are divided into “a” and “b,” the “b” area representing the mildest part of the zone. Plants designated “a” with the zone number are hardy in the colder part of that zone; those designated “b” in only the milder section.

Plant hardiness ratings are determined by testing over several years at agricultural research and testing stations as well as private nurseries and gardens. A plant which is hardy to a particular zone can be expected to survive in all regions on the map which have an average annual minimum temperature equal to or greater than the hardiness zone rating for that plant.

Currently, two hardiness zone maps are widely used in North America:

- Agriculture Canada
- United States Department of Agriculture (U.S.D.A.)

In Canada, horticulturists often refer to the Agriculture Canada hardiness zone map. It is similar to the U.S.D.A. system except that the temperature range for each of the 9 zones is given in degrees

Celsius instead of degrees Fahrenheit. Table 22.1 lists examples of hardiness zones for some Canadian communities.

Table 22.1: Hardiness zones for Canadian communities

Location	Zone
Edmonton, Alta.	2
Prince George, B.C.	3
Ottawa, Ont.	3
Fredericton, N.B.	5
Langley, B.C.	7
Vancouver, B.C.	8

A map that outlines all of the different zones is available at this link to *Canada's Plant Hardiness Zones* [New Tab].[1]

Horticulturists in the United States most commonly use the U.S.D.A. map. It divides the United States into 13 zones based on the average annual extreme minimum temperature with zone 1 being the coldest (-60 F.) and zone 13 being the warmest (above 60 F.). It is included in many books and catalogs, and is available at this link to the *USDA Plant Hardiness Zone Map* [New Tab].[2]

Changing Climate Means Changing Hardiness Zones

Natural Resources Canada updated the plant hardiness zones map to include, among other factors, the effects of elevation on plant hardiness. The update provided evidence that there have been marked changes in hardiness zones in Western Canada. While the map expanded the factors affecting plant hardiness, local variability in topography, shelter, and snow cover were not captured. In an effort to increase knowledge about the effect of changing climate climate on the range of species growth in different locales, Natural Resources Canada created an interactive zone map where experts and gardeners contribute information about plant survival at this link to *Canada's Plant Hardiness Site* [New Tab].[3]

REVIEW

Identify the hardiness zone for each plant available at this link to the *KPU Plant Database* [New Tab].[4]

1. https://landscapetrades.com/thumbnailer.php?image=/assets/1420488717.New-hardiness-zone-map.png&imgWH=800
2. https://kpu.pressbooks.pub/introplantmaterials/wp-admin/post.php?post=147&action=edit
3. http://planthardiness.gc.ca/?m=2d
4. https://plantdatabase.kpu.ca/plant/search.gsp

An interactive or media element has been excluded from this version of the text. You can view it online here: https://opentextbc.ca/plantidentification/?p=80

23.

Plant Requirements

Learning Objectives

- Identify plant requirements for woody and non-woody plants.

Although plants established in cultivated gardens and landscapes are not the result of long-term evolution, the concept of “right plant, right place” can be effectively applied in these settings. Plant selection and placement that matches a species growth characteristics with existing conditions and available maintenance requirements supports healthy growth and vigor.

Cultural requirements are defined as site conditions that influence plant growth and longevity. Conditions typically include diverse combinations of light exposure, moisture conditions, soil types and nutrient availability, and hardiness zones. Depending on the site, conditions may also include plant tolerance for wind, salt, and drought. While garden plants require some routine maintenance for healthy growth, proper plant selection and planting practices decrease unsustainable maintenance inputs and reduce incidences of pest and disease and plant failure or death.

Maintenance requirements are related to factors that influence plant growth and development. Light exposure is typically classified as full (six or more hours of direct sunlight per day), part (four to six hours of sunlight) or part shade (two to fours hours of sunlight), and shade (less than two hours of sunlight per day). Water requirements and existing moisture conditions range from dry or xeric, to well-drained, and poorly drained or wet depending on the amount of rainfall or irrigation, the site slope, and the soil type. Soil drainage will be influenced by the amount and arrangement of particles of sand, silt and clay. Gravel or sandy soils tend to drain rapidly and have low nutrient levels because they are made up of relatively large particles with large pores or spaces between them. In contrast, clay and silt soils are composed of tiny particles separated by minute spaces that tend to retain nutrients and drain more slowly. Garden loam that is fertile and well drained is the result of a balanced combination sand, silt, and clay.

Information from resources about plant growth requirements for light, water, soils and nutrients combined with knowledge of prevailing conditions and smaller-scale garden variations in temperature, air quality, wind, and humidity, and environmental stresses or pests and disease supports the identification of the right plant for the right place.

REVIEW

Identify plant requirements for light exposure, soil type, and water use available at this link to the *KPU Plant Database* [New Tab].[1]

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/plantidentification/?p=82

1. https://plantdatabase.kpu.ca/plant/search.gsp

III

Part 3 Plants for Different Planting Situations

24.

Introduction to Interior Landscaping

Learning Objectives

- Describe the benefits of interior landscaping.

The domestication of wild plants for food crops about 10,000 years ago was a major factor in the development of human civilization. However, art and archaeological evidence from early civilizations in Egypt, China, Iran, Greece, and Rome reveal that plants were also selected and cultivated for ornamental purposes. Foliage and fruit plants in containers adorned the inner courtyards and rooftop gardens of homes, and flowers were cultivated in hothouses for bouquets and garlands. Figure 1.1 shows an example of a fresco tomb painting of the courtyard garden of a wealthy Egyptian homeowner.

Figure 1.1 Tomb painting of an ancient Egyptian garden

From the 15th to the late 19th century, European world explorers collected many plants for ornamental interest and enjoyment by the wealthy. Exotic plants from the tropics that were cultivated indoors in northern regions became the forerunners of modern-day foliage, flower, fern, climber, and succulent house plants. By the mid 19th century, indoor gardening was a popular hobby of the wealthy and the emerging middle class. The impact of the Industrial Revolution on building lighting and heating increased the number of plants that could be grown indoors. Developments in building construction methods and heating and ventilation systems in the early to mid 20th century expanded the use of plants to beautify the indoor environments of offices, hospitals, public spaces, and private homes. In response, the horticultural production and hybridization of foliage and flowering plants increased and landscaping companies specialized in interior landscape design, installation, and maintenance services.

In addition to providing visual interest and softening the hard edges of structures with foliage texture, studies have shown that plants can improve indoor air quality. For example, during the energy crisis in the late 20th century, the construction of air tight buildings and use of synthetic materials were intended to reduce energy costs. However, toxic air pollutants such as trichloroethylene, benzene, and formaldehyde given off from paint, plywood, insulation, plastic, carpet and fabrics became concentrated in the air tight spaces and made inhabitants feel sick. The NASA Clean Air study demonstrated that indoor plants purified air by removing and trapping air pollutants in leaves, roots, and soil. Learn more about the study at this link to *Indoor Air-Wolverton Environmental* [New Tab].[1]

1. https://www.wolvertonenvironmental.com/IAQ.html

Human civilization has developed in conjunction with nature and the psychological and physical health benefits of integrating vegetation into our habitats is well recognized in the 21st century. Research suggests that for people who spend significant time indoors at work, the presence of plants can improve mood, contribute to contentment, and promote motivation and productivity. Read more about the benefits of indoor plants at this link to *Houseplants: to support human health* [New Tab][2].

The benefits of indoor plants have become part of the design of living and working environments in the 21st century. Interior landscapes or plantscapes have diversified the use of tropical foliage and flowering plants in atria and large conservatories, indoor and vertical gardens, potted office plants and hanging baskets, as well as color bowls, dish gardens, and terrariums. Figure 1.2 shows an example of interior landscaping using vertical gardens vegetated with tropical plants.

Figure 1.2 Interior vertical gardens vegetated with tropical plants

2. https://www.rhs.org.uk/advice/profile?PID=949

25.

Plants for Tropical and Interior Landscaping

Learning Objectives

- Recognize plants suitable for common tropical and interior landscape situations.

Plant species that are native to regions around the equator are described as tropical. They are adapted to climate conditions with an average temperature of 18^{o}C (64.4^{o}F), no chance of frost, and considerable precipitation at least part of the year. Depending on the latitude, plant species may be adapted to tropical humid (rain forest) or tropical dry (savanna) conditions.

Rain forest vegetation is lush with tall trees and thick lianas forming a dense canopy that filters sunlight from the smaller trees, vines, palms, orchids, and ferns growing in the understory. Examples of plant adaptations for high humidity and competition for light include large leaves with waxy surfaces and pointed tips that shed water. More information about interesting plant adaptions for this hot, humid climate is available at this link to *The Tropical Rainforest* [New Tab].[1].

Grasses, shrubs and trees of the tropical savanna are well adapted for climate extremes. Long tap roots, thick fire resistant bark, tree trunks that store water, leaf drop during the dry season, and storage organs like bulbs and corms allow plants to survive an extremely hot, long dry season and a very wet season. Learn about some of these unique plants at this link to *The Savanna* [New Tab].[2].

Many tropical rain forest plants are available year round in temperate climates for use in interior landscaping. Some common indoor plants include *Codiaeum variegatum* var. *pictum* (croton), *Dieffenbachia seguine* (dumb cane), *Dypsis lutescens* (Areca palm), and *Epipremnum aureum* (devil's ivy, golden pothos). The morphology of these plants can be readily recognized as belonging to particular family groups and related genera share identifiable morphology. It is often possible to use vegetative features alone to identify these family groups, relying on reproductive features only when needed. For example, the square stems and opposite leaf arrangement of *Solenostemon* x *hybridus* (coleus), an indoor house plant and outdoor bedding plant, can be recognized as a member of the mint family, Lamiaceae. The morphological characteristics used to identify some plant families and genera commonly used in interior landscapes are summarized below. Access to images of the genera is available at this link to the *KPU Plant Database* [New Tab].[3]

1. http://www.mbgnet.net/bioplants/troprf.html
2. https://savanna2012.weebly.com/unique-plant-adaptions.html
3. https://plantdatabase.kpu.ca/plant/search.gsp

ARACEAE – ARUM FAMILY

Members of the arum family are called aroids. There are over 100 genera and 2500 species distributed on every continent, with the majority in North Africa and Mediterranean regions. These moncots are known as much for their magnificent foliage as for their characteristic inflorescence. In natural habitats, they range from shrubs such as *Dieffenbachia seguine* and climbers such as *Epipremnum aureum* to enormous herbs with corms or tubers.

The leaves are mostly spirally arranged and often parallel but sometimes net-veined and either simple or compound. The petiole has a membranous, sheathing base. The roots of all species are adventitious (i.e., they can arise anywhere on the stem) and are without root hairs. Climbing and epiphytic aroids have two kinds of roots, ones that are absorbent and grow downwards into the soil, and clasping roots that grow into crevices, away from light.

Individual flowers are tiny, and are borne on specialized inflorescence called a spadix. In the majority of species the spadix is surrounded by a leaf-like bract called a spathe. The spathe is frequently colored and serves as a pollinator attractant. In most cases, aroids are pollinated by flies; the resultant fruits are typically berries. Species grown in interior landscapes will prefer bright, indirect light and moist, well drained fertile soils, and evenly warm temperatures. The ARACEAE family has many familiar shrubs and climbers for indoor containers, including:

- *Aglaonema* (Chinese evergreen)
- *Anthurium* (flamingo flower)
- *Caladium* (elephant ear)
- *Dieffenbachia* (dumb cane)
- *Epipremnum* (devil's ivy)
- *Monstera* (split-leaf philodendron)
- *Philodendron* (philodendron)
- *Scindapsus* (silver pothos)
- *Spathiphyllum* (peace lily)

ARECACEAE – PALM FAMILY

The palms comprise a large family (more than 200 genera and 2650 species) of evergreen trees and rattans (climbers) with primarily tropical and warm temperate distribution (few in Africa). Palms such as *Dypsis lutescens* are immediately recognizable to most people, having spirally arranged, often very large leaves in terminal rosettes.

The slender, unbranched stem of the coconut palm (of tropical-island-paradise fame) is typical of many palms, but there are other distinctive shapes and sizes of palms. Palms are usually categorized as either feather palms (pinnate leaves) or as fan palms (palmate leaves), and may be stout or slender, solitary or suckering, and from dwarf to full-size.

Flowering is rare in indoor cultivation, except with some smaller species (especially *Chamaedorea*). Flowers are usually small, yellow, 3-parted and partially embedded in the flower stems. After successful pollination, palms generally produce a rounded, fleshy or fibrous drupe (seldom as large as a coconut nor as succulent as a date). Depending on the species, palms grown in interior landscapes will prefer indirect bright to low light and loose well drained soil with regular fertility. Genera commonly cultivated indoors in atriums and containers include:

- *Caryota* (fishtail palm)
- *Chamaedorea* (parlour palms)
- *Chamaerops* (european fan palm)
- *Chrysalidocarpus* (butterfly palm)
- *Dypsis lutescens* (areca palm)
- *Howea* (Kentia, sentry palms)
- *Phoenix* (date palm)
- *Ravenea* (majestic palm)
- *Rhapis* (lady palm)
- *Trachycarpus* (windmill palm)

EUPHORBIACEAE – SPURGE FAMILY

The spurge family is large with more than 300 genera and 7500 species of annual and perennial flowering herbs, shrubs, trees, and some climbers growing in tropical and temperate climates. Some species are succulent and cactus-like and some are characterized by milky sap that may be poisonous. Genera are commonly used in both indoor and outdoor landscapes for their colorful bracts and unusual forms. Tender species such as *Codiaeum variegatum* var. *pictum*, an ornamental shrub with attractive, multicolored foliage, is commonly used in interior landscaping.

Family members usually have simple or sometimes palmately compound leaves that may be sessile or petiolate, often with stipules, and alternately arranged on the stem. Species are frequently monoecious with a raceme or cyme inflorescence and often a radially symmetrical cyathium that is composed of 5 colorful bracts surrounding the reproductive flower parts. The fruit is usually a capsular schizocarp. Euphorbs grown indoors will prefer bright light and well drained soil with moderate to low moisture and fertility. Some examples of genera used for interior landscaping indoor include:

- *Acalypha* (chenille plant)
- *Codiaeum* (croton)
- *Euphorbia* (spurge)

26.

Plants for Floral Landscape Situations

Learning Objectives

- Recognize plants suitable for common floral landscape situations.

Worldwide, the floriculture industry grows an enormous range of tropical species in greenhouses and nursery fields for interior and exterior landscape situations. In addition to improving everyday life, potted flowering plants and cut flowers have significance for the celebration of cultural traditions and events. Examples of potted plants used in traditional seasonal displays include *Euphorbia pulcherrima* (poinsettia), *Chrysanthemum morifolium* (garden mum), and *Lilium longiflorum* (Easter lily). Events such as weddings, graduations, and funerals are usually celebrated with cut flowers and greens in arrangements, garlands, and bouquets. Among the many types of cut flowers available, the tropical species *Alstroemeria* cvs. (alstroemeria) and *Antirrhinum majus* (snapdragon) are frequently used in floral design.

Key morphological characteristics that distinguish these plants within their family taxon are summarized below. View detailed images of the plant examples available at this link to the *KPU Plant Database* [New Tab].[1]

ALSTROEMERIACEAE – ALSTROEMERIA FAMILY

- Erect herbaceous perennial with tuberous roots
- Leaves are alternate and simple with parallel veins, an entire margin, and are resupinate (twisted)
- Inflorescence is an umbel
- Flowers are zygomorphic (bilateral symmetry), funnel-form, the inner whorl of tepals are spotted
- Fruit is a capsule
- Example: *Alstroemeria* cvs. (alstroemeria) for growing conditions of part sun to part shade and well drained fertile soils

1. https://plantdatabase.kpu.ca/

PLANTAGINACEAE – PLANTAIN FAMILY

- Erect herbaceous perennial
- Leaves are alternate, simple, with pinnate veins and an entire margin
- Inflorescence is a raceme
- Flowers are zygomorphic, tubular and bilabiate (two-lipped)
- Fruit is a capsule
- Example: *Antirrhinum majus* (snapdragon) for growing conditions of full sun part sun/part shade and well drained soils

While tender tropical members of plant families, such as *Solenostemon* x *hybridus* (coleus) in the mint family are typically grown in interior landscapes in northern regions, some are used in exterior containers and bed plantings for summer interest. A few examples of the many tender tropical annual species grown for bedding and container displays are *Ageratum houstonianum* (floss flower), *Celosia argentea* (cockscomb), and *Cleome hassleriana* (spider flower). Examples of tropical herbaceous perennials grown for exterior displays include *Lantana camara* (lantana), *Pelargonium* spp. (geranium), and *Salvia* x *superba* 'May Night' (salvia cultivars). As a result of extensive hybridization, tender herbaceous perennials such as *Begonia* x *semperflorens-cultorum* (fibrous begonia), *Canna* x *generalis* (canna), *Pelargonium* x *hortorum* (zonal or bedding geranium), *Solenostemon* x *hybridus* (coleus), and *Salvia* x *superba* 'May Night' (salvia cultivars) may be described as being of garden origin.

Key morphological characteristics that distinguish these plants within their family taxon are described below. View detailed images of the plant examples available at this link to the *KPU Plant Database* [New Tab].[2]

AMARANTHACEAE – AMARANTH FAMILY

- Erect herbaceous annual
- Leaves are alternate, simple, with pinnate veins, an entire margin, and without stipules
- Inflorescence is a spike (dense plume or crested)
- Flowers are radial and small, with colorful persistent bracts below each flower
- Fruit is a capsule
- Example: *Celosia argentea* (cockscomb) for growing conditions of full sun part sun/part shade and well drained soils

ASTERACEAE – ASTER FAMILY

- Compact, mounded herbaceous annual

2. https://plantdatabase.kpu.ca/

- Leaves are simple and opposite, with pinnate venation, a crenate margin, and hirsute (hairy) blade
- Inflorescence is a head (capitulum), arranged in corymbs
- Flowers are ligulate (ray flowers)
- Fruit is a cypsela
- Example: *Ageratum houstonianum* (floss flower) for growing conditions of full sun part sun/part shade and moist, well drained soils

BEGONIACEAE – BEGONIA FAMILY

- Upright, mounded annual with succulent tissue and fibrous roots
- Leaves are alternate, simple, waxy, with pinnate veins and an asymmetrical base
- Inflorescence is a cyme
- Flowers are monoecious, single or double blooms
- Fruit is a capsule
- Example: *Begonia* x *semperflorens–cultorum* (fibrous begonia) for growing conditions of full sun part sun/part shade and well drained soils

CANNACEAE – CANNA FAMILY

- Erect, unbranched herbaceous perennial, with rhizomes
- Leaves are alternate, simple, with a sheathed base and pinnate venation
- Inflorescence is a raceme
- Flowers are asymmetric, with 3 unequal petals basally fused into a tube, 3 sepals are not fused, the modified fertile stamens are petal-like
- Fruit is a capsule
- Example: *Canna* x *generalis* (canna) for growing conditions of full sun and moist, well drained soils

CAPPARIDACEAE – CAPER FAMILY

- Erect, branched herbaceous annual
- Leaves are alternate, palmately compound, with glandular hairs and stipules, pinnate venation, and entire, ciliate margins
- Inflorescence is a raceme
- Flowers are held on upright pedicels, petals are held above long-exerted stamens

- Fruit is a cylindrical capsule held spreading or pendulous on the plant
- Example: *Cleome hassleriana* (spider flower) for growing conditions of full sun and well drained soils

GERANIACEAE – GERANIUM FAMILY

- Rounded to spreading tender herbaceous perennials and hybrids, with succulent tissue
- Leaves are alternate, simple, orbicular with banded markings, palmate venation, and round or acutely lobed margins, leafy stipules are present
- Inflorescence is umbel-like
- Flowers are zygomorphic, the upper 2 petals differ in shape and/or size from lower 3 petals, with single, semi-double or double blooms
- Fruit is an achene or schizocarp, it is often aborted or absent
- Examples: *Pelargonium* spp., *Pelargonium* x *hortorum* for growing conditions of full sun and well drained soils

LAMIACEAE – MINT FAMILY

- Erect to rounded herbaceous perennials and hybrids with squared stems
- Leaves are opposite, simple, with pinnate venation, a crenate margin, and are often aromatic
- Inflorescence is a spike-like verticillaster
- Flowers are zygomorphic and bilabiate
- Fruit is a nutlet
- Examples: *Solenostemon* x *hybridus (coleus), and Salvia* x *superba* ‘May Night’ for growing conditions of full sun and well drained soils

VERBENACEAE – VERBENA FAMILY

- Upright, arching perennial shrub, stems with prickles, many annual cultivars
- Leaves are simple, opposite, with pinnate venation, a serrate margin, and a rough blade surface
- Inflorescence is a compact raceme (umbel-like head)
- Flowers are small, tubular to salverform opening in four rounded lobes, with variable coloring
- Fruit is a berry, it is often aborted in cultivars
- Example: *Lantana camara* (lantana) for growing conditions of full sun part sun/part shade and well drained soils

PRACTICE

Recognize plants suitable for common floral landscape situations.

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27.

Introduction to Plants for Difficult Planting Situations

Learning Objectives

- Describe plant tolerance for difficult planting conditions.

Few landscapes and gardens will contain the perfect planting conditions. Environmental stress from variable combinations of light and moisture levels, exposure to wind and cold, soil characteristics, site slopes and drainage can create difficult situations for planting. Some plants will be better suited to tolerate environmental stress because of morphological and physiological adaptations developed in their native habitat. For example, *Berberis buxifolia* (box leaf barberry), *Gleditsia triacanthos* f. *inermis* (thornless honey locust), and *Ginkgo biloba* (maidenhair tree, ginkgo) are able to tolerate a fairly wide range of planting conditions. When planting in difficult situations such as the examples described below, select plants from similar habitats that are naturally adapted to grow under the existing conditions.

SUNNY ARID CONDITIONS

Environmental stress associated with arid (xeric) conditions can severely limit plant growth. Climate characteristics include full light exposure, high summer temperatures, low and unpredictable precipitation, and low humidity with drying winds. Soils with poor structure, minimal organic matter or soil biology and low water holding capacity and nutrient availability are common in arid conditions. Where hardiness is a limiting factor for plant selection, local regional native plants adapted to the existing climate, soils, and moisture regimes are often the most suitable choice.

Shallow, extensive root systems allow species such as *Rudbeckia fulgida* (black-eyed Susan) to survive in drought and poor soil conditions. Plant characteristics such as small, compound, and modified leaves and stems, and light or gray colored leaves with hairy or waxy surfaces reflect sunlight, moderate the temperature at the leaf surface, and reduce water loss. *Achillea filipendulina* 'Gold Plate' (Gold Plate yarrow), *Artemisia schmidtiana* (silver mound), *Festuca ovina glauca* (blue fescue), *Rosa rugosa* (rugosa rose), and *Abies concolor* (white fir) are some examples of plants with these characteristics. Read more about plant adaptations at this link to *Plant Adaptations to Arid Environments* [New Tab].[1]

1. https://www.redbuttegarden.org/gardening/plant-adaptations-to-arid-environments/

SHADE

Shaded areas that may seem problematic are in fact ideal for plants that occur naturally in habitats with low light, such as woodlands and ravines. There are many shrubs, trees, climbers, bulbs, ferns, and ground cover plants that either tolerate or prefer partial to full shade. For example, evergreen species and cultivars of *Rhododendron* spp. prefer deep to part shade while *Rhododendron* Northern Lights Group (azalea) prefers full sun to part shade. Characteristics of shade plants such as branched habits, two-ranked leaf arrangement, and broad, thin leaf blades are suited to capture available light. A strategy of some herbaceous plants, such as *Crocus* cvs. (crocus) is to emerge early, flower, set seed, and die back to resting structures before tree and shrub leaves fill in completely. Some shade tolerant trees, such as *Tsuga heterophylla* (western hemlock) and *Acer saccharum* (sugar maple) will germinate and grow as understory species until openings in the canopy allow them to grow to full size.

There is a wide array of ornamental plants suitable for planting in partial to full shade. Examples of ferns are *Athyrium niponicum* var. *pictum* (Japanese painted fern), and *Matteuccia struthiopteris* (ostrich fern). Shrubs for shade include *Aucuba japonica* (Japanese aucuba), *Kalmia latifolia* (mountain laurel), *Kerria japonica* (Japanese kerria), and *Leucothoe fontanesiana* 'Rainbow' (Rainbow leucothoe). Shade tolerant ground covers include *Pachysandra terminalis* (Japanese spurge) and *Sarcococca hookeriana* var. *humilis* (dwarf sweet box). The woodland understory tree, *Cornus florida* (Eastern flowering dogwood, pink flowering dogwood) is adapted to growing in partial shade. Learn more about shade gardening at this link to *RHS Shade Gardening* [New Tab].[2]

DRY SOIL

Multiple factors can contribute to dry soil conditions on a site. Soils with high sand or aggregate content that drain quickly move available water below the plant root zone, and surface slopes with rapid runoff reduce water infiltration into the soil. Overhead structures that block rainfall, such as building eaves or tree canopies with competing roots below ground can also create dry areas. While few plants will survive in permanently dry areas, drought tolerant native and garden plants can flourish in dry soil once established. Examples include ground covers, *Arctostaphylos uva-ursi* (bearberry, kinnikinnick) and *Thymus serpyllum* (mother of thyme), and herbaceous perennials, *Arabis caucasica* (rock cress) and *Echinops bannaticus* (globe thistle). A few examples of adapted deciduous shrubs and trees are *Chaenomeles japonica* (flowering quince), *Crataegus laevigata* cvs. (English hawthorn), *Pyrus calleryana* (ornamental pear) and *Quercus robur* (English oak). A conifer example, *Juniperus virginiana* (eastern red cedar) is tolerant of dry soil. Read more about suitable species for dry soil conditions at this link to*Drought Tolerant Plants For Your Garden* [New Tab].[3]

DRY SHADE

A combination of shade and dry soil can create a difficult planting situation. Dry shade is typically found under tree canopies where dense fibrous roots close to the surface compete with other plants for water. While plants will not survive extended periods of drought without some watering, there are some such

2. https://www.rhs.org.uk/advice/profile?PID=934
3. http://www.artsnursery.com/blog/drought-tolerant-plants-for-your-garden

as *Berberis* spp. that will tolerate dry shade once they are properly established. *Alchemilla mollis* (lady's mantle), *Epimedium* hybrid cvs. (hybrid barrenwort), and *Pachysandra terminalis* (Japanese spurge) are suitable herbaceous ground covers for planting in dry shade. Learn about some practical approaches to planting in dry shade at this link to *RHS The Garden Dry Shade* [New Tab].[4]

WETLANDS

Natural wetlands with soil that is permanently or seasonally saturated often have anaerobic (low oxygen) conditions. Wetlands are typically vegetated with hydrophytic plants that are adapted to grow wholly or partially in water. Some hydrophytic species float on the surface of water, while others are completely submerged. Emergent species that root in soil underwater and grow shoots up and out of the water are usually found along the shoreline or margin of a wetland.

While the roots of many garden plants would rot when deprived of oxygen, hydrophytic plants are suitable choices for sites with water features as well as low areas with seasonal poor drainage or a high water table. Examples of herbaceous perennials suitable for wetland planting include *Acorus gramineus* 'Variegatus' (variegated sweet flag), and *Matteuccia struthiopteris* (ostrich fern). *Aronia melanocarpa* (black chokeberry), and *Sambucus nigra* (elderberry) are adaptable deciduous shrubs for wet conditions as are the deciduous trees *Liquidambar styraciflua* (American sweetgum), and *Salix* x *sepulcralis* var. *chrysocoma* (weeping willow). Depending on the available space, the large conifer *Metasequoia glyptostroboides* (dawn redwood) may be a suitable choice. Learn more at this link to *RHS Gardening on Wet soils* [New Tab].[5]

COMPACTED SOILS

Compacted soils are common in urban areas that undergo construction damage, or repeated machinery use and foot traffic. Damage to soil structure from tilling or working heavy clay and loam soils when they are too wet or frozen, and crusting of bare soils from the impact of rainfall contribute to compaction. As soil particles become densely packed together pore space is reduced and the movement of air, water, organisms, and plant roots is impeded. Once compacted, poor soil drainage, water logging, low oxygen, and hard surface conditions inhibit plant root growth. Plants symptoms may include poorly formed or rotted roots, stunted growth, discolored leaves, and drought stress.

While the addition of compost is a long term solution for compacted garden soils, there are a number of species that are able to tolerate compacted soils reasonably well. For example, *Catalpa speciosa* (western catalpa) is a tough tree that tolerates poor soils and compaction as well as dry and wet soils. *Acer saccharhinum* (silver maple), *Juglans nigra* (black walnut), and *Ulmus americana* (American elm) tolerate some compaction as do *Amelanchier canadensis* (serviceberry), *Juniperus communis* 'Green Carpet' (Green Carpet juniper), and *Matteuccia struthiopteris* (ostrich fern). Read more about adapted species available at this link to *Plants for Compacted soils* [New Tab].[6]

4. https://www.rhs.org.uk/about-the-rhs/publications/the-garden/2014-issues/december/rhs-problem-solver-on-dry-shade.pdf
5. https://www.rhs.org.uk/Advice/profile?PID=303
6. https://extension.umaine.edu/gardening/manual/plants-compacted-soils/

SLOPES

Sloped embankments and hillsides can be difficult planting situations. Successful plant growth will be influenced by soil type, the north to south aspect, the amount of rainfall, and the degree of incline and length of the slope. Steeper slopes increase the risk of erosion and soil loss that exposes roots or buries small plants. In addition, the run off of sediment from eroded slopes can adversely affect drainage systems and waterways that connect to fish habitat.

Planting slopes with grasses and shrubs is an effective way to protect soil and prevent erosion. Fast-growing, adaptable species with dense fine roots that hold the soil together and take up water help stabilize slopes and keep soil in place. Complete vegetation coverage will reduce the impact of rainfall and the potential for soil disturbance and erosion. Methods such as planting pockets and terraced steps will slow surface run off and facilitate the infiltration of irrigation for plant establishment.

Plants for slopes typically include native and ornamental grasses and low, spreading shrubs and ground covers that leave no areas of bare soil exposed to the elements. On hot, dry southern aspects, drought-tolerant shrubs and grasses such as *Juniperus sabina* 'Tamariscifolia' (tamarix juniper), *Rosa rugosa* (rugosa rose), and *Festuca ovina glauca* (blue fescue) are suitable options. Cooler, moister northern aspects are better suited for shade-tolerant understory shrubs and ground covers such as *Gaultheria shallon* (salal), and *Pachysandra terminalis* (Japanese spurge). Read more about slope gardening at this link to *Pacific Horticulture Society Dry Slope Gardening in Seattle* [New Tab].[7]

7. https://www.pacifichorticulture.org/articles/dry-slope-gardening-in-seattle/

28.

Recognize Plants Suitable for Planting in Difficult Situations

Learning Objectives

- Recognize plants suitable for planting in difficult situations.

PRACTICE

Finish the sentences by selecting the matching growing condition for each plant. Click the images for a larger view. Review the detailed information about each plant available at this link to the *KPU Plant Database* [New Tab].[1]

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1. https://plantdatabase.kpu.ca/plant/search.gsp

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29.

Plants for Favorable Planting Situations

Learning Objectives

- Identify plants for favourable planting situations.

Horticulturists understand and use the climate and conditions of a given site to select and grow healthy plants. While growing conditions can be optimized by choosing the right plant for the right place, temperature will remain the least controllable of the environmental factors in exterior landscapes. Given suitable plant hardiness, average conditions of full to part sun or part shade, and well drained, moist soils with appropriate pH will provide favourable growing conditions for many garden plants.

Species that prefer average growing conditions are found in a wide range of plant families. Some familiar plant families with members that thrive in average growing conditions include:

- Caryophyllaceae – *Arenaria verna* (Irish moss)
- Cupressaceae – *Callitropsis nootkatensis* 'Pendula' (weeping Nootka false cypress)
- Ericaceae – *Rhododendron* Northern Lights Group (azalea)
- Fabaceae – *Wisteria sinensis* (Chinese wisteria)
- Lamiaceae – *Callicarpa bodinieri* var. *giraldii* 'Profusion' (beautyberry)
- Ranunculaceae – *Clematis* cvs. (clematis)
- Rosaceae – *Prunuslaurocerasus* 'Otto Luyken' (Otto Luyken laurel), *Prunus serrulata* 'Kwanzan' (flowering cherry)
- Sapindaceae – Acer *macrophyllum* (bigleaf maple)
- Pinaceae – *Picea abies* 'Nidiformis' (nest spruce), *Picea abies* 'Pendula' (weeping Norway spruce), *Picea glauca* (white spruce), *Picea glauca* 'Conica' (dwarf Alberta spruce), *Pinus contorta* var. *contorta* (shore pine), and *Pinus nigra* (Austrian pine)

View the images of plant family members available at this link to the *KPU Plant Database* [New Tab][1].

In addition to shared morphological patterns in flowers and reproductive structures, family members

1. https://plantdatabase.kpu.ca/plant/search.gsp

tend to have similar growth characteristics, nutrient needs, and often the same pests. Key characteristics that distinguish members of some additional plant families are summarized below.

Adoxaceae – moschatel family

- Mostly deciduous shrubs
- Buds are conical
- Leaves are opposite in arrangement, simple, with prominent pinnate venation and serrate margin
- Inflorescence is a cyme of showy florets
- Fruit is a drupe
- Example: *Viburnum plicatum* cvs. (doublefile viburnum)[New Tab][2]

Betulaceae – birch family

- Deciduous trees and some shrub species
- Plant stems are mostly smooth, the genus *Betula* (birch) has bark peeling in layers
- Leaves are alternate in arrangement, simple, with double serrate margin and pinnate venation
- Inflorescence is a long pendulous catkin (male flower) and short, cone-like pendulous or erect catkin (female flower)
- Fruit is a small, single-seeded indehiscent nut in a short-winged samara
- Example: *Betula papyrifera* (paper birch)[New Tab][3]

Brassicaceae – mustard family

- Herbaceous perennial, and annual and biennial species
- Leaves are alternate in arrangement, simple and pinnately lobed, without stipules
- Inflorescence is a raceme
- Flower structure is uniform throughout the family with 4 sepals and 4 petals in a cross-like arrangement (note the historical name ‘Cruciferae’)
- Fruit is a silique formed by two valves joined by a thin flat membrane that often persists
- Example: *Arabis caucasica* (rock cress)[New Tab][4]

Cannabaceae – hop family

- Herbaceous perennial, climbing vine, a dioecious plant

2. https://plantdatabase.kpu.ca/plant/plantDetail/188
3. https://plantdatabase.kpu.ca/plant/plantDetail/16
4. https://plantdatabase.kpu.ca/plant/plantDetail/864

- Leaves are opposite in arrangement, simple and three-lobed with a serrate margin and prominent venation
- Inflorescence is a catkin (male) and cone-like spike (female)
- Flowers are small, without petals (wind pollinated), with aromatic glands at the base
- Fruit is an achene subtended by a papery floral bract
- Example: *Humulus lupulus* (common hop)[New Tab][5]

Caprifoliaceae – honeysuckle family

- Deciduous and broadleaf evergreen shrubs, twining lianas, and some herbaceous perennials
- Stems have pith inside
- Leaves are opposite in arrangement, often simple
- Inflorescence a panicle-like corymb in the example. Solitary flowers occur in pairs or in cymes, spikes and racemes in some species
- Flowers are tubular, funnel-shaped, or bell-like often with five outward spreading lobes or points
- Fruit is a capsule or berry in pairs
- Example: *Kolkwitzia amabilis* (beautybush)[New Tab][6]

Cornaceae – dogwood family

- Mostly trees and shrubs, rarely rhizomatous perennial herbs
- Leaves are opposite in arrangement, simple with undivided, entire margins, and 6-7 pairs of veins
- Flower buds are flattened and globose, vegetative buds are narrow and conical
- Inflorescence is a dense head of inconspicuous true flowers surrounded by 4-8 showy bracts
- Fruit is a drupe, may be multiple in some species
- Examples:
    - *Cornus* ‘Eddie’s White Wonder’ (Eddie’s White Wonder dogwood)[New Tab][7]
    - *Cornus florida* (eastern flowering dogwood, pink flowering dogwood)[New Tab][8]
    - *Cornus kousa* var. *chinensis* (Chinese kousa dogwood)[New Tab][9]

5. https://plantdatabase.kpu.ca/plant/plantDetail/538
6. https://plantdatabase.kpu.ca/plant/plantDetail/260
7. https://plantdatabase.kpu.ca/plant/plantDetail/681
8. https://plantdatabase.kpu.ca/plant/plantDetail/38
9. https://plantdatabase.kpu.ca/plant/plantDetail/39

Hamamelidaceae – witch hazel family

- Deciduous shrubs and trees
- Leaves are alternate in arrangement, simple with prominent pinnate venation, serrate margins, and a pubescent surface
- Inflorescence are clusters of 4-parted cross-shaped florets with small triangular sepals and thin, ribbon-like petals
- Fruit is a woody capsule
- Example: *Hamamelis mollis* (Chinese witch hazel)[New Tab][10]

Hydrangeaceae – hydrangea family

- Deciduous shrubs
- Leaves are opposite in arrangement, whorled in some species, simple, with netted venation and serrate to toothed margins
- Inflorescence a raceme in the genus *Deutzia*
- Flowers are rotate with 5 separate petals
- Fruit is a capsule
- Example: *Deutzia gracilis* (slender deutzia)[New Tab][11]

Iridaceae – iris family

- Herbaceous perennial monocot from a bulb, other species from bulbs, corms and rhizomes
- Leaves are typically basal, sheathing and linear with parallel veins and entire margins
- Inflorescence a solitary, 3-parted flower other species, may be a raceme or spike
- Fruit is a capsule
- Example: *Crocus* cvs. (Dutch crocus, crocus)[New Tab][12]

Magnoliaceae – magnolia family

- Deciduous tree, other species are evergreen trees and shrubs
- Leaves are alternate in arrangement, simple, with an entire margin
- Inflorescence is a solitary flower
- Flowers have tepals, with stamens and pistils on a conical receptacle
- Fruit is an aggregate of woody follicles

10. https://plantdatabase.kpu.ca/plant/plantDetail/242
11. https://plantdatabase.kpu.ca/plant/plantDetail/898
12. https://plantdatabase.kpu.ca/plant/plantDetail/1852

- Example: *Magnolia stellata* (star magnolia)[New Tab][13]

Rutaceae – rue or citrus family

- Mostly trees and some shrubs
- Leaves are opposite in arrangement and trifoliate compound in the genus *Choisya*. Leaves are alternate and simple in the genus *Citrus*. Foliage is aromatic, the leaf blade dotted with glands.
- Inflorescence a cyme
- Flower is rotate with 5 petals, fragrant
- Fruit is a capsule
- Example: *Choisya ternata* (Mexican mock orange)[New Tab][14]

Theaceae – tea family

- Mostly broadleaf evergreen shrubs and trees, few deciduous.
- Leaves are alternate and spiral in arrangement, simple, usually glossy, with serrate margin and a gland (hyathode) that excretes water at serration tips
- Inflorescence is solitary flower
- Flower is radially symmetric, rotate with 11+ petals
- Fruit is a capsule
- Example: *Camellia japonica* (common camellia, Japanese camellia)[New Tab][15]

Tiliaceae – basswood or linden family

- Deciduous tree, some species are shrubs
- Leaves are alternate in arrangement, simple with a pubescent surface and hair tufts in vein axils, a serrate margin and a heart-shaped, asymmetrical base
- Buds are alternate, oval in shape with 2 scales.
- Inflorescence is a cyme with an elongated yellow-green bract
- Flowers are small 5-parted, highly scented
- Fruit is a nut-like drupe
- Example: *Tilia cordata* (little leaf linden)[New Tab][16]

13. https://plantdatabase.kpu.ca/plant/plantDetail/269
14. https://plantdatabase.kpu.ca/plant/plantDetail/218
15. https://plantdatabase.kpu.ca/plant/plantDetail/211
16. https://plantdatabase.kpu.ca/plant/plantDetail/180

PRACTICE

Identify plants for favourable planting situations.

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IV

Part 4 Plants for Horticultural Applications

30.

Native Plants

Learning Objectives

- Describe native plants common to the horticulture industry.

Biodiversity is described as the variety of plants and other living organisms that interact with the non-living environment of a particular habitat or ecosystem. Regardless of the size or type, each organism is dependent on every other, either directly or indirectly through food webs and the natural processes of nutrient cycling and energy flow that sustain ecosystems. Plant biodiversity has an invaluable role in the function of ecosystems and the services that people obtain from them including:

- provision of clean air, water, food, materials, and medicines,
- regulation of climate, carbon storage, water and waste treatment, and erosion and disease control,
- support for pollination, biodiversity and habitat, and
- cultural benefits for health, education, recreation, relaxation, and spiritual well being.

Read more about the importance of ecosystem services at this link to *The Economics of Ecosystems & Biodiversity* [New Tab].[1]

Regardless of whether a plant occurs naturally in a place or has been planted indoors or outdoors for ornament or food value, as a species, it has a native home somewhere in the world. Native plant species originated and co-evolved in communities with other organisms in fourteen identified biomes around the world. Biomes are composed of groups of ecosystems with distinct vegetation types and climate patterns. They are typically named for the dominant vegetation type, such as a forest or grassland. Figure 7.1 shows a map of the distribution of the major biomes around the world.

1. www.teebweb.org/resources/ecosystem-services/

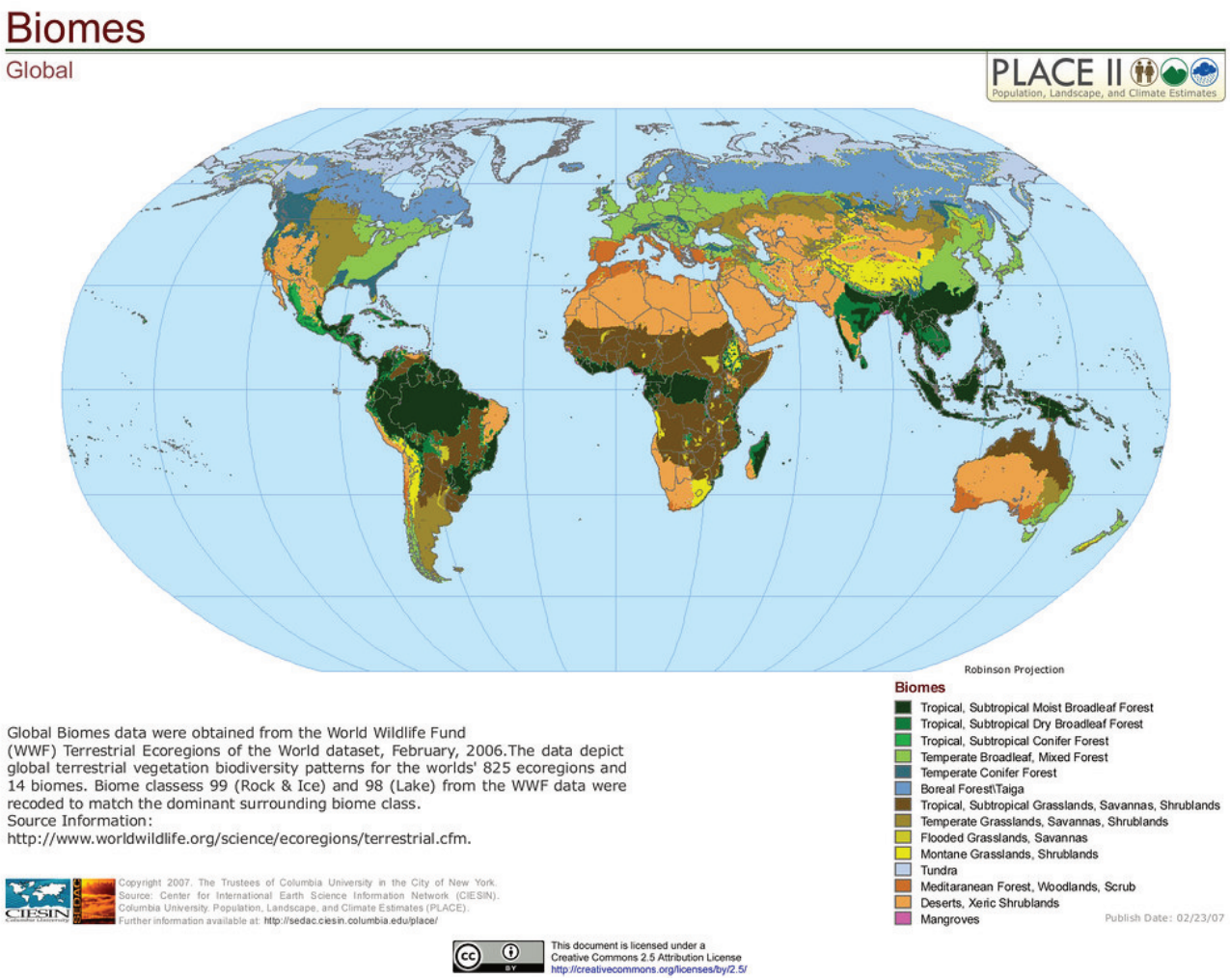

Figure 7.1 Map and legend showing locations and types of global biomes.

With an understanding of plant biology, hardiness, and interactions with soils and climate, native species from different biomes can be successfully grown in landscapes and gardens around the world. For example, *Gunnera manicata* (gunnera) from South America and *Impatiens walleriana* (impatiens) from South Africa that originated in the Tropical, Subtropical Broadleaf Forest biome are often grown as ornamental garden plants. The magnificent specimen tree, *Cedrus deodara* (Deodar cedar) is native to the Tropical, Subtropical Conifer Forest while hedging plants *Thuja occidentalis* (white cedar) and *Taxus cuspidata* 'Capitata' (upright yew) originated in the Temperate Conifer Forest biome. Many species of the Temperate Broadleaf Mixed Forest biome are commonly grown in landscapes and gardens. Examples of deciduous specimen trees include *Acer tataricum* ssp. *ginnala* (Amur maple, Tatarian maple) and *Syringa reticulata* 'Ivory Silk' (Japanese lilac tree) from Eastern Asia, *Cercis canadensis* (redbud) and *Quercus alba* (white oak) from Eastern North America, and the European species *Prunus padus* var. *commutata* (European bird cherry), and *Sorbus aucuparia* (European mountain ash). *Viburnum trilobum* (highbush cranberry) is an understory shrub from northern North America while the closely related *Viburnum opulus* (European snowball) is native to Europe and Asia. Some familiar garden plants that originated in the Mediterranean Forest, Woodlands, Scrub biome are *Cyclamen persicum* (cyclamen), *Helictotrichon sempervirens* (blue oat grass), *Lithodora diffusa* 'Grace Ward'

(blue lithospermum), and *Rosmarinus officinalis* (rosemary). View images of the plant examples available at this link to the *KPU Plant Database* [New Tab][2]. Now, complete the practice exercise.

PRACTICE

Recognize plants native to world biomes.

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Individual ecosystems within larger biomes are characterized by the naturally occurring communities of native plants and animals and the distinct soil types, land forms, and climate of the area. For example, a plant community of the Temperate Conifer Forest biome located in the Pacific Northwest region of North America would include conifers such as *Pinus contorta* var. *contorta* (shore pine), *Pseudostuga menziesii* (Douglas Fir), *Thuja plicata* (western red cedar), and *Tsuga heterophylla* (western hemlock). Depending on the specific site conditions, deciduous and broadleaf evergreen trees may include *Alnus rubra* (red alder), *Arbutus menziesii* (arbutus, madrona), *Frangula purshiana* (cascara), and *Populus trichocarpa* (black cottonwood, western balsam-poplar). Associated deciduous shrubs may include *Ribes sanguineum* (flowering currant, winter currant), *Rubus spectabilis* (salmonberry), *Salix discolor* (native pussy willow, pussy willow), and *Symphoricarpos albus* (snowberry). Some deciduous and evergreen native ferns are *Adiantum pedatum* (maidenhair fern) and *Polystichum munitum* (western sword fern). A few examples of the many native herbaceous flowering plants are *Asarum caudatum* (western wild ginger), *Erythronium americanum* (trout lily, adder's tongue), *Vancouveria hexandra* (inside-out flower), and the semiaquatic *Sagittaria latifolia* (wapato, arrowhead, duck potato). Read more about plant communities and their distinct ecosystems at this link to *Vegetation Regions*, *The Canadian Encyclopedia* [New Tab].[3]

Historically, horticultural activities have had a significant impact on the geographic distribution of native plant species. Currently, landscape contractors, nurseries, garden centres, and mass-market chain stores are the largest distribution channels of native plants in addition to ornamental and floriculture products. The import and export of species for use in arboriculture, landscape horticulture, floriculture, turf, and food production sectors continues to shape the distribution of species in plant communities and ecosystems. While constructed landscapes and gardens may be considered artificial ecosystems, it is possible to plan and maintain communities of local native species and appropriate ornamental plants that support natural processes and ecosystem services.

PRACTICE

Match the images of plants native to the Pacific Northwest.

2. https://plantdatabase.kpu.ca/plant/search.gsp
3. https://www.thecanadianencyclopedia.ca/article/vegetation-regions

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Media Attributions

- Figure 7.1 Global Biomes by SEDACMaps is under a CC BY 2.5 Licence.

31.

Seasonal Plants

Learning Objectives

- Describe seasonal plants common to the horticulture industry.

Planning combinations of woody and herbaceous plants with different life cycles and high visual impact generates year round interest in exterior and interior plantings. When visual interest is planned for one period such as early summer, borders and containers can have a poor appearance the rest of the year. Optimizing the use of grasses, bulbs, perennials, annuals, biennials, shrubs, climbers, and trees can provide a succession of plant forms, colours, textures, and habits throughout the seasons. In temperate regions, year round interest is maximized by selecting plants with at least two, and even three or four seasons of interest.

Conifers and broadleaf evergreens shrubs are often used for year round colour and spatial structure. For example, *Taxus cuspidata* 'Capitata' (upright yew) provides reliable winter colour and a framework that can be enhanced with other shapes, textures, and colours. On the other hand, a planting of broadleaf evergreens such as *Skimmia japonica* (Japanese skimmia) offers winter colour and structure as well as showy spring flowers and colourful fruit in the autumn. Distinctive plant shapes and the bark of trees such as *Cryptomeria japonica* (Japanese cedar) and *Morus alba* 'Pendula' or species with persistent fruit like *Sorbus aucuparia* (European mountain ash) also contribute structure and winter interest.

PRACTICE

Recognize woody plants for winter interest.

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Some deciduous shrubs and trees like *Caryopteris* x *clandonensis* (bluebeard), *Cercidiphyllum japonicum* (katsura), and *Rhus typhina* (staghorn sumac) have interesting branching patterns throughout all seasons. The bark and buds of *Ribes sanguineum* (flowering currant, winter currant), *Magnolia* x *soulangeana* (saucer magnolia), *Liriodendron tulipifera*, and *Styrax japonicus* (Japanese snowbell,

Japanese snowcone) provide winter interest and interesting buds forecast the appearance of foliage and flowers. Climbers with variegated or textured foliage and colourful flowers like *Actinidia kolomikta* (actinitdia) and *Campsis radicans* (trumpet vine) also contribute vertical structure. View the images seasonal plant characteristics available at this link to the *KPU Plant Database* [New Tab].[1]

The appearance of plants before, during, and after flowering is an important consideration for planning seasonal interest. For example, the herbaceous specimen plant *Gunnera manicata* (gunnera, giant rhubarb) provides a bold shape and texture for at least half to perhaps three quarters of the year. With planning, the eye-catching winter stems and seed heads of grasses and perennial species such as *Pennisetum alopecuroides* (fountain grass), *Pennisetum setaceum* 'Rubrum' (red fountain grass), and *Perovskia atriplicifolia* (Russian sage) can serve as distractions from seasonal voids. Layering various heights of ground covers, bulbs, annuals and perennials under and around woody shrubs and trees allows a succession of foliage shapes, sizes, textures, and colours to become prominent as the year progresses. In this way, emphasis is placed on year round interest and not only the seasonal show of flowers. A planting calendar is a useful tool for working out the succession of flowers and colour palettes as well as other planting design features. Figure 8.1 shows an example of a basic planting calendar that allows the planner to visualize the times of the year that are most colourful and interesting and those that could use additional development.

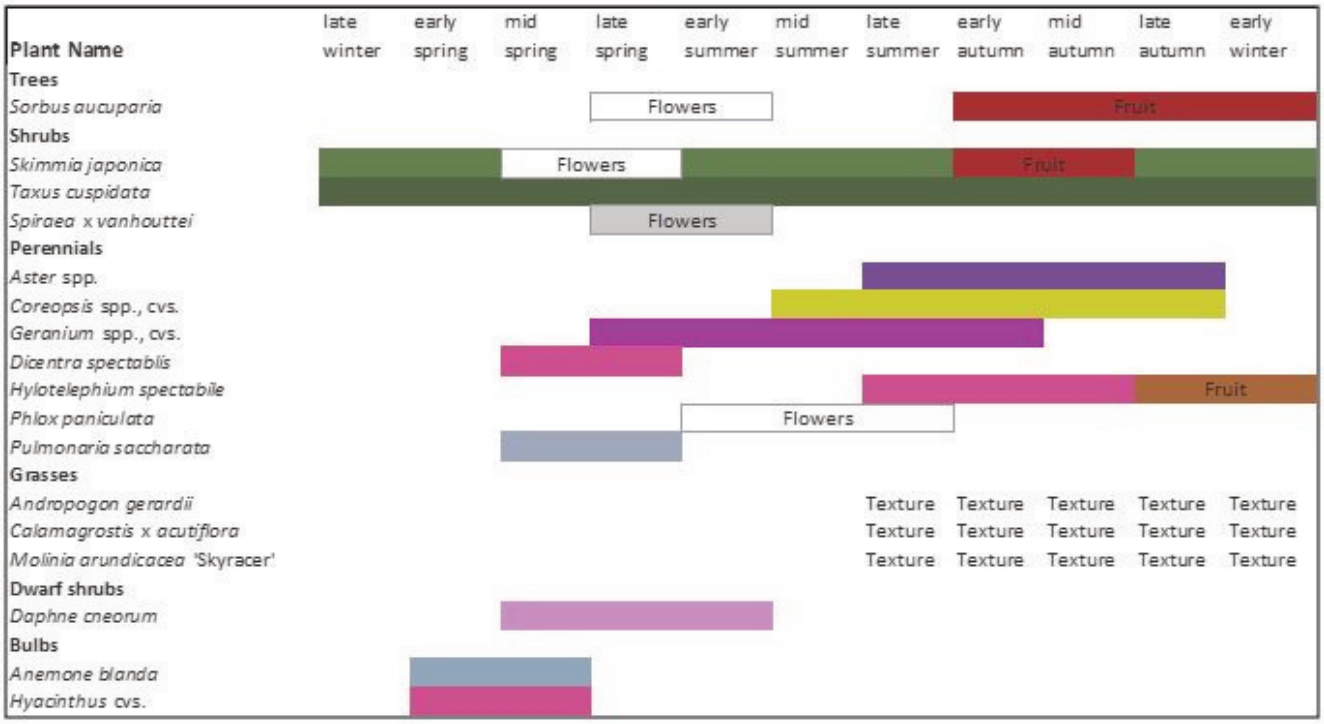

Figure 8.1 Sample planting calendar

As the succession of spring bulbs like *Anemone blanda* (Greek windflower, blue wood) and *Hyacinthus* cvs. (hyacinth) finish flowering and foliage fades, deciduous shrubs such as *Spiraea* x *vanhouttei* (bridal wreath spirea) and an array of herbaceous annuals, biennials and perennials come into flower in early and mid spring. Examples of spring blooming perennials include *Aubrieta* x *cultorum* (common rock cress), *Brunnera macrophylla* (Siberian bugloss), *Papaver orientale* (oriental poppy), *Pulmonaria saccharata* (lungwort), and *Dicentra spectabilis* (bleeding heart). From late spring and early to mid

1. https://plantdatabase.kpu.ca/plant/search.gsp

summer, the flowers and foliage of broadleaf evergreen shrubs such as *Daphne cneorum* (garland daphne) and herbaceous species like *Thymus pseudolanuginosus* (woolly thyme), *Heuchera* cvs. (coralbells, alumroot), and *Phlox paniculata* (common phlox) take prominence. The progression of seasonal foliage and bloom continues in mid to late summer and through autumn with perennials such as *Actaea simplex* Atropurpurea Group (cimicifuga), *Aster* spp. (common aster), *Astrantia major* (masterwort, astrantia), *Coreopsis* spp. & cvs. (coreopsis), *Geranium* spp. & cvs. (geranium), and *Gaillardia* cvs. (blanket flower). The texture and seed heads of perennials like *Hylotelephium spectabile* (autumn joy sedum, stonecrop), and grasses such as *Andropogon gerardii* (big bluestem), *Calamagrostis* x *acutiflora* (feather reed grass), and *Molinia arundinacea* 'Skyracer' (tall moor grass) extend the visual interest from late autumn into winter. Year round interest is fulfilled by evergreens and the flowers of winter blooming shrubs and perennials. View images of the seasonal plant characteristics available at this link to the *KPU Plant Database* [New Tab].[2] Read more about seasonal plant combinations at this link to *Gardenia Seasonal Garden Ideas* [New Tab].[3]

PRACTICE

Recognize plants for seasonal interest.

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https://opentextbc.ca/plantidentification/?p=124

2. https://plantdatabase.kpu.ca/plant/search.gsp
3. https://www.gardenia.net/gardens/seasons

32.

Plants for Green Infrastructure Projects

Learning Objectives

- Describe plants suitable for green infrastructure projects.

The basic infrastructure that supplies a plant with water and food is made up of roots, stems, and leaves. By comparison, an infrastructure that supplies a community with drinking water is made up of a network of parts that include wells, reservoirs, water mains and smaller pipes. Other familiar examples of infrastructure found in communities are transportation, communications, and electrical networks. These constructed networks are often called grey infrastructure. In nature, networks of rivers, streams, lakes, and oceans make up a natural infrastructure that supports the function of ecosystems and the plants and animals that live there. Where human activities lead to the loss of ecosystems and biodiversity, green infrastructure can be planned and managed to conserve ecosystem services and reduce negative environmental impacts. Green infrastructure is made up of vegetation, soils, and bioengineered technologies that provide communities with a wide range of environmental, social, and economic benefits. When connected in a larger framework of natural and urban forests, habitats, streams and rivers, constructed wetlands and floodplains, as well as parks, residential yards, edible landscapes, community gardens, green roofs, green walls, bioswales, and rain gardens, a green infrastructure network is created.

Traditional stormwater infrastructure that collects, drains and discharges water from sites as quickly as possible can increase the potential for flash flooding, pollution, and scouring damage downstream. Sealed surfaces like rooftops, parking lots, and roads accelerate surface water runoff and prevent infiltration into soil for cleansing, groundwater recharge, and plant use. In contrast, green infrastructure for stormwater management mimics natural landscapes that intercept, retain, absorb, filter, and slowly release stormwater by evapotranspiration and controlled runoff. Combinations of green infrastructure components such as green roofs, green walls, bioswales, rain gardens, and permeable paving reduce the quantity and improve the quality of stormwater before its release from a site. Read more about the potential benefits of green infrastructure available at this link to *Introduction to Green Infrastructure*[PDF][New Tab].[1]

1. https://s3-ca-central-1.amazonaws.com/trcaca/app/uploads/2016/08/17163548/Introduction-to-Green-Infrastructure_uploaded-June-2018.pdf

Green infrastructure is designed to optimize the beneficial services provided by plants. Plants and their processes of photosynthesis, water uptake, and respiration contribute to:

- oxygen production and carbon sequestration,
- pollution removal from air, soil, and water,
- flood control, and groundwater and stormwater management,
- surface shading and cooling of air temperature by evapotranspiration, and
- wildlife and pollinator habitat, and green space for human well being.

Plants for green infrastructure projects are often locally available native species, but not always. Both native and non-native plants are used for the ecosystems services a species or plant community provides. Plants suitable for the growing conditions, function, appearance, and maintenance levels associated with green roofs, green walls, bioswales and rain gardens will be selected within the constraints of a particular project.

PLANTS FOR GREEN ROOFS

Green roofs that are partly or completely covered with vegetation and growing media provide many ecosystem services in urban settings. Services include reducing the volume of rainfall runoff through plant uptake, providing wildlife habitat and green space, and reducing the urban heat island effect through shading and plant evapotranspiration. In addition, the insulating properties of vegetation and growing media dampen noise levels, reduce the heating and cooling costs in buildings, and extend the life of roofing materials. Read more about the benefits of green roofs at this link to *Green Roofs for Healthy Cities, About Green Roofs* [New Tab].[2]

Green roofs are categorized as either intensive or extensive depending on the depth of growing media. Intensive green roof systems with growing media depths greater than 150 mm (6”) can support many plant types including ground covers, herbaceous species, shrubs, trees, and climbers. The high structural loading capacity of intensive green roofs also allows for access to amenities like paths, patios, and water features. Like a traditional garden on a roof, intensive plantings have high requirements for maintenance and inputs. In contrast, extensive green roofs with light weight growing media less than 150 mm (6″) in depth support plants with shallow roots and low requirements for maintenance and inputs. Extensive green roofs provide habitat for wildlife but their lower structural loading capacity may restrict human access to maintenance visits. Figure 9.1 shows an example of an extensive green roof that provides visual access to green space in an urban setting.

2. https://greenroofs.org/about-green-roofs

Figure 9.1 Example of an extensive green roof

Almost any plant type can be grown on a green roof however, the shallow depth and low organic content of extensive green roof growing media will be the limiting factor for plant selection. In general, suitable species are determined by examining the microclimate of the green roof and comparing it to a species' native habitat. Extensive green roof features that influence plant selection will include water availability, wind speeds, soil depths and temperatures, as well as solar exposure and climate. Plant growth characteristics for extensive green roofs include fast establishment, long lived with dense coverage, pest and disease resistance, shallow rooting, self-regeneration from seed and vegetative parts, tolerance for extreme weather and very dry to saturated conditions, and low requirements for maintenance and inputs. Examples of native habitats that match the extreme conditions found on extensive green roofs include:

- dry grasslands, cliffs and coasts,
- arid mountain ranges,
- steppe, heath, and alpine communities,
- sandy, talus, and cliff communities, and
- wastelands, gravel and sand pits, rocky outcrops, other hard surfaces.

Plants suitable for extensive green roofs may include succulents, bulbs and corms, annual or biennial self seeders, bunch and stoloniferous grass-like plants, and some wetland and perennial herbs. Succulents, in particular *Sedum* cvs. (stonecrop) have been extensively used because they are well adapted for growing in the extensive green roof microclimate. Learn more about the interesting characteristics of the genus *Sedum* at this link to *Living Architecture Monitor, Sedum: The Workhorse of Green Roofs Plants* [New Tab].[3] In addition to planting sedums, diversified communities may include adapted species such as *Aster* spp. (common aster), *Campanula carpatica* (Carpathian harebell, canterbury bells), *Heuchera* cvs. (coral bells, alumroot), *Penstemon* cvs. (beardtongue), *Phlox subulata* (creeping phlox), as well as sedges and grasses like *Andropogon gerardii* (big bluestem), and *Panicum virgatum* (switch grass).

PRACTICE

Match the images of plants suitable for green roofs.

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https://opentextbc.ca/plantidentification/?p=130

PLANTS FOR GREEN WALLS

Green walls composed of vertical systems of vegetation, growing media, irrigation, and drainage are increasingly used in exterior and interior landscapes for their aesthetic and environmental benefits. The shading, water management, screening, buffering, and insulating properties of green walls can reduce air temperature, noise levels, and the energy costs for cooling buildings. The three major categories of green walls are green facades, living walls, and retaining living walls. Green facades of cable systems, trellises, arbors, and fences offset from a building face support the growth of vines and lianas or cascading plants that are rooted in ground level or above ground planters. Living wall systems of vegetated modules, panels, or bags containing growing media that are freestanding or attached to structural walls or frames support shallow fibrous rooted and creeping herbaceous and woody plants. Retaining living wall systems that are designed to stabilize slopes incorporate vegetation within interlocking geotextile fabric bags, mats, precast concrete units, or in woven wattles of *Salix discolor* (native pussy willow, pussy willow). Figure 9.2 shows an example of a living green wall on a building. Read more about the properties and benefits of green walls at this link to *Green Roofs for Healthy Cities, About Green Walls* [New Tab].[4]

3. https://livingarchitecturemonitor.com/news/2018/2/19/sedum-the-workhorse-of-green-roof-plants
4. https://greenroofs.org/about-green-walls

Figure 9.2 Example of a living green wall

Similar to green roofs, green walls have unique growing conditions that will influence plant selection. Factors for consideration include an indoor or outdoor climate, specialized soil requirements and wall orientation, the green wall design and level of maintenance required. Where green walls are not connected to groundwater, irrigation and intensive maintenance are necessary to ensure appropriate appearance and function. In situations where wall height and desiccation by wind and lack of shade limit plant growth, species adapted to cliff-faces, extreme slopes and thin soil habitats offer suitable choices. Depending on the type of green wall, suitable plants may range from annuals to herbaceous and woody perennials. Some examples of suitable species are *Heuchera* cvs. (coral bells, alumroot), *Penstemon* cvs. (beard tongue), *Cotoneaster apiculatus* (cranberry cotoneaster), *Fragaria* x *ananassa* (garden strawberry), and *Gaultheria procumbens* (wintergreen), as well as succulents and tropical species. Depending on the need for seasonal shading on buildings, green facades may include evergreen or deciduous climbers such as *Actinidia kolomikta* (actinidia) and *Campsis radicans* (trumpet vine).

PRACTICE

Recognize plants suitable for green walls. Move cursor over images for plant names.

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PLANTS FOR BIOSWALES AND RAIN GARDENS

Green infrastructure uses the process of bioretention to manage stormwater quantity and quality.

Bioretention structures such as bioswales and rain gardens are designed to capture, detain, convey, infiltrate, and evaporate water from a planting. Vegetated bioswales are broad shallow straight or meandering channels with porous soil and gently sloped sides and bottom that collect and convey stormwater from one location to another while maximizing soil infiltration and plant uptake. Bioswales are designed to manage short intense periods of rain and flooding followed by dry periods. They reduce the impact of stormwater events and capture the first flush of pollutants from paved and sealed surfaces for remediation by plants and soil microorganisms. Figure 9.3 shows an example of how a vegetated bioswale captures and conveys stormwater runoff from the sealed pavement as well as the turf area.

Figure 9.3 Example of a vegetated bioswale

Rain gardens are shallow infiltration basins located in depressions and low lying areas that capture and temporarily retain water for infiltration and groundwater recharge. Porous soil filters pollutants and allows for uptake and transpiration by plants to reduce air and water temperatures. Figure 9.4 shows an example of a rain garden. Note that the roof downspout enters the rain garden, and when combined with porous pavement, the site becomes an absorbent landscape.

Figure 9.4 Example of a rain garden

Learn more about the components and characteristics of green infrastructure for stormwater management available at this link to *Capital Regional District, Green Stormwater Infrastructure* [New Tab].[5]

In addition to specific growing conditions and appearance expectations, plants for green stormwater infrastructure projects must fulfill basic functional requirements that include:

5. https://www.crd.bc.ca/education/green-stormwater-infrastructure

- tolerance and resilience to flooding, sediment events, drought, and wilting,
- extensive and deep root structure for resistance to heavy water flows,
- dense foliage and spreading growth that prevents erosion and increases evapotranspiration,
- reliable, vigorous growth without becoming invasive, and
- an ability to tolerate and accumulate contaminants from water or saturated soil.

Native and ornamental species are usually planted according to their tolerance for the wetter bottom or drier side and upper edges of bioswales and rain gardens. Where space and soil volume permit, planting trees and large shrubs such as *Alnus rubra* (red alder), *Frangula purshiana* (cascara), and *Salix discolor* (native willow, pussy willow) will prevent erosion and transpire great amounts of water. Examples of shrubs for bioswales and raingardens include *Clethra alnifolia* (summersweet), *Ribes sanguineum* (flowering currant, winter currant), *Rubus spectabilis* (salmonberry), and *Symphoricarpos albus* (snowberry). Where space for trees and shrubs is limited, planting multiple layers of herbaceous vegetation will increase the foliage density and the benefits of transpiration. Some examples of adapted herbaceous species include *Aconitum napellus* (monkshood), *Aster* spp. (common aster), *Carex oshimensis* 'Evergold' (Evergold Japanese sedge), *Lysimachia clethroides* (gooseneck lysimachia), *Panicum virgatum* (switchgrass), and *Pennisetum alopecuroide*s (fountain grass).

PRACTICE

Recognize plants suitable for bioswales and rain gardens.

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In order for green infrastructure to provide ecosystem services as designed, maintenance practices must ensure appropriate vegetation cover for proper function and aesthetic performance. Improper maintenance can defeat the purpose of green infrastructure and lead to costly replacement or restoration. Routine maintenance involves inspection and repair for erosion, appearance, and removal of sediment and potential invasive species. Regular soil testing, weeding, and trash removal will influence the long term efficiency and effectiveness of pollutant removal and stormwater management by vegetated bioretention structures.

33.

Plants for Edible Landscapes

Learning Objectives

- Describe plants suitable for edible landscapes.

As part of green infrastructure, gardening for food production offers a wide range of environmental, economic, and social benefits. Growing local food within and around communities supports:

- habitat for pollinators and biodiversity,
- regulation of local climate and water management,
- reduction of energy use and carbon footprints,
- food security and local economy, and
- physical health and social connections.

Urban agriculture is the process of growing, processing, and distributing local food and food products. There are many types of urban agriculture including community gardens, boulevard planting, green roofs, vertical farms, urban chickens, bee keeping, aquaculture, and small scale faming for farmers markets. Some other forms of food production are edible landscapes, food forests, urban orchards, gleaning (public land harvest), grow a row donations and backyard sharing, and guerrilla gardening. Figure 10.1 shows an example of products of urban agriculture available for purchase at a farmers market. Read more about the benefits and different types of urban agriculture at this link to *The Urban Farmer* [New Tab][1]

1. http://www.theurbanfarmer.ca/urban-agriculture

Figure 10.1 Example of urban agriculture products for sale at a farmers market stall

Communities plan and manage urban agriculture through policies, zoning bylaws, and land use regulations that allow certain public green spaces to be used for growing food. For example, community gardens for non-commercial food production that are allowed in some or all land use designations will have guidelines for safety, accessibility, maintenance, and aesthetics. Read about an example of jurisdictional policy and regulations for community gardens available at this link to *City of Victoria Community Gardens Policy*[PDF][New Tab].[2]

Food production in residential landscapes is commonly associated with vegetable plots in backyards. Annual species grown for produce are usually arranged in agricultural patterns of straight lines in designated areas. Soil is often amended with compost, heavily irrigated, and seasonally tilled over for new planting. In contrast, edible landscapes, sometimes called foodscapes, incorporate plants for food as well as ornamental value within existing and new residential and public landscape designs. In general, plants for edible landscapes are herbaceous and woody perennial species that:

- are adapted for the climate and naturally resistant to pest and disease,
- require less intensive or similar levels of maintenance and inputs as the rest of the planting area, and
- provide multiple benefits such as food, aesthetics, shading, and water management.

Plants selected for preferred foods and the attributes of form, texture, and colour are integrated with other ornamental plants to achieve a desired garden style and aesthetic appearance. For example, the fruit producing tree, *Morus alba* ‘Pendula’ (weeping mulberry) serves as a specimen plant with distinctive form. Shrubs with berries and vibrant autumn foliage colour like *Vaccinium corymbosum* (highbush blueberry) may be planted as hedging. Edible spreaders like *Fragaria* x *ananassa* (garden strawberry) and *Gaultheria procumbens* (wintergreen) provide ground cover while vegetables with fine texture foliage like *Daucus carota* ssp. *sativus* (carrot) contrast coarse texture plants like *Rheum palmatum* (rhubarb). Aromatic herbs such as *Origanum laevigatum* ‘Herrenhausen’ and *Rosmarinus officinalis* (rosemary) provide structure, scent, and visual interest alongside edible flowers like *Impatiens walleriana* (impatiens) and *Phlox paniculata* (summer phlox, border phlox). Learn more information

2. https://www.victoria.ca/assets/Departments/Parks~Rec~Culture/Parks/Documents/community-garden-policy.pdf

about the origins, benefits, maintenance, and types of plants for edible landscapes available at this link to *Foodscaping-Wikipedia* [New Tab].[3]

PRACTICE

Recognize plants for edible landscapes.

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Techniques that maximize space use and vegetation cover such as interplanting larger, slow growing food plants with smaller, fast growing plants reduce soil erosion and suppress opportunistic weeds. Combining plants with different heights and structure, nutrient requirements, and rooting depths creates growing microclimates and reduces plant competition for soil nutrients. Certain companion plants such as members of the Fabaceae (pea) family that fix atmospheric nitrogen in available forms in root nodules can benefit nearby nitrogen feeders like leafy vegetables. Aromatic herbs can be used to repel pests attracted to other species by smell, and the deliberate planting of host plants distract pests from other plants and attract beneficial insects and predators that feed on pests. Read more information about the benefits of companion planting available at this link to *Companion planting – Wikipedia* [New Tab].[4]

Edible landscapes that are intended to provide food products for human consumption are distinguished

3. https://en.wikipedia.org/wiki/Foodscaping
4. https://en.wikipedia.org/wiki/Companion_planting

from planted habitats that are intended to attract wildlife. As areas of natural ecosystems are converted to residential, agricultural, industrial, and other uses, the loss of habitat negatively impacts native wildlife. However, where fragments or patches of habitat are not too small and are close together, they can be connected by corridors of vegetation that allow native species to access adequate food, water, shelter and protection. Planting regional native plants that mimic the habitat characteristics of the desired wildlife species in landscapes and gardens can provide the particular needs for food, water, shelter and protection.

Creating connections between native and ornamental vegetation and water sources in urban forests, parks, gardens, boulevards, and other plantings allows wildlife to move safely among habitat patches in urban areas. For example, evergreen trees like *Cryptomeria japonica* (Japanese cedar) with branches close to the ground and deciduous trees with open canopies and multiple branches such as *Frangula purshiana* (cascara), and *Prunus padus* var. *commutata* (European bird cherry) offer shelter and protection, as well as nesting sites and food. Interplanting layers of shrubs like *Ribes alpinum* (alpine currant), *Ribes sanguineum* (flowering currant, winter currant), and *Rubus spectabilis* (salmonberry) with herbaceous species like *Andropogon gerardii* (big bluestem), *Asarum caudatum* (western wild ginger), and *Polystichum munitum* (western sword fern) provides a range of wildlife species with food, shelter, and protection. Review images of plant examples at this link to *KPU Plant Database* [New Tab].[5] Learn more about gardening for wildlife habitat available at this link to *Fraser Valley Conservancy Native Plants Guide*[PDF][New Tab].[6]

Habitat loss and invasive species are major threats to wildlife habitats, particularly in wetlands and forests. Selecting ornamental plants for habitat planting includes examining the potential for species to escape, establish, and overtake natural ecosystems. Non-invasive ornamentals and regional native plants are the responsible alternative to invasive plants. For example, an introduced horticultural plant that has become invasive in wetlands is *Butomus umbellatus* (flowering rush). Alternate choices for this plant include the native species *Scirpus microcarpus (s*mall-flowered bulrush), *Carex* spp. (sedges), and *Sagittaria latifolia* (wapato, arrowhead). Alternate choices for another invasive, *Euphorbia esula* (green spurge, leafy spurge) include species in the genera *Delosperma* (ice plant) and *Helianthemum* (rock rose). Species in the genera *Salvia* (sage), and *Penstemon* (beardtongue) provide alternate choices for the invasive species, *Echium vulgare* (blueweed). Another invasive species, *Linaria vulgaris* (toadflax) can be replaced with selections from the genera *Penstemon* (beardtongue), *Hemerocallis* (daylily), *Antirrhinum* (snapdragon), and *Kniphofia* (torch lily). Learn more about the threat of invasive horticultural plants and alternative plant choices at this link to *Invasive Species Council of BC Grow Me Instead*[PDF][New Tab].[7]

PRACTICE

Name the invasive species. Move the cursor over the image to check your response.

An interactive or media element has been excluded from this version of the text. You can view it online here:
https://opentextbc.ca/plantidentification/?p=133

5. https://plantdatabase.kpu.ca/
6. https://fraservalleyconservancy.ca/wp-content/uploads/2018/08/FVC-Native-Plants-guide-Aug-2018-web.pdf
7. https://www.bcinvasives.ca/documents/ISCBC-GMI-Brochure-180425-WEB.pdf

Versioning History

This page provides a record of edits and changes made to this book since its initial publication in the B.C. Open Textbook Collection.[1] Whenever edits or updates are made in the text, we provide a record and description of those changes here. If the change is minor, the version number increases by 0.01. If the edits involve substantial updates, the version number increases to the next full number.

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Version	Date	Change	Details
1.00	September 22, 2020	Added to the B.C. Open Textbook Collection.	

1. https://open.bccampus.ca/
2. https://open.bccampus.ca/reporting-an-open-textbook-error/