**Pine**

Pine (genus Pinus) is a genus of about 120 species of evergreen conifers of the pine family (Pinaceae), distributed throughout the world but native primarily to northern temperate regions. The chief economic value of pines is in the construction and paper-products industries, but they are also sources of turpentine, rosin, oils, and wood tars. Edible pine seeds, which are sold commercially as pine nuts, piñons, or pinyons, are produced by several species. Many pines are cultivated as ornamentals, including black, white, Himalayan, and stone pines, and some are planted in reforestation projects or for windbreaks. Pine-leaf oil, used medicinally, is a distillation product of the leaves; charcoal, lampblack, and fuel gases are distillation by-products.

Pines are softwoods, but commercially they may be designated as soft pines or hard pines. Soft pines, such as white, sugar, and piñon pines, have relatively soft timber, needles in bundles of five (less commonly, one to four), stalked cones with scales lacking prickles, and little resin. Their wood is close-grained, with thin, nearly white sapwood; the sheaths of the leaf clusters are deciduous, and the leaves contain a single fibrovascular bundle. Hard pines, such as Scotch, Corsican, and loblolly pines, have relatively hard timber, needles in bundles of two or three (rarely, five to eight), cone scales with prickles, and large amounts of resin. Their wood is coarse-grained and usually dark-coloured, with pale, often thick sapwood; the sheaths of the leaf clusters are persistent, and the leaves have two fibrovascular bundles.

Young pine trees are usually conical, with whorls of horizontal branches. Older trees may have round, flat, or spreading crowns. Most species have thick rough furrowed bark. Pines have two types of branches, long shoots and short shoots, and three types of leaves, primordial, scale, and adult. Seedling plants bear the lance-shaped spirally arranged primordial leaves. The triangular scale leaves, also lance-shaped, are borne on the long shoots of older trees. Both long and short shoots develop in the axils of the deciduous scale leaves. The needlelike photosynthetic adult leaves, with two or more resin canals, are borne in fascicles (bundles) of two to five (rarely, up to eight or solitary) at the tip of each short shoot; they remain on the tree 2 to 17 years.

Many botanists consider the genus *Pinus* to contain two subgenera: *Haploxylon*, or soft pines, which have one fibrovascular bundle, and *Diploxylon*, or hard pines, which have two.

**Oaks**

Oaks can be separated into three groups, sometimes considered subgenera: white oaks (Leucobalanus) and red or black oaks (Erythrobalanus) have the scales of the acorn cups spirally arranged; in the third group (Cyclobalanus) the scales are fused into concentric rings. White oaks have smooth, non-bristle-tipped leaves, occasionally with glandular margins. Their acorns mature in one season, have sweet-tasting seeds, and germinate within a few days after their fall. Red or black oaks have bristle-tipped leaves, hairy-lined acorn shells, and bitter fruits, which mature at the end of the second growing season.

In North America several oaks are of ornamental landscape value, including pin oak (Q. palustris) and northern red oak (Q. rubra). White oak (Q. alba) and bur oak (Q. macrocarpa) form picturesque oak groves locally in the Midwest. Many oaks native to the Mediterranean area have economic value: galls produced on the twigs of the Aleppo oak (Q. infectoria) are a source of Aleppo tannin, used in ink manufacture; commercial cork is obtained from the bark of the cork oak (Q. suber), and the tannin-rich kermes oak (Q. coccifera) is the host of the kermes insect, once harvested for a dye contained in its body fluids.

Two eastern Asian oaks also are economically valuable: the Mongolian oak (Q. mongolica) provides useful timber, and the Oriental oak (Q. variabilis) is the source of a black dye as well as a popular ornamental. Other cultivated ornamentals are the Armenian, or pontic, oak (Q. pontica), chestnut-leaved oak (Q. castaneaefolia), golden oak (Q. alnifolia), Holm, or holly, oak (Q. ilex), Italian oak (Q. frainetto), Lebanon oak (Q. libani), Macedonian oak (Q. trojana), and Portuguese oak (Q. lusitanica). Popular Asian ornamentals include the blue Japanese oak (Q. glauca), daimyo oak (Q. dentata), Japanese evergreen oak (Q. acuta), and sawtooth oak (Q. acutissima). The English oak, a timber tree native to Eurasia and northern Africa, is cultivated in other areas of the world as an ornamental.

Acorns provide food for small game animals and are used to fatten swine and poultry. Red- and white-oak lumber is used in construction, flooring, furniture, millwork, cooperage, and the production of crossties, structural timbers, and mine props.

Oaks can be propagated easily from acorns and grow well in rich, moderately moist soil or dry, sandy soil. Many grow again from stump sprouts. They are hardy and long-lived but are not shade-tolerant and may be injured by leaf-eating organisms or oak wilt fungus.

The taxonomy of the genus Quercus is confusing because of the many natural hybrids.

**Evergreen plants. sruce**

*Evergreen* is any plant that retains its leaves through the year and into the following growing season. Many tropical species of broad-leaved flowering plants are evergreen, but in cold-temperate and Arctic areas the evergreens commonly are cone-bearing shrubs or trees (conifers), such as pines and firs. The leaves of evergreens usually are thicker and more leathery than those of deciduous trees (those that shed their leaves in autumn or in the tropical dry season) and often are needlelike or scalelike in cone-bearing trees. A leaf may remain on an evergreen tree for two years or longer and may fall during any season. An evergreen forest may be needle-leaved, as the coniferous forests of the Northern Hemisphere, or broad-leaved, as the temperate rain forests of the Southern Hemisphere and the broad sclerophyll forests (with thickened, hardened foliage resistant to water loss) of coastal areas of the Northern Hemisphere. Most tropical rain forests contain broad-leaved evergreens. See also coniferous forest; chaparral.

*Spruce* is any of about 40 species of evergreen ornamental and timber trees constituting the genus Picea of the conifer family Pinaceae, native to the temperate and cold regions of the Northern Hemisphere. They are pyramidal trees with whorled branches and thin, scaly bark. Each of the linear, spirally arranged leaves is jointed near the stem on a separate woody base. The base remains as a peglike projection on the twig when the leaf falls. The hanging, persistent-scaled cones are egg-shaped or cylindrical. Resonant spruce wood is used for sounding boards in pianos and the bodies of violins, as well as in construction and for boats and barrels and as pulpwood.

Black spruce (Picea mariana) and white spruce (P. glauca) are found throughout most of northern North America, from the Great Lakes to the Arctic tree line. Both are used for pulp; white spruce produces good lumber, and black spruce is the source of spruce gum. White spruce usually is 18 to 21 metres (about 60 to 70 feet) tall. A drought-tolerant cultivar, Picea glauca ‘Black Hills,’ is useful in landscaping and in windbreaks. The cones of black spruce are purple, those of white spruce brown. Engelmann spruce (P. engelmannii) of western North America is an important timber source. The blue spruce, or Colorado spruce (P. pungens), has a similar range and is used as an ornamental because of its bluish leaves and symmetrical growth habit.

The Norway spruce (P. abies), an important timber and ornamental tree native to northern Europe, is used in reforestation both there and in North America.

**Logging**

Logging is the process of harvesting trees, sawing them into appropriate lengths (bucking), and transporting them (skidding) to a sawmill. The different phases of this process vary with local conditions and technology.

In the 19th century logging was a hand process, and in some parts of the world it has remained one. In colder regions, trees are felled by ax in winter and conveyed by a sled drawn by oxen, mules, or horses to a frozen river. After the spring thaw, the logs are floated downriver to a sawmill.

Sawmill is a type of machine or plant with power-driven machines for sawing logs into rough-squared sections or into planks and boards. A sawmill may be equipped with planing, molding, tenoning, and other machines for finishing processes. The biggest mills are usually situated where timber can be brought by river or rail, and the design of the mill is affected by the mode of transportation. Waterborne logs float into the mill and are dragged out in turn by a winch. More space is necessary for storage in the rail-borne system; an overhead crane serves the stockyard and carries the logs to the machines.

In mechanized modern logging, trees are felled by crosscut saw or power-driven chain saw or, for trees of relatively young plantations, by a machine that cuts the entire tree in one bite. Trees are then cut into standard lengths and skidded to the mill by truck or tractor or conveyed to a central point by cable, either high above ground (high-lead and overhead skidding) or along the ground (groundline skidding). Helicopters and balloons are also used to transport logs.

Local conditions may dictate uncommon logging methods. In India, teakwood trees are killed by girdling (making a circular cut around the tree through the outer bark and cortex to interrupt the circulation of water and nutrients) and harvested several years later. Then, as is also common in Nigeria, they may be floated down the river by raft. In several Asian countries, timber may be transported by elephant.

**wood**

In botanical terms, wood is part of the system that conveys water and dissolved minerals from the roots to the rest of the plant, stores food created by photosynthesis, and furnishes mechanical support. It is produced by an estimated 25,000 to 30,000 species of plants, including herbaceous ones, though only 3,000 to 4,000 species produce wood that is suitable for use as a material. Wood-producing forest trees and other woody plants are of two categories: gymnosperms and angiosperms. Gymnosperms, or cone-bearing trees, produce softwoods, such as pine and spruce, and angiosperms produce temperate and tropical hardwoods, such as oak, beech, teak, and balsa. Softwoods account for about 40 percent and hardwoods about 60 percent of the world’s production of lumber. It should be noted that the distinction implied by hardwood and softwood is not true in all cases. Some hardwoods – e.g., balsa – are softer than some softwoods – e.g., yew.

Wood is a material of great economic importance. It is found throughout the world and is a renewable resource – in contrast to coal, ores, and petroleum, which are gradually exhausted. By means of its harvesting in forests, its transportation, its processing in workshops and industries, and its trade and use, wood provides jobs and supports economic development and, in some countries, basic subsistence. Indicative of this importance is the high demand for wood and wood products (see table) and the projected growth in consumption. In the late 1990s yearly world production (and consumption) of wood in the form of roundwood, or logs, was about 3.5 billion cubic metres, up from 1.5 billion cubic metres in 1950. (A cubic metre is about 35 cubic feet.) Consumption of roundwood is projected to approach 4 billion cubic metres in 2010.

On a weight basis, the consumption of wood exceeds by far that of other materials. In the mid-1990s the average daily consumption of wood per person was 1.8 kg (about 4 pounds), which was 3 times that of cement, 5 times that of steel, 30 times that of plastics, and 200 times that of aluminum. More than half of roundwood production is consumed as fuel, mainly in less-developed countries. Production of paper and paperboard has shown the most rapid increase among wood products; this trend is expected to continue as consumption per person in the less-developed countries approaches that in the developed nations (see part B of the figure above).

**Wood management**

Wood is the principal strengthening and nutrient-conducting tissue of trees and other plants and one of the most abundant and versatile natural materials. Produced by many botanical species, wood is available in various colours and grain patterns. It is strong in relation to its weight, is insulating to heat and electricity, and has desirable acoustic properties. Furthermore, it imparts a feeling of “warmth” not possessed by competing materials such as metals, and it is relatively easily worked. As a material, wood has been in service since humans appeared on Earth. Today, in spite of technological advancement and competition from metals, plastics, cement, and other materials, wood maintains a place in most of its traditional roles, and its serviceability is expanding through new uses. In addition to well-known products such as lumber, furniture, and plywood, wood is the raw material for wood-based panels, pulp and paper, and many chemical products. Finally, wood is still an important fuel in much of the world.

Harvesting of wood differs radically from harvesting of other crops. The yearly growth of each individual tree cannot be detached from the living plant. Rather, new wood is added inseparably to preexisting growth until the entire tree is harvested, after a waiting period that varies widely depending on intended use of the wood – for example, 2–3 years on energy plantations (where biomass is produced as fuel for power generation), 6–8 years for pulpwood (eucalypts), 12–15 years for fast-growing poplar hybrids, 30–50 years for fast-growing pines, and 100 years or more in temperate and tropical forests producing wood of large dimensions.

A prerequisite to harvesting is a management plan, which determines the yearly yield and the method of removal. The harvest method chosen can involve clear-cutting large areas or selective cutting of individual trees or groups of trees. For a forest harvested under the sustained-yield concept, the volume of timber removed at periodic intervals is dependent on the net growth of all trees – as estimated by statistical sampling – during that interval. This concept, combined with natural and artificial seeding and planting, ensures a continuous production of wood and conservation of forests. To promote sustained-yield management, efforts have been made to introduce appropriate ecological labeling (ecolabeling) of marketed wood and wood products. Ecolabeling is intended to ensure that goods offered to the consumer have not been produced in a way detrimental to the environment.

**Classifications of Trees**

A tree is a woody plant that regularly renews its growth (perennial). Most plants classified as trees have a single self-supporting trunk containing woody tissues, and in most species the trunk produces secondary limbs, called branches.

Trees have been grouped in various ways, some of which more or less parallel their scientific classification: softwoods are conifers, and hardwoods are dicotyledons. Hardwoods are also known as broadleaf trees. The designations softwood, hardwood, and broadleaf, however, are often imprecise. The wood of some hardwoods – for example, certain willows and poplars and the softest of all woods, balsa – is softer than that of some softwoods – e.g., the longleaf pine (Pinus palustris). Similarly, some broadleaf trees (tree heaths, Erica arborea, and some tamarisks) have narrower leaves than do those of certain conifers (Podocarpus).

A popular and convenient grouping of trees is evergreen and deciduous. This is most useful at the local rather than the worldwide level; whether a particular species retains its foliage throughout the year and thus qualifies as evergreen may depend on climate. At the limits of their occurrence in the Northern or Southern Hemisphere, and at high elevations, species that under more-favourable circumstances retain their foliage may become leafless for a period. Many tropical and subtropical species that in uniformly humid climates are never without foliage are deciduous in regions in which dry and wet seasons alternate. In northern North America, the term evergreen is often used as a synonym for conifer and thus excludes foliage-retaining angiosperms. But five coniferous genera – Larix (larch), Metasequoia (dawn redwood), Pseudolarix (golden larch), Taxodium (swamp cypress), and Glyptostrobus – are composed of or include deciduous species.

Other tree groups are popularly recognized: tree ferns, palms, and, among desert plants, the tree forms of agaves, aloes, cactuses, euphorbias, and yuccas. Sometimes the layperson includes as trees plants that botanists cannot accept as such – e.g., the banana. Such confusion arises from the fact that what appears to be the trunk of the “banana tree” is actually leafstalks rolled tightly around each other. The banana plant is entirely herbaceous, has no true trunk, and thus is not considered a tree by botanists.

**General features of the tree body**

As vascular plants, trees are organized into three major organs: the roots, the stems, and the leaves. The leaves are the principal photosynthetic organs of most higher vascular plants. They are attached by a continuous vascular system to the rest of the plant so that free exchange of nutrients, water, and end products of photosynthesis (oxygen and carbohydrates in particular) can be carried to its various parts.

The stem is divided into nodes (points where leaves are or were attached) and internodes (the length of the stem between nodes). The leaves and stem together are called the shoot. Shoots can be separated into long shoots and short shoots on the basis of the distance between buds (internode length). The stem provides support, water and food conduction, and storage.

Roots provide structural anchorage to keep trees from toppling over. They also have a massive system for harvesting the enormous quantities of water and the mineral resources of the soil required by trees. In some cases, roots supplement the nutrition of the tree through symbiotic associations, such as with nitrogen-fixing microorganisms and fungal symbionts called mycorrhizae, which are known to increase phosphorous uptake. Tree roots also serve as storage depots, especially in seasonal climates.

As is true of other higher vascular plants, all the branches and the central stem of trees (the trunk or bole) terminate in growing points called shoot apical meristems. These are centres of potentially indefinite growth and development, annually producing the leaves as well as a bud in the axis of most leaves that has the potential to grow out as a branch. These shoot apical growing centres form the primary plant body, and all the tissues directly formed by them are called the primary tissues. As in the stems, the growing points of the roots are at their tips (root apical meristems); however, they produce only more root tissue, not whole organs (leaves and stems). The root meristem also produces the root cap that covers the outside of the root tip.

The outermost layer of cells surrounding the roots and stems of the primary body of a vascular plant (including the leaves, flowers, fruits, and seeds) is called the epidermis. The closely knit cells afford some protection against physical shock, and, when invested with cutin and covered with a cuticle, they also provide some protection from desiccation. Stomata (pores) are interspersed throughout the epidermal cells of the leaves (and to some extent on the stems) and regulate the movement of gases and water vapour into and out of the plant body.

**Dendrology. Dendrochronology**

*Dendrology* or xylology is the science and study of wooded plants (trees, shrubs, and lianas), specifically, their taxonomic classifications. There is no sharp boundary between plant taxonomy and dendrology; however, woody plants not only belong to many different plant families, but these families may be made up of both woody and non-woody members. Some families include only a few woody species. Dendrology, as a discipline of industrial forestry, tends to focus on identification of economically useful woody plants and their taxonomic interrelationships. As an academic course of study, dendrology will include all woody plants, native and non-native, that occur in a region. A related discipline is the study of sylvics, which focuses on the autecology of genera and species.

*Dendrochronology*, also called tree-ring dating, the scientific discipline concerned with dating and interpreting past events, particularly paleoclimates and climatic trends, based on the analysis of tree rings. Samples are obtained by means of an increment borer, a simple metal tube of small diameter that can be driven into a tree to get a core extending from bark to centre. This core is split in the laboratory, the rings are counted and measured, and the sequence of rings is correlated with sequences from other cores.

Dendrochronology is based on the fact that many species of trees produce growth rings during annual growing seasons. The width of the ring (i.e., the amount of growth) for each year is determined by various internal and external factors, but it tends to vary mainly in proportion to either the amount of available precipitation or the prevailing temperatures. The ring measurements taken from trees with overlapping ages can extend knowledge of climates back thousands of years. The bristlecone pines of California have proven to be particularly suitable for such chronologies, since some individual trees are more than 4,000 years old.

*Growth rings*, in a cross section of the stem of a woody plant, are the increment of wood added during a single growth period. In temperate regions the growth period is usually one year, in which case the growth ring may be called an “annual ring.” In tropical regions, growth rings may not be discernible or are not annual. Even in temperate regions, growth rings are occasionally missing, and a second, or “false,” ring may be deposited during a single year – for example, following insect defoliation.

**Birch**

A birch has smooth, resinous, varicoloured or white bark, marked by horizontal pores (lenticels), which usually peels horizontally in thin sheets, especially on young trees. On older trunks the thick, deeply furrowed bark breaks into irregular plates. Short, slender branches rise to a narrow pyramidal crown on a young tree; they become horizontal, often pendulous, on an older tree. The egg-shaped or triangular, usually pointed leaves have toothed margins; they are alternately arranged on the branchlets. They are usually bright green, turning yellow in autumn. The drooping male catkins flower before the leaves emerge; smaller, upright female catkins on the same tree develop in conelike clusters, which disintegrate at maturity, releasing tiny, one-seeded, winged nutlets.

Gray birch, paper birch, river birch, sweet birch, yellow birch, and white birch are the best known; white birch is usually called silver birch in England, but the latter name is also sometimes given to paper birch and to yellow birch. The Japanese monarch birch (B. maximowicziana) is a valuable timber tree of Japan, especially in the plywood industry. Usually 30 metres (100 feet) high, with flaking gray or orange-gray bark, it has heart-shaped leaves about 15 centimetres (6 inches) long and is a hardy ornamental. The similar Japanese cherry birch (B. grossa) also produces useful timber.

Water birch, a shrubby tree native to moist sites along the western coast of North America, has nonpeeling, dark-red bark; it grows in clusters, with all stems rising from a common root system. It is sometimes called red birch, black birch, or mountain birch. Swamp birch (B. pumila), a similar but smaller shrub, is found on boggy sites; it may be erect or trailing and matted. Bog birch (B. glandulosa) of North America, also called tundra dwarf birch or resin birch, and dwarf birch, or dwarf Arctic birch (B. nana), native to most far northern areas of the world, are small alpine and tundra shrubs commonly known as ground birch. Both species have almost circular leaves, are food sources for birds and grazing animals, and may be planted as ornamentals. Several Chinese birches and the Japanese white birch (B. platyphylla japonica) are sometimes used ornamentally. A few natural hybrids between trees and shrubs of the genus Betula are cultivated as ornamentals in Europe and North America.