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Apple

An **apple** is the round, edible fruit of an apple tree (*Malus* spp.). Fruit trees of the **orchard** or **domestic apple** (***Malus domestica***), the most widely grown in the genus, are cultivated worldwide. The tree originated in Central Asia, where its wild ancestor, *Malus sieversii*, is still found. Apples have been grown for thousands of years in Eurasia before they were introduced to North America by European colonists. Apples have cultural significance in many mythologies (including Norse and Greek) and religions (such as Christianity in Europe).

Apples grown from seeds tend to be very different from those of their parents, and the resultant fruit frequently lacks desired characteristics. For commercial purposes, including botanical evaluation, apple cultivars are propagated by clonal grafting onto rootstocks. Apple trees grown without rootstocks tend to be larger and much slower to fruit after planting. Rootstocks are used to control the speed of growth and the size of the resulting tree, allowing for easier harvesting.

There are more than 7,500 cultivars of apples. Different cultivars are bred for various tastes and uses, including cooking, eating raw, and cider or apple juice production. Trees and fruit are prone to fungal, bacterial, and pest problems, which can be controlled by a number of organic and non-organic means. In 2010, the fruit's genome was sequenced as part of research on disease control and selective breeding in apple production.

Etymology

The word *apple* is derived from Old English *æppel*, meaning "fruit", not specifically the apple.[4] That in turn is descended from the Proto-Germanic noun **aplaz*, descended in turn from Proto-Indo-European

Apple

'Cripps Pink' cultivar

Flowers of *M. domestica*

Scientific classification

Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Rosales
Family:	Rosaceae
Genus:	*Malus*
Species:	***M. domestica***

Binomial name

Malus domestica
(Suckow) Borkh., 1803[1]

Synonyms[2][3]

**h₂ébōl*.[5] As late as the 17th century, the word also functioned as a generic term for all fruit, including nuts. This can be compared to the 14th-century Middle English expression *appel of paradis*, meaning a banana.[4]

- *M. communis* Desf., 1768
- *M. pumila* Mil.
- *M. frutescens* Medik.
- *M. paradisiaca* (L.) Medikus
- *M. sylvestris* Mil.
- *Pyrus malus* L.
- *Pyrus malus* var. *paradisiaca* L.
- *Pyrus dioica* Moench

Description

The apple tree is deciduous, generally standing from 2 to 4.5 metres (6 to 15 feet) tall in cultivation and up to 15 m (49 ft) in the wild, though more typically 2 to 10 m (6.5 to 33 ft).[6][2] When cultivated, the size, shape and branch density are determined by rootstock selection and trimming method.[6] Apple trees may naturally have a rounded to erect crown with a dense canopy of leaves.[7] The bark of the trunk is dark gray or gray-brown, but young branches are reddish or dark-brown with a smooth texture.[2][8] Young twigs are covered in fine downy hairs; they become hairless when older.[8]

The buds are egg-shaped and dark red or purple in color; they range in size from 3 to 5 millimeters, but are usually less than 4 mm. The bud scales have very hairy edges. When emerging from the buds, the leaves are convolute, meaning that their edges overlap each other.[2] Leaves can be simple ovals (elliptic), medium or wide in width, somewhat egg-shaped with the wider portion toward their base (ovate), or even with sides that are more parallel to each other instead of curved (oblong) with a narrow pointed end.[8][2] The edges have broadly-angled teeth, but do not have lobes. The top surface of the leaves are glabrescent, almost hairless, while the undersides are densely covered in fine hairs.[2] The leaves are attached alternately by short leaf stems 1-to-3.5 cm ($\frac{1}{2}$-to-$1\frac{1}{2}$ in) long.[7][2]

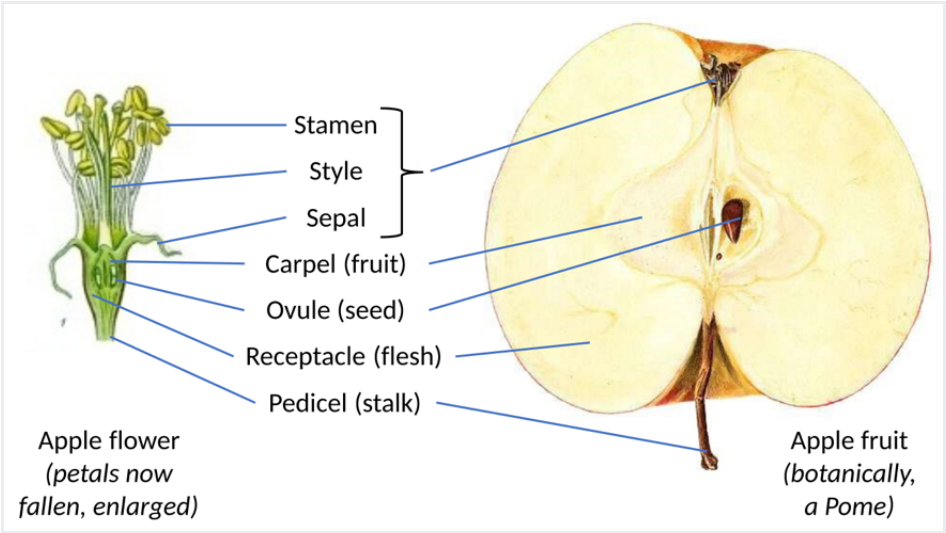
Blossoms are produced in spring simultaneously with the budding of the leaves and are produced on spurs and some long shoots.[6] When the flower buds first begin to open the petals are rose-pink and fade to white or light pink when fully open with each flower 3-to-4-centimeter (1-to-$1\frac{1}{2}$-inch) in diameter.[2] The five-petaled flowers are group in an inflorescence consisting of a cyme with 3–7 flowers.[9] The central flower of the inflorescence is called the "king bloom"; it opens first and can develop a larger fruit.[7] Open apple blossoms are damaged by even brief exposures to temperatures −2 °C (28 °F) or less, although the overwintering wood and buds are hardy down to −40 °C (−40 °F).[9]

Apple blossoms

Botanical illustration

Fruit

The fruit is a pome that matures in late summer or autumn.[2] The true fruits or carpels are the harder interior chambers inside the apple's core. There are usually five carpels inside an apple, but there may be as few as three. Each of the chambers contains one or two seeds.[10] The edible flesh is formed from the receptacle at the base of the flower.[11]



How apple fruit derives from flower structures

The seeds are egg- to pear-shaped and may be colored from light brown or tan to a very dark brown, often with red shades or even purplish-black. They may have a blunt or sharp point.[12] The five sepals remain attached and stand out from the surface of the apple.[2]

The size of the fruit varies widely between cultivars, but generally has a diameter between 2.5 and 12 cm (1 and 5 in).[8] The shape is quite variable and may be nearly round, elongated, conical, or short and wide.[13]

The groundcolor of ripe apples is yellow, green, yellow-green or whitish yellow. The overcolor of ripe apples can be orange-red, pink-red, red, purple-red or brown-red. The overcolor amount can be 0–100%.[14] The skin may be wholly or partly russeted, making it rough and brown. The skin is covered in a protective layer of epicuticular wax.[15] The skin may also be marked with scattered dots.[2] The flesh is generally pale yellowish-white, though it can be pink, yellow or green.[14]

Apples can have any amount of overcolor, a darker tint over a pale groundcolor.

0% overcolor

100% overcolor

Chemistry

Important volatile compounds in apples that contribute to their scent and flavour include acetaldehyde, ethyl acetate, 1-butanal, ethanol, 2-methylbutanal, 3-methylbutanal, ethyl propionate, ethyl 2-methylpropionate, ethyl butyrate, ethyl 2-methyl butyrate, hexanal, 1-butanol, 3-methylbutyl acetate, 2-methylbutyl acetate, 1-propyl butyrate, ethyl pentanoate, amyl acetate, 2-methyl-1-butanol, trans-2-hexenal, ethyl hexanoate, hexanol.[16][17]

Taxonomy

The apple as a species has more than 100 alternative scientific names, or synonyms.[18] In modern times, *Malus pumila* and *Malus domestica* are the two main names in use. *M. pumila* is the older name, but *M. domestica* has become much more commonly used starting in the 21st century, especially in the western world. Two proposals were made to make *M. domestica* a conserved name: the earlier proposal was voted down by the Committee for Vascular Plants of the IAPT in 2014, but in April 2017 the Committee decided, with a narrow majority, that the newly popular name should be conserved.[19] The General Committee of the IAPT decided in June 2017 to approve this change, officially conserving *M. domestica*.[20] Nevertheless, some works published after 2017 still use *M. pumila* as the correct name, under an alternate taxonomy.[3]

When first classified by Linnaeus in 1753, the pears, apples, and quinces were combined into one genus that he named *Pyrus* and he named the apple as *Pyrus malus*. This was widely accepted. However, the botanist Philip Miller published an alternate classification in *The Gardeners Dictionary*, with the apple species separated from *Pyrus*, in 1754. He did not clearly indicate that by *Malus pumila* he meant the domesticated apple; nonetheless, the term was used as such by many botanists. When Moritz Balthasar Borkhausen published his scientific description of the apple in 1803 it may have been a new combination of *P. malus* var. *domestica*, but this was not directly referenced by Borkhausen.[18] The earliest use of var. *domestica* for the apple was by Georg Adolf Suckow in 1786.[3]

Genome

Apples are diploid, with two sets of chromosomes per cell (though triploid cultivars, with three sets, are not uncommon), have 17 chromosomes and an estimated genome size of approximately 650 Mb. Several whole genome sequences have been completed and made available. The first one in 2010 was based on the diploid cultivar 'Golden Delicious'.[21] However, this first whole genome sequence contained several errors,[22] in part owing to the high degree of heterozygosity in diploid apples which, in combination with an ancient genome duplication, complicated the assembly. Recently, double- and trihaploid individuals have been sequenced, yielding whole genome sequences of higher quality.[23][24]

The first whole genome assembly was estimated to contain around 57,000 genes,[21] though the more recent genome sequences support estimates between 42,000 and 44,700 protein-coding genes.[23][24] The availability of whole genome sequences has provided evidence that the wild ancestor of the cultivated apple most likely is *Malus sieversii*. Re-sequencing of multiple accessions has supported this, while also suggesting extensive introgression from *Malus sylvestris* following domestication.[25]

Cultivation

History