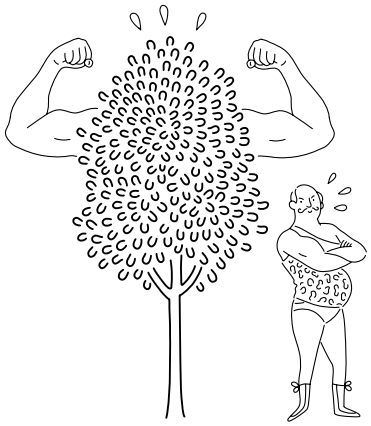
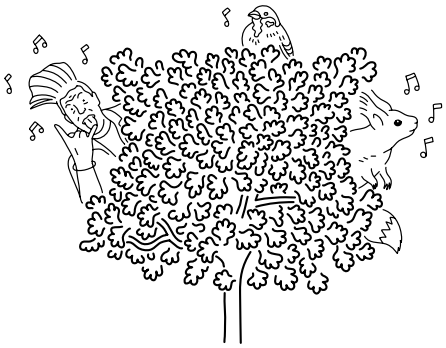

to old branch
THE
from small seed



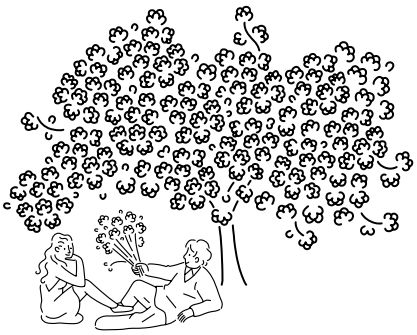
– A tree is the strongest.
– Oh yeah? We'll see about that...!

– A tree is really tall.
– Yeah, so are skyscrapers...
– Me too, one day I'll be really tall!



– A tree is home to all kinds of animals.
– Like a rock festival!

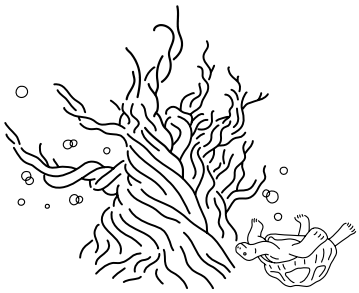
– A tree provides cool shade.
– A parasol too...
– Yeah, but it's always cooler under a tree.



– A tree produces beautiful flowers.
– Just like lovers...

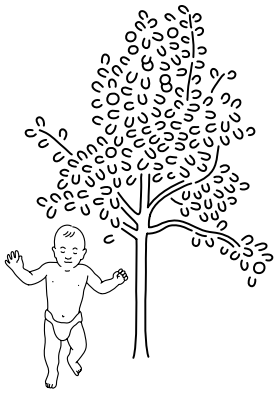
– A tree bears fruit.
– So do mothers - and beautiful too!

– A tree is alive!
– Children too!

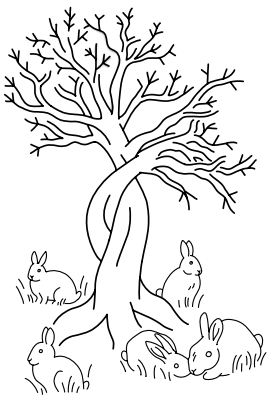


– A tree can live for a long, long time!
– If everything goes well, so can a turtle.
– Yes, but when I say "very long", I mean really long... up to 20,000 years!

– A tree grows almost anywhere.
– Hair too... well, except on Grandpa's head!

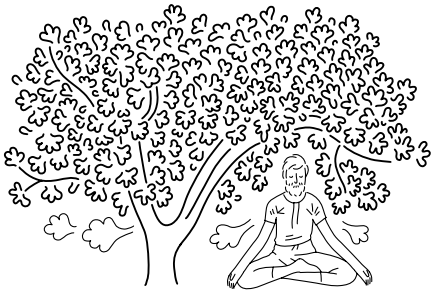


– A tree can stand on its own.
– My little brother too... well, almost!



– A tree... he he ... reproduces!
– A rabbit too, and much faster!

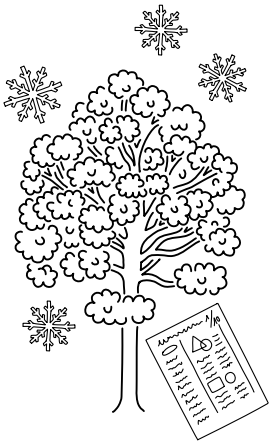
– A tree feeds.
– But not as much as Obelix!



– A tree breathes.
– Like yogis. Inhaaaale, eeexhale.

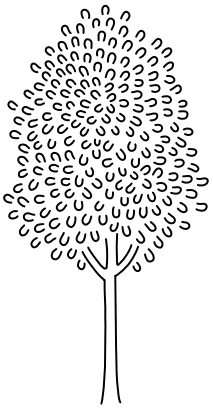
– A tree puts up with urban pollution.
– People too. Well… mostly they contribute to it.

– A tree communicates!
– Yup, just like my big sister… a lot too!



– A tree cools the atmosphere.
– A snap math test too…

– A tree has roots.
– Speaking of roots and maths… er… did you study?



– But only a tree can do all of this at the same time.

Whose seed is it anyway...?

All trees come from seeds. The seed is the embryo that will develop into a new specimen. Most are surrounded by fruit and vary in shape, size and appearance from one species to another.

Try to find out which tree comes from which seed and which fruit. Tap on the name of a tree to uncover its seed and see its silhouette.

Chêne vert → Holm oak
5 to 20 m high

Acorns are dried fruit, just like beechnuts and hazelnuts. Although the holm oak is not native to our region, it can be found in our parks, as it has been introduced here by humans.

When you take the outside stairs to reach the second floor of the exhibition, you will walk underneath a beautiful holm oak.

Érable sycomore → Sycamore maple
35 to 40 m high

The maple seed fruit forms a wing that carries it away on the wind. This type of wing-forming fruit is called a samara or, as in this case, a double samara.

Bouleau verruqueux → Silver birch
15 to 25 m high

The female flower of the birch tree is a small ear called a catkin. It is made of scales that protect the growing seeds. Its fruit is equipped with two small wings, which make sure the seed is carried far away by the wind.

Abricotier → Apricot tree
5 to 6 m high

The apricot seed is a kernel enclosed in a stone protected by fruit. This type of fruit is called a drupe.

Poirier → Pear tree
10 to 20 m high

Pear seeds are the pips we find in the centre of the protective layer of fruit.

Aulne glutineux → Common alder
10 to 20 m high

The very light and very small seeds of the alder are located between the scales of its strobilus, a kind of miniature pine cone.

Châtaignier → Chestnut tree
25 to 35 m high

The chestnut is the edible seed of the chestnut tree, not to be confused with the conker.
It is doubly protected by a shell forming the fruit and by a bur, covered with very sharp spines, which opens at maturity.

Épicéa → Spruce
35 to 60 m high

The seeds of the spruce, like those of other conifers, are protected under the scales of a cone, hence the name conifer.

In French-speaking Switzerland, these cones are referred to as 'pives', and not 'pommes de pine'.

Learn more about: Seeds

The seed is the starting point in the life of a tree. It results from the fertilisation of a male gamete (present in pollen) and a female gamete (ovule).

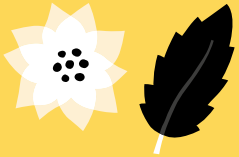
The seed contains both the embryo and the nutrients needed to begin growing. It will germinate when conditions are favourable, that is, when it is sufficiently warm and humid. By germinating, it will give rise to a new specimen, contributing to the survival of its species.

Whilst still in its seed state, the future seedling is protected from external attack by its outer shell, or integument, and sometimes also thanks to a dry or fleshy fruit layer, which helps to protect it or ensure it is dispersed.

Is it budding?

The bud is a small treasure trove containing a thousand promises and keeping its secrets well-guarded.

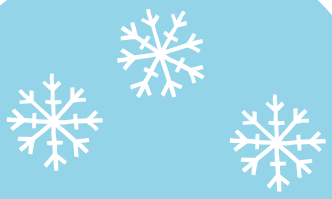
From among the following statements about seeds, can you tell which is true and which is false?



A bud can turn into a leaf or a flower.

Apical buds attract bees.

Tree buds form in summer.



If its buds freeze during winter, a tree dies.

Roots do not form buds.

On the 21st of March, the buds wake up.

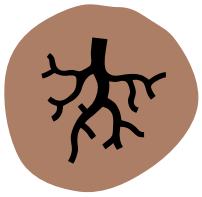
True! Depending on which it will be, we call them either floral or vegetative buds (vegetative buds grow into stems with leaves).

True! Buds form in summer in preparation for the following spring. This formation is called cold hardening. The bud can withstand the cold of winter thanks to its very hard scales and its stuffing of whitish hairs, which insulate the core.

False! The apical buds, also called terminal buds, are located at the tips of the branches. They are what makes branches grow longer. The secondary buds (also called lateral or auxiliary buds) are responsible for branching.

False! Most of the time, a tree prepares emergency replacement buds. After a severe frostbite, these new buds are ready to bloom and allow the tree to continue its growth. However, a tree that has endured such cold conditions will likely produce fewer flowers and grow less that year.

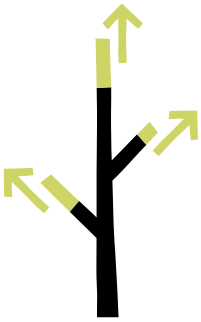
False! In autumn, the fall in temperatures and the lack of sunlight cause the buds to enter dormancy. It is the length and temperature lows of the winter that are the main factors in deciding when spring starts for a tree. In milder winters, for example, buds may wake up later and therefore delay flowering.



True! Roots grow continuously, and the growing area is protected by a small cushion, called a root cap, and not by bud-like scales.

Length and width...

In spring and summer, the tree grows in successive stages both above and below ground...



Primary growth

The tree extends its size by forming new branches and roots.

Secondary growth

The primary growth thickens.

Dormancy

In autumn and winter the tree does not grow, i.e., it is dormant.

Everyone knows that trees grow as they get older. But how do they grow? That's not so simple!

By turning the handle, you can observe how this amazing process unfolds with the changing of the seasons, year after year...

Learn more about: Growth

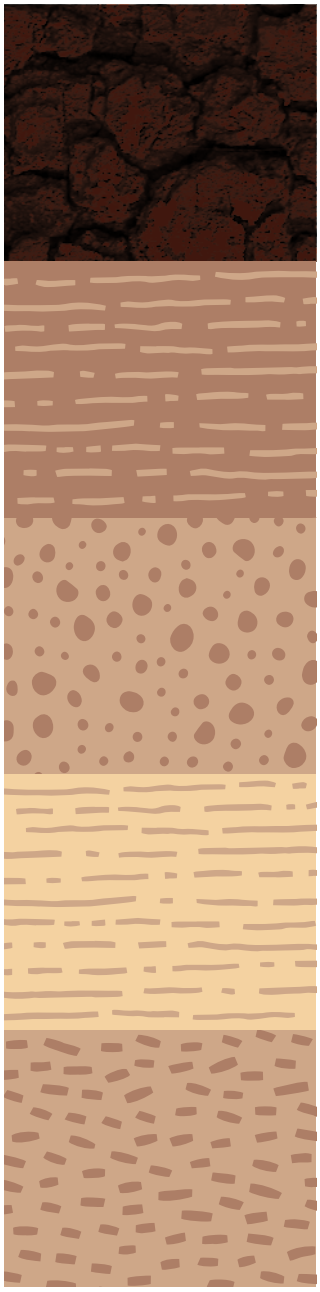
Primary growth: Buds are the actors of primary growth. They ensure new branches grow and leaves develop. This type of growth happens at the tips of the branches (apical buds) and along the stems where they branch out (auxiliary buds). This growth is outward and upward. Primary growth in the roots also results in lengthening but here it is outward and downward.

Secondary growth: this is where new growth becomes woody, resulting in a thickening of the trunk, branches and roots. This expansion mainly occurs in the cambium and leads to the creation of rings, which, as everyone knows, are only visible when a tree is cut down. Secondary growth is more pronounced during the early years of a tree's life; the growth rings at the centre of the trunk are therefore often very wide.

Tree growth takes place in meristematic tissue, a zone where cells divide infinitely. Meristems are found mainly in the buds and cambia.

Strip-trees

Peel away the layers of this trunk to discover what wood it's made from and how the many elements have differing lives and functions.



External bark

The outside of a tree, bark, is also called the rhytidome. It is formed of several waterproof layers of cork and serves to protect the trunk from insect attacks, frost, solar radiation and injuries. Over time, the bark either peels or cracks depending on the species.

Inner bark

This is also known as the phloem. It is a very thin, living layer with vessels that carry some of a tree's sap. Injury to the phloem can sometimes prevent the tree from growing normally.

Cambium

This tiny but very important layer of cells is unique, as it is where wood is 'manufactured'. The new wood formed here grows on the internal and external sides of the phloem. For every new phloem cell, the cambium produces ten wood cells.

Sapwood

Some of a tree's sap rises through the vessels of this living wood.
It's a nutrient-rich zone that serves as the tree's pantry and is readily attacked by fungi and wood-boring insects.

Heartwood

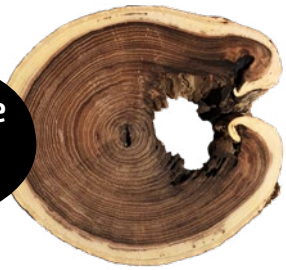
This part is also called the duramen. It is hard and often darker than sapwood, making it possible to distinguish them.
It is no longer alive, but it does help to keep the tree upright.

Identify the problem

Not only do the rings of a tree tell us its age, but also some of its life story.

Before turning these slices over, study them carefully to see what you can deduce...

A hole in the middle of the trunk, what happened?



This alder has lost a branch of significant size. This would have left a big hole, where fungi could have moved in and caused rot. To prevent that from happening, the tree created woody growth around the wound to try and close it. Here we can also see the boundary between the darker heartwood in the centre and the lighter sapwood on the outside.

A paint splash in the middle of the trunk, really?

These funny dark brown spots are caused by one or more fungi that have settled in the trunk of this beech tree. To protect itself, the tree makes watertight walls to prevent the fungus from spreading.

Why is the centre not at the centre?

This Scots pine grew on a slope. To overcome gravity and stay upright, it produced so-called compression wood on its downslope side. This is what offset the centre of the rings.

Why are there two centres?

This section of a silk-tree trunk was cut just below a branch line. It reveals not only the centre of the main trunk but also the centre of the branch leaving the trunk. The growth of the branches follows the same process as that of the trunk.

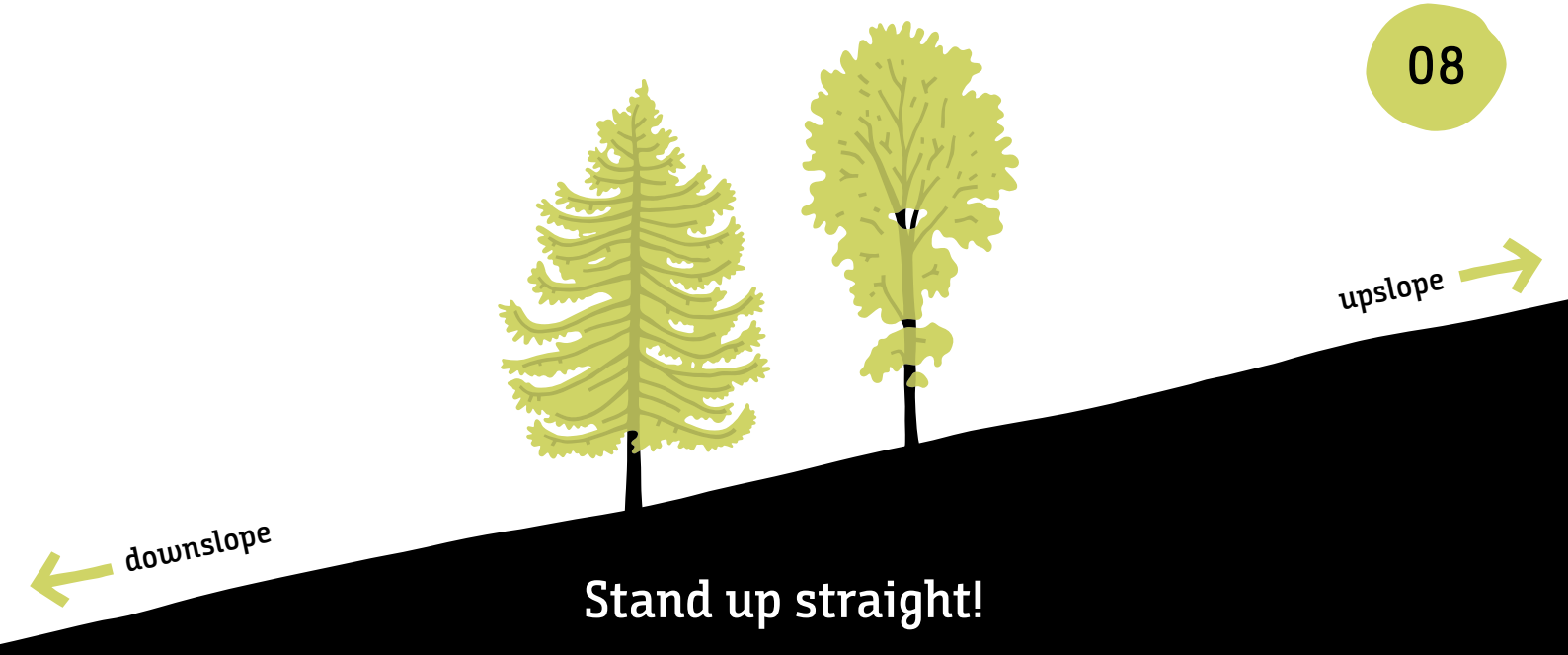
A tree that doesn't have rings, isn't that unusual?

It's a palm tree! For botanists, the palm is not actually a tree but a giant herb. It doesn't have a real trunk rather a large stem that results from the production of new leaf sheaths. As the palm tree has no cambium, its trunk cannot grow in width and therefore has no growth rings.

Learn more about: Growth rings

Growth rings result from the seasonal variations in the activity of the cambium.

To distinguish each ring, we look for differences in the density of the wood produced in each growing season. The visible boundary is found between the summer wood of one year and the spring wood of the following year. Spring wood appears as a fairly wide band of softer, lighter coloured wood and is the result of the rapid growth possible under favourable spring conditions. Summer wood produces a darker and narrower ring as a result of the more difficult climatic conditions (heat and drought) that slow down growth. The width of the rings therefore depends on climatic conditions (sunlight, temperature, rain...).



Stand up straight!

If a tree is to remain stable, it has to grow vertically.

Put this tree back in its vertical position by using the handles.

Pull the handle down

Coniferous trees produce more wood on their downslope side in order to push the tree vertically. The centre of the rings is thereby shifted upslope.

We call this *compression wood*.

Push the handle up

Deciduous trees produce more wood on the upslope side, pulling themselves upright. The centre of their rings is then shifted downslope.

Here we talk about *tension wood.*

Learn more about: Reaction wood

The ability of a tree to push itself in the right direction relative to gravity is called gravitropism. As a tree's stability depends on its verticality, trees have developed cells that work a bit like a spirit level, serving as a reference and making sure they grow straight up.

When a tree trunk goes awry, these cells promote asymmetrical growth within the trunk. The resulting growth is called reaction wood, the fibres of which shrink or stretch, causing the trunk to bend and eventually straighten.

Depending on whether the tree is coniferous or deciduous, it will react differently to this uncomfortable position. A conifer tree will produce compression wood downslope, which forces the trunk vertical by pushing that side upwards. A deciduous tree, on the other hand, will produce tension wood upslope, which will pull that side of the trunk downwards. In both cases, cross-sections of the trunk reveal that the innermost rings are not at the centre of the tree.

Save our saps!

Sap is an essential liquid that circulates in trees.

Work the pump to see how it circulates and which pipes it passes through.

1. External bark / 2. Inner bark / 3. Cambium / 4. Sapwood / 5. Heartwood

Xylem sap

Rising sap is known as *xylem sap.* It is mainly made up of water drawn from the soil by the roots. Its role is to provide water right to the very tips of a tree's branches.

Xylem sap circulates in the vessels of the sapwood. You might be surprised to know that the vessels are actually made of dead cells, whereas the sapwood itself is still alive.

Phloem sap

When the sap returns downward, it is known as *phloem sap.* It has become highly enriched with sugar produced by photosynthesis, and it feeds the parts of the tree where energy is needed for growth and for creating new branches and leaves.

The phloem sap circulates in the tubes of the phloem, which are made up of living cells.

Learn more about: Sap

Phloem sap: This sap is rich in sugars and comes mainly from the leaves, where photosynthesis takes place. It circulates in the phloem, the thin layer of wood just below the bark, from which it takes its name. In summer and autumn, phloem sap is transported from the leaves to the roots and fruits.

Xylem sap: This sap is mainly made up of water and contains mineral salts absorbed from the soil by the root system. It travels up into the sapwood to the leaves where it supplies the nutrients necessary for photosynthesis. In spring, xylem sap transports reserves from storage in a tree's roots to its buds, which need energy for growth.

How does the sap rise?

The very impressive way in which sap rises is the result of three separate processes coming together:

Leaf transpiration: Water evaporates from the surface of leaves through small holes, known as stomata, causing a very strong suction effect that pulls the sap upwards. This is the main force causing sap to rise.

Capillarity: Some liquids rise inside very thin tubes when they have a high surface tension and an affinity with the tube material. This process is also known as capillary action. In trees, these very fine small tube-like vessels are located in the sapwood, in a tissue called the xylem.

Osmosis: When two liquids – separated by a membrane – contain a dissolved element in different concentrations, the concentrations will balance out, provided the membrane is permeable. It is this same phenomenon that allows the water contained in the soil to be captured by the roots, which are more concentrated in mineral salts.

The maximum size of a tree is limited by these three phenomena and by the static stress it bears.

Sap or resin?

Be careful not to confuse sap and resin!

Resin, rubber and latex are substances produced by injured trees. They have a very different chemical composition from sap. They are actually antiseptic liquids that dry to form a physical barrier against insects and fungi. Moreover, they do not circulate around the tree: they remain in pockets which burst on impact or secrete them when necessary.

Resin is more common in conifers (fir, spruce, pine...) hence the French word for this type of tree résineux (lit. 'resinous'). But there are also some deciduous trees that produce resin. Fruit trees produce gum, and other trees, such as rubber trees, secrete latex.

The three substances are used in a variety of applications: paints, lacquers, varnishes, rubber, stabilisers, preservatives, incense, etc.

Maple syrup and birch water are made from xylem sap.

Tree or not?

In addition to wood, trees provide many varied products, some are foodstuffs, others not...

Among the products in this grocery shop, guess which ones come from trees.

Check your answers by scanning their barcodes.

Français	English
Acide citrique	**Citric acid,** or E330, is found in large quantities in lemons, the fruit of the lemon tree. However, for reasons relating to yield, it is produced industrially using mould and sweetcorn...
Alcool de damassine	**Damassine alcohol:** This typically Swiss alcohol is produced in the canton of Jura from small plums known as damson plums.
Ananas	**Pineapple:** This is the fruit of a herbaceous plant that grows in tropical countries. The flowers that produce pineapples after fertilisation are grouped at the end of a stem at the plant's centre.
Anis étoilé	**Star anise:** This spice with an aniseed taste is the fruit of a tree, the Chinese star anise. It is also sometimes called badian. The Chinese call it 'eight horns' because of its eight-pointed star shape.
Avocats	**The avocado** is the fruit of the avocado tree, which is widely cultivated in South America. It is used a lot for making guacamole.
Balayette	Like this **brush,** some plastic objects are made in such a way that they look like they are made of wood. For example, there are many plastic floor coverings made to look like parquet floors.
Bonbons aux bourgeons de sapin	**Fir bud sweets:** These sweets contain mainly sugar but their characteristic taste comes from the extracts of fir buds.
Cacahuètes	**Peanuts** are the seeds of the groundnut, a plant of the legume family (the same family as beans or peas). The groundnut has the particularity of burying its seeds.
Cacao	**Cocoa** comes from the crushing of cocoa beans, the seeds of the cocoa tree. These seeds grow directly on the trunk of the tree.
Café	**Coffee:** The fruit of the coffee tree is harvested and roasted to make coffee beans. On coffee plantations, trees are pruned not to exceed two to three metres in height.
Cannelle	**Cinnamon:** This delicious spice comes from the bark of the cinnamon tree. The bark is scraped off and then rolled up as it dries, forming cinnamon sticks.
Câpres	The **caper** is a species of shrub found in the Mediterranean region. Capers are the flower buds of this plant.
Clou de girofle	**Cloves** are the floral buds of the clove tree, which comes from Indonesia. In addition to being used in cooking, cloves are also prized for their antiseptic and anaesthetic properties.

Confiture d'abricots	**Apricot jam:** This delicious fleshy fruit comes from a tree grown widely in Valais: the apricot tree.
Confiture de coings	**Quince jam:** Quinces are the fruit of a small tree called the quince tree. Quinces are very hard and cannot be eaten raw.
Confiture de framboises	**Raspberry jam:** The raspberry is a fruit from a small shrub.
Confiture de sureau	**Elderberry jam:** The elder is sometimes considered as a tree and sometimes as a shrub. This jam is made with the almost black fruits of the elderberry. You can also make elderberry jelly and syrup from its flowers.
Cornichons	**Gherkins:** This is the fruit of a herbaceous plant. The edible varieties of gherkin were selected from cucumbers. The cucumber and the gherkin belong to the same species.
Dessous de plat en liège	**Cork table mat:** Cork oak is a species of oak that produces a very thick bark, which we know as cork. It's light and thermal and is used extensively for stopping wine bottles but also for table settings such as this one.
Ficelle en lin	**Linen yarn:** This yarn is made from a plant called flax. It is not a tree but a herbaceous plant whose fibres were used as long ago as by the Ancient Egyptians to make fabrics and ropes.
Gants de ménage	**Household gloves:** Latex is soft and strong. That's what makes it ideal for making household gloves, although some are made of a mixture of natural and synthetic latex. Latex is secreted by the rubber tree, a species native to South America.
Gel de douche	**Shower gel:** Personal hygiene products are sometimes made with natural products, but very few come from trees. Here cedar and fig extracts have been used to add aromas to this shower gel.
Gousse de vanille	**Vanilla pods:** Vanilla is not a tree but a kind of orchid-liana, whose fruits - vanilla pods - are harvested and dried.
Graisse de coco	**Coconut fat** comes from coconuts, the fruit of the coconut tree. The coconut tree is a species of palm and therefore not really a tree, botanically speaking. It does not produce any wood.
Huile d'olive	**Olive oil** is produced by pressing olives, the fruit of the olive tree. This tree thrives in the Mediterranean climate, lives very long and often has convoluted shapes.
Kiwis	**Kiwi fruit:** This hairy fruit grows on lianas. Although lianas produce wood, botanically speaking, they are not trees. They also need support to grow. Kiwis originate from China but are also grown in Switzerland.
Livre	**Book:** Cardboard and paper objects, such as this book, are mainly made of cellulose, a component of wood. Paper and cardboard can be recycled.
Lolettes	Most **dummies** and bottle teats are made of silicone, but there are still some made of natural latex, the one you just scanned for example. Latex is secreted by the rubber tree, a species native to South America.
Miel de forêt, de sapin	**Forest honey/fir honey:** The flowers of conifers do not produce nectar themselves, but the aphids that suck out the elaborate sap do secrete honeydew. This honeydew is used by the bee produce its honey.
Moutarde	**Mustard** seeds come from a plant of the Brassicaceae family, which also includes rapeseed and cabbage.
Noix	The **walnut** is the fruit of the common walnut tree, which is very common in the countryside of the Swiss plateau. The flesh that surrounds the nuts stains the fingers of anyone harvesting them. It is called walnut stain and can be used to darken wood.
Noix de cajou	**Cashew nuts** are the fruit of the cashew tree, which is native to Brazil. Cashew nuts are consumed cooked, as they are toxic when raw. The fruit develops at the end of a juicy edible false fruit called the cashew apple.

Noix de muscade	**Nutmeg** can be grated to obtain a powder with a very strong taste. It is the seed of the nutmeg tree. The nutmeg is enclosed in a shell, which is itself surrounded by a bright red membrane. The whole thing is then hidden in a fleshy envelope similar to that of the almond tree.
Pignons de pin	**Pine nuts** are seeds that hide in between the scales of pine cones. Only some conifers produce seeds large enough to be eaten by humans, such as the stone pine.
Planchette à découper en bambou	**Bamboo chopping board:** This chopping board is made of bamboo. Bamboo is not a tree but a giant grass. As the long stems are very strong, they are used not only make objects such as this board, but in Asia even construction scaffolding.
Planchette à découper en bois	**Wooden cutting board:** As we all know, wood is produced by trees. When buying wooden objects, it is best to opt for those made from locally sourced species. This board is made of beech, a common tree in our forests.
Poires	The **pear** comes from the pear tree, of which there are more than two thousand different varieties. Besides Williams and Conference pears, do you know any others?
Poivre	The **pepper** plant is not a tree but a liana. Pepper is often grown on tea and coffee plantations, where it climbs the plants.
Schweppes Tonic	**Schweppes tonic** contains a small amount of quinine, which gives the drink its bitter taste. Quinine comes from the bark of cinchona, a small tree native to the Equator. Quinine was originally used against malaria. In modern antimalarial drugs, this molecule has been replaced by synthetic derivatives.
Sève de bouleau	**Birch sap** is harvested in the spring just before the buds burst open. At this time, the sap is rising from the roots to nourish the tree. It is a slightly sweet drink.
Sirop d'érable	**Maple syrup:** This product is made in spring from the sap of the maple tree's very sugary xylem. At this time of the year, the sap is rising from the roots, as the tree needs energy to open its buds.
Sirop de fleurs de sureau	**Elderberry flower syrup:** The elder is sometimes considered as a tree and sometimes as a shrub. Its white and very fragrant flowers are harvested to make this syrup.
Sucre de canne	**Sugar cane** is not a tree but a large grass. In Switzerland, sugar is produced from sugar beet, which is not a tree either!
Tagliatelles aux châtaignes	**Tagliatelle with chestnuts:** This dish is made with wheat semolina and chestnut flour. The sweet chestnut comes from the chestnut tree, not to be confused with the horse chestnut tree, whose fruits (conkers) are toxic!
Tee-shirt	**T-shirt:** Cotton is used to make clothing, like this t-shirt. It comes from a plant, the cotton plant, which is not a tree.
Thé	**Tea** is obtained by infusing the dried leaves of a tree known as the tea plant. The different flavours of tea result not only from the different varieties of this tree but also from the different processes of harvesting, drying, fermentation, etc.
Tisane de tilleul	**Lime blossom tea:** The flowers of the lime tree are very fragrant due to the nectar they produce to attract pollinating insects. Lime blossom tea is prepared by infusing the flowers in hot water.
Tisane de verveine	**Verbena tea:** Verbena is an aromatic plant native to South America. Verbena tea is prepared by infusing the fragrant verbena leaves in hot water.
Volants de badminton	The base of a **shuttlecock** is made of cork, a natural material made of the bark of cork oak. Cork is light and thermal and is used extensively to seal wine bottles.
Wunder Baum Arbre magique	**Wunder-Baum Little Trees:** It is not the smell of this air-freshener that comes from trees but the material. The product is made of cardboard, which is produced with cellulose, which in turn is made of wood. Although the fragrance may be reminiscent of the forest, it is completely artificial.

Dr. Arbre & Mr. Tree - Anaëlle Clot

The tree is the king of forests, and there's nothing inconvenient about them growing there. But what about growing elsewhere?

Grab a lamp, enter the gallery and illuminate Anaëlle Clot's drawings...

The blue light will reveal the advantages trees bring to an environment. The red light will show why trees may be less welcome...

left-hand side wall

Aaaaaachoo!

The pollen from birch, hazel and ash trees is dispersed by the wind. It causes allergic reactions in about 20% of the Swiss population. In some cases, an allergy may be very debilitating.

Yummy, yummy!

The pollen containing the male seed of a tree's flower is an essential part of its reproduction. And it's because of the pollen that fruit forms. Where would we be without apples, apricots, plums and even hazelnuts?

Swarming and moaning!

Not all of a tree's occupants are necessarily kind and caring. Wood borers like to feed on wood, meaning trees can be damaged, and structures and furniture weakened.

Swarming and chirping!

A single tree is a haven for life, providing food and shelter to hundreds of different species, from the smallest to the largest. Having trees in the city therefore promotes urban biodiversity.

central wall

Watch your footing!

Roots thread themselves every which way in search of water. When trapped in compacted soil, they can even lift paving stones and split tarmac as they grow.

Taking root

By absorbing large quantities of water, roots reduce the risk of floods. They also help to retain the soil on slopes and along waterways.

Autumn leaves...

In autumn, falling leaves clog drains and sewers. They can leave footpaths slippery when it rains and make streets look dirty and neglected...

Useful leaves

A tree's leaves provide shade and freshness in summer, and they also purify the air by partially eliminating certain pollutants. They capture carbon dioxide and emit oxygen, aiding photosynthesis. When leaves fall to the ground, they decompose and enrich the soil.

right-hand side wall

Old stump!

A dead tree in the city or next to a road poses a danger to passers-by whilst it's still standing and therefore needs careful monitoring. And for the obsessively neat and tidy, a dead tree is also a bit of an eyesore...

Dead tree, really?

Dead trees play host to a multitude of creatures. If we systematically fell aging trees, woodpeckers and stag beetles (which you can see as part of this exhibition) may disappear.

Crash!

Roadside trees reduce visibility, increasing the risk of accidents. And if you leave the road in a vehicle, it will be much worse if you hit a tree.

Landmarks

Trees planted by the roadside are useful landmarks for drivers, helping them perceive direction, turning points, and speed. They can also form natural barriers separating different road users: pedestrians, cyclists and drivers.

Tree Advisor

Do trees grow everywhere? Not quite! If these green giants are to grow, certain conditions must be met.

By playing with the three different categories, you can discover in more detail the ideal conditions and optimal geographical areas for trees.

Latitude

The temperature of a region is influenced by its latitude. In polar regions, it is too cold for trees to grow.

Whereas close to the Equator, the climate is mild year-round, favouring the growth of many trees.

Altitude

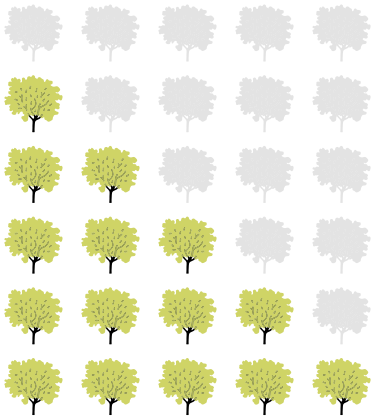
Above a certain altitude, it becomes too cold for trees and they stop growing. The altitude of this boundary varies among regions.

In Switzerland, it's between 2,000 and 2,700 m, whereas it can be as low as 300 m in northern Russia and above 4,000 m in the Himalayas.

Precipitation

Like all living things, trees need water. In desert regions with little rainfall (i.e., 0 to 50 cm/yr), there are no trees at all.

In tropical forests, however, where water is abundant (200 to 400 cm/yr), trees reign supreme.



= No trees at all

= Very few trees

= Some trees

= Trees in average number

= Many trees

= Lush vegetation

Learn more about: For trees to grow...

...the climate must offer mild temperatures for a sufficiently long period of time. If the growing season is too short or too cold, trees will lack the energy needed to develop their trunks. It's because of this need for adequate temperatures for a relatively long period of time that trees don't grow in areas close to the Poles, such as the tundra of Greenland.

...there must be enough water. In very dry areas, such as deserts, there are no trees at all. Some hot and relatively dry areas will nurture a few isolated trees. This is the case of the African savannah or the Australian bush. Climates that are very cold in winter and then hot and dry in summer will not feature any trees at all. An example of this is the Mongolian steppe.

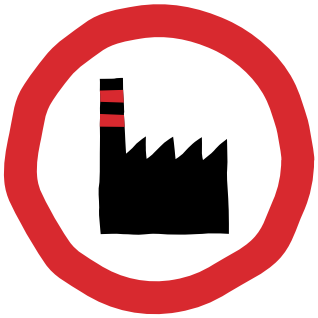
In summary, when temperatures are mild and water sufficiently abundant, trees can populate an area and forests will be established. This is what happened with our forests (temperate forests), the taiga (boreal forest) and tropical forests.

With global warming, trees will start to grow at increasingly high altitudes and also increasingly closer to the Poles.

The dead tree

Knowing that some trees live for thousands of years, would you say they are immortal? Whatever your opinion, it's inescapable that certain events will weaken or injure a tree to the point of death.

Who are the enemies of trees and how do they contribute to their demise? Discover more by opening the doors of this... wooden coffin.



Human footprint

Today's industrialised era is causing major environmental upheavals on a global scale. The warming of the climate is likely to cause the death of every tree unable to adapt to the new conditions. For example, the beech is expected to disappear from the Swiss plateau within a few decades. In addition to climate change, human activity is also polluting the air and soil. Some trees die due to the impact of this pollution on the environment.

Parasitic fungi

While some fungi may be beneficial to a tree, others are parasitic and make trees sick to the point that, in certain cases, they may die. Some of the more well-known fungi include chestnut blight, sycamore lace bug and Dutch elm disease. Each has its own particular mode of attack: blight, for example, attacks the trunk and leads to the formation of large swellings. These mushrooms (below) grow on birch trees. The small cap on the trunk is only the visible part of the fungus. Inside the trunk, the other part is hidden from sight, grows by feeding on the wood and causes the tree to rot.

Does cutting down a tree kill it?

Does a tree die once it is cut down? Not necessarily! There are several mechanisms that will allow it to start afresh. The roots are still very much alive and will continue to supply the tree stump with water. New branches can sprout directly from the stump. In some cases, the roots of a tree will grow a sucker, a whole new tree that appears from the ground a few metres away. Does anyone else cut down trees or is it just humans? Well, beavers are quite heavy handed when it comes to eating wood and building dams!

Insects

The tree is a habitat for insects at all its levels. Others just pass through, and better yet, take pollen with them on their way. Then there are the insects that are harmful to trees and that eventually kill it. The European spruce bark beetle lays its eggs under the bark of the spruce tree. Once a tree becomes fully infested, the tunnels created by larvae and young beetles cut off the movement of sap, which eventually kills the tree, especially if it is already sick.

Natural hazards

Trees are subject to a variety of natural hazards. They can be injured or even uprooted by storms, rockslides, avalanches and floods. They can be struck by lightning or burned by fire. They can also suffer during droughts. A tree does not always necessarily die during a dry spell, but it will undergo stress and become weakened, making it more likely to be attacked by insects, fungi or other pests.

Immortality?

Some trees are millennia old. There are several mechanisms that explain this longevity:

- Each year, a new youth is given to the tree through its new buds.
- 80,000 years old? Some trees, such as poplars, can grow shoots that form colonies of hundreds of individual trees, all connected by their roots and all derived from a single seed.
- Trees have developed tricks at the cellular level to ward off the effects of aging. Some of their cells divide very slowly, reducing the accumulation of age-related mutations. Animal cells, on the other hand, divide quickly, increasing the number of mutations.

The most beautiful trees in Lausanne

Trees are elegant and visually appealing, not to mention cool and shady. In short, they provide us with opportunities to be happy. They are also a real tourist attraction and one which is close to home.

Allow yourself to be guided by the photographer Marino Trotta and discover some of the most beautiful trees in Lausanne: some of which you may – or may not – already know!

Translation french → english

cèdre à encens	→ incense cedar
cèdre bleu	→ blue cedar
cèdre de l'Atlas	→ Atlas cedar
cèdre du Liban	→ cedar of Lebanon
charme commun	→ common hornbeam
chêne pédonculé	→ common oak
chêne vert	→ holm oak
ginkgo	→ ginkgo
hêtre pleureur	→ weeping beech
if	→ yew
marronnier	→ chestnut
mûrier blanc	→ white mulberry
noyer noir	→ black walnut
pin noir	→ European black pine
platane	→ plane tree
séquoia	→ redwood
sapin de Vancouver	→ grand fir
saule pleureur	→ weeping willow
tilleul à grandes feuilles	→ large-leaved lime
tulipier	→ tulip tree

Beautiful wood

Just like we choose wood for our parquet floors according to its colour and grain, Bastien Chevalier chooses wood for his marquetry...

Can you guess which types of wood were used in this piece of marquetry?

1 Maple

Maple wood is very light, sometimes almost white.

2 Oak

The yellow-brown veins are clearly visible in oak.

3 Walnut

Walnut is dark and very strong. It has long been used in furniture.

4 Burr walnut

The so-called burr walnut (also known as walnut burl) is defined by the presence of knots in the wood. This particular kind of growth is due to an injury, insect or parasite.

The wood from which heroes are born

Trees yield an extraordinary raw material that humankind has been using for millennia in a very wide range of uses: wood!

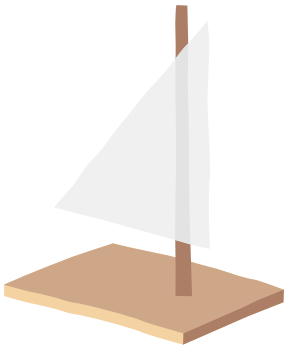
In reality, there's more than just one wood: not all wood species have the same characteristics and therefore aren't used for the same purposes. In addition to appearance and colour, there are many other properties that characterise a species...

In this carpentry shop, find out which wood is the heaviest, the most elastic and the most musical.

Heavier than it looks!

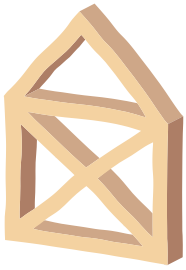
Not all woods have the same density. Some are known for their lightness while others are so heavy that they sink... Can you find out which species they are?

Weigh these wooden cubes to find out which species they come from...



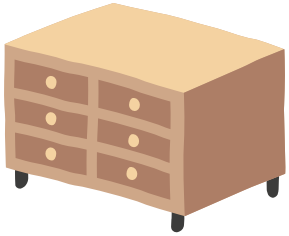
106 grams = Balsa

This tree comes from the equatorial regions of South America. It produces an incredibly light wood that is perfect for model aircraft. Its name comes from Spanish and means 'raft', although it was actually Amazonian natives that used its trunks to make rafts.



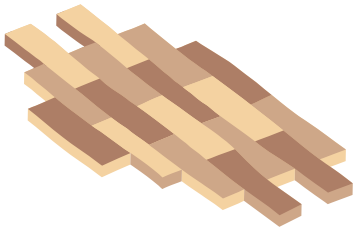
488 grams = Fir

Fir wood is used in carpentry and joinery. It is a light wood, relatively soft and good value for money.



785 grams = Oak

Oak produces hardwood that is resistant to insects and fungi. It is a very popular wood in carpentry and parquet flooring. It is also used to make barrels for wine, hence the terms 'aged in oak barrels' and 'oak-barrel aged'.



1,109 grams = Ipe

This tree is pronounced, and sometimes also written as, 'epay'. It comes from the tropical regions of the Americas and is an extremely dense wood that will sink in water. It is prized for its stability and durability, for example in open-air decking.

Up and away!

Each tree's wood has different elastic properties.

Place the figurine on the different diving boards and, one by one, observe how high you can make it jump.

The higher the figurine jumps, the more energy was stored in the stretched diving board, and then transferred to the figurine.

Wood used from left to right: Linden / Beech / Cherry / Fir

Musical wood

Thanks to wood's resonant qualities,
it is widely used for musical instruments.
But do all woods sound the same?

To find out, it's up to you: rank the samples in order of pitch, from the lowest to the highest and then check your rating with the baton.

Wood used:

Chêne	→ Oak
Épicéa	→ Spruce
Hêtre	→ Beech
Mélèze	→ Larch
Noyer	→ Walnut
Sapin	→ Fir
Tilleul	→ Linden

Learn more about: Resonance

Lute-making is the art of shaping wood into musical instruments. Choosing the right wood is a serious matter, as there are very special conditions for wood to be considered resonant.

In addition to the choice of species (not all are suitable), altitude is a factor and should ideally be between 1,000 and 1,500 metres asl. The tree's life also plays a major role. Ideally it will have grown slowly and steadily, leaving consistent rings. The part of the wood that is to be used must also be free of knots. Finally, it needs to be cut down at the right time of the year. In French-speaking Switzerland, such exceptional wood can be found in some forests in Vallée de Joux, Pays-d'en-Haut and Brévine.

Spruce is widely used to make guitars, violins and pianos. For oboes and clarinets, it is often ebony that is used. Other species such as mahogany, poplar or willow are used to make the smaller components of instruments.

Taxi!

Trees are unable to move and have developed several techniques for spreading their seeds. In some cases, animals transport a tree's seeds without even knowing it. This is known as *zoochory.*

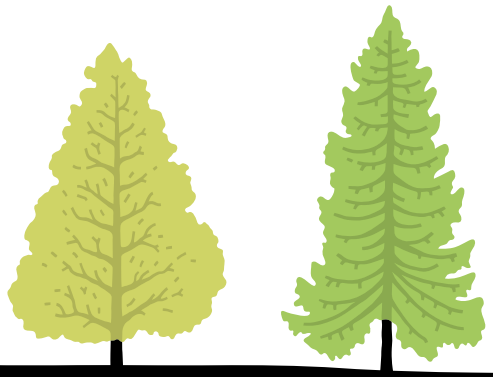
The weasel, for example, clearly loves the cherries that fall to the ground in the spring and fills its belly with them. The cherry stones then turn up in the weasel's droppings. Wild boars and jays have a somewhat more palatable approach and disperse acorns without eating them.

Learn more about: Seed dispersal - *Zoochory*

When seeds are transported away from the mother tree by animals, we talk of zoochory. Some seeds cling to the fur of animals or the feathers of birds, only to fall back off some way away. They can also be eaten. And that's why we have fleshy fruit!

Fruit is brightly coloured and sweet tasting, so animals can't get enough of it. The pulp is digested whereas the seed, protected in its shell, cannot be. It is therefore rejected during defecation. On the tree, the seed remains protected whilst it matures, inside fruit that remains an unnoticeable (green) colour throughout its development. When the seed is ready, the fruit turns a bright colour and emits an appetising smell to attract ravenous animals.

Humans can also encourage the spread of seeds: apple cores thrown into the wild, spreading chestnuts, cherry stones spat out at picnics...



Strange roots...

All trees have roots. And just as there is a great variety in the general appearance of trees, the architecture of their roots also varies among species and according to the soil in which they grow.

With a little imagination and assuming that the soil is ideal for their growth, can you tell apart the roots of the spruce and the alder? Do they look like a comb, a whip or a brush? Open the doors with the right keys. Be careful, there's an intruder!

Translation: *Aulne* → Alder / *Épicéa* → Spruce

Brush-shaped roots

The roots of the alder form a dense network of oblique roots that grow out from a primary vertical taproot. Horizontal roots are few in number and short in length. This allows the tree to grow in a waterlogged environment.

Even though the plane tree's root architecture is different, it has powerful roots. It is planted in cities and along rivers to retain the soil.

Comb-shaped roots

The roots of the spruce first form a horizontal network on the soil's surface (primary roots). Vertical taproots grow from these at the centre. The spruce's roots are generally shallow, making it vulnerable to storms and avalanches.

Although the white fir is also coniferous, it develops more primary roots and much deeper secondary taproots.

Learn more about: Roots

Roots are very important. They ensure the tree remains anchored in the ground and provide it with water and minerals. They also serve as a place to store reserves.

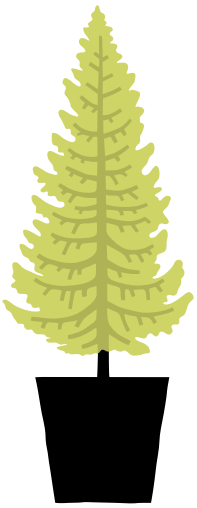
It's not just the species of tree that defines the root architecture but also the age of the specimen and the type of soil. Roots can be creepers or sinkers. Young trees begin by making a central taproot that later branches out. Over the years, primary horizontal creepers and vertical sinkers form. In adulthood, roots rarely go beyond 1.50 m deep and generally remain in the first 60 cm.

The fine roots (with a diameter of less than 1 mm) that explore the soil in search of water represent only 5% of the total root mass but 90% of the total root length! These small roots are called rootlets, are renewed every year, and play host to mycorrhizal fungi.

Facing the elements

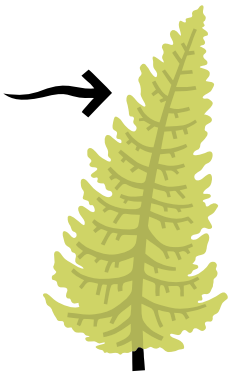
The majority of trees are not lucky enough to grow in ideal soil under perfect conditions. So, how do they overcome physical obstacles and withstand difficult climate conditions?

Imagine what the roots of these three trees look like and then uproot them to find out.



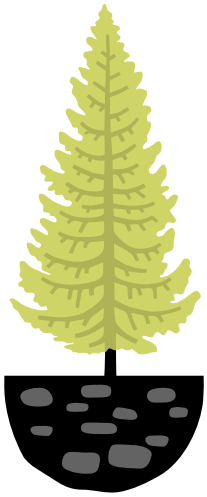
Pushed into a pot

As roots are constantly seeking water, in pot plants they will eventually take over the entire pot, even taking on its shape. And if there is a hole in the pot with water underneath it, they will also grow out through the hole.



Pushed into the wind

Standing up to the wind requires trees to build stronger downwind roots. These thick roots will act like a crutch.



Pushed into stony soil

If they are to go deeper, roots must sometimes deal with obstacles, either by bypassing them, e.g., working their way between the stones, or by pushing them to one side. The latter is what happens in the city when roots lift paving slabs.

Exchanges

As we all know, trees have neither eyes nor ears, but they do interact with their environment and other living beings.

Choose an organism from among the selection and guess how it might interact with the tree.

To find out the answer, slide your chosen organism into the slot!

Bees – Reward: Pollen grains are the male seed of trees. Their sole purpose is to fertilise the female part of a flower and ensure a seed is formed. But even when the pollen is ready, it still has to be able to move! Many trees recruit insects as matchmakers. They draw them in with an enticing smell and with nectar, a sweet substance produced only for this purpose. It's a win-win situation!

Kudus – Early warning system... When Kudus first graze the foliage of an acacia tree, the tree produces tannins, which make its leaves taste astringent. The kudus are then less likely to eat them and will move on to the next tree. But the first acacia tree to be attacked also released volatile ethylene, which warns its neighbours of what has just happened. This causes the surrounding acacias to produce tannins to avoid being eaten too.

Mycorrhizae – Swaps: The mycelia of some fungi delicately surround the roots of the tree. These are known as mycorrhizae. Having coated the root, the fungus turns to the soil and skilfully extracts nutrients and mineral salts. It passes them on to the tree, which needs them to exist. In return, the tree provides the fungus with sugar, which it has made through photosynthesis. As the fungus lacks chlorophyll, it is unable to produce its own organic matter. For every metre of root, there is about one kilometre of mycorrhizal filaments! Such 'win-win' collaborations are called symbiosis.

Rootworm larvae: Psst! When trees are attacked by herbivorous insects, they produce repellent substances that deter their assailants. They may also emit other substances, some of which attract predatory insects that feed on the herbivorous insect that first attacked the tree.

Caring people – Free hugs: There are no rules about hugging trees or talking to them. However, there is also no evidence to suggest that it will have any influence on them. But, of course, we can't rule out that it will make you feel better...

Learn more about: *Allelopathy*

Just as is the case with animals, plants both compete and cooperate with each other. For a long time, research in this area has focused on agricultural crops and only recently on trees.

A tree produces many chemical compounds, some of which are unnecessary for its own metabolism. They are called secondary metabolites. We now know these substances are involved in interactions with other animal or plant species. For example, they produce pleasant smells in flowers, contributing to pollination by attracting insects. They can also give an unpleasant taste to leaves, deterring anyone or anything from eating them or allowing the tree to defend itself against attacks from microorganisms.

The term used to describe interaction among species is 'allelopathy'.

Under the microscope

Adjust the microscope as necessary, study the different samples and enter the world of the very small.

Objects under the microscope:

1 Larch (cross section): The difference between the wood formed in spring (light) and in summer (dark) can be very clearly seen in the larch.

2 Oak (cross section): See what makes up a ring. Large vessels are formed in the spring and smaller ones in the summer.

3 Palm tree (cross section): As the palm is not really a tree, it has no growth rings. Note the many fibres that store and circulate sap.

4 Birch fruits: The birch seed is found in a fruit. It has tiny wings, meaning it can float on the wind.

5 Bostrichidae: These small beetles feed on wood. The larvae dig tunnels under the bark.

6 Longicorn: Longhorn beetles are insects that live around dead wood, upon which their larvae develop and feed.

7 Elm pollen: The flat, disc-like pollen grain of the elm has between four and six small holes on its side. These are the pores that allow fertilisation to take place.

8 White fir pollen: The Mickey-Mouse shaped pollen grains of the fir tree fill their sacs with air to move in the wind and find a female flower.

9 Maple leaf with galls: Observe the dozens of small galls formed by a mite on a field maple leaf.

10 Male willow flower: Around one hundred small flowers, each with two stamens, make up the male catkins of the willow tree.

11 Female willow flower: No petals and only pistils can be seen on this grouping of a hundred small flowers that makes up the female catkins of the willow.