Sonja Kuster 12/11/2023

Woody plant physiology
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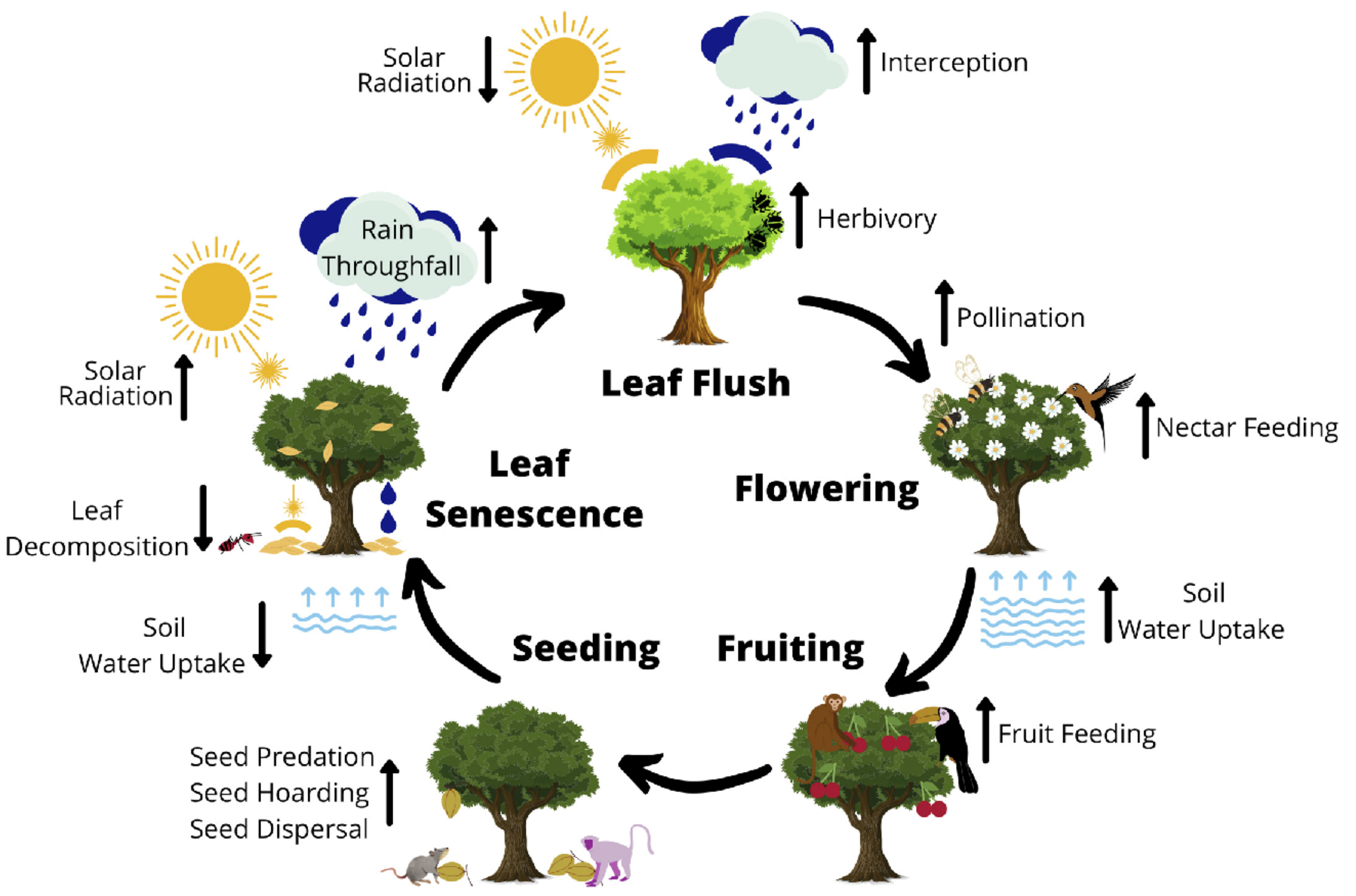
UNIT GUIDE 2023-24

LO 4 Understand principles applied to the growth of woody plants

4.1. Explain the two critical periods in the phenological cycle when the tree is vulnerable to attack

The life cycles of plants are divided into different stages of development (germination, bud bloom, flowering, etc.) – called phenological stages.



Ecosystem processes and conditions that drive phenological events.

The main stages of the cycle are:

1. Onset of growth

Bud burst and first leaves develop, usually in Spring

2. Formation of new leaves or needles

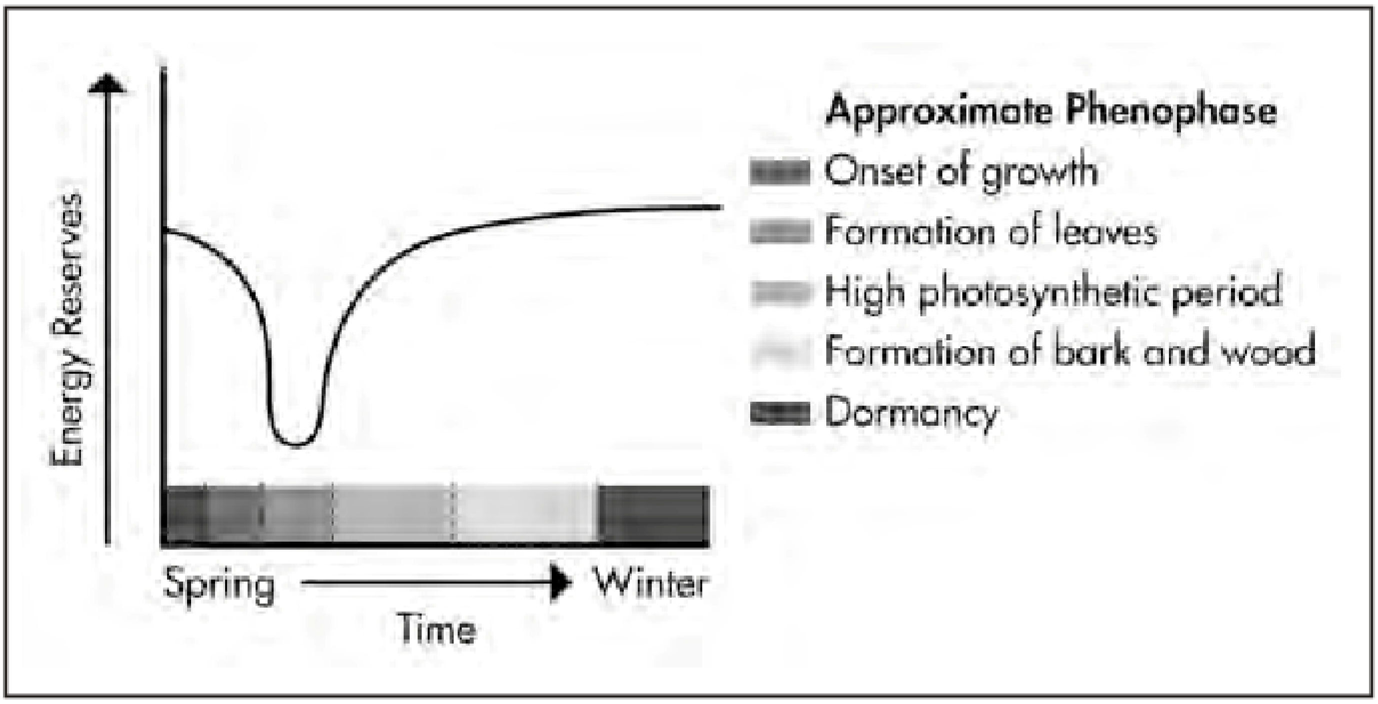
The tree is covered in leaves during Spring

3. Formation of wood or inner bark

The tree puts on secondary growth (increased girth) and new branches during the summer

4. Storage of energy Sugars from photosynthesis are stored and the carbohydrates and nutrients in the leaves are transported into the branches, usually in the autumn, and the leaves dropped (abscission)

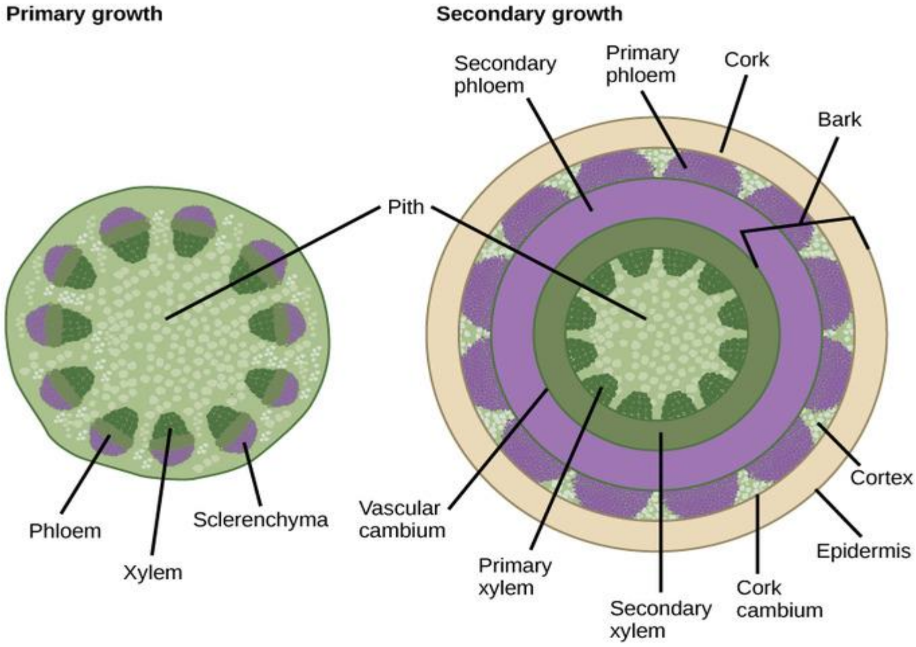
5. Dormancy The tree has reduced photosynthetic capability and reduced transpiration.



The model suggests that potential energy rapidly declines during leaf formation and before a period of high photosynthetic activity rapidly restores the potential energy to levels present in dormancy. A much more gradual increase in potential energy continues through summer into autumn, leaving energy levels high at dormancy.
Energy is used by trees to power many physiological functions, some of which require more energy than others. Reproduction, abscission, and bud burst consume the most energy.
Tree work should ideally be avoided in the spring, when the sap is rising to allow the leaves to flush (come out) for photosynthesis to begin, and in the autumn, when the tree is sucking nutrients back into itself as the leaves turn brown. If the operation is done in the spring, the tree may be more susceptible to pest and disease assault. If work is done in the autumn, the tree may not be able to acquire all the nutrients it requires for the following spring, and the tree may be subjected to additional stress, increasing the possibility of disease.
Despite their defences, trees are vulnerable to attack from a range of sources, including humans, herbivores, insects, fungi, bacteria, and viruses. When a tree is pruned or loses limbs due to heavy winds, wound wood develops to cover the exposed cambium. An herbivore nibbling on a tree may induce it to produce more prickled leaves, such as holly, or more new leaves on those branches. Organisms may emit volatile organic compounds (VOCs) or convey them to insect predators in reaction to insects and bacteria.
A tree can only have so much energy available to it at any given time, which is needed for these defences. This implies that an attack on a tree during budburst or abscission will have a more negative outcome than if it occurs at another time.

4.2. Outline the processes of secondary thickening

Plants grow by lengthening their stems and roots. Some plants, particularly those that are woody, grow thicker over their lifetime. Primary growth is defined as an increase in the length of the shoot and root. Cell division in the shoot apical meristem produces it. Secondary growth is distinguished by an increase in plant thickness, or girth. Cell division in the lateral meristem causes it. Herbaceous plants grow primarily, with little secondary growth or thickness expansion. Secondary growth, or "wood," is visible in woody plants; it occurs in some dicots but is uncommon in monocots.
Primary growth in woody plants is followed by secondary growth, which causes the plant stem to thicken or girthen. As the plant develops, secondary vascular tissue and a cork layer are added. A tree's bark runs from the vascular cambium to the epidermis.



The lateral meristems, which are absent in herbaceous plants, are responsible for the rise in stem thickness that follows secondary development. The vascular cambium and the cork cambium in woody plants are examples of lateral meristems. Situated inside the primary phloem and immediately outside the major xylem is the vascular cambium. The vascular cambium's cells split, forming a secondary phloem (sieve elements and companion cells) on the exterior and a secondary xylem (tracheid and vessel elements) on the interior. The vascular cambium's production of secondary phloem and secondary xylem, together with the activity of the cork cambium, which creates the tough outermost layer of the stem, cause the thickening of the stem that happens during secondary growth. Lignin gives the secondary xylem's cells their strength and toughness.

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<u>4.3. Define the terms dioecious and monoecious and identify two species representing each</u>

Male and female flowers are located in different structures in monoecious plants. "Mono" literally means "one," and "monoecious" literally means "one house". Several blooms, some male and others female, grow on the same plant. It is monoecious to squash. Squash blossoms feature a little fruit at the base, which makes it easy to identify which blooms are female. The male flowers, of course, do not. When all the blooms on the squash plant do not bear fruit, knowing that only the female flowers do will save some pain. On squash plants, only 50% of the flowers are female. The male and female flowers of dioecious plants are housed on separate plants. Thus, in addition to having distinct male and female flowers, the plant also has male plants that have only male flowers and female plants that have only female flowers. Asparagus and hollies are dioecious. Holly plants require a male and a female plant to be near one another, as only the female plants can bear fruit. Male holly plants are easily identified since they are commonly called manly titles such as "Blue Prince," "Southern Gentleman," or "Jim Dandy." To guarantee pollination and fruit set, as well as to conceal the male plants that do not bear the eye-catching fruit, male hollies are sometimes nestled beneath female hollies in landscape design. Gardeners prefer the male varieties of asparagus above the females. This is because male spears produce more fruit with less effort because they are bigger. Also, male plants may be more orderly. Unlike their female counterparts, male ash trees do not yield "canoe paddle-like" fruits. The reason male Ginkgo, Cork, and Kentucky Coffee tree trees are so well-liked is that their fruit does not become messy. Holly, Ilex aquifolium, is dioecious, as is Gingko, Gingko biloba. Birch, Betula pendula is monoecious, as is the alder, Alnus incana.

4.4. Describe the methods of seed dispersal as used commonly by trees

Pollination

The process by which blooming plants procreate is called pollination. A plant needs pollen to fertilise it to form seeds that will sprout into new plants before it can produce offspring.

There are male and female components in flowers. The male portion is known as a stamen, and it consists of a long, thin stalk that ends with pollen. Usually, there are many stamens in the centre of the flower. The stigma, or feminine portion, is in the middle of the flower. It is the tip of a tube that descends into the secreted ovule within the flower. The "eggs" that, when fertilised by pollen, develop into seeds are found inside the ovule.

Certain plants can "self-pollinate." This indicates that when the plant's own pollen enters the ovule from the stamens, it has been fertilised. But most plants "cross-pollinate." This indicates that they require fertilisation with pollen from a different plant of the same kind. Pollinating creatures like bees and butterflies, as well as the wind, are two ways that plants pollinate.

Nectar is a sweet, energising liquid that flowers emit to attract pollinators. Pollen adheres to their bodies as they descend upon the bloom to feed. Butterflies and bees are two instances of this. They proceed to another flower, carrying the pollen. Part of it will get into the stigma and help the plant spread. Blooms evolved their bright colours and exquisite fragrances to attract pollinators. A relationship that is mutually beneficial to pollinators and plants is a perfect illustration of "mutualism" in action.

Typically, pollen is a tiny, powdery material with a yellowish hue. If you examine a bloom attentively, you might be able to spot pollen at the tips of the stamen stalks. Because pollen is rich in protein and sugar, bees will consume it.

Pollinators are essential for the reproduction of many tree species. Bees and other insects pollinate blooming plants such as hazel, crab apple, and rowan. Conifer species generate cones rather than flowers and are pollinated by the wind. Male cones produce pollen, which the wind transports to female cones, where it is used to form seeds.

All plants that carry seeds have an adaptation process called **seed dispersal** that helps transfer or transport seeds away from their parent plant to ensure that some of the seeds germinate and survive to become adult plants. To move the seed from one location to another, there are several vectors available. There are different ways in which seeds from its parent plant is dispersed. These include:

Dispersal of Seeds by **Wind**

In the kingdom of plants, wind is the primary and natural route of seed dispersion. Many plants that go via this route of distribution have relatively light seeds. Plants whose seeds are spread by the wind include orchids, dandelion, swan plants, cottonwood trees, hornbeam, ash, cattail, puya, and willow herb.

Dispersal of Seeds by **Water**

Seeds dispersed by this approach float away from the parent plant. These are typically found in plants that are submerged in water or that are close to bodies of water, such as lakes, ponds, and beaches. Plants whose seeds are distributed by water include coconut, palm, mangroves, water lilies, and water mint.

Birds and **animals** Spreading Seeds

Colourful, bright fruits do not attract many animals or birds. They consume the whole fruit; only the juicy portion is broken down by their digestive system, and the seeds are expelled as droppings, which germinate to become new plants. This is how the seeds of blackberries, cherries, tomatoes, and apples are distributed. Certain squirrel species gather nuts from various plants, such as acorns, and burrow them into the ground to store food for the winter. They frequently forget the location of their previous burrows, and the seeds sprout into new trees. A few plants produce seeds that have hooks on them. One species of plant that fits this description is the burdock plant. Plants whose seeds are distributed by animals and birds include dates, rambutan, sea grapes, sea holly, tamarind, raspberry, sunflower, and tomatoes.

Dispersal of Seeds by **Gravity**

All objects in the universe are attracted to one another by the force of gravity. Due to gravity, the fruits of the tree occasionally tumble down to a smaller area before becoming buried in the ground and sprouting into new plants after a few days. A greater dispersal of seeds occurs when fruits with a less dense seed coat occasionally fracture and split after falling from a height. Sometimes other forces, like water, wind, birds, or animals, carry the fallen fruit, which aids in the dispersal of seeds. Several plants, including apples, commelina, canna, coconuts, calabash, and passion fruit, have seeds that are disseminated by gravity, which is an attraction force.

Deployment of Seeds by **Explosions**
Fruits that explode literally mean to burst with all their vigour. In this instance, the fruits mature and release their seeds into the surrounding area. Most plants that exhibit this kind of seed distribution have pods. Plants such as okra, lupins, gorse, and broom are known to release their seeds when they explode. Bean and pea plants also produce pods, from which seeds sprout after the pod dries up and ripens.

Deployment of Seeds by **Fire**
Since plants are unable to flee from fire, some have evolved strategies to aid in the survival of their seeds. Certain types of pine trees need the presence of fire heat for their cones to open and discharge seeds. Australian flora, such as eucalypts and banksias, also depends on fire. It matters how strong the fire is and when it starts. The temperature must be high enough for the cones to open, but too many fires will prevent the plants from growing to a size large enough to produce new seeds.

4.5. Identify a minimum of three factors involved in germination of tree seeds

Seeds remain dormant or inactive until conditions are right for germination. All seeds need **water, oxygen**, and proper **temperature** to germinate. Some seeds require proper **light** also. Some germinate better in full light while others require **darkness** to germinate.

When a seed is exposed to the proper conditions, water and oxygen are taken in through the seed coat. The embryo's cells start to enlarge. Then the seed coat breaks open and a root or radicle (an immature root) emerges first, followed by the shoot or plumule (the part of an embryo that turns into the shoot of a plant) that contains the leaves and stem.

A seed is a design used by trees for millennia to assure the existence of the following generation of trees. Seeds have developed into various sizes and forms, allowing them to be disseminated by wind, water, or animals. Each seed contains all the resources it requires to survive on its own until it reaches a safe environment to grow. Once the seed finds its ideal surroundings, it must protect itself. The initial root penetrates the seed, attaching it and absorbing water for the growing plant. The embryonic shoot emerges as the next step in germination. The shoot pushes through the dirt, with the shoot leaves sticking above the ground or withering underneath as the remainder of the shoot develops above. When a shoot emerges from the earth, it develops into a seedling. This is the time when trees are most vulnerable to illnesses and damage from deer grazing. When a tree reaches 3 feet in height, it is considered a sapling. The length of the sapling stage varies according to the tree type; however, saplings have distinguishing characteristics:
Adaptable trunks
Bark that is smoother than that of mature trees
Inability to grow fruit or flowers.
Trees with extremely lengthy life spans, such as yews and oaks, are saplings for considerably longer than species with lower life spans, such as silver birch and wild cherry. When a tree begins to produce fruits or flowers, it has reached maturity. This is the most productive time for the tree. The period it will be productive is determined by the species. A typical English oak tree begins producing acorns at roughly 40 years of age, with output peaking between 80 and 120 years. In general, oaks can be productive for 300 years and then rest for 300 years before continuing in their life cycle. Rowan, on the other hand, begins producing berries after around 15 years, and by 120 years or so, it has reached the end of its life. The fruits are spread, and the life cycle begins again.

4.6. Define the term ‘root to shoot’ ratio

The root-to-shoot ratio compares the quantity of plant tissue with supporting functions (roots) to the amount of plant tissue with growth functions (shoots). A plant with a larger proportion of roots than a neighbouring plant will be able to compete more successfully for soil resources. Plants with a higher number of shoots are better equipped to receive light energy and grow larger. Because the roots are still sensitive in the early stages of growth, plants will likely have higher proportions of shoot production. Unsurprisingly, as the plant grows and the roots get stronger, there is a higher proportion of root creation to sustain the plant's stability. The root-to-shoot ratio in plants is calculated using two measurements that you presumably already have if you are a passionate grower: root and above-ground dry weights. Simply divide the root dry weight by the above-ground dry weight to get your measurement.

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