The Villablanca Connection

UNIT 6:

PLANTS

“The clearest way into the Universe is through a forest wilderness.”
John Muir.

Unit 6: Plants.
Biology and Geology 1º ESO
Villablanca Connection

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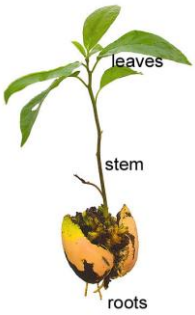
Unit 6: PLANTS.

1. Introduction.

From an immediate point of view, plants are very conspicuous living beings green in color and very limited in their movements. In a more scientific approximation, we can say that they are **eukaryotic multicellular** organisms with **cellulose** in the cell wall and **chlorophyll** in the chloroplasts. They live usually attached to the ground, from where they obtain water and minerals, and they also take carbon dioxide from the air to produce their organic food thanks to the sunlight. So, they are **photosynthetic autotrophic** organisms.



All plants are classified into a kingdom of their own: the **plant kingdom**. Plants usually have real tissues and, in most of the cases, real organs. The organs that are commonly present in plants are the **root** (to extract water and minerals from the soil), the **stem** (to transport nutrients between the different parts of the plant) and the **leaves** (to get the CO_2 from the air and collect the sunlight to perform photosynthesis). In many cases we can also find **flowers** to produce the gametes responsible for the sexual reproduction.

Plants are classified in two main groups:

- **Plants without seeds**. They are very simple plants that reproduce through spores and have to live in wet environments. We are going to study two groups in this type of plants:
  - **Mosses**
  - **Ferns**
- **Plants with seeds (=Spermatophytes)**. These plants have flowers and are more widely widespread. We consider two groups inside this type of plants:
  - **Gymnosperms**. Plants with unnoticeable flowers and bare seeds (=the seeds are not inside a fruit).
  - **Angiosperms**. Plants with conspicuous flowers and the seeds inside a fruit.

Activity 79.
What are the substances needed by the plants to grow?

Activity 80.
What are the organs that the plants use to take the CO_2?

Activity 81.
State whether these statements are true or false and correct the false ones:
a) Mosses reproduce by seeds.
b) Plants are heterotrophic organisms that produce their own food
c) Plants are autotrophic organisms because they produce inorganic matter.
d) Plants have chitin in their cell walls.
e) Ferns are plants without seeds.
f) The fruit of the gymnosperms is conspicuous and edible.

Activity 82.
Copy the drawing in your notebook and write the names of the main organs of the plants.

2. Plants without seeds.

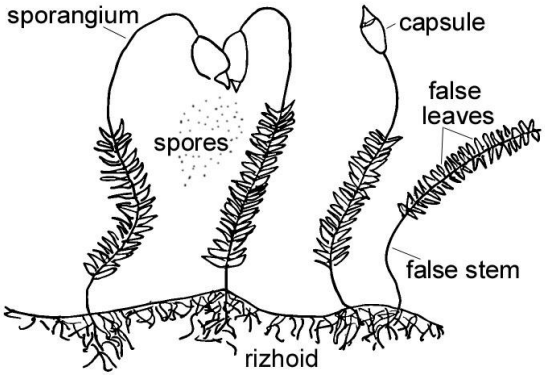
400 million years ago there were no multicellular autotrophic organisms outside the water. To conquer the terrestrial environment the primeval plants had to find a way to:

1. **avoid dehydration**,
2. a way to **sustain their body**,
3. a way to **transport water and nutrients** to the different parts of their bodies and
4. a water **independent reproduction system**.

One of the first succeeding attempts was carried out by the primitive mosses.

2.1. Mosses.

Mosses are very little plants that avoid dehydration by living in wet and shady environments and by their small size (no more than some centimeters tall). They do not have real supporting structures and they can stand by growing very close one of another forming miniature forests.
Mosses do not have transport tissues (they are not really **vascular plants**) and absorb the water and the nutrients through their entire surface. Although they present structures that are similar to the roots, stem and leaves of the vascular plants they receive different names because these structures do not perform the same function than the real roots, stem and leaves.
When the conditions become favorable mosses grow a sporangium with a capsule where spores are produced and eventually released to reproduce themselves.



Parts of the external anatomy of the mosses


A group of mosses with sporangia

Mosses can colonize any environment that remains wet most of the time, but some species can dry up and survive for a long time so when the rain falls again they become green once more.
The mosses need a humid environment, so they grow preferably in the part of the rocks or the bark of the trees that is more exposed to the rain, which can be used to get directions inside a forest where orientation is difficult by other means.

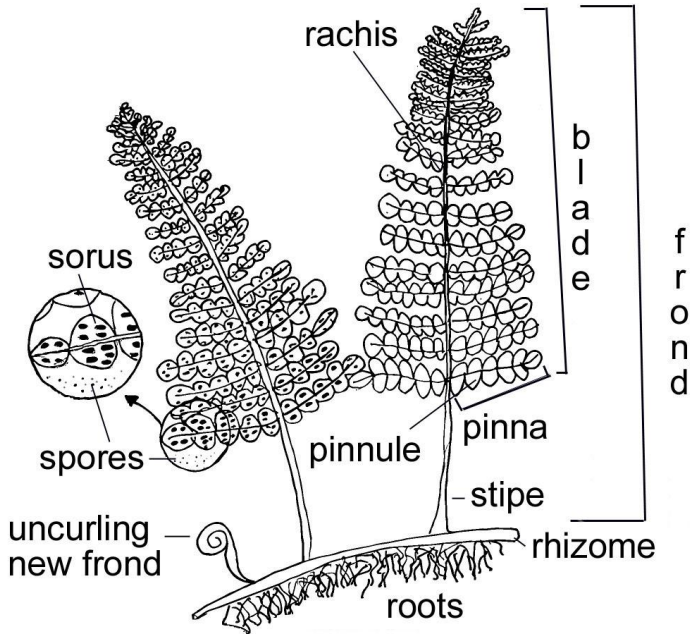

Moss indicates the direction of the rain.


Sphagnum sp. can form “green blankets”.

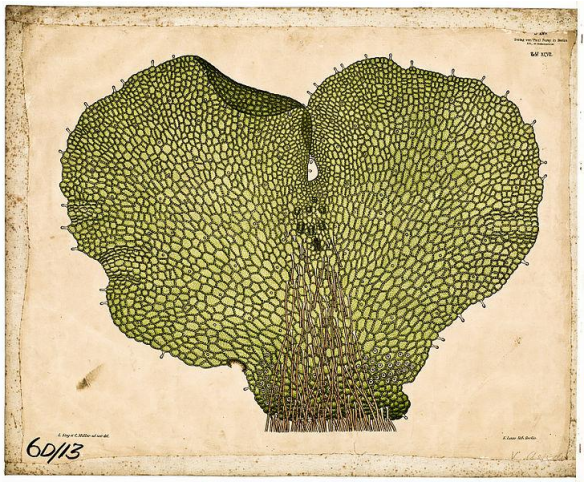
2.2. Ferns.

Ferns have real tissues and real organs. They are considered the first **vascular plants** that appeared on Earth. This means that ferns have specialized transport tissues to distribute the nutrients and the products of the photosynthesis. These **conductive vessels** make possible a more efficient distribution between more distant parts of the plant, and this means that ferns can be much bigger in size than mosses. In fact, before the appearance of more complex plants many million of years ago, the ferns formed extensive forests of huge trees. Their remains are nowadays the big coal deposits that can be found all over the world.

The ferns that we can find today are usually the size of a bush or an interior ornamental plant. They have **real roots**, **real stem** and **real leaves**, and they live in shady places under the cover of the trees in the forests. The stem, which is called **rhizome**, is most of the times horizontal and grows underground, so the only aerial part of the plant are the **fronds**, that is the name of the leaves of the ferns. In the lower surface of the fronds we can find the **sori** (it is plural for "**sorus**"), little brownish spots where the sporangia are. They reproduce through spores that germinate in shady wet soil to produce an underground heart-shaped structure known as **prothallus** that eventually will produce male and female gametes that, after the fertilization, will become a new fern.



External anatomy of a fern.



Prothallus of a fern

Ferns in the undergrowth of a pine forest in the Sierra de Guadarrama

Detail of sori in the underside of a frond.

Activity 83.
Make a drawing of a moss and label the different parts of its external anatomy.

Activity 84.
Why do we say that the "rhizoid" of a moss is not a real root?

Activity 85.
Define “sporangium”.

Activity 86.
Decide whether these statements are true or false and correct the false ones:
a) Mosses and ferns are not plants.
b) Lichens are not plants.
c) Mosses and ferns have conductive vessels to distribute the nutrients to the different parts of their body.
d) Spores need a wet place to germinate.
e) Seeds are more resistant to desiccation than spores.
f) Fronds are not real leaves.
g) Mosses are usually bigger than ferns thanks to their transport tissues.
h) The living being that can be seen growing on the bark of this tree is a real plant:

i) Mosses are organisms that result from the symbiosis of a fungus and an alga.
j) Although mosses are eukaryotic organisms they cannot perform photosynthesis.
k) The cells of the ferns do not have chloroplasts and they have heterotrophic nutrition.
l) The sporangia of the ferns are in the sori placed in the underside of their fronds.

Activity 87.
Why do mosses and ferns have to live in wet environments?

Activity 88.
What is the main difference between mosses and ferns?

Activity 89.
Draw a fern and label the different parts of its external anatomy.

Activity 90.
This drawing shows a moss called *Eustichium norvegicum*. What are the names of structures 1, 2 and 3?

Activity 91.
According to the text of this Unit, what are the four problems that primeval plants had to solve to conquer the terrestrial environment?

Activity 92.
Make a diagram to show the different groups into which plants are classified.

3. Spermatophytes: Plants with seeds.

Plants with seeds are organisms a little bit more **complex** than mosses or ferns. They possess more types of tissues and they use a totally different way to reproduce that implies a new organ: the **flower**. In the flower, the male and female structures produce the gametes that are required to **sexual reproduction** and, as a consequence of the development of the **zygote**, the seeds will guarantee that the new generation of plants germinates even in not so strict conditions of water availability.

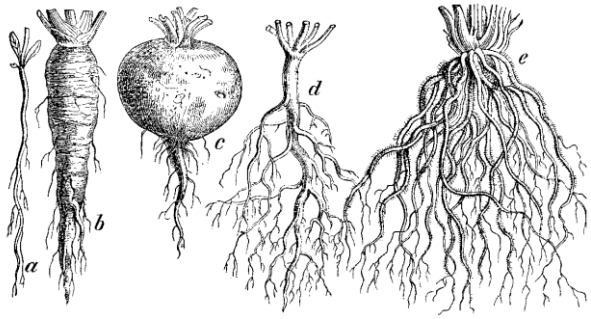
3.1. The basic plant structure: root, stem and leaves.

The root.

The root is the underground organ of the plants that is in charge of two important functions:

1. The root **anchors the plant to the ground**, avoiding that the wind and the rain drag it.
2. The root **collects water and mineral nutrients** present in the soil and takes them up to the rest of the plant. It can absorb the nutrients thanks to the **root hairs**.

Sometimes the root can also accumulate substances as a reservoir of energy (like carrots, for instance).



Types of roots:

a) thread-like root.
b) taproot.
c) taproot of a bulb.
d) fascicled root.
e) fibrous root.

The stem.

The stem is the organ that **supports** the plant and makes possible the **transport** of substances between the aerial and subterranean parts of the plant. These substances are dissolved in the **sap** that moves through the **conductive vessels**.
There are two types of conductive tissues in the plants: the **xylem** and the **phloem**.
The **xylem sap** is composed by the water and dissolved minerals that have been absorbed in the root and always moves upwards to the leaves and aerial parts of the plants to supply the cells with the water and mineral salts that are required to perform photosynthesis.
The **phloem sap** is composed by water, carbohydrates and other organic substances that have been produced by photosynthesis in the leaves and moves downwards to supply food to the underground parts of the plants.

Types of stem:


trunk


stipe


cane


bulb


tuber

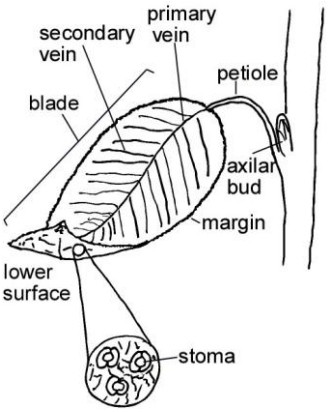
rhizome

The leaves.

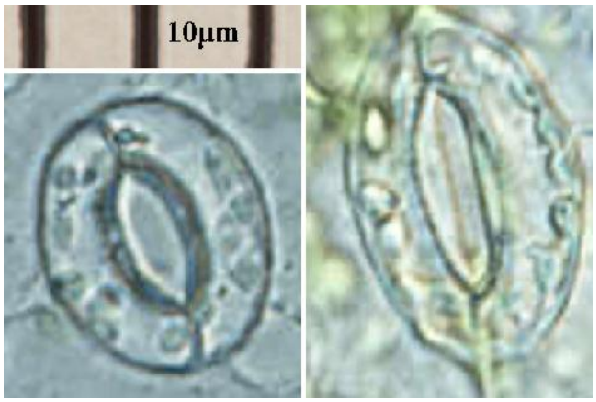
The leaves are the organs of the plants specialized in the **photosynthesis**. They receive water and minerals from the root in the xylem sap and they get CO_2 directly from the air. With these inorganic ingredients the leaves produce organic matter (like carbohydrates) thanks to the sunlight energy they collect with the chlorophyll of the chloroplasts. The carbohydrates and the other organic substances are then distributed to rest of the organs of the plant with the phloem sap. A byproduct of the photosynthesis is the **oxygen** that the leaves release to the atmosphere.

The typical leaf is formed by a little segment that connects it to the stem (the **petiole**) and a laminar structure that is called the **blade**. In the lower surface of the blade there are many microscopic organs called **stomata** with an opening that the plant can open and close to regulate the intake of CO_2 and the output of water and oxygen (=transpiration).

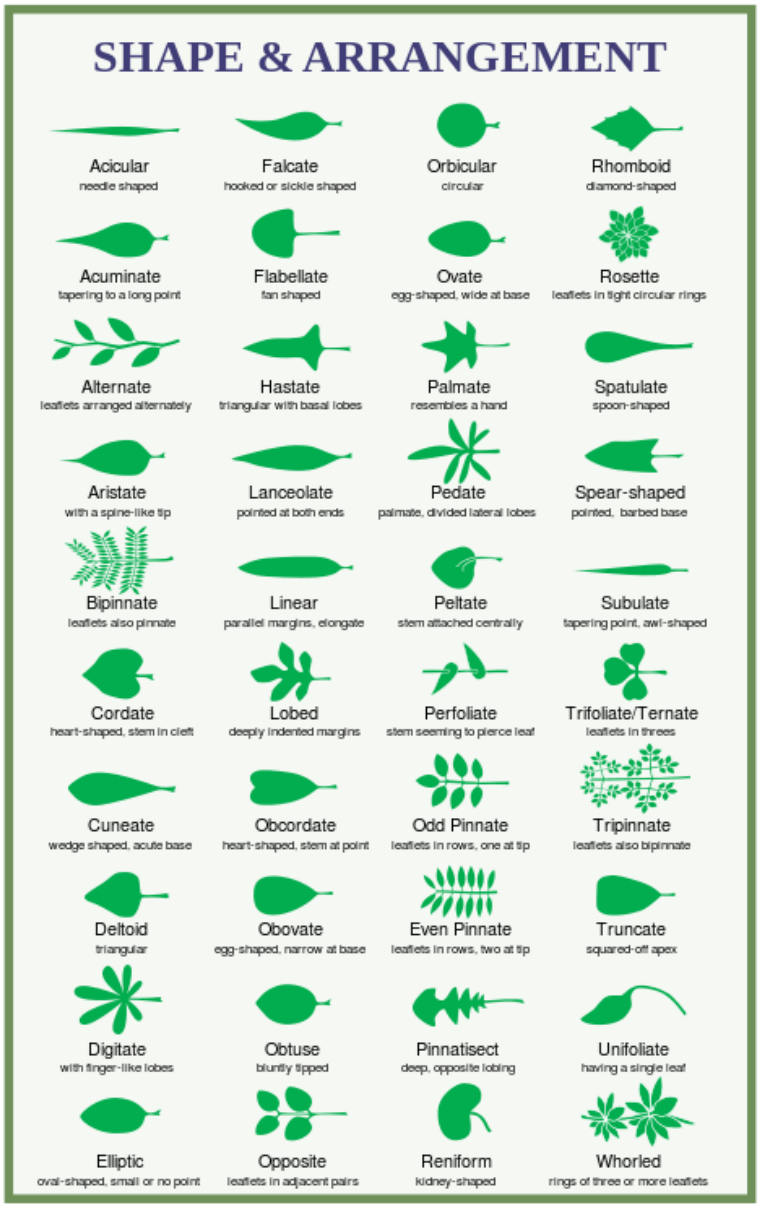
Parts of a leaf

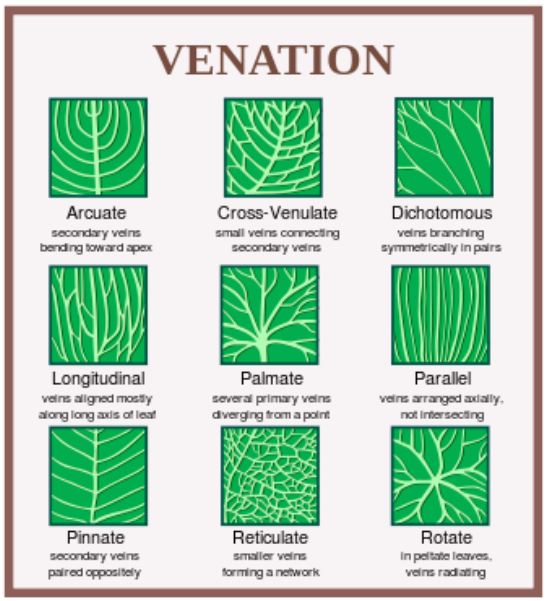


open stoma *closed stoma*



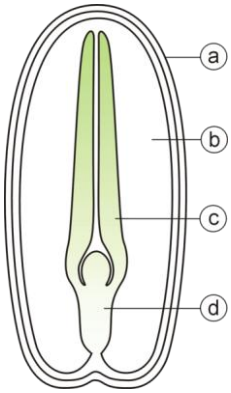
Types of leaves:





3.2. The seed.

The seed is the reproductive structure of the spermatophytes. The seeds are more resistant than spores and can resist in dry environments for a long time before they germinate. The seed accumulates nutrients so the new born plants can develop for some time without an external source of food.
In a seed there are four basic elements:



a – **seed coat**. It protects the seed from dehydration and parasites.

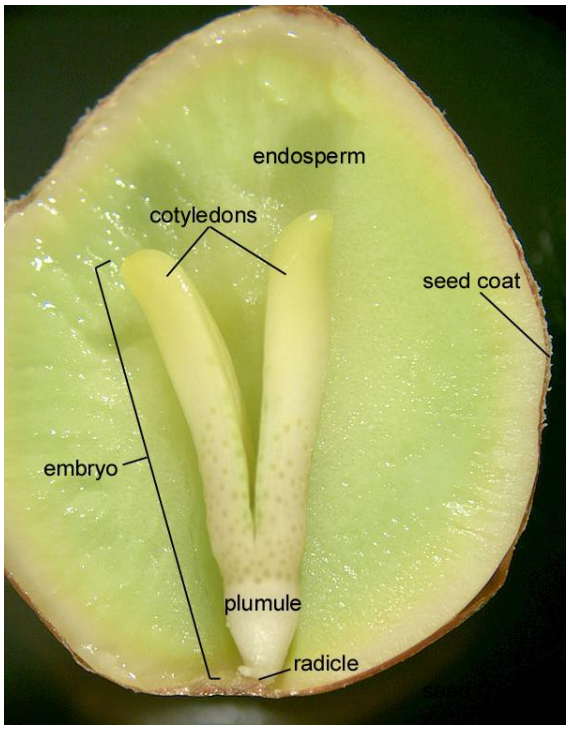
b – **endosperm**. This is where the reserves of nutrients are stored.

c – **cotyledons**. This is the name of the embryonic leaves.

d – **embryo**. A miniature plant, with a small root (**radicle**) and a small stem (**plumule**).

Germination of the seed.

The seeds can remain lethargic for a long time, but when the rain falls and filters into the soil, the seeds swell because of the accumulation of water, and the embryo begins its development breaking the seed coat and emerging from the soil surface.
When the reserves of nutrients in the endosperm are finished the plant has already a functional root, with root hairs that can absorb water and minerals from the soil, and the first leaves have been formed to perform photosynthesis and obtain CO_2 from the air.



Cross section of a seed of *Ginkgo biloba*.

3.3. Gymnosperms: Plants with seeds but without fruit.

The spermatophytes are classified into **Gymnosperms** (*gymnos*="naked" and *sperma*="seed", in Greek) and **Angiosperms** (*angeion*="recipient" and *sperma*="seed", in Greek).
The most common gymnosperms are **conifers** like pines, cypresses and junipers. They are called that way because their flowers group together to make **cones**. Conifers are very common in the cold and template regions of the northern hemisphere. They usually have the following characteristics:

- Most of them are big **shrubs** and **trees** that can form very dense forests.
- They have leaves with the **shape of a needle**, presenting a small surface adapted to extreme temperatures.
- They have a **perennial foliation**. This means that the leaves are always present in the plant because it does not lose all of them at the same season.
- The flowers are grouped together forming **cones** and they are **unisexual**. There are male cones and females cones in different parts of the same plant. The female cones are covered with woody scales to protect the ovules.
- The pollen is produced in the male cones and it is transported to the female cone by the wind.

Female cones of a pine

Male cones of a pine

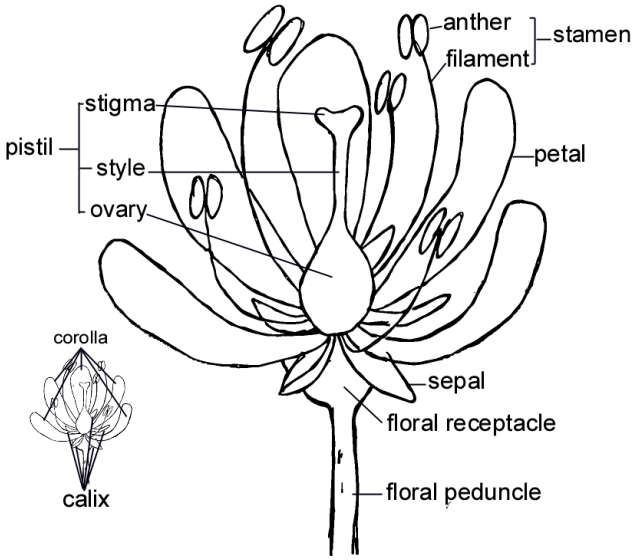
Acicular leaves, a male cone and a female cone in the same branch of a pine.

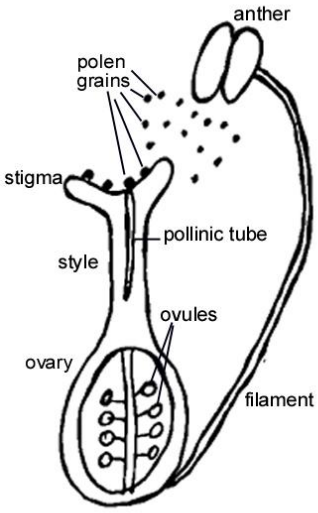
3.4. Angiosperms: Plants with seeds and fruit.

Angiosperms are the most widespread plants and live in most of the terrestrial ecosystems. They have **flowers** where the ovules are inside an **ovary** that will be transformed into a **fruit**. The fruit holds the **seeds** inside.
The flowers of the angiosperms are the reproductive organs and they are hermaphrodite in most of the cases.

Structure of the flower.

The structure of the flower is like you can see in the following drawing:





The flower is the reproductive organ of the angiosperms and it is formed by four concentric circles of modified leaves called **calyx**, **corolla**, **stamens** and **carpels** or **pistils**.
The external circle is the **calyx** that protects the flower while it is still growing and it is formed by several **sepals**.
The next circle is the **corolla**, formed by the **petals**, that usually has attractive colors because its function is to draw the attention of the **pollinators**.
The **stamens** are the male reproductive organs and produce the **pollen grains** inside the **anthers**.
The **pistils** or **carpels** are the female reproductive organs and contain the **ovules** inside the **ovary**.

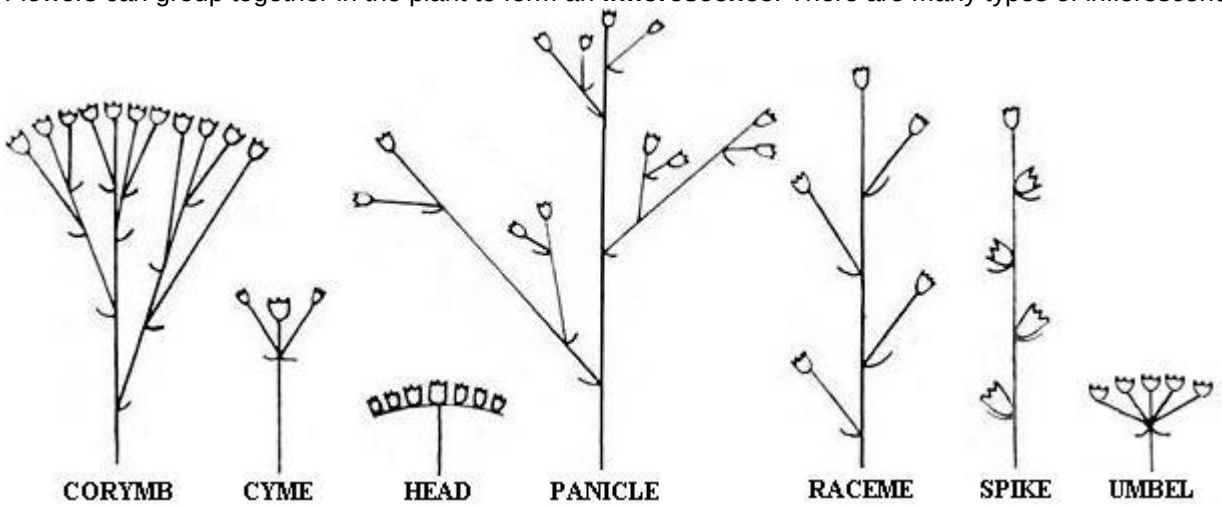
Pollination and fecundation.

We call **pollination** to the process by which the pollen grains travel from the anther to the stigma of the pistil. Sometimes pollination depends on just the wind or the raindrops, but very often pollination is carried out by animals like birds, bats or insects that establish a **symbiosis** with the different plants they pollinate. These animals also benefit because they get **nectar**, pollen or some other food while the pollen gets attached to their body so it can travel to a different plant.
When a pollen grain arrives to the stigma of the pistil it gets stuck to it due to a sticky substance that is produced there. Then the pollen grain develops a structure, like a very small tube, that gets down from the stigma inside the style. This tube-shaped structure is called the **pollinic tube**. Eventually, the pollinic tube will get to the ovary and will attach to the ovule. Then the male gametes travel from the pollen grain to the ovule through the pollinic tube and **fecundation** takes place. As a result of the fecundation the ovule becomes a **seed** and the ovary becomes a **fruit**.

Types of flowers.

There are different types of flowers. The type that has been described above is a **complete** flower because it has the four circles of modified leaves, but sometimes some of these circles are not present and we talk about an **incomplete** flower. We also say that this flower is **hermaphrodite** because it has both male and female organs but

very often we can find flowers without stamens (and then it is a **female flower**) or without pistils (and then it is a **male flower**).
Flowers can group together in the plant to form an **inflorescence**. There are many types of inflorescences.



Fruits and dispersion of the seeds.

Angiosperms are more widely spread than gymnosperms. One of the reasons is that angiosperms are more efficient from the point of view of the **dispersion of the seeds**, and this is because of the fruit.
Fruits can have a dry consistence, like hazelnuts, or a fleshy one, like apricots. Sometimes fruits can also group together in a multiple fruit, like in the pineapple.

Fruits make possible the dispersion of the seeds in many different ways. Sometimes they develop wing-like or parachute-like structures to be dispersed by the wind, sometimes they form “hooks” to get hooked to passing-by hairy animals, sometimes they just float to be carried away by the water of the rivers or the oceans, and even sometimes their appetizing appearance makes that animals eat them and disperse the seeds with their depositions.


Maple tree


Dandelion

Proboscidea parviflora

Coconut

Watermelon

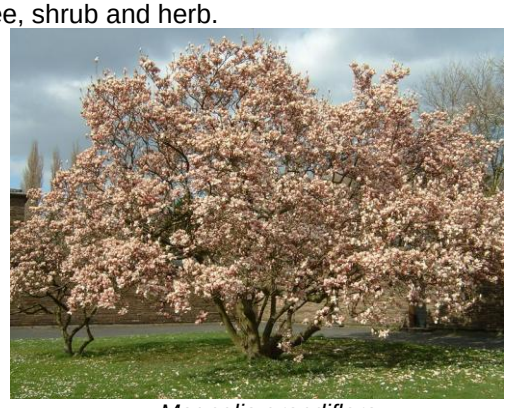
Other characteristics of the angiosperms.

- Angiosperms are the most widespread plants and they live in almost every terrestrial ecosystem.
- There are species adapted to cold environments and species adapted to hot or warm environments. Even some species are adapted to live in aquatic environments.
- They can be **herbs**, **shrubs** and **trees**.
- The trees of this group usually have **deciduous foliation**. They lose their leaves during the cold season.
- Some angiosperms are **unisexual** (they have separate sexes) while others are **hermaphrodite**, depending on the type of flower they have.

Activity 93.
Classify these photographs in one of the following categories: tree, shrub and herb.

Allium schoenoprasum

Buxus sempervirens



Magnolia grandiflora

Activity 94.
What type of root has a carrot?

Activity 95.
What is a root hair? How does it work?

Activity 96.
Explain how the sap moves in a plant.

Activity 97.
What is a rhizome?

Activity 98.
Why some gymnosperms are called “conifers”?

Activity 99.
Answer the following questions:
a) What are the main differences between gymnosperms and angiosperms?
b) What type of stem can we find in a palm-tree?
c) How do we call the part of the leaf that connects it to the stem?
d) What are the stomata for? Where are they placed?

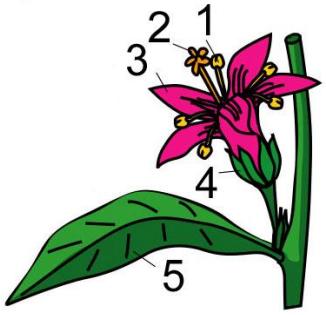
Activity 100.
Draw a leaf and label its parts.

Activity 101.
Draw a seed and label its parts.

Activity 102.
Explain the function of the parts of a seed.

Activity 103.
Draw a flower and label its parts.

Activity 104.
Name the structures numbered in the following drawing:



Activity 105.
Write the concepts of these definitions:
a) The set of the sepals.
b) The male reproductive organ of a spermatophyte.
c) The female reproductive organ of a spermatophyte.
d) Part of the pistil that contains the ovules.
e) Part of a stamen that contains the pollen grains.
f) Structure produced by a pollen grain to conduct the male gametes to the ovule.
g) The elements that form the corolla.
h) The process by which the pollen grains travel to the pistil.
i) The plant that keeps its leaves all year round.
j) The vessels that conduct the water and the minerals from the root to the rest of the plant.
k) The part of the pistil where the pollen grains get stuck.
l) The characteristic way in which a plant group its flowers.
m) The plants that lose its leaves during the cold season of the year.
n) The organ that contains the seeds and contributes to their dispersion.
ñ) Part of the seed that stores the nutrients needed in the germination.

Activity 106.
Explain how a seed germinates.

Activity 107.
What type of relationship has a plant with its pollinators?

Activity 108.
Decide whether these statements are true or false and correct the false ones:
a) Tomatoes are fruits.
b) Beans are fruits.
c) Fleshy fruits are often eaten by animals that disperse the seeds with their depositions.
d) Potatoes and onions are fruits.
e) Phloem sap has organic substances produced by the leaves by photosynthesis.
f) The apple is the seed of the apple-tree.
g) Plants are heterotrophic organisms and lichens are autotrophic organisms.
h) Cyanobacteria are plants and perform photosynthesis, producing oxygen as a byproduct.

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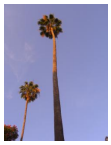 By Régis Lachaume. Yo, el titular de los derechos de autor de esta obra, lo libero al dominio público. Esto aplica en todo el mundo.

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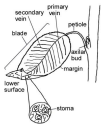

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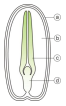 By Nova. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.

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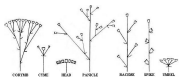 By Draeco at en.wikipedia.

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