1 st year Agronomic Sciences

SNV. Uiversity of MEDEA

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# Plant Biology courses

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# Chapter 1: Introduction to plant biology

**1.1. Systematic**

**1.2. Plant cytology (cell membrane, cell wall, vacuoles, plastes)**

# Chapter 1: Introduction to plant biology

Plant Biology is a broad discipline that studies plants in their environment (aquatic or terrestrial) as well as their morphology, the anatomy of their organs and their mode of reproduction.

Plants above all are **multicellular eukaryotes**, they include **roots, a stem of the leaves and generally flowers**, the material of which is composed of cellulose. Plants are able to produce sugars themselves, thanks to photosynthesis, it uses mineral and gaseous elements, they are **autotrophic**. Unlike other living things, most plants are attached to the ground by roots.

## 1.1. Systematic

The living world, to which plants belong, is divided into two fundamentally different groups of organisms "**prokaryotes, eukaryotes"** and in **five kingdoms (Prokaryotes, Protists/Protoctists, Fungi, Animals and Plants)**. Thus the plant kingdom is subdivided into two major groups according to the structural organization of the plant: **Thallophytes and Cormophytes** (Fig. 1)**.**

The systematics of plants intervenes to give them a name and classify them as well as to study the relations between them.

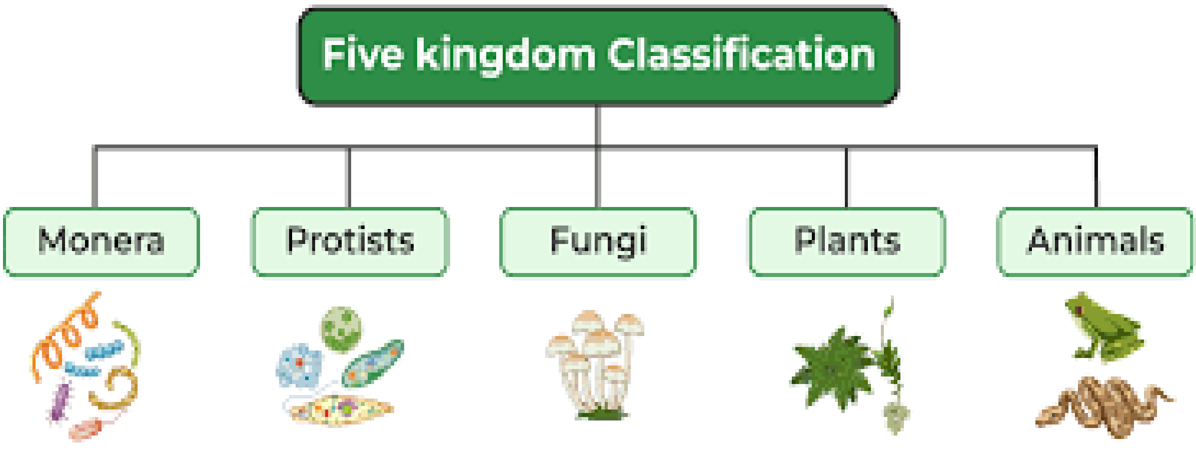


**Figure 1: Five kingdom classification**

### 1.1.1. Thallophytes

Thallophytes have a simple vegetative apparatus so: **thalli have no stems, leaves, roots, or conductive vessels,** they are composed by cells that look alike without physiological differentiation. Their size is very variable, depending on the species, some thallophytes are **unicellular such as cyanobacteria (blue-green algae),** and sometimes **the thallus presents complex and pluricellular structures, such as fungi**, **algae and yeasts**. Reproduction is done by spores or gametes, or duplicate by vegetative multiplication (Fig. 1).

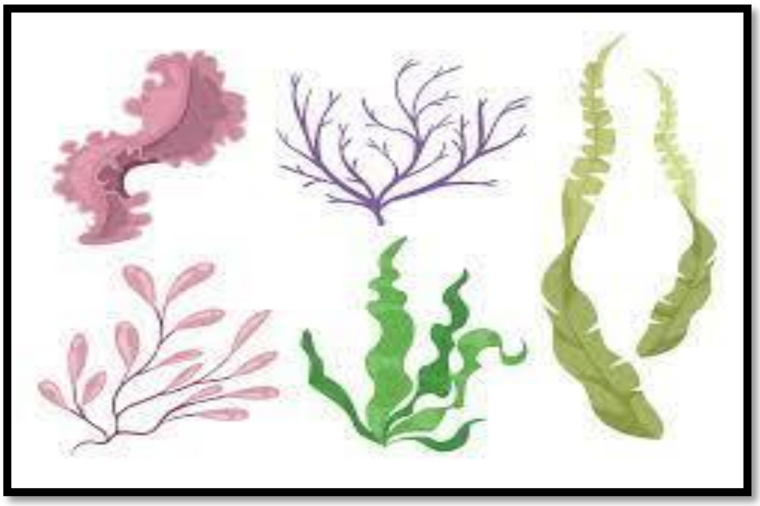

**Figure 2: Thallophytes**

### 1.1.2. Cormophytes

Cormophytes whose vegetative apparatus is a cormus (from the Latin "***cormus"*** meaning **stem**, from the Greek "***kormos"*** meaning **trunk**), they are much more complex than a thallus, they contain a group of higher plants that correspond to organisms that are always pluricellular and whose eukaryotic cells are joined into tissues forming organs. Cormophytes are divided into several branches.

- **1$^{st}$ branch: Bryophytes**

Bryophytes include plants more commonly called **mosses**, they have a **stem and leaves but no roots**, **rhizoids** having a role of fixation. They are also devoid of the vessels conducting the sap, are **avascular plants .** Bryophytes most often live on land, growing in humid places (Fig. 3).

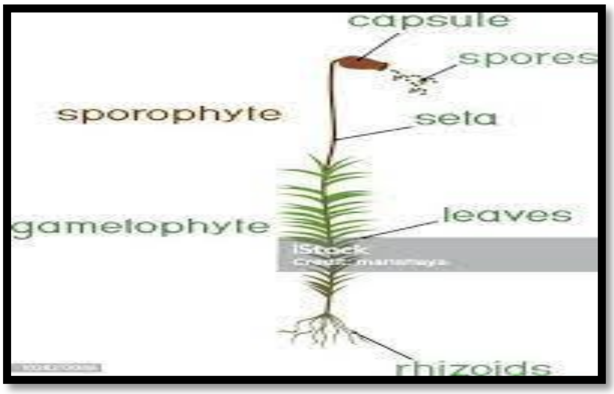


**Figure 3: Mousses.**

- **2nd Branch: Pteridophytes**

Pteridophhytes (ex: ferns) are characterized by a cormus more developed than that of bryophytes, they consist of leaves and an underground stem called rizhome, are thin roots, little ramified.the latter allow fixation and absorption (Fig. 4).

Pteridophytes are vascular plants (presence of conductive elements) and they are cryptogamous (hidden reproductive organs). They generally live in wetlands and some are aquatic.

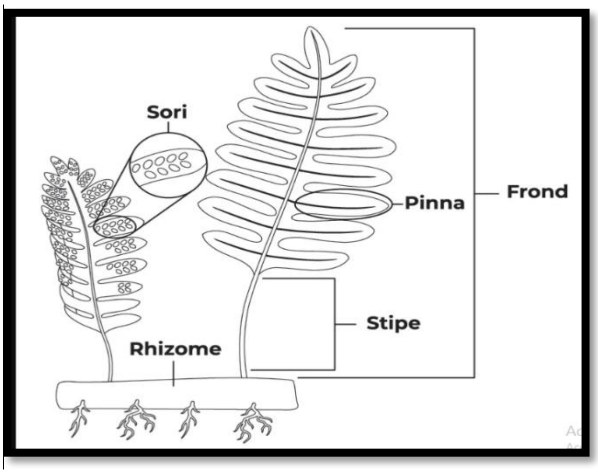


**Figure 4 : Ferns.**

- **3rd Branch: Spermaphytes**

This group represents more than 90% of plant species. They are characterized by **a more developed stem and root system (vascular plants)**. Are phanerogamous plants whose reproductive organs are apparent in **the cone or in the flower**.

The spermaphytes branch includes two sub branches

**a- Gymnosperms:**

Ovules and seeds are naked, ie they are not included in a protective organ.

Most Gymnosperms are conifers, such as Fir (Abies), Spruce (Picea), Larch (Larix), Redwood (Sequoiadendron), Pine (Pinus), Juniper (Perus), Cypress (Chamaecyperis), or Thuyas (Thuja) (Fig. 5).

**Figure 5: Pine (*Pinus sp*.)**

**b- Angiosperms**

They contain most of the plant kingdom of 250,000 to 300,000 species. They are characterized by the presence of the ovule in an ovary and the seed in a fruit (Fig. 6). They have two classes. **Monocotyledons** (the seed has a single cotolydon) and **Dicotolydons** (the seed has two cotyledons) (Fig. 6).

**Figure 6: Flower and the fruit of the orange tree *(Citrus sinensis* (L.)).**

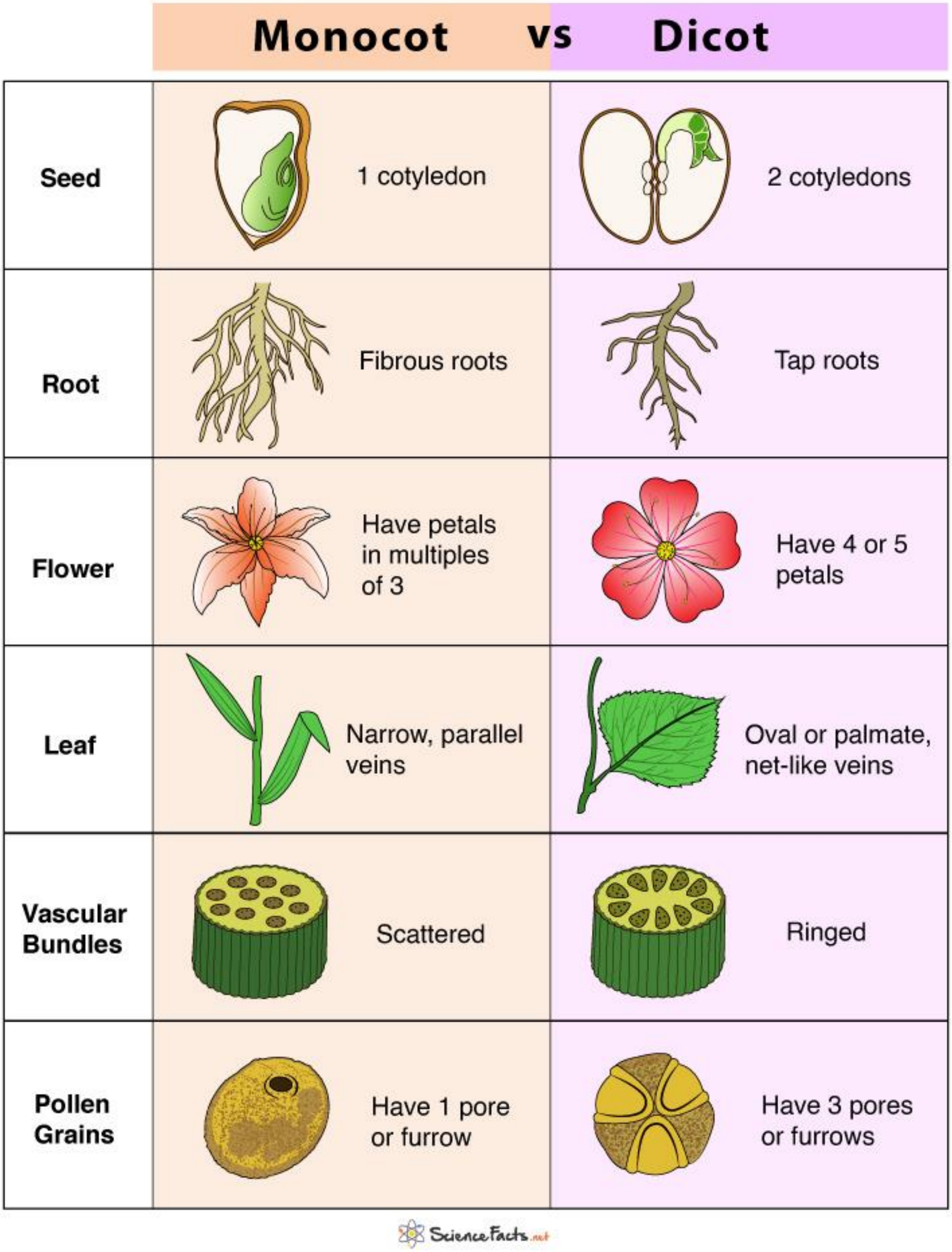


**Figure7: Monocotyledons and dicotyledons.**

**1.2 Plant cytology (reminder of cell membrane, cell wall, vacuole and plastid concepts)**

The organization of plant cells is very similar to that of animal cells. However, they are characterized by **the absence of a centriole**, and by the presence of three specific structures that we will describe in greater detail below: **the cell wall, the plastids and the vacuoles**. The size of plant cells is 10-15 µm in young cells, 100-200µm in adult cells, and up to several centimetres in some specialized cells (e.g. 4 cm for cotton fibre**).**

**a- Cell membrane**

Also known as **the plasma membrane**, composed **of phospholipids and proteins**. Also present in plant cells, it is located inside the cell wall and contains the cell's organelles.

It's a flexible, fluid membrane surrounding the cell and separating it from anything external, like a border. It plays an important role **in controlling exchanges essential to cell activity, such as the passage of carbon dioxide, nutrients and oxygen**.

In the plant cell, there are two important membranes: **the plasmalemma**, a thin envelope delimiting the intracellular from the extracellular environment, formed by **a double lipid layer**, and **the tonoplast** (containing water, carbohydrates, organic and inorganic ions and pigments), a membrane **separating the vacuole from the cytoplasm**, which is permeable to elements stored in the vacuole. Under a transmission electron microscope, a cross-section of the plasmalemma appears as a sandwich made up of two dark layers 2 nm thick surrounding a light layer 3.5 nm thick (1nm = 10-9 m) (Fig. 8).

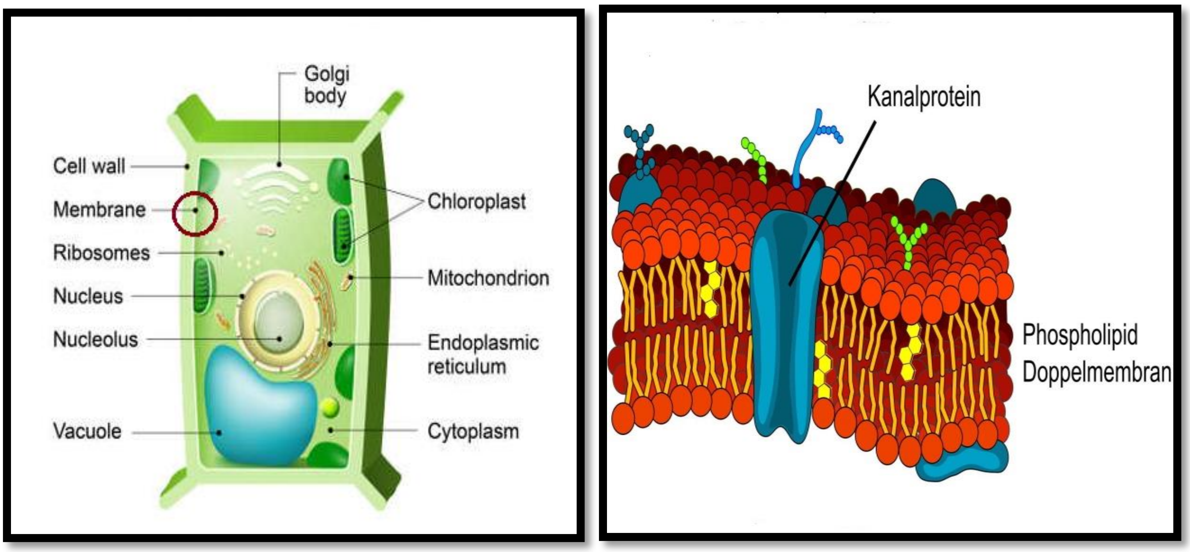


**Figure 8: Plant cell and cell membrane.**

**b- Cell wall**

The cell wall is the rigid envelope of the plant cell, forming **the external skeleton** of the cell. It is essentially composed of **carbohydrate polymers, cellulose and pectin, proteins and other phenolic compounds (lignin and suberin).** The thickness of the cell wall varies from **0.1 to several µm.**

**Cellulose** is organized in a hierarchical fibrillar structure. Cellulose fibrils are partially bound together by a homogeneous amorphous matrix composed **of protopectins** and **hemicellulose.** Around a hundred cellulose molecules are organized parallel to each other in **a micellar bundle or elementary fibrils**, within which the molecules establish **hydrogen bridges** that maintain a constant distance between the chains and stabilize them (Fig. 9).

- **It is composed of:**

**Middle lamella: or median lamella**, is the outermost part of the plant wall. It consists mainly of **pectin** and is common to two adjacent cells.

**Primary wall**: **pecto-cellulosic** in nature, it exists alone only in juvenile cells. It is extensible, enabling cell growth (elongation).

**Secondary wall:** Appears during cell differentiation. It consists of **cellulose and hemicellulose**, and is enriched with **phenolic compounds: - lignin, - cutin, - suberin**. This differentiation can be observed in the sap-conducting cells of the xylem (wood) and in various support tissues (sclerenchyma) or protective tissues (cork).

Its chemical composition is a heterogeneous structure made up of **cellulose in the form of microfibrils embedded in a glycoprotein matrix, pectin and hemicellulose, and proteins**. Walls are highly hydrated structures: water can represent up to 3/4 of the wall's weight.

The cell wall or skeletal wall is permeable to water and dissolved substances, enabling the exchange of matter between plant cells. These exchanges are facilitated by the existence of **punctata** (a thinning of the cell wall) and **plasmodesmata** (intercellular communications that cross the wall).

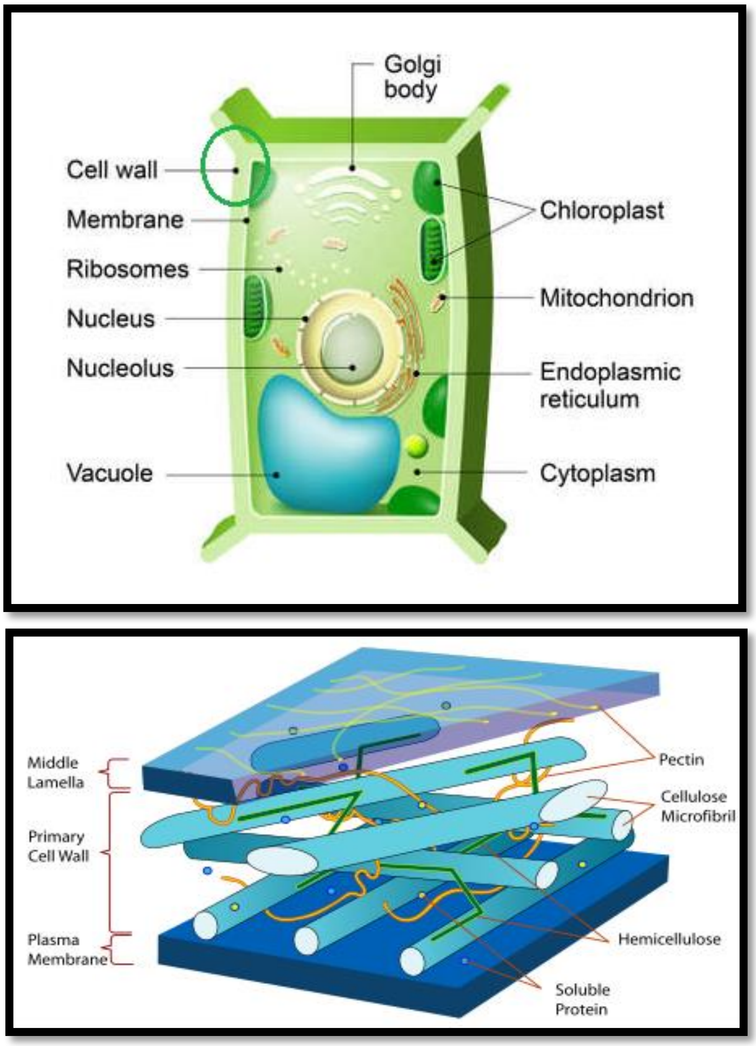


**Figure 9: Cell wall**

**c- Vacuole**

The vacuolar apparatus, characteristic of plant cells, contributes to water exchange and ensures cell turgor. In this respect, its physiological role is essential. Under the electron microscope, a vacuole appears as a large, clear enclave bounded by a simple membrane or **tonoplast**. In a **"meristematic"** cell, vacuoles are small, numerous and scattered throughout the cytoplasm (Fig. 10).

During cell differentiation, all these small enclaves tend to group together into two or three, then into a single large vacuole, pushing the cytoplasm back along the cell membrane. The vacuole is where the cell's water-soluble substances accumulate, and can contain a wide variety of substances, such as the **anthocyanins** and **flavones** that give flowers and fruit their color.

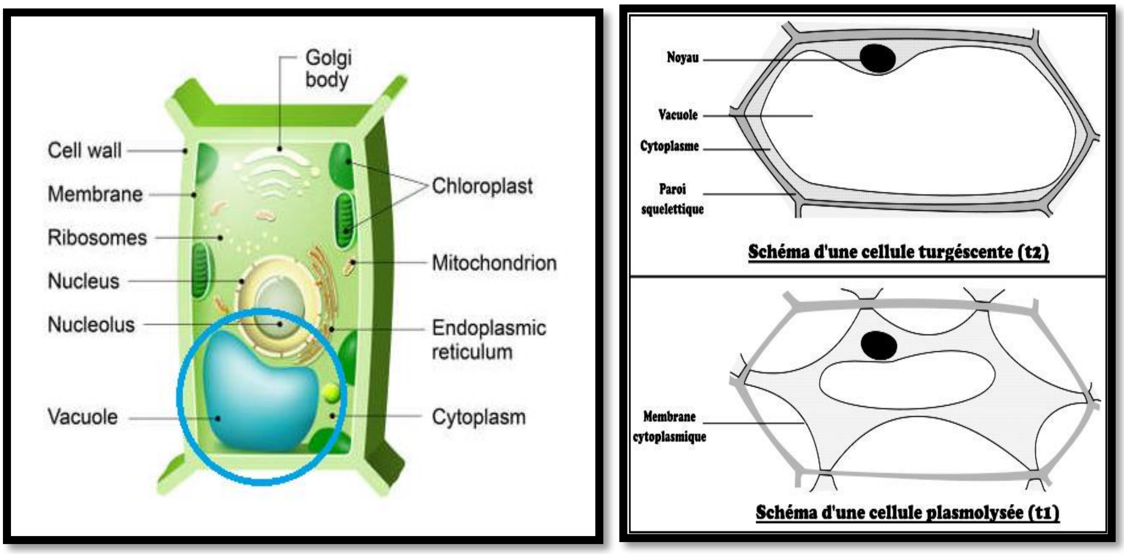


**Figure 10: vacuole of a plant cell**

**d- Plasts**

All plant organs contain plastids, which can vary in **size** and are derived from **pro-plasts,** which are simple, undifferentiated structures generally found in meristems. The plastid is a cellular organelle with its own DNA. A plastid has an inner and an outer membrane, forming **a plastid envelope**. **They are found in chlorophyllous eukaryotic cells** (algae and plants) (Fig. 11).

Several types of plastids can be distinguished:

**-Proplasts**: these are small, structurally simple, undifferentiated organelles specific to plant cells, generally found in meristems.

**- Chloroplasts**: these are organelles found in the cytoplasm of plant cells. They often take the form of flattened discs 2 to 10 µm in diameter. They are sensitive to different wavelengths of the light spectrum. Through the chlorophyll they contain. This is where photosynthesis takes place.

**- Etioplasts:** these are either chloroplasts that have not yet differentiated, or chloroplasts that have etiolated due to lack of light. They are generally found in plants that have grown in the dark.

**- Chromoplasts**: these are organelles found in the cells of plant organs rich in non-chlorophyll pigments, such as xanthophylls and carotenes, colored from yellow to orange (e.g. flower petal cells).

**- Leucoplasts**: these represent a category of plastids that have no pigments. Leucoplasts are not green, suggesting that they are located in roots and non-photosynthetic tissues. They can specialize to store starch, lipid or protein reserves, in which case they are respectively called **amyloplasts,** found in potato tubers**, oleoplasts**, found in the petals of some irises, or **proteinoplasts,** found in many seeds such as peanuts.

A plastid can change type, a process known as plastid interconversion. For example, a potato eucoplast can be transformed into a chloroplast in the presence of light, while a lemon

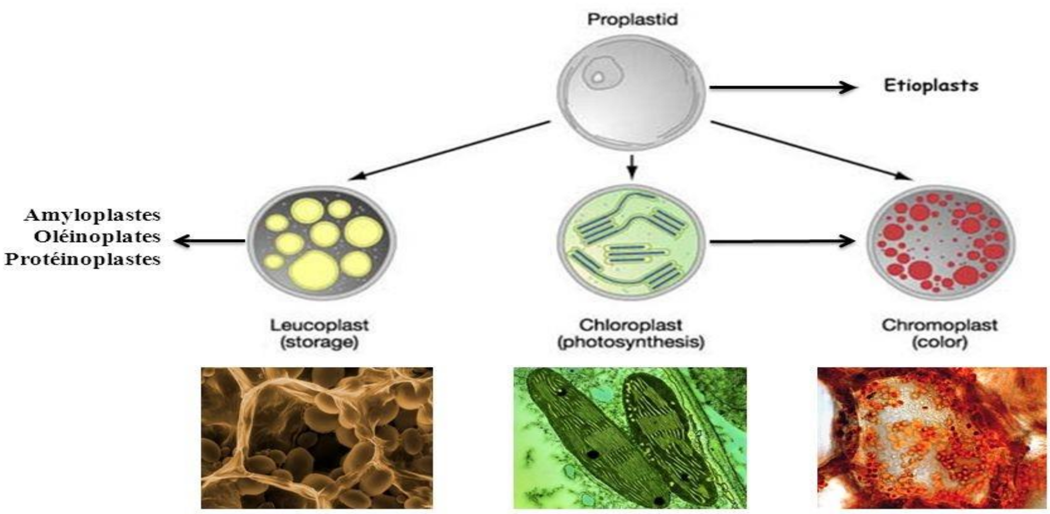


**Figure 11 : the different types of plastids**