1. Introduction to plant biology

Plants are de fined as generally green organisms that, despite their evolution, are unchanging in form and behaviour. They use energy to produce the various molecules essential for the survival of animals and other organisms that cannot produce their own food. The plant kingdom is characterised by its structure, first by its cells and then by the structure of its tissues.

1.1 Plant classification

Plants are classified according to several criteria: cytological, anatomical and morphological. Plants can be divided into two main subgroups according to their structural organisation: Thallophytes and Cormophytes.

1. 1. 1 Thallophytes

These are plants whose structure is a thallus made up of similar cells with no physiological differentiation, in which no roots, stems, leaves or vascular system can be distinguished. Some thallophytes are unicellular, such as cyanobacteria (blue-green algae), but sometimes the thallus has complex, multicellular structures, such as fungi and yeasts. Reproduction is by spores or by mutually produced gametes.

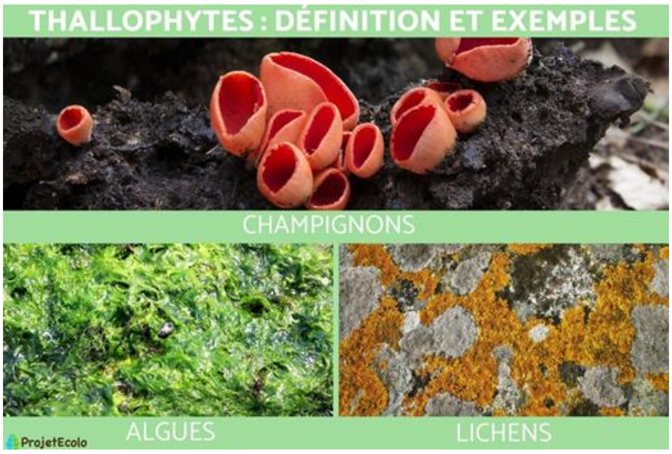

Figure 1: Images of some thallophyte species. https://www.projetecolo.com/thallophyte-definition-et-exemples-977.html

1. 1. 2. Cormophytes

This group is made up of multicellular higher plants with a set of leafy stems with or without roots, the cormus, hence the name cormophyte. They are divided into several phyla:

1.1. 2. 1. Bryophytes (mosses)

The plant has 'stems' and 'leaves', but no real root system or conductive tissues.

Figure 2: Mosses. https://www.futura-sciences.com/planete/definitions/botanique-bryophyte-5908/

1. 1. 2. 2. Pteridophytes (ferns)

This phylum is characterised by the appearance of a root system and true vascular tissues, but there are no flowers or seeds.

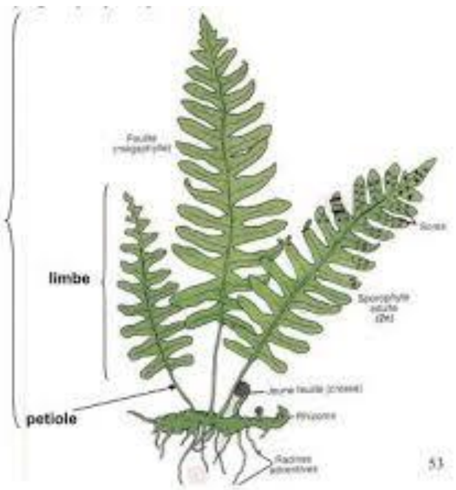

Figure 3: The frond. https://univ.ency-education.com/uploads/1/3/1/0/13102001/pharm2an05_botanique-pteridophytes.pdf

1. 1. 2. 3 The Prepermaphytes (Prephanerogams)

An intermediate group between the Pteridophytes and the Spermaphytes.

1. 1. 2. 4 The Spermaphytes (Phanerogams)

These plants are characterised by the appearance of both flower and seed, hence the name spermaphytes (from the Greek sperma: seed; phytes: plant...), also known as ovule plants. This phylum is divided into 3 subphyla:

- **Gymnosperms:** (Gymnos: naked; sperma: seed) in which the ovules and seeds themselves are not surrounded by a closed envelope.
- **Chlamydosperms:** (Chlamydos: envelope; sperma: seed), their reproductive organs are surrounded by a simple envelope.

- **Angiosperms:**

Includes flowering plants, and therefore plants that bear fruit. Angiosperm means "seed in a container" in Greek, as opposed to gymnosperms (bare seed). Angiosperms include Dicotyledons and Monocotyledons.

1.2. The plant cell

Almost all plant cell organelles are also present in the cells of other eukaryotic organisms. The cell of higher eukaryotic plants consists of a true nucleus, a pectocellulose wall, a large vacuole, plastids and cytosomes.

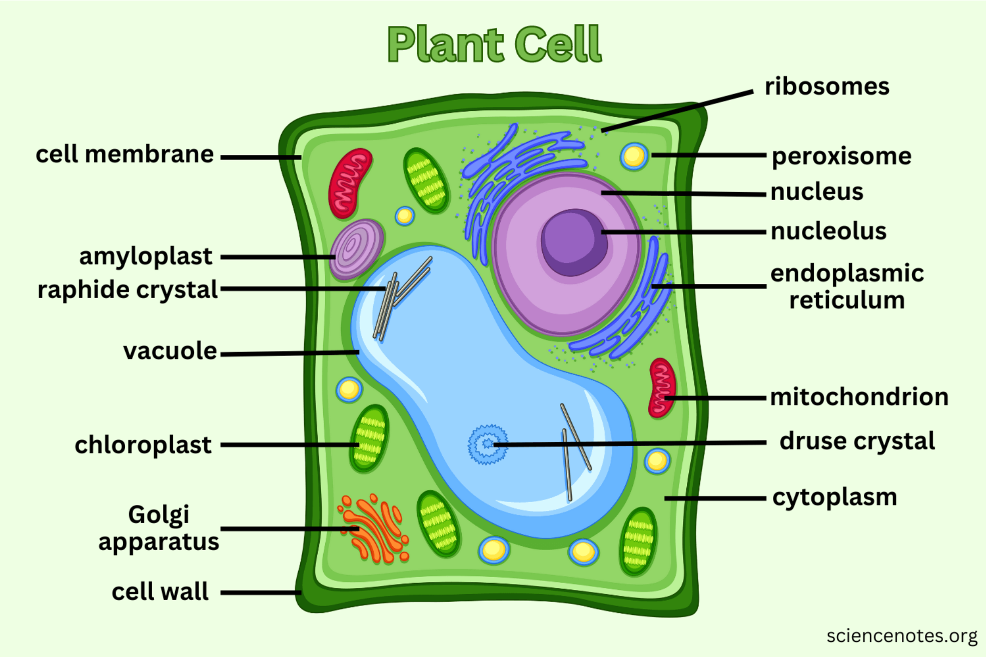

Figure 4: cell plant https://sciencenotes.org/plant-cell-diagram-organelles-and-characteristics/#google_vignette

1.2.1. Cell membranes

Peripheral zone of the cytoplasm dominated by certain lipid and protein molecules in an architectural arrangement. In plant cells, there are two major membranes.

 The plasmalemma (plasma membrane): delimits the cytoplasm from the cell periphery, playing a dual role of protection and control of exchanges between the intracellular and extracellular environments. It does not completely isolate the cell, as there is a symplasmic continuum between cells, called plasmodesmata.

 The tonoplast: a simple membrane that isolates the vacuole from the cytoplasm. It is permeable to elements stored in the vacuole. Also known as tonoplast or endoplasm.

1. 2.2. The cell wall :

Unlike animal cells, plant cells have a thick, rigid pectocellulose wall. Its role is to maintain the cell and its physical links with neighboring cells. It forms an extracytoplasmic compartment called the apoplasm, which is made up of three compartments.

- Middle lamella: From the Latin (lamina meaning thin blade), this is the outermost part of the cell wall, composed of pectic substances produced during cell division. It forms the cement that holds cells together. The middle lamella is cellulose-free.

- Primary wall: The primary wall is deposited before and during plant cell growth. It is made up of proteins, hemicellulose and pectic compounds, but mainly cellulose. It lies between the middle lamella and the plasma membrane, and is extensible, enabling cell growth (elongation).

-- The secondary wall: The secondary wall is formed mainly when cell growth is complete (during cell differentiation). Thicker than the primary wall, it is made up of three sub-layers that differ in thickness and in the orientation of the micro-fibrils that make them up; its total thickness can range from 4 to 10µm. It lies between the primary wall and the plasma membrane, made up of cellulose and hemicellulose and rich in phenolic compounds such as lignin (for rigidity), suberin and cutin (for impermeability).

1.2.3 The vacuole

The vacuole is a feature that distinguishes plant cells from animal cells. It generally occupies over 40% of cell space, and is bounded by a membrane called the tonoplast. Many vacuoles are filled with a liquid, generally called vacuolar juice, mainly composed of water, mineral elements, organic substances and pigments (e.g. anthocyanins). The vacuole plays a number of very important roles, some of which concern the cellular metabolism, controlling the cell's water balance. It also plays a detoxifying role with regard to toxic substances, and regulates salt concentration. The vacuole can store toxic ions and ions required for specific chemical reactions. It also helps maintain cell shape by exerting pressure on the cell wall.

1.1.4. Plasts

Cytoplasmic inclusions of various shapes, colours, sizes and functions found in all plants. They are derived from proplasts. Each plastid has its own DNA and is surrounded by a double membrane that forms the plastid envelope. Plastids are involved in processes such as photosynthesis and storage of reserves. The most common plastid is the chloroplast, which contains the chlorophyll needed for photosynthesis. But there are also: etioplasts, chloroplasts, chromoplasts, leucoplasts, amyloplasts, and proplasts, which, as their name suggests, are the origin of other plastids.

1.2.4.1 Proplasts: undifferentiated plastids

1.2. 4.2 Etioplasts: plant plastids that lack light

1.2. 4.3. Chloroplasts

Chloroplasts are generally between 4 and 10 μm long. These organelles, the sites of photosynthesis, contain chlorophylls (responsible for the green colour of plants) and carotenoid pigments. The chloroplast is surrounded by a double membrane. The outer membrane is continuous, while the inner membrane sometimes invaginates into the stroma. The stroma is traversed by an elaborate system of membranes that form flattened sacs called thylakoids. Stacks of thylakoids are called grana, and these grana, which can consist of 2 to 100 disks, are linked together by stromal lamellae to form a continuous network. The stroma also contains ribosomes and circular DNA. Chlorophyll pigments are embedded in the thylakoid membranes.

1.2. 4. 4 Chromoplasts

Chromoplasts lack chlorophyll, but synthesize and store carotenoids, pigments often responsible for the colors yellow, red and orange.

many flowers, ripe fruit and autumn leaves. Chromoplasts are usually found in plant cells exposed to light. However, some cells not exposed to light may also contain carotene (carrots in the soil).

1.2.4.5 Leucoplasts

Adult plastids whose structure is the least differentiated; they possess neither pigments nor an elaborate system of internal membranes. They are found in roots and nonphotosynthetic tissues. They also include starch-storing amyloplasts, lipid-storing oleoplasts and protein-storing proteinoplasts.

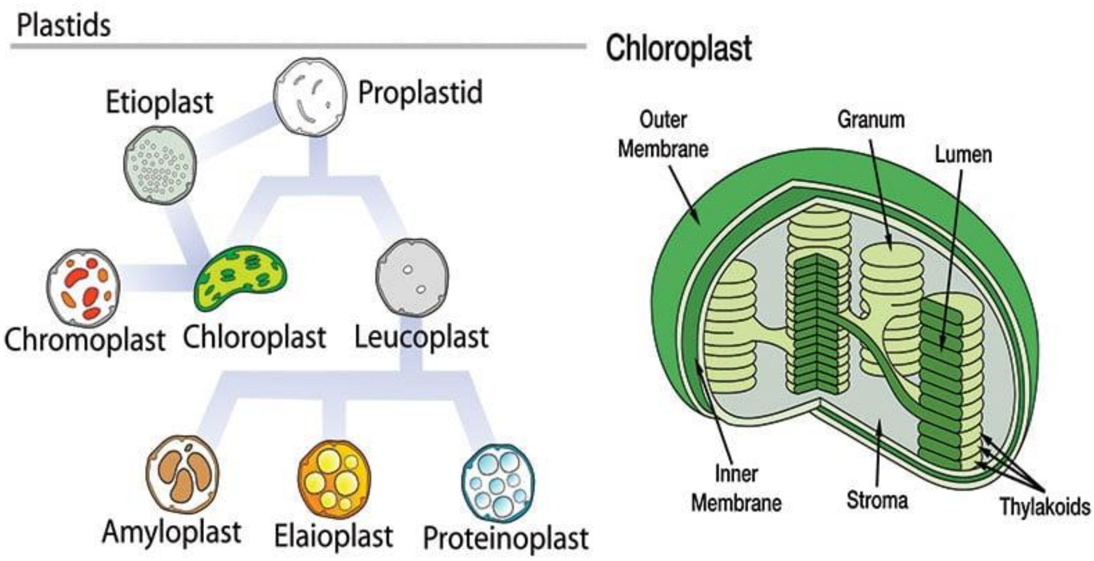

Figure 5: Diagram of Plastids. https://microbenotes.com/plastids-types-structure-and-functions/

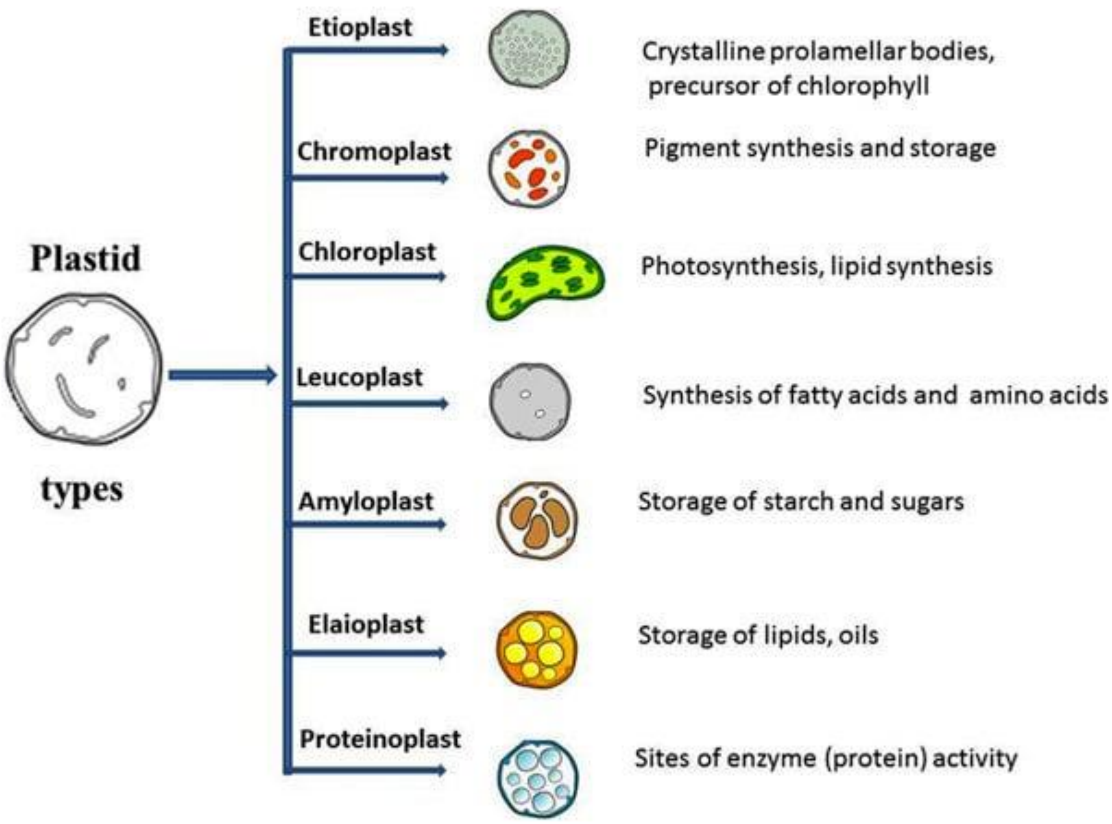

figure 6 : Types of Plastids Sitanshu Sekhar Sahu (https://doi.org/10.1186/1471-2105-14-S14-S7)

1.2.5. Cytosomes

Cytosomes, also known as "microbodies", are spherical cellular organelles bounded by a simple membrane. Their interior contains a number of enzymes, enabling us to classify them as follows:

A/ Lysosomes, containing lytic enzymes that cut numerous macromolecules such as polysaccharides and nucleic acids.

B/ Glyoxysomes are cellular organelles which, in collaboration with the mitochondria, convert reserve lipids into carbohydrates. These reactions, which do not occur in animals, are particularly important in seeds during germination.

C/ Peroxisomes are spherical organelles closely associated with mitochondria and chloroplasts. They are found in photosynthetically active cells. They are the site of the main stages of photorespiration.