

01. INTRODUCTION

The spectacular diversity of plant size and form is familiar to everyone. In nature all plants carry out similar physiological processes. As primary producers, plants convert solar energy to chemical energy. Being non motile, plants must grow toward light, and they must have efficient vascular systems for movement of water, mineral nutrients, and photosynthetic products throughout the plant body. Green land plants must also have mechanisms for avoiding desiccation.

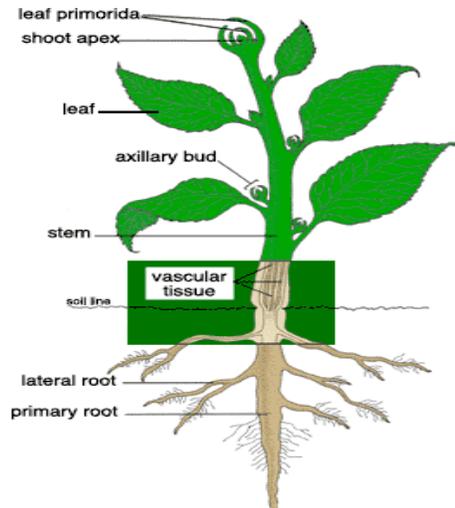


Figure 1. Principal Parts of a Vascular Plant

The meaning of Plant Physiology refers to “the science of properties and functions in normal conditions”. The aim of the Plant Physiology has been described as early as the early 20th Century by the Russian Plant Physiologist, V.I. Palladin as : “Which is to gain a complete and thorough knowledge of all the Phenomena occurring in plants, to analyse complex life processes. So as to interpret them in terms of simpler one and reduce them finally to the principles of physics and chemistry”. Nevertheless, Noggle and Fritz (1983) described the Plant Physiology as “the science concerned with processes and functions, the response of plants to changes in environment and the growth and development that results from responses

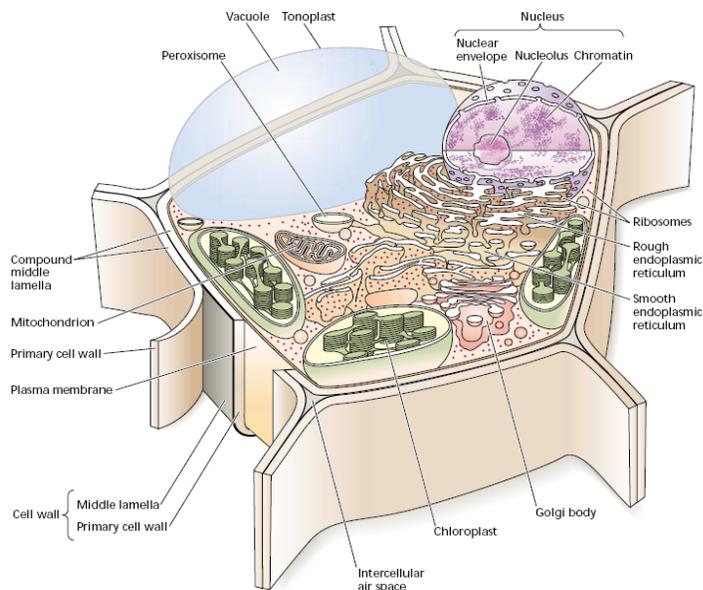
Crop physiology is concerned with the processes and functions of the crops at cellular, sub-cellular and whole plant levels in response to environmental variables and growth. In short, **physiology is the study of functional aspects of crop plants.**

Cell

Plants are multicellular organisms composed of millions of cells with specialized functions. At maturity, such specialized cells may differ greatly from one another in their structures. However, all plant cells have the same basic eukaryotic organization: They contain a nucleus, a cytoplasm, and sub cellular organelles, and they are enclosed in a membrane that defines their boundaries.

In plants, cell migrations are prevented because each walled cell and its neighbor are cemented together by a **middle lamella**. As a consequence, plant development unlike animal development, depends solely on patterns of cell division and cell enlargement.

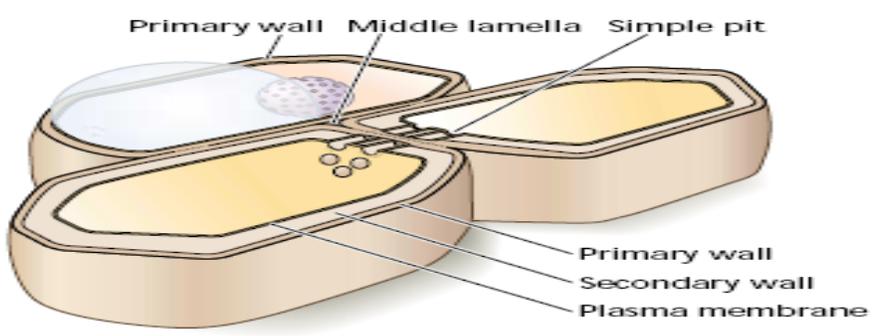
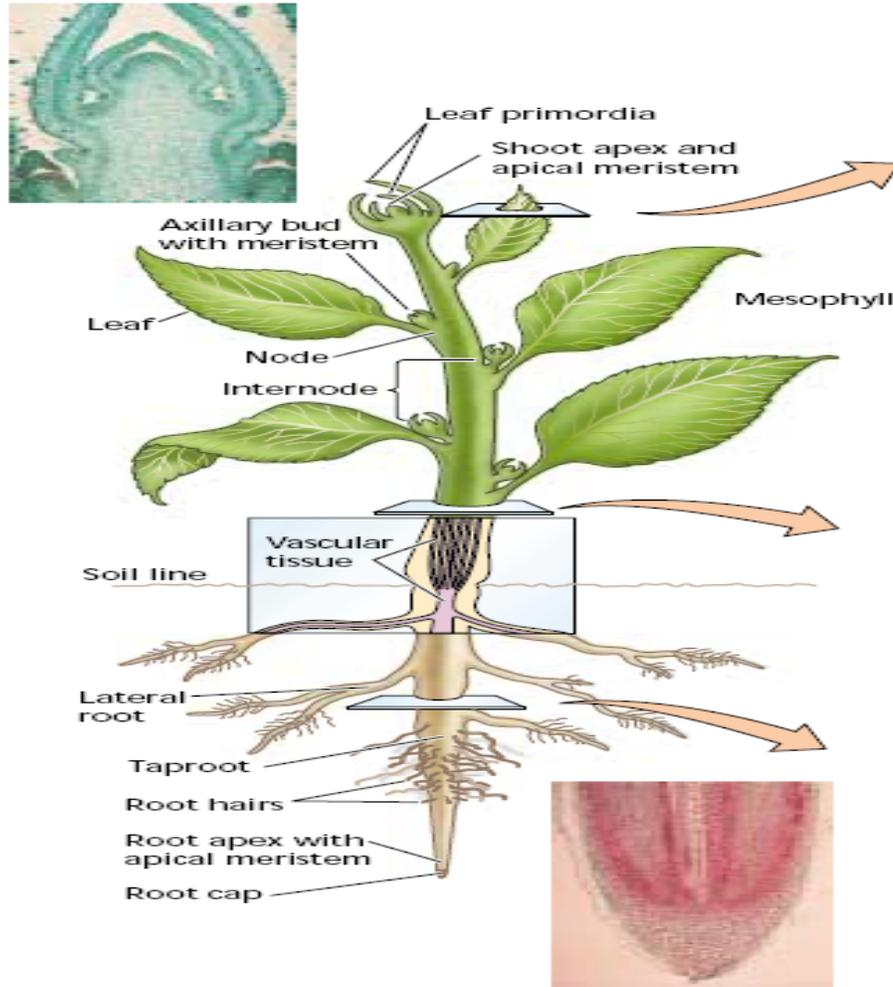
Plant cells have two types of walls: primary and secondary. **Primary cell walls** are typically thin and are characteristic of young, growing cells. **Secondary cell walls** are thicker and stronger than primary walls and are deposited when most cell enlargement has ended. Secondary cell walls owe their strength and toughness to **lignin**, a brittle, glue-like material. The evolution of lignified secondary cell walls provided plants with the structural reinforcement necessary to grow vertically above the soil and to colonize the land.



Plant anatomy

There are two categories of seed plants, gymnosperms and angiosperms. **Gymnosperms** are the less advanced type. **Angiosperms**, the more advanced type of seed plant which dominate the landscape. About 250,000 species are known, but many more remain to be characterized. The major innovation of the angiosperms is the flower; hence they are referred to as **flowering plants**.

Three major tissue systems are found in **flowering plants**; in all plant organs contain dermal tissue, ground tissue, and vascular tissue. The vegetative body is composed of three organs: **leaf**, **stem**, and **root**. The primary function of a leaf is photosynthesis, that of the stem is support, and that of the root is anchorage and absorption of water and minerals. Leaves are attached to the stem at **nodes**, and the region of the stem between two nodes is termed the **internode**. The stem together with its leaves is commonly referred to as the **shoot**.



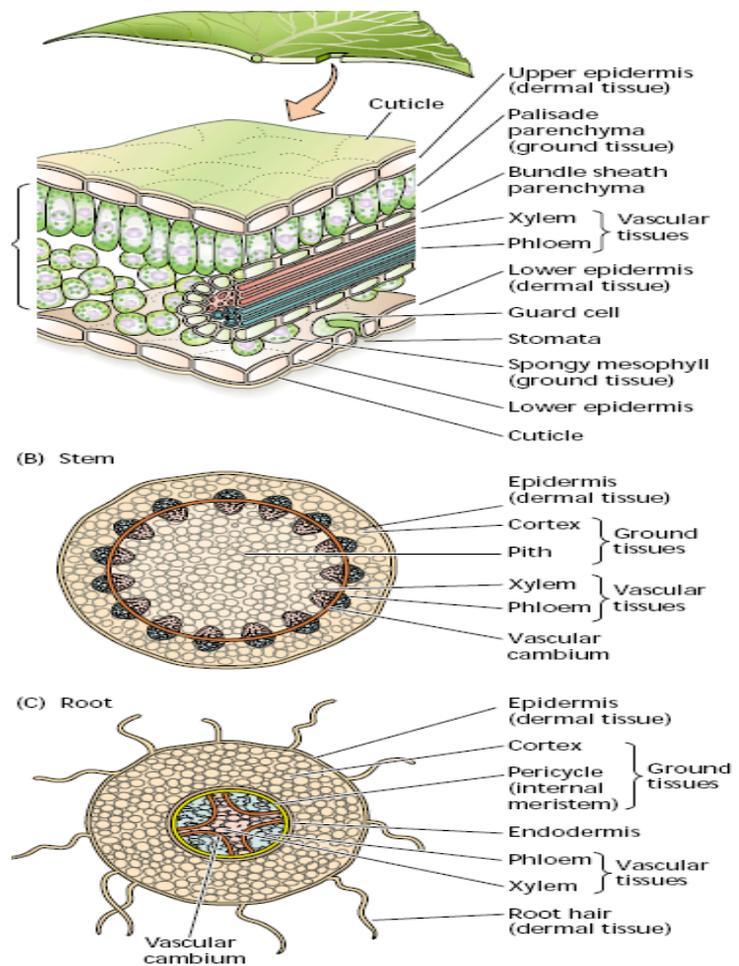
Plant parts (Source: Plant Physiology by Taiz and Zeiger)

Plant growth is concentrated in localized regions of cell division called **meristems**. Nearly all nuclear divisions (mitosis) and cell divisions (cytokinesis) occur in these meristematic regions. In a young plant, the most active meristems are called **apical meristems**; they are located at the tips of the stem and the root. At the nodes, **axillary buds** contain the apical meristems for branch shoots. Lateral roots arise from the **pericycle**, an internal meristematic tissue. Proximal and overlapping the meristematic regions are zones of cell elongation in which cells increase dramatically in length and width.

Cells usually differentiate into specialized types after they elongate. The phase of plant development that gives rise to new organs and to the basic plant form is called **primary growth**. Primary growth results from the activity of apical meristems, in which cell division is followed by progressive cell enlargement, typically elongation. After elongation in a given region is complete, **secondary growth** may occur. Secondary growth involves two lateral meristems: the **vascular cambium** (plural *cambia*) and the **cork cambium**. The vascular cambium gives rise to secondary xylem (wood) and secondary phloem. The cork cambium produces the periderm, consisting mainly of cork cells.

The architecture, mechanics, and function of plants depend crucially on the structure of the cell wall. The wall is secreted and assembled as a complex structure that varies in form and composition as the cell differentiates. Without a cell wall, plants would be very different organisms from what we know. Indeed, the plant cell wall is essential for many processes in plant growth, development, maintenance, and reproduction:

- Plant cell walls determine the mechanical strength of plant structures, allowing those structures to grow to great heights.
- Cell walls glue cells together, preventing them from sliding past one another. This constraint on cellular movement contrasts markedly to the situation in animal cells, and it dictates the way in which plants develop



- A tough outer coating enclosing the cell, the cell wall acts as a cellular “exoskeleton” that controls cell shape and allows high turgor pressures to develop.
- Plant morphogenesis depends largely on the control of cell wall properties because the expansive growth of plant cells is limited principally by the ability of the cell wall to expand.
- The cell wall is required for normal water relations of plants because the wall determines the relationship between the cell turgor pressure and cell volume
- The bulk flow of water in the xylem requires a mechanically tough wall that resists collapse by the negative pressure in the xylem.
- The wall acts as a diffusion barrier that limits the size of macromolecules that can reach the plasma membrane from outside, and it is a major structural barrier to pathogen invasion.

Much of the carbon that is assimilated in photosynthesis is channeled into polysaccharides in the wall. During specific phases of development, these polymers may be hydrolyzed into their constituent sugars, which may be scavenged by the cell and used to make new polymers