lecture 1

# Plant anatomy

Plant anatomy is the study of the internal structure of plants. It involves examining the different tissues, organs, and cell types that make up a plant, as well as understanding their arrangement and functions.

This field of biology provides essential knowledge for understanding plant growth, development, and adaptation.

## Key Concepts

- **Cells:** The basic building blocks of plants, each with specialized functions.
- **Tissues:** Groups of cells with similar structures and functions, such as parenchyma, collenchyma, and sclerenchyma.
- **Organs:** Structures composed of multiple tissues, such as roots, stems, leaves, flowers, and fruits.
- **Systems:** Groups of organs that work together to perform specific functions, such as the root system and the shoot system.

## Importance of Studying Plant Anatomy

- **Understanding plant growth and development:** Gain insights into the processes involved in plant growth, from seed germination to flowering and fruiting.
- **Identifying plant species:** Distinguish between different plant species based on their unique anatomical features.
- **Improving agriculture and horticulture:** Develop better agricultural practices, such as selecting crop varieties with desirable traits and optimizing planting and harvesting methods.
- **Studying plant adaptations:** Explore how plants have adapted to different environments, such as deserts, rainforests, and aquatic habitats.

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- **Medical and pharmaceutical applications:** Identify and isolate plant compounds with medicinal properties for drug development.

**History of Plant Anatomy: A Brief Overview**

The history of plant anatomy is intertwined with the development of the microscope and the scientific method. Before the invention of the microscope, our understanding of plants was limited to macroscopic observations. However, with the advent of magnifying lenses, scientists began to explore the intricate details of plant structures.

- **Robert Hooke (1635-1703):** One of the earliest pioneers, Hooke coined the term "cell" after observing honeycomb-like structures in cork under a microscope.
- **Nehemiah Grew (1641-1712):** A British physician and natural philosopher, Grew made significant contributions to plant anatomy, describing various plant tissues and organs.
- **Marcello Malpighi (1628-1694):** An Italian physician and biologist, Malpighi is considered one of the founders of plant anatomy. He published "Anatomia Plantarum," a groundbreaking work on plant structures.
- **Matthias Schleiden (1804-1881) and Theodor Schwann (1810-1882):** These scientists formulated the cell theory, stating that all organisms are composed of cells. This fundamental principle had a profound impact on the study of plant anatomy.
- **Carl von Nägeli (1817-1891):** Nägeli made significant contributions to cell biology and plant anatomy, studying cell division and the structure of plant tissues.
- **Wilhelm Hofmeister (1824-1877):** Hofmeister's work on plant embryology and life cycles provided valuable insights into plant development and anatomy.

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# Plant cell

All plants (and every other living organism) are composed of cells. Cells represent the smallest structural and functional units of life. Living organisms consist of single cells or of complexes of cells.

Cells vary greatly in size, form, structure, and function. Some are measured in micrometers, others in millimeters, and still others in centimeters (fibers in certain plants).

Some cells perform a number of functions; others are specialized in their activities. Despite the extraordinary diversity among cells they are remarkably similar to one another, both in their physical organization and in their biochemical properties.

Plant cells usually composed of two main components:

**Cell wall and protoplast.**

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## Cell wall

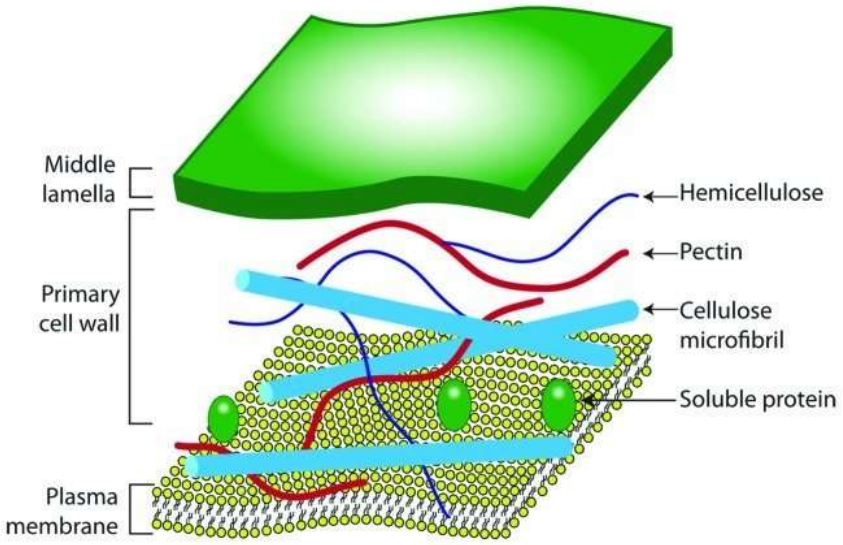
Cell walls are rigid structures found outside the plasma membrane of plant cells. They provide support, shape, and protection to the cell.

**Composition**

The primary cell wall of a plant cell is composed primarily of **cellulose** microfibrils embedded in a matrix of **hemicellulose** and **pectin**. These components are interconnected to form a strong and flexible network.

- **Cellulose:** A long, unbranched polymer of glucose molecules linked together by β-1,4 glycosidic bonds. Cellulose microfibrils are arranged in a parallel fashion, providing strength and rigidity to the cell wall.
- **Hemicellulose:** A complex polysaccharide composed of various sugars, including xylose, mannose, and galactose. Hemicellulose cross-links with cellulose microfibrils, contributing to the cell wall's structural integrity.

- **Pectin:** A polysaccharide composed of galacturonic acid units. Pectin forms a gel-like matrix that surrounds the cellulose microfibrils and hemicellulose, providing flexibility and hydration to the cell wall.




In some plant cells, a **secondary cell wall** may form inside the primary cell wall. The secondary cell wall is often thicker and contains more lignin, a complex polymer that provides additional strength and rigidity.

### Structure of plant cell wall

- It is derived from the living protoplast.
- It consists of the middle lamella, primary cell wall, secondary cell wall, plasmodesmata and pits.

**Middle lamella**

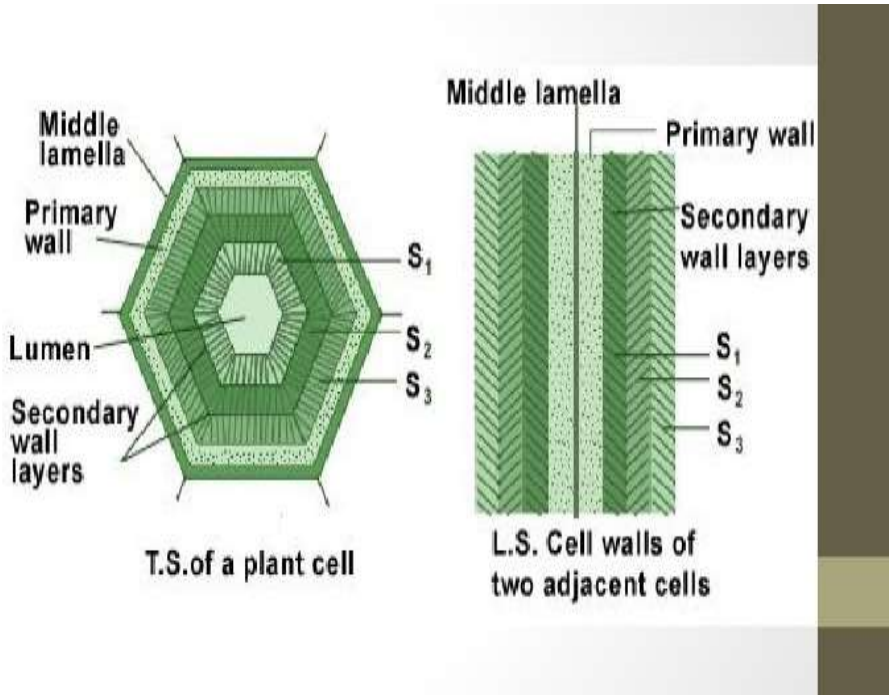
- After the cytokinesis, it is the first-formed layer.
- It is present in between the two adjacent cells.
- It is made up of calcium and magnesium pectate.
- It helps to join the two adjacent cells.

**Primary cell wall**

- It is the first formed cell wall.
- It is present in the inner side of the middle lamella.
- It is the thin and permeable layer that can be expanded.
- Cutin and cutin waxes are present in some epidermal cells of the leaf and stem. It makes the primary cell wall impermeable.
- It is formed before the growth and development of the cell.
- It is made up of matrix and microfibrils.
- Matrix is made up of water, hemicelluloses, pectin, lipids, and proteins.
- Microfibrils are embedded in the gel-like matrix.
- The primary cell wall of the plant is made of cellulose.
- In the fungi, chitin makes the primary cell wall, and in bacteria murein makes it.
- Primary cell wall forms the only cell wall in the immature meristematic and parenchyma cells.

**Plasmodesma (plural: plasmodesmata)**

- Plasmodesmata are cytoplasmic or protoplasmic bridges present in the primary cell wall of adjacent cells.
- They form a protoplasmic continuum called symplast.
- They transfer cytoplasmic materials among adjacent cells.



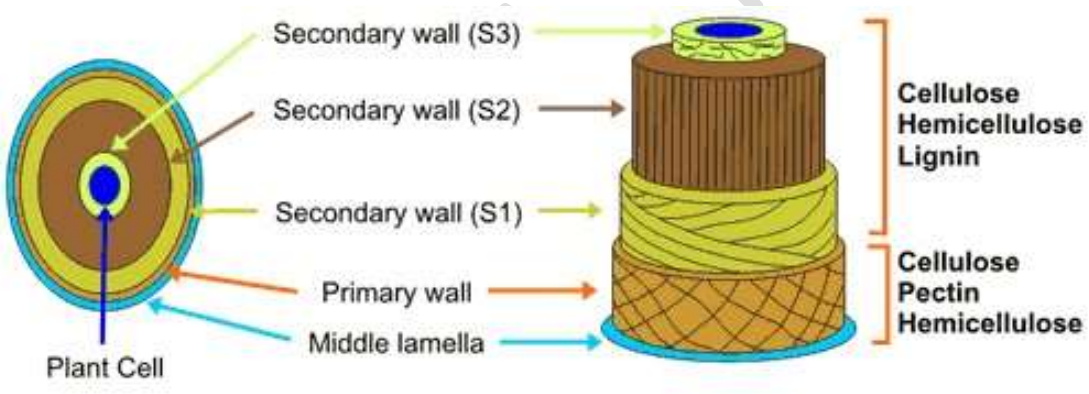

**Secondary cell wall**

- The secondary cell wall is situated inner to the primary cell wall.
- This is the thick layer, permeable, and cannot be expanded.
- It forms after the growth and development of the cell.
- It is present in the cells of the thick-walled dead tissue of the plant.
  Eg: Cells of sclerenchyma, tracheids, and vessels.
- It is differentiated into the outer layer ($S_1$), middle layer ($S_2$), and inner layer ($S_3$).
- Each layer is made up of a matrix and microfibrils.
- The chemical composition of the matrix is almost similar to the matrix of the primary cell.
- Microfibrils of the secondary cell wall is made up of cellulose and lignin.
- Some chemicals like suberin, silica, wax, resins, oils, etc. are also deposited in the secondary cell wall.

## Formation

Cell wall formation occurs during cytokinesis, the division of the cytoplasm during cell division. After nuclear division, a cell plate forms at the equatorial plane of the cell. Vesicles containing cell wall materials, such as cellulose, hemicellulose, and pectin, fuse with the cell plate to form the primary cell wall.

The orientation of cellulose microfibrils in the cell wall is influenced by the cytoskeleton, a network of protein filaments within the cell. The cytoskeleton directs the assembly of cellulose microfibrils, determining the cell wall's structure and properties.




**plant cell wall structure**

**Key point**

- Cell walls are rigid structures found outside the plasma membrane of plant cells.
- The primary cell wall is composed of cellulose, hemicellulose, and pectin.
- The secondary cell wall is thicker and contains more lignin.
- Cell wall formation occurs during cytokinesis.
- The cytoskeleton influences the orientation of cellulose microfibrils in the cell wall.

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