SUBJECT : BOTANY Paper Code : US03CBOT22 (T) PLANT ANATOMY, PHYSIOLOGY, TAXONOMY AND BIOINFORMATICS

Unit 1 Plant Anatomy:
Introduction and scope of Plant Anatomy : Applications in systematics, forensics, and Pharmacognosy.
Plant tissues : Classification of tissues; Simple and complex tissues.
Plant Histology: Internal organization of plant body : The three tissue systems, types of cells and tissues.
Meristem: Introduction, classification, cytological characters.
Parenchyma : Shape and arrangement, structure and contents.
Collenchyma : Position in the plant body,structure, and arrangement.
Sclerenchyma : structure and types.
Xylem: cell types and their cytology.
Phloem: cell types and their cytology.

Unit 1 Plant Anatomy : Introduction and scope of Plant Anatomy:

A plant is a complex structure that consists of a number of parts which constitute the whole plant. If you learn to identify each individual part, you will gain a much greater understanding as to how the plant works as a whole. This can be helpful to aroma-therapists who need to be aware of the part of the plant an essential oil was derived from because there is often a connection between the oils location in a plant and its therapeutic action. Understanding plant anatomy also helps everyone appreciate the art of distillation and extraction.

Plant anatomy is the study of **plant** tissues and cells in order to learn more about the way these organisms are constructed and how they work. These studies are very important because they lead to a better understanding of how to care for **plants** and fight **plant** diseases. Plant anatomy is also known as **Phytotomy.**

Applications in systematics, forensics, and pharmacognosy.

Anatomical characters of vegetative and floral parts of flowering plants have been successfully employed to solve taxonomic problems and for the explanation of phylogenetic relationship.

Anatomical evidence can be useful in systematic in several ways :

1. It can well be exploited taxonomically in the identification of fragmentary, say a piece of wood.
2. When morphological characters prove to be of no help in the preliminary identification of herbarium material, anatomical study may prove helpful.
3. Anatomical data has proved to be very useful in understanding evolutionary trends and interrelationship of taxa at and above the species level and at higher taxonomic categories.
4. They are most useful in determing relationship between different genera, families, orders and other taxonomic categories.

- **Plant anatomy** provides characters such as trichomes, stomata, cuticular pattern, leaf venation, wood **anatomy**, growth rings etc. to aid in species identification and in performing physical matches of evidence.

  plant anatomy can be important as a **forensic** tool in criminal investigations. The knowledge of the preparation of **plant** fragments, the analysis of these fragments, and the interpretation of the data obtained - all must be part of **forensic** botany.

  Fragments of herbarium specimens, leaf, dried and powdered medicinal plants etc. The prerequisite of any botanical research is the proper identification of the specimen. Trichome **anatomy**, wood and leaf **anatomy**, leaf epidermis and cuticle etc. provide valuable characters in differentiation between species.
  consistsof tracheidsand vessels. Vessels in

Plant tissues: Classification of tissues; Simple and complex tissues.

- Plant Tissues are three types
  - Meristematic Tissue
  - Permanent Tissue
  - Special

- Simple Permanent Tissue
  - Parenchyma
  - Chlorenchyma
  - Aerenchyma
  - Collenchyma
  - Sclerenchyma
  - Epidermis
- Complex Permanent Tissue
  - Xylem
  - Phloem

Plant Tissues

- Plants are fixed – they don't move. Most of the tissues they have are supportive, which provides them with structural strength.
- Most of the plant tissues are dead, since dead cells can provide mechanical strength as easily as live ones, and need less maintenance.
- There are some tissues in plants that divide throughout their life. These tissues are localised in certain regions.
- Based on the dividing capacity of the tissues, various plant tissues can be classified as **growing or meristematic tissue** and **permanent tissue**.

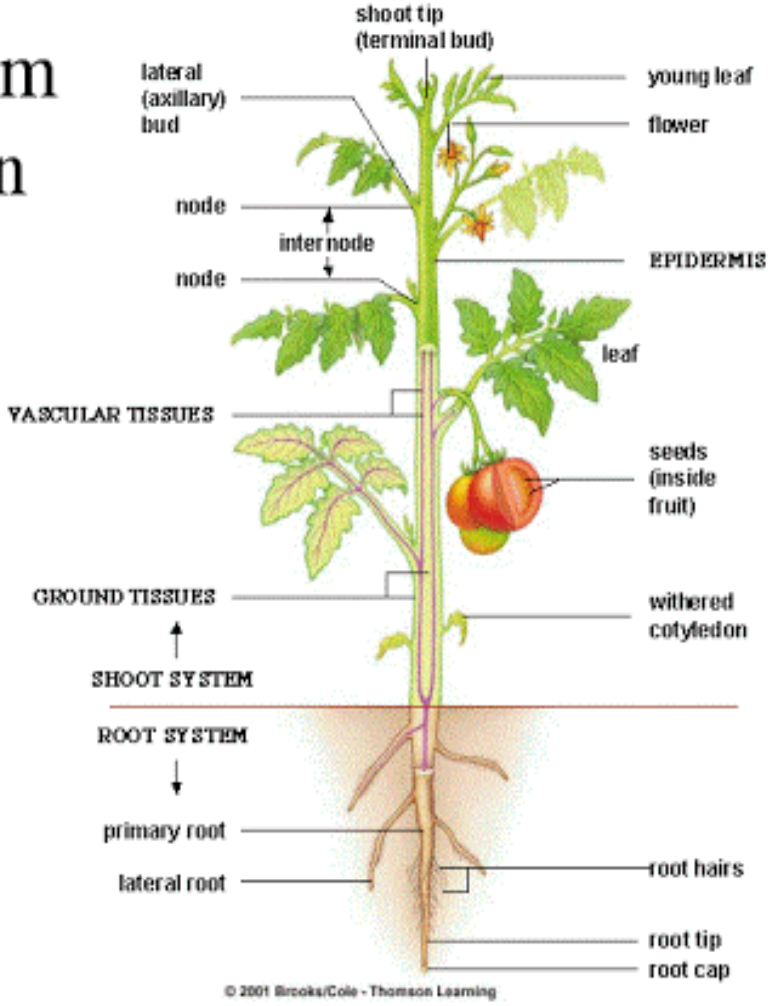
Plant Histology: Internal organization of plant body: The three tissue systems, types of cells and tissues.

Histology is the study of tissues and cells under a microscope.

Histology is related to Cell Biology(Cytology) and to Anatomy.

Angiosperm Body Plan

- Ground tissue system
- Vascular tissue system
- Dermal tissue system



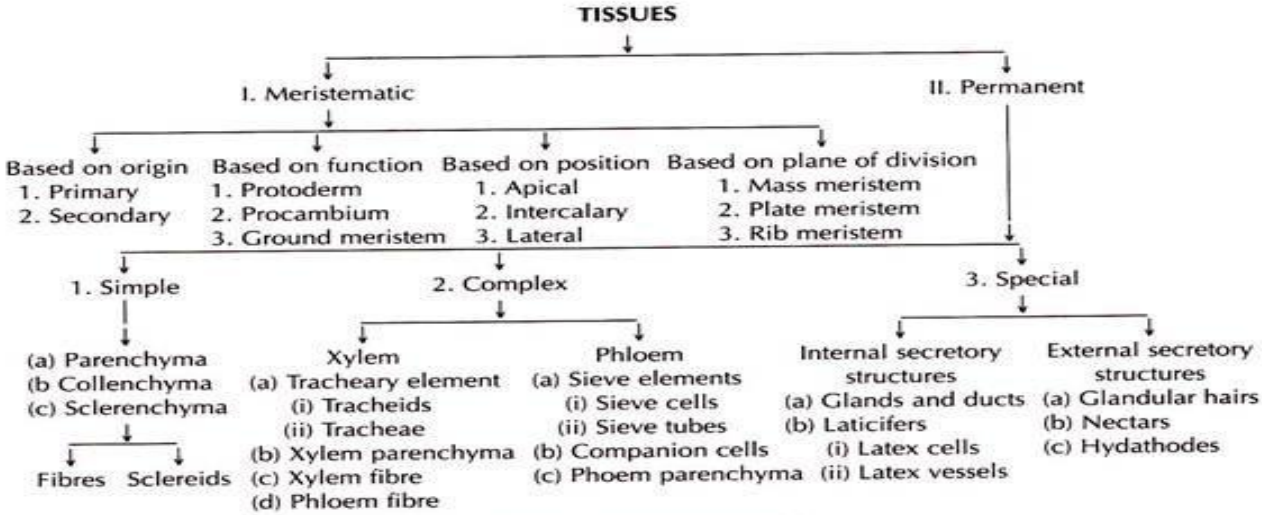


Fig. 5. 38 : Outline classification of tissues

Meristematic Tissue : MERISTEM is a group of cells which constantly divide and produce new cells indefinitely through the life of plant.

- The growth of plants occurs only in certain specific regions. This is because the **dividing tissue**, also known as meristematic tissue, is located only at these points.
- Depending on the region where they are present, meristematic tissues are classified as **apical meristems, lateral meristems** and **intercalary meristems**.
- New cells produced by meristem are initially like those of meristem itself, but as they grow and mature, their characteristics slowly change and they become differentiated as components of other tissues.

1. **Apical meristem** is present at the growing tips of stems and roots and increases the length of the stem and the root.
2. The girth of the stem or root increases due to **lateral meristem (cambium)**.
3. **Intercalary meristem** is the meristem at the base of the leaves or internodes (on either side of the node) on twigs.

- As the cells of this tissue are very active, they have **dense cytoplasm, thin cellulose walls** and **prominent nuclei**. They **lack vacuoles**.

Permanent Tissue

- What happens to the cells formed by meristematic tissue?
- They take up a specific role and lose the ability to divide. As a result, they form a permanent tissue.
- This process of taking up a permanent shape, size, and a function is called **differentiation**. Cells of meristematic tissue differentiate to form different types of permanent tissue.

- A few layers of cells form the basic **packing tissue**. This tissue is parenchyma, a type of permanent tissue. It consists of relatively **unspecialised cells with thin cell walls**.

Parenchyma : They are **live cells**. They are usually loosely packed, so that large spaces between cells (intercellular spaces) are found in this tissue.

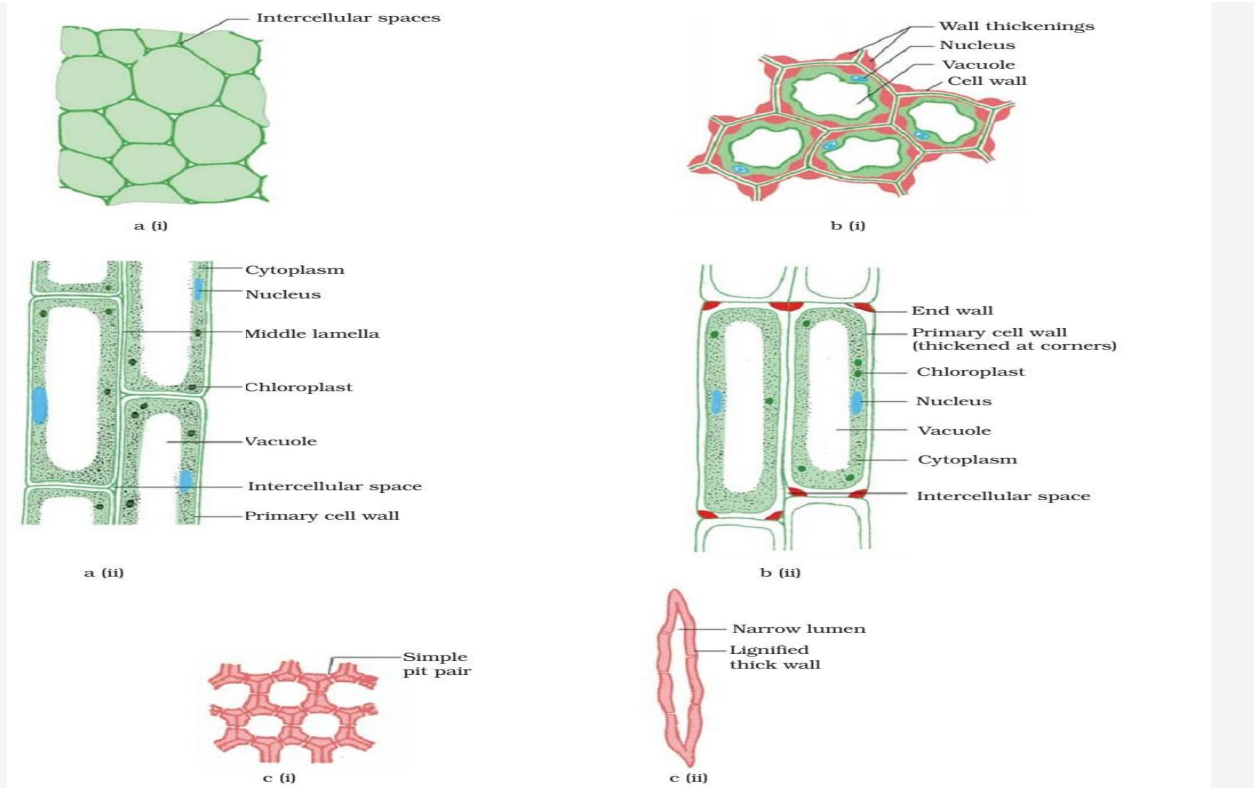
Chlorenchyma : This tissue provides support to plants and also **stores food**. In some situations, it contains chlorophyll and performs photosynthesis, and then it is called chlorenchyma.

Aerenchyma : In aquatic plants, large air cavities are present in parenchyma to give **buoyancy** to the plants to help them float. Such a parenchyma type is called aerenchyma. The parenchyma of stems and roots also stores nutrients and water.

Collenchyma : The flexibility in plants is due to another permanent tissue, collenchyma. It allows easy bending in various parts of a plant (leaf, stem) without breaking. It also provides mechanical support to plants. We can find this tissue in leaf stalks below the epidermis. The cells of this tissue are living, elongated and irregularly thickened at the corners. There is **very little intercellular space**.

Sclerenchyma : Yet another type of permanent tissue is sclerenchyma. It is the tissue which makes the plant **hard and stiff**. We have seen the husk of a coconut. It is made of sclerenchymatous tissue. The cells of this tissue are **dead**. They are long and narrow as the walls are thickened due to **lignin** (a chemical substance which acts as cement and hardens them). Often these walls are so thick that there is **no internal space** inside the cell. This tissue is present in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts. It provides strength to the plant parts.

Simple Permanent Tissue



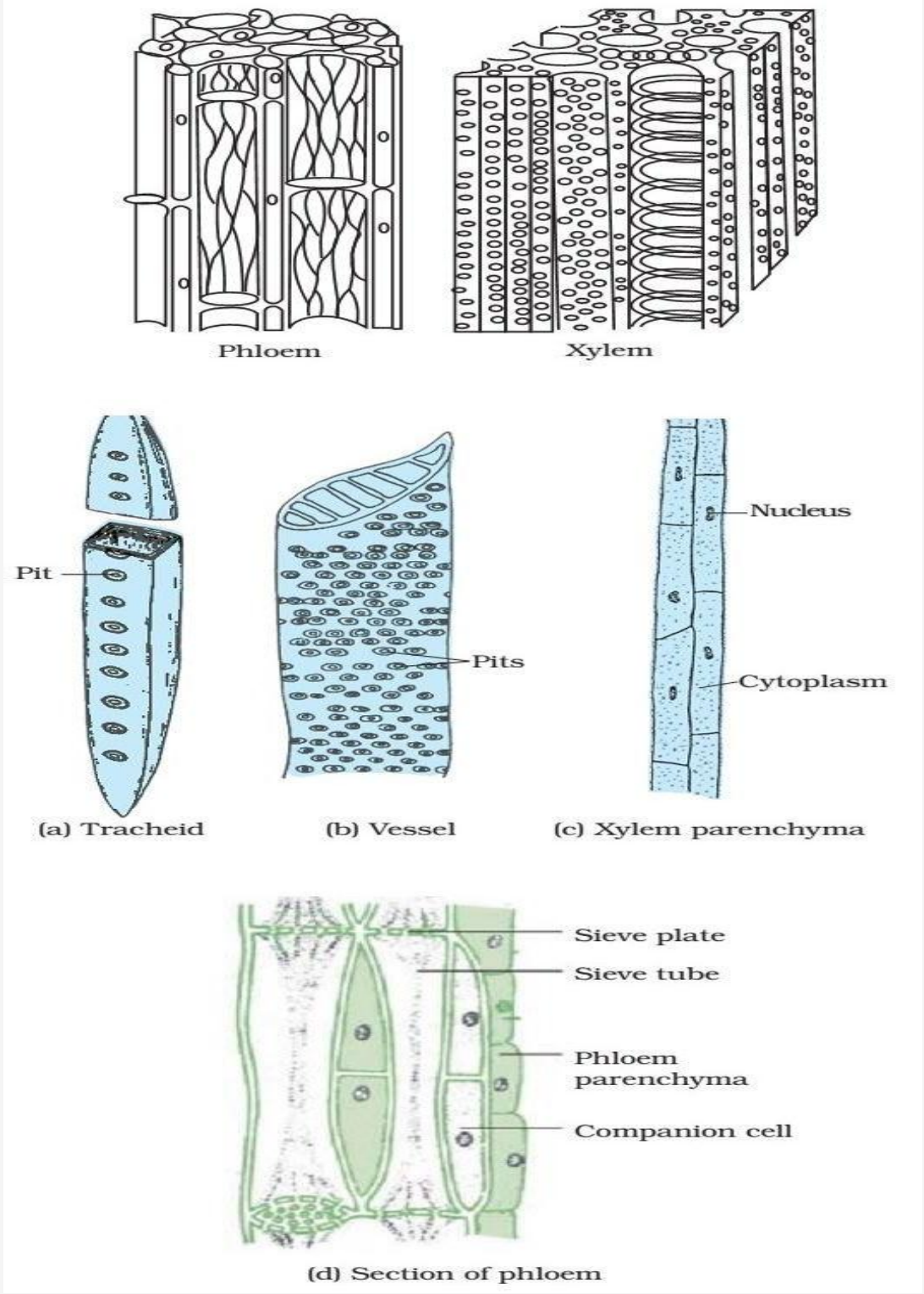
. 6.4: *Various types of simple tissues: (a) Parenchyma (i) transverse section, (ii) longitudinal section; (b) Collenchyma (i) transverse section, (ii) longitudinal section; (c) Sclerenchyma (i) transverse section, (ii) longitudinal section.*

Epidermis

- What you observe is the outermost layer of cells, called epidermis. The epidermis is usually made of a single layer of cells.
- In some plants living in very dry habitats, the Epidermis may be thicker since protection against water loss is critical.
- The entire surface of a plant has this outer covering of epidermis. It protects all the parts of the plant.
- Epidermal cells on the aerial parts of the plant often secrete a waxy, water-resistant layer on their outer surface. This aids in protection against loss of water, mechanical injury and protect by parasitic fungi.
- Since it has a **protective role** to play, cells of epidermal tissue form a continuous layer **without intercellular spaces**.
- Most epidermal cells are relatively flat. Often their outer and side walls are thicker than the inner wall.
- Small pores in the epidermis of the leaf are called **stomata**. Stomata are enclosed by two kidney-shaped cells called **guard cells**. They are necessary for exchanging gases with the atmosphere.
- **Transpiration** (loss of water in the form of water vapour) also takes place through stomata
- Epidermal cells of the roots, whose function is water absorption, commonly bear long hair-like parts that greatly increase the total absorptive surface area.
- In some plants like desert plants, epidermis has a thick waxy coating of **cutin** (chemical substance with waterproof quality) on its outer surface.
- As plants grow older, the outer protective tissue undergoes certain changes. A strip of secondary meristem replaces the epidermis of the stem. Cells on the outside are cut off from this layer. This forms the several-layer thick cork or the bark of the tree. Cells of cork are dead and compactly arranged without intercellular spaces. They also have a chemical called suberin in their walls that makes them impervious to gases and water

Complex Permanent Tissue

- The different types of tissues we have discussed until now are all made of **one type of cells**, which look like each other. Such tissues are called simple permanent tissue. Yet another type of permanent tissue is complex tissue.
- Complex tissues are made of **more than one type of cells**. All these cells coordinate to perform a common function.
- **Xylem** and **phloem** are examples of such complex tissues. They are both conducting tissues and constitute a vascular bundle.
- Vascular or conductive tissue is a distinctive feature of the complex plants, one that has made possible their survival in the terrestrial .



Xylem

- Xylem consists of **tracheids, vessels, xylem parenchyma** and **xylem fibres**. The cells have thick walls, and many of them are dead cells.

- Tracheids and vessels are tubular structures. This allows them to transport water and minerals vertically.
- The parenchyma **stores food** and helps in the **sideways conduction of water**. Fibres are mainly supportive in function.

Phloem

- Phloem is made up of four types of elements: **sieve tubes, companion cells, phloem fibres** and the **phloem parenchyma**. Sieve tubes are tubular cells with perforated walls.
- Phloem is unlike xylem in that materials can move in **both directions** in it. Phloem transports **food** from leaves to other Parts of the plant. Except for phloem fibres, phloem cells are living cells.

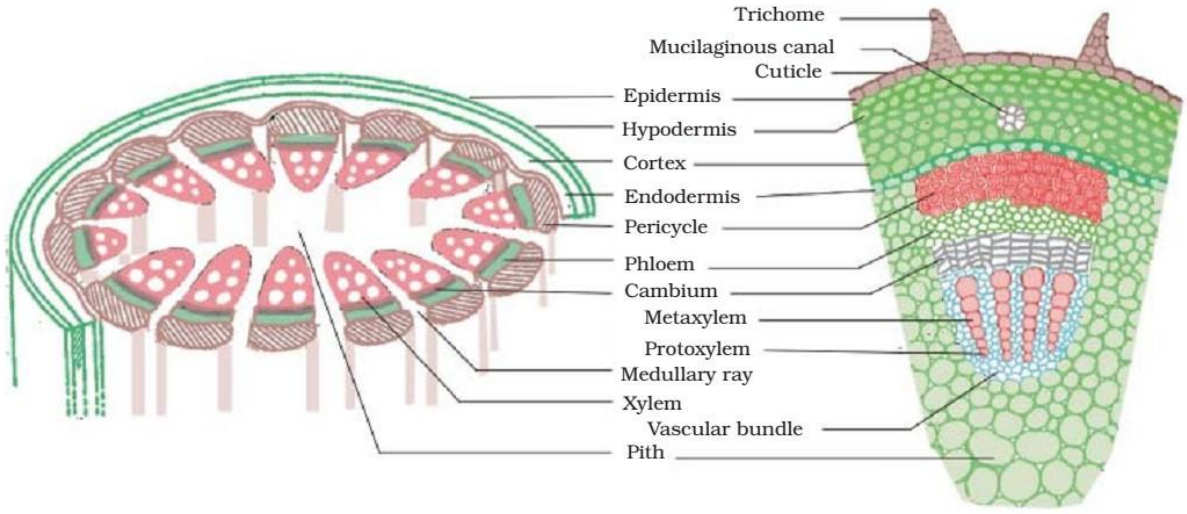


Fig. 6.3: *Section of a stem*

Meristem: Introduction, classification, cytological characters.

Meristematic Tissue Definition

"Meristematic tissue is the plant tissue that has the ability to divide actively throughout its life."

What is Meristematic Tissue?

The term meristem was given by Carl Wilhelm von Nägeli. Meristematic tissue contains undifferentiated cells which are the building blocks of the specialized plant structures.

Meristematic tissues contain living cells with varied shapes. They possess a large nucleus devoid of the vacuole. The cells have no intercellular space. The zone where these cells exist is known as meristem.

The cells of the meristematic tissue divide actively to form specialized structures such as buds of leaves and flowers, tips of roots and shoots, etc. These cells help to increase the length and girth of the plant.

Characteristics of Meristematic Tissue

The characteristics of meristematic tissue are as follows:

1. The cells of these tissues are commonly called meristems.
2. The meristematic tissue has the quality of self-renewal. Every time the cell divides, one cell remains identical to the parent cell and the others form specialized structures.
3. They have very small and few vacuoles.
4. The meristematic tissue are living and thin-walled.
5. The protoplasm of the cells is very dense.
6. The meristematic tissues heal the wounds of an injured plant.
7. The cells of the meristematic tissue are young and immature.
8. They do not store food.
9. They exhibit a very high metabolic activity.
10. They possess a single, large and prominent nucleus.

Types of Meristematic Tissue

Meristematic Tissue On the basis of Origin

Promeristem

- The earliest and youngest meristematic tissue.
- It originates from the embryo.
- The primary meristem arises from the promeristem.
- It is found in the root and the shoot tips.

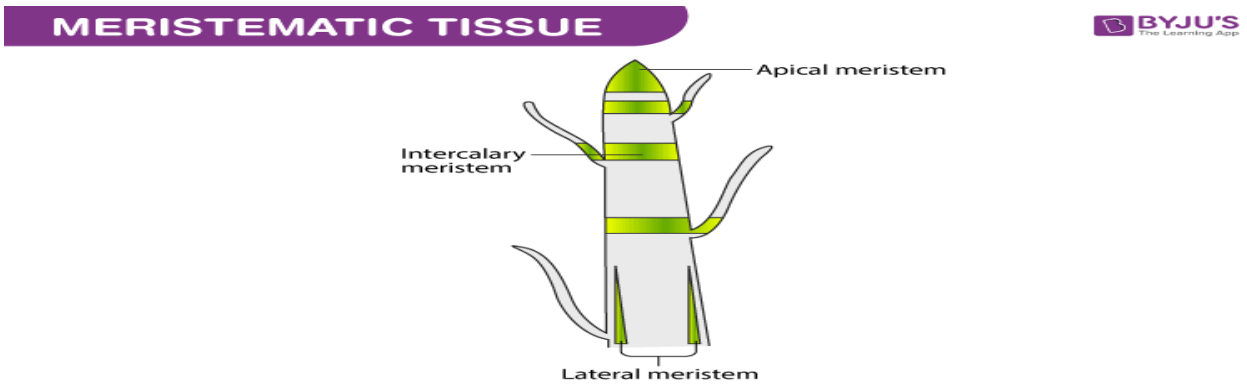
Primary Meristem

- It arises from the promeristem.
- Cells divide actively.
- It is present below the promeristem and forms the permanent tissue.

Secondary Meristem

- It originates from the primary meristem.
- The permanent tissue forms from the secondary meristem.

Meristematic Tissue On the Basis of Position



Meristematic Tissue – Based on Occurrence

Apical Meristem

- These are present at the tips of the roots and shoots and help in the increase in height of the plants.
- Various cell divisions facilitate the growth of the cells in the roots and shoots. and help in cellular enlargement.
- Apical meristem is divided into-promeristem zone which contains actively dividing cells, and the meristematic zone which contains protoderm, procambium, and ground meristem.

Intercalary Meristem

- It is located in the leaves and internodes at the intercalary position.
- These help to increase the length of the internode.
- It is found in grass, monocots, and pines.
- It is a part of apical meristem and adds to the height of the plant.

Lateral Meristem

- It is located in the stems and roots on the lateral side.
- It increases the thickness of the plant.
- Vascular cambium and cork cambium are the two lateral meristems.
- These divide periclinically or radially and give rise to secondary permanent tissues.

Meristematic Tissue On the Basis of Function

Protoderm

- It is the outermost plant tissue and forms the epidermis.

- It protects the plants from any mechanical shocks.

Procambium

- It is the innermost tissue and gives rise to xylem and phloem.
- It helps in the transport of water and nutrients to different parts of the plant.

Ground Meristem

- The cells are large with thick walls.
- It forms the cortex, pericycle, and pith.

The meristematic tissue is usually found in the apices of the root systems and the shoots and is in a continuous state of division.