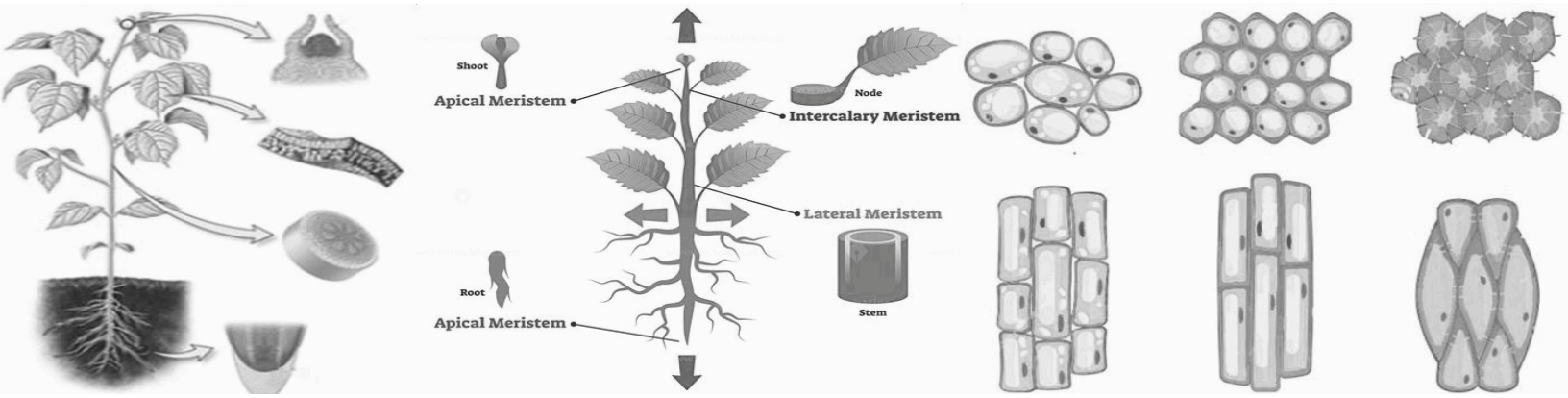


TISSUES

Concepts Covered

- Basic structures and functions of different types of tissues present in plants

Introduction

In unicellular organisms all the life processes are carried out within a single cell. In multicellular organisms, because of the increase in body size, it is difficult for each cell to efficiently cope with the vast variety of the physiological needs of the organisms, so cells differentiate into specific tissues to perform specific functions. So, the formation of tissues has brought about the division of labour in multicellular organisms.

Tissue

A collection of cells having similar shape, origin and usually performing a common function is called tissue.

The term tissue was coined by Nehemiah Grew. He first used this term in the year 1682. He was a British plant anatomist and physiologist. Nehemiah Grew is popularly known as 'The Father of Plant Anatomy'.

On the basis of dividing capacity of the tissue, plant tissues are of two types: -
1. Meristematic tissue (growing tissue)
2. Permanent tissue

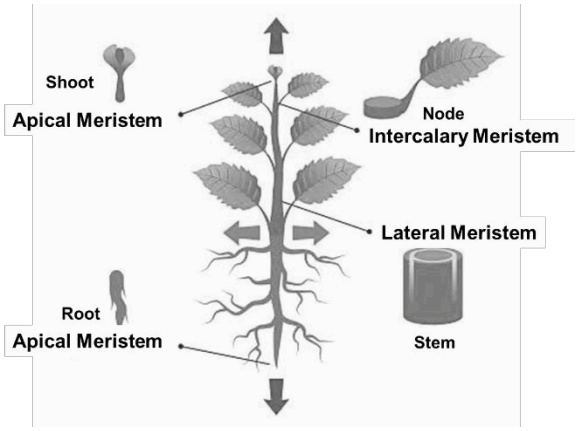
1. Meristematic Tissue

Meristematic tissues are seen in plants. They are primarily made up of rapidly dividing cells.

They are the growing tissues of the plant.

In these tissues, cells are thin-walled, living and isodiametric. They are oval or rounded or polygonal shaped.

Characteristics:
(i) Their cell wall is formed by cellulose.
(ii) Cells are compactly arranged or polygonal shaped.
(iii) They possess dense cytoplasm with no or a few vacuoles.
(iv) Cells contain a prominent and large nucleus.
(v) These are metabolically highly active and hence, capable of division throughout life.



Classification of Meristematic Tissues

On the basis of their location, meristematic tissues are of three types.

(i) Apical Meristem
- Found in root tip and shoot tip.
- Responsible for the increase in the length of plant organs and primary growth.

(ii) Intercalary Meristem
- Found between plant organs.
- They are short-lived and convert into permanent tissue.
- It helps in longitudinal growth which is also called primary growth.

Example: Base of internode of grasses and base of Pinus leaves.

(iii) Lateral Meristem
- Found on the lateral sides of stem and root.
- It helps is increasing the diameter (width) of plant, so help of secondary growth.

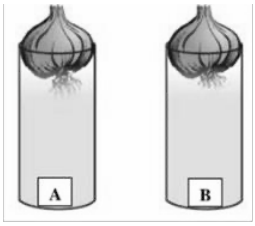
DID you KNOW

Root apical meristem is covered by a root cap which protects it from getting damaged by the rubbing of soil particles.

Activity

To demonstrate that apical meristem causes growth in length of root.

Method
Take two glass jars. Fill them with water. Place an onion bulb over the mouth of each jar in such a way the stem base of the bulb dips in water. Observe daily roots develop from the base of the bulbs in both the jars. Measure the length of the roots daily. On the fourth day, remove 1 cm long apical portion of the roots of bulb (2). Measure the lengths of the roots in both the bulbs on fifth and sixth day.



Growth of roots in Onion.
(1) With intact apical meristem.
(2) With apical meristem removed on fourth day.

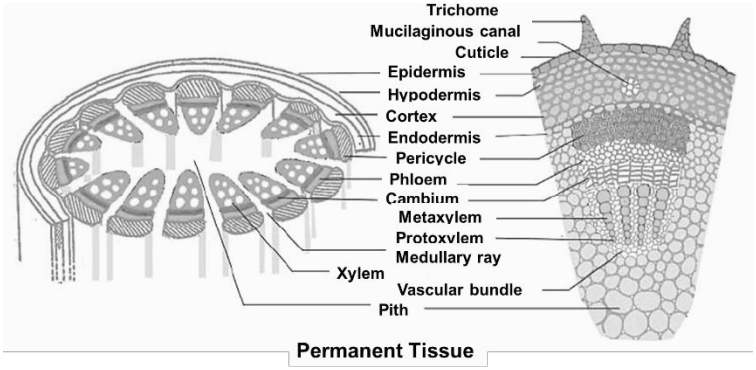
Observation
It is seen that roots of bulb (1) continue to grow on fifth and sixth day. They stop growing in case of bulb (2).
The difference between the two jars is that in bulb (1),
Root apical meristems are intact while in bulb (2),
Root apical meristems have been removed.

2. Permanent Tissue

Characteristics
(a) Cells may be oval, rounded, polygonal or elongated.
(b) They are composed of cells which have lost the power of division temporarily or permanent.
(c) They are formed by the division and differentiation of meristematic tissue.
(d) Cells may be living or dead.

Permanent tissue is of two types
(i) Simple Permanent Tissue
Further grouped into three categories:
a. Parenchyma
b. Collenchyma
c. Sclerenchyma

(ii) Compound or Complex Permanent Tissue
Further grouped into two categories-
a. Xylem
b. Phloem

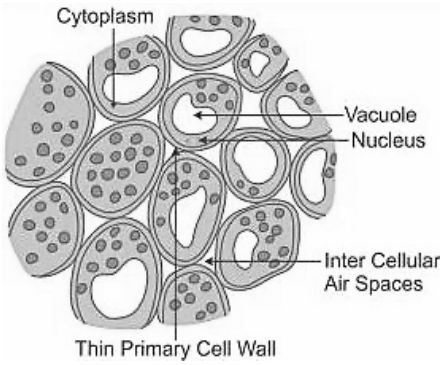


Permanent Tissue

(i) Simple Permanent Tissues

These are tissues that are made up of only one type of cell. They usually have a structural role.

(i) Parenchyma
- It consists of living cells.
- Intercellular spaces are present.
- The cell wall is thin without having secondary deposition.
- Its cells contain cytoplasm.
- Cell wall does not have pits.



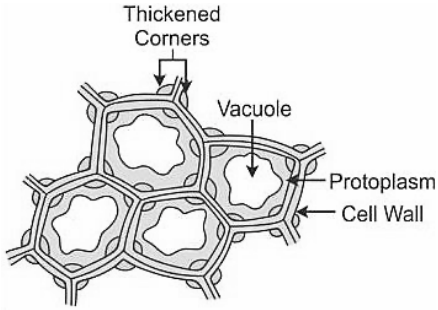
Modification of parenchyma:
(a) Chlorenchyma: Chlorenchyma is the type of parenchyma in which an abundant quantity of chloroplasts (containing chlorophyll) are found. They are present in mesophyll of leaves.
Function: Synthesis of food (Photosynthesis).

(b) Aerenchyma: Aerenchyma is made up of rounded cells which surrounds the large air cavities. It is found in aquatic plants or hydrophytes.
Function: It provides buoyancy to the aquatic plants to help them float.

Parenchyma is the first evolved permanent tissue which is present in all soft parts of plant (therefore called as universal tissue).

(ii) Collenchyma

- It consists of living cells, intercellular spaces may or not be present.
- Cells wall is thick due to secondary deposition.
- Cells contain cytoplasm.
- Call wall does not have pits.

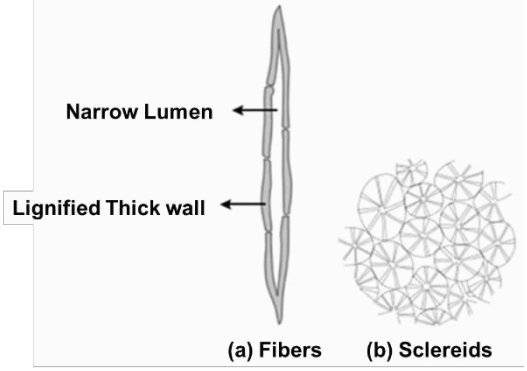


(iii) Sclerenchyma

- It is composed of extremely thick-walled cells with little or no protoplasm.
- Cells are dead & possess very thick lignified walls.
- Lignin is water-proof material.
- Intercellular spaces are absent.
- Cells of sclerenchyma are of two types: (a) Fibres (b) Sclereids.

(a) Fibers

- They are very long, narrow, thick, lignified cells. Lumen is large as compared to sclereids. They are generally 1-3 mm long.
- In the thick walls of both the fibres and sclereids are present thin areas called as pits.
- Sclerenchyma fibres are used in the manufacture of ropes, mats and certain textile fibres.
- Jute and coir are obtained from the thick bundle of fibres.

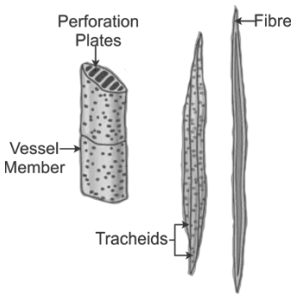


(b) Sclereids

- These are also called grit cells or stone cells.
- These are small cells, where lumen is so small due to higher thickening of cell wall, as present in drupe fruit (mango, coconut, walnut) in legume seeds (Macrosclereid).

Lignin is a complex polymer which acts as cement and hardens the cell wall. Lignin makes the cell wall impermeable so important substances are unable to pass through it. As a result, cells that are heavily lignified do not have living content (protoplasm).

(ii) Complex permanent tissue



Complex permanent tissues are made by a combination of different types of cells. These cells work together to perform a specific ask.

- These are conducting tissues of plants.
- These are of two types: -
  - Xylem
  - Phloem

(1) Xylem

Xylem is a complex permanent tissue found in all parts such as the root, stem and leaf of the higher plants. It is made up of four types of cells out of which one is living (xylem parenchyma) and three are dead (vessels, tracheid and xylem fibres).

(i) Tracheid

Elongated cell with a tapering end.
The wall is highly thickened with lignin except at pits.

(ii) Vessels

Very long tube like structures of formed by a row of cells placed end to end.
The transverse walls between the vessels are partially or completely dissolved to from continuous channels or water - pipes.

Function: Tracheids and vessels help in long-distance conduction of water and minerals upward from the root system to various parts of plant and help in mechanical support.

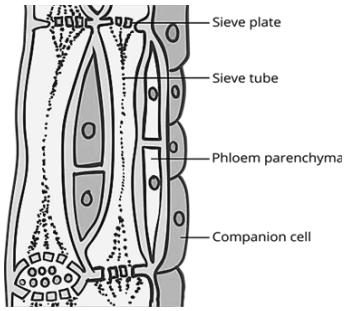
(iii) Xylem Fibers

These are dead and lignified Sclerenchymatous cells which are mainly supportive in function

(iv) Xylem Parenchyma
It is formed of living parenchymatous cells which help in the storage of food and lateral conduction of water and minerals.

Vascular bundles consist of xylem and phloem and both are known as conducting tissue. They transport water, mineral and food materials respectively from one part to another part of the plant body.

(2) Phloem
Phloem is the tissue that transports food from the site of photosynthesis to different parts of plants. It is composed of four types of cells out of which 3 are living sieve tube cells, companion cells, phloem parenchyma, and one is dead phloem fibre or bast fibre.



(a) Sieve Tube Cells
- Sieve tubes are slender tube-like structures made up of elongated, thin-walled cells placed end to end.
- The end walls of sieve tube cells are perforated by numerous pores, called sieve plates.
- The nucleus of sieve cell degenerates at maturity. However, cytoplasm persists, because of protoplasmic continuation of sieve tube with companion cell through plasmodesmata.
- Sieve cells possess slime protein or protein which is concerned with the growth and repair of sieve cells.

(b) Companion Cells
- Companion cells have dense cytoplasm and prominent nuclei.
- Sieve cells & companion cells are so-called sister cells because they originate from single mother cells.

(c) Phloem Parenchyma/Bast Parenchyma
- These are living and thin-walled cells.
- It stores various materials like resin, latex, and mucilage.
- It helps in the conduction of food in the radial direction.

(d) Phloem Fibres
- These are dead and Sclerenchymatous cells. They provide mechanical support to the conducting elements.

Difference between Xylem and Phloem

S.no.	Xylem	Phloem
1	It contains mainly dead elements.	It contains mainly living cells.
2	It conducts water and minerals from roots to stem and leaves.	It transfers prepared food (sucrose) from leaves to storage organs and growing points of plant body.
3	Two types of conducting elements, tracheid and vessels are found.	Only one type of conducting element, namely sieve tubes are present.
4	It also provides mechanical strength to the plant.	Only phloem fibres provide mechanical strength.

The nucleus of each sieve tube degenerates at maturity, however, cytoplasm persists in the mature sieve tube. Thus, nuclei are absent in mature sieve tube elements.

Difference between meristematic tissue and permanent tissue

S.no.	Meristematic Tissue	Permanent Tissue
1	Cells are small, isodiametric and undifferentiated.	Cells are large and differentiated or specialized to perform different functions.
2	Cells may be rounded, oval, rectangular or polygonal.	Cells are of different shapes according to the type of permanent tissues.
3	Cells are living and able to divide throughout plant life.	Cells may be living or nonliving.
4	Intercellular spaces are absent.	Intercellular spaces are often present.
5	Cell wall is thin and formed of cellulose.	Cell wall may be thin in some tissues but thick in others.
6	Nucleus is large and central.	Nucleus is relatively small and located in periphery.
7	Vacuoles are either absent or small.	A large, central vacuole is usually present.

4. Protective Tissue

Protective tissues are usually present in the outermost layer of the plant body such as leaves, stems and roots and offer protection to the plant body. They prevent desiccation, mechanical injury, and infection in plants.

Types of protective tissues:

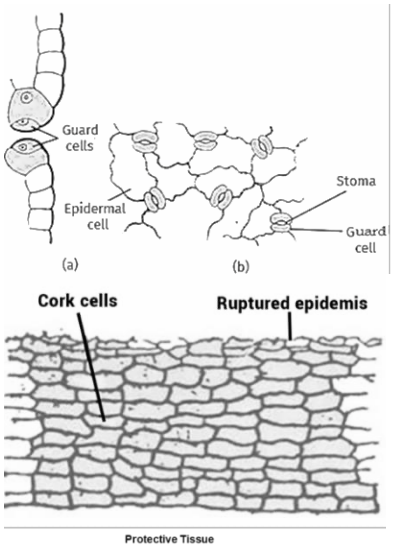
1. **Epidermis**
2. **Cork**

(i) Epidermis

The epidermis is the outermost layer of cells covering the stem, root, leaf, flower, fruit, and seed parts of a plant.

It protects the internal tissues from mechanical injuries and entry of germs.

- The outer wall of epidermis is deposited with a fatty substance, called cutin which forms a water proof layer called cuticle.
- It checks the loss of water by transpiration.
- Lower epidermis of dicot leaves has large number of microscopic aperture called stomata, which help in exchange of gases.
- It helps in loss of water vapors through transpiration, and develops a force called transpiration pull, which helps in the absorption of water by the roots.
- Epidermal cells of roots have root hair which greatly increases their surface area for absorption of water and minerals.



Protective Tissue

Guard cells and epidermal cells: (a) Lateral View, (b) Surface view

(ii) Cork

Cork is peripheral tissues of the old stem of woody trees and is formed due to activity of cork cambium,

- It is made up of dead cells with thick walls but no intercellular spaces.
- It is waterproof and helps in conservation of water in the trees.

Commercial Importance of Cork

1. Cork is light and highly compressible and does not catch fire easily.
2. It is used for insulation, and sports goods. Such as shuttle cock and cricket ball.

The walls of cork cells are heavily thickened by the deposition of an organic substance (a fatty substance), called suberin. Suberin makes these cells impermeable to water and gases and it also helps in the conservation of water in the trees.

Secondary Growth in Plants

- Secondary growth is characterized by an increase in thickness or girth of the plant. It is caused by cell division in the lateral meristem.
- The lateral meristems that produce secondary growths are called cambiums.
- The vascular cambium and cork cambium are the two important cambiums important for secondary growth.
- Vascular cambium produces more xylem and phloem and replaces the original xylem and phloem and adds to the girth of the plant – known as secondary xylem and secondary phloem.
- On its interior, vascular cambium adds secondary xylem and on its exterior, it adds secondary phloem.
- In trees, layers of secondary xylem form wood and layers of the secondary phloem form bark.

Check Your Concept - 1

(i) Why do leaf margin in plants are not cracked due to action of wind?

(ii) Why do sclerenchymatous cells become dead after deposition of lignin?

(iii) What will happen when we bite a fruit of pear?

Solved Examples

(1) **You find a slide of root epidermis is wrongly labelled as leaf epidermis. How will you confirm your observation?**

Answer: The Slide of root epidermis has the following features:
(a) Does not have cuticle.
(b) Does not have stomata.
(e) Unicellular root hairs are present.

(2) **Name and give the function of each cell of xylem.**

Answer: Xylem consists of tracheids, vessels, xylem parenchyma and xylem fibres.
Tracheids and vessels—Allows the transport of water and minerals.
Xylem parenchyma—Stores food and helps in the sideways conduction of water.
Xylem fibres —Are supportive in function.

(3) **Why does epidermal tissue have no intercellular space?**

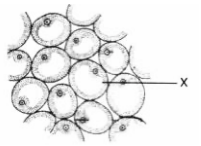
Answer: The epidermal (layer) tissue forms a protective outer covering for the plants and it protects the internal parts of the plant. It aids in the protection against loss of water, mechanical injury and invasion by parasitic fungi.
For this protective role to play the continuation of cells is necessary, hence it does not have intercellular space.

(4) **Describe 'epidermis' in plants.**

Answer: Epidermis forms the entire outermost layer of the plant. It is made up of a single cell layer. It protects all the internal parts of the plant. On aerial parts, the epidermis secretes waxy, water-resistant layer on their outer surface. This helps in protection against loss of water, mechanical injury and invasion of parasitic fungi.
In leaves, epidermis consists of small pores called stomata. These pores help in the transpiration and exchange of gases, like oxygen and carbon dioxide for plants. In roots, epidermis have long hair-like parts that provide greater surface for water absorption. In desert plants, epidermis has a thick waxy coating of cutting which acts as a water proofing agent.

(5) **Identify the labelled part (X) of the given figure:**

(A) Air cavity **(B) Intercellular space**
(C) Intracellular space **(D) Vacuole**



Answer: (A) Air cavity

Exercise

FILL IN THE BLANKS

(1) _____ gives flexibility in plants.
(2) Husk of coconut is made of _____ tissue.
(3) _____ are forms of complex tissue.
(4) Xylem transports _____ and from soil.
(5) _____ and _____ are both conducting tissues.
(6) Phloem transports from to other parts of the plant.
(7) _____ have tubular cells with perforated walls and are living in nature.
(8) _____ surrounded by guard cells.
(9) Cells of cork contain a chemical called _____.
(10) A thick waterproof coating of _____ occurs over the epidermis in desert plants.

TRUE OR FALSE

(1) Vacuoles are absent in meristematic plant cells.
(2) Apical meristem helps in longitudinal growth, while lateral meristem helps in secondary growth.
(3) Aerenchyma is a modified parenchyma and occurs in aquatic plants.
(4) Collenchyma cells have deposition of lignin, while sclerenchyma cells have deposition of pectin.
(5) Sclerenchyma has irregularly thickened cells.
(6) Husk of coconut is made up of sclerenchyma tissue.
(7) Sieve tube cells are found in the xylem, while vessels are found in the phloem.
(8) Tracheid and vessels are collectively called tracheary elements.
(9) Absorptive surface areas of roots are increased by the presence of root hairs.
(10) Cells of cork are dead, suberized and compactly arranged.

OBJECTIVE TYPE QUESTIONS

(1) Movement takes place at
(A) Cellular level (B) Organ level
(C) Organism level (D) All A, B and C

(2) Collenchyma can be distinguished from parenchyma by
(A) Being dead cells (B) Without large vacuole
(C) Increased thickness of their cell walls (D) All A, B and C

(3) A tissue whose function is support and it performs that function while it is dead is _____.
(A) Collenchyma (B) Parenchyma
(C) Sclerenchyma (D) A and B

(4) The unspecialized packing tissue found in epidermis, cortex and pith is
(A) Parenchyma (B) Collenchyma
(C) Sclerenchyma (D) Cork cambium

(5) Xylem vessels have walls impregnated with
(A) Cutin (B) Chitin
(C) Keratin (D) Lignin

(6) The _____ covers the plant but is replaced by _____.
(A) Cuticle, epidermis (B) Endodermis, Epidermis
(C) Epidermis, cork (D) All A, B and C

(7) Secondary growth in plants begins with the formation of
(A) Vascular cambium only (B) Cork cambium only
(C) Vascular and cork cambium (D) Inter-calary meristems

(8) Cork is waterproof because its cell walls are impregnated with
(A) Chitin (B) Suberin
(C) Keratin (D) Pillin

(9) Sieve tubes and companion cells occur in –
(A) Xylem (B) Cambium
(C) Meristem (D) Phloem

(10) Elongated lignified cells with pointed ends belong to-
(A) Collenchyma (B) Parenchyma
(C) Sclerenchyma (D) None of these

Answer Key

FILL IN THE BLANKS

(1) Collenchyma
(2) Sclerenchyma
(3) Xylem and phloem
(4) Water, minerals
(5) Xylem, phloem
(6) Food, leaves
(7) Sieve tubes
(8) Stomata
(9) Suberin
(10) Cutin

TRUE OR FALSE

(1) True
(2) True
(3) True
(4) False
(5) False
(6) True
(7) False
(8) True
(9) True
(10) True

OBJECTIVE TYPE QUESTIONS

(1) **(D)**
(2) **(C)**
(3) **(C)**
(4) **(A)**
(5) **(D)**
(6) **(C)**
(7) **(C)**
(8) **(B)**
(9) **(D)**
(10) **(C)**