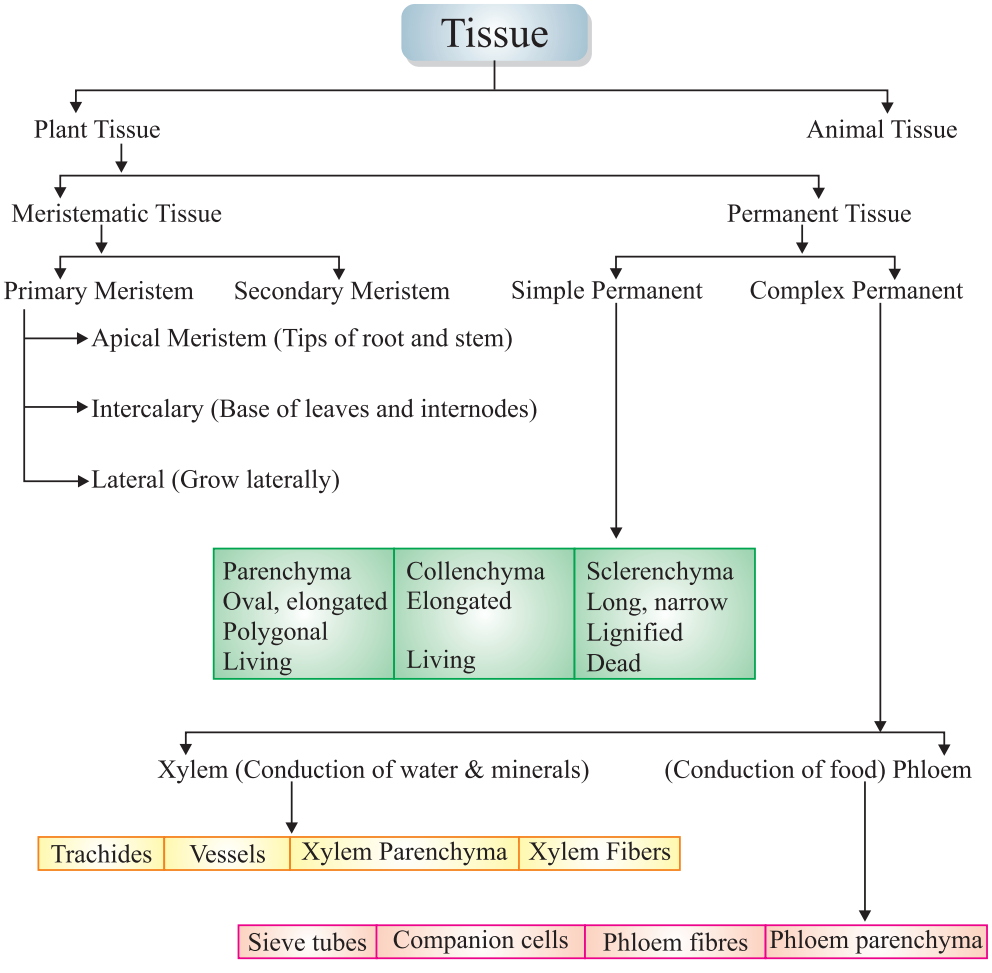
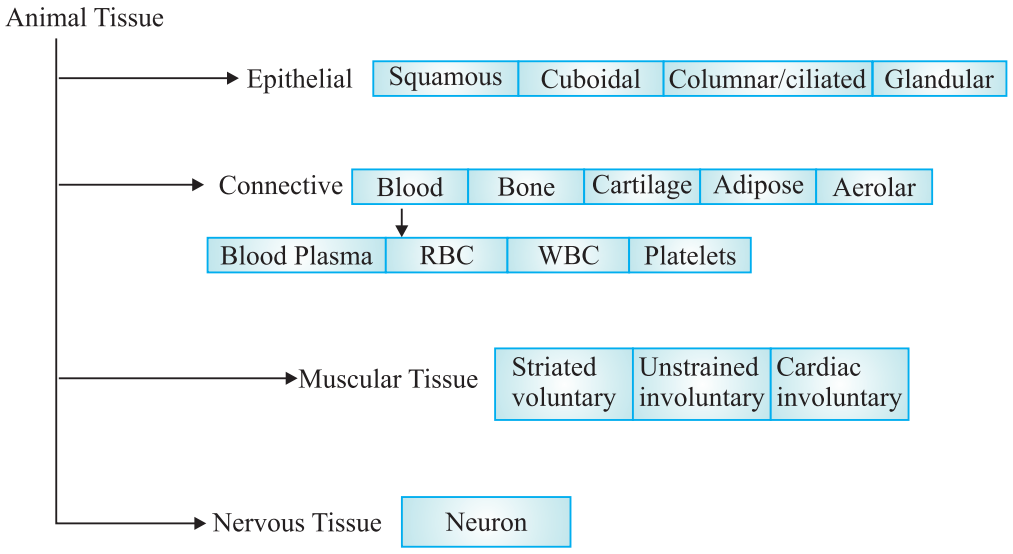
Chapter - 6

Tissue

CHAPTER AT A GLANCE





Key Points : *Tissue, Plant Tissue, Meristematic, Apical Meristem, Intercalary Meristem, Lateral Meristem Permanent, Protective Tissue, Epidermis, Cork, Parenchyma, Collenchyma, Sclerenchyma, Sclereids, Fibers, Sclerenchyma Fibres, Complex Permanent Tissue, Xylem, Phloem, Sieve Tubes, Animal Tissue, Epithlial Tissue, Connective Tissue, Muscular Tissue, Nerve Tissue.*

PLANT TISSUE – Meristematic & Permanent

Meristematic Tissue

These are simple living tissues having thin walled compactly arranged immature cells which are capable of division and formation of new cells.

Main features of Meristematic tissues are :

- Thin primary cell wall (cellulosic).
- Intercellular spaces are absent (compact tissue).
- Generally vacuols are absent, dense cytoplasm & prominent nuclei are present.
- Large numbers of cell organelles are present.
- Active metabolic state, stored food is absent.
- Actively dividing cells are present in growing regions of plants e.g., root & shoot tips.

Classification on the Basis of Origin

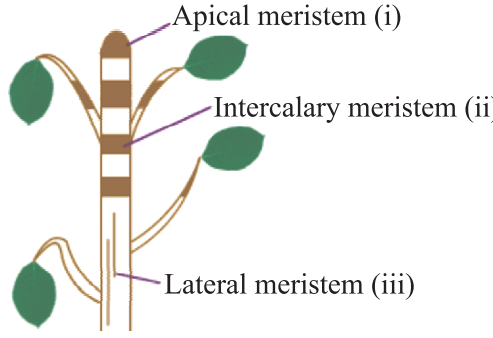
(A) Primary (Promeristem)

- Derived directly from the meristems of embryo.
- They consist of cells derived from primary meristem.
- They add to primary growth of plants.

(B) *Secondary*

- Formed by permanent tissues.
- These are having cells derived from primary permanent tissue.
- They usually add to the diameter of plants.

Permanent tissue differentiation Secondary meristem



Classification on the Basis of Location

(A) *Apical Meristem*

- It is present at the growing tips of stems and roots.
- Cell division in this tissue leads to the elongation of stem & root, thus it is involved in primary growth of the plant.

(B) *Intercalary Meristem*

- It is present behind the apex.
- It is the part of apical meristem which is left behind during growth period.
- These are present at the base of leaf & internode region.
- These lead to the increase in the length of leaf (Primary) e.g., in grass stem, bamboo stem, mint stem etc.

(C) *Lateral Meristem*

- It is also called as secondary meristem.
- It occurs along the sides of longitudinal axis of the plant.
- It gives rise to the vascular tissues.
- Causes growth in girth of stem & root.
- They are responsible for secondary growth.

PERMANENT TISSUE

- The permanent tissues are composed of those cells which have lost their capability to divide.
- They have definite shape, size and thickness. The permanent tissue may be dead or living.
- The division & differentiation of the cells of meristematic tissues give rise

to permanent tissues.

- In cell differentiation, developing tissue and organs change from simple to more complex forms to become specialized for specific functions.
- The cells of permanent tissue loose the capacity to divide and attain a permanent shape, size and function.

Depending upon the Structure and Composition, the Permanent tissues are classified into two types :

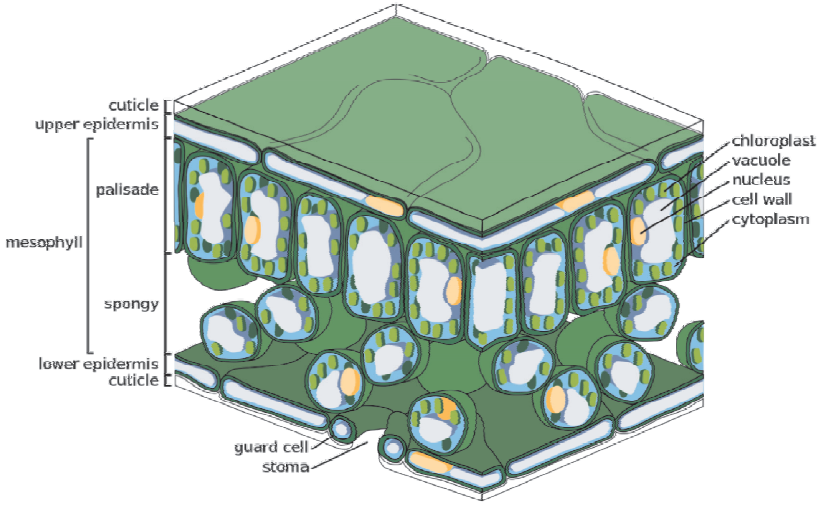
(A) Simple Permanent Tissues

- These are made up of same type of cells which are similar structurally and functionally.
- They include two types of tissue :

(a) *Protective Tissues :* These tissues are primarily protective in function. They consist of :

(i) Epidermis

- Epidermis forms one cell thick outermost layer of various body organs of plants such as leaves, flowers, stems and roots.
- Epidermis is covered outside by cuticle. Cuticle is a water-proof layer of waxy substance called as cutin which is secreted by the epidermal cells.
- Cuticle is very thick in xerophytes.
- Cells of epidermis of leaves are not continuous at some places due to the presence of small pores called as stomata.
- Each stomata is guarded by a pair of bean-shaped cells called as guard cells. These are the only epidermal cells which possess chloroplasts, the rest being colourless.



Functions of Epidermis

- The main function of epidermis is to protect the plant from desiccation and infection.
- Cuticle of epidermis cuts the rate of transpiration and evaporation of water and prevents wilting.
- Stomata in epidermis allow gaseous exchange to occur during photosynthesis respiration.
- Stomata also helps in transpiration.

(ii) **Cork or Phellem**

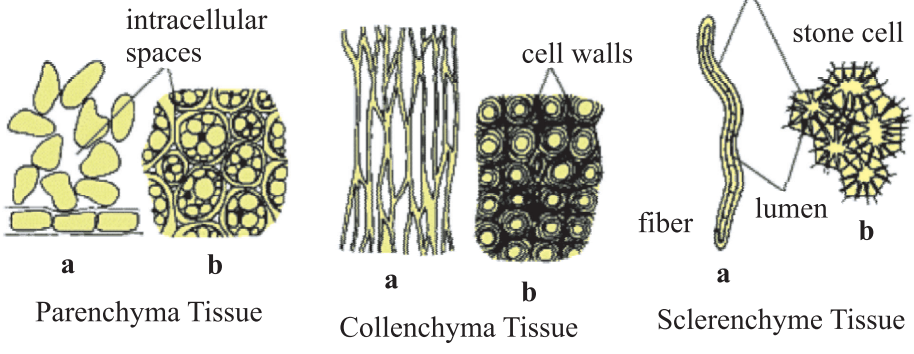
- In older roots and stems, tissues at the periphery become cork cells or phellem cells.
- Cork is made up to dead cells with thick walls and do not have any intercellular spaces.
- The cell walls in cork deposit waxy substance called as suberin.
- The cells of cork become impermeable to water and gases due to the deposition of suberin.
- The cork cells are without any protoplasm but are filled with resins or tannins.

Functions of Cork :

- Cork is protective in function. Cork cells prevent desiccation, infection and mechanical injury.
- Imperviousness, lightness, toughness, compressibility and elasticity make the cork commercially valuable.
- Cork is used for insulation, as shock absorber in linoleum.
- Cork is used in the making of a variety of sport goods such as cricket balls, table tennis, shuttle cocks, wooden paddles etc.

(b) *Supporting Tissues* : These are supportive in function and are of three types :

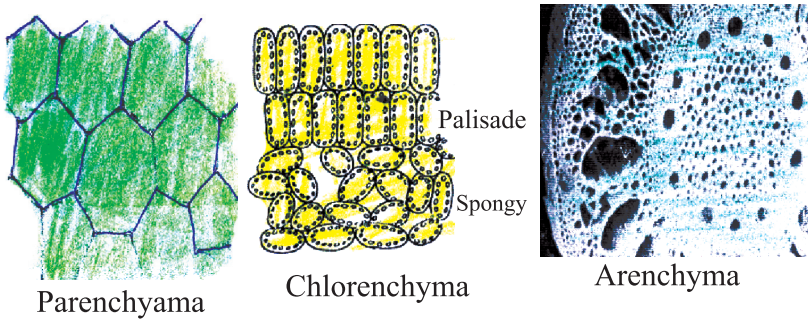
The Three Basis Types of Plant Tissue



[a lengthwise
b cross section]

(i) Parenchyma : It is the fundamental tissue.

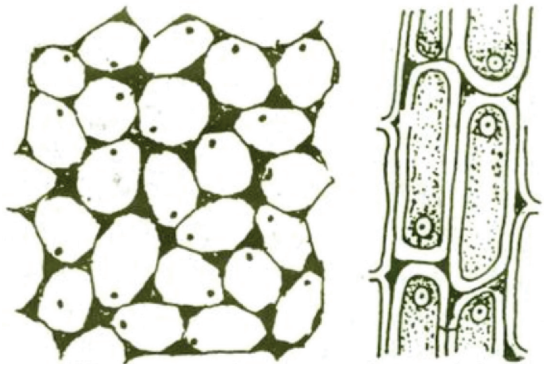
- Tissue first time evolved in bryophyte.
- Thin walled cells, oval or spherical in structure.
- Cell wall mainly composed of cellulose & pectin.
- Large central vacuole for food & water storage.
- Primary function is food storage.



Parenchyama Chlorenchyma Arenchyma

- Some parenchyma involved in excretory substance storage are so called as idioblast, storing such as resin, tannin, gums & oils.
- In typical parenchyma chlorophyll is absent.
- Chloroplast containing parenchyma tissue are chlorenchyma which perform photosynthesis e.g., mesophyll of leaves.
- In hydrophytic plants aerenchyma (a type of parenchyma containing air spaces) provides buoyancy.
- Parenchyma provides turgidity to cells.

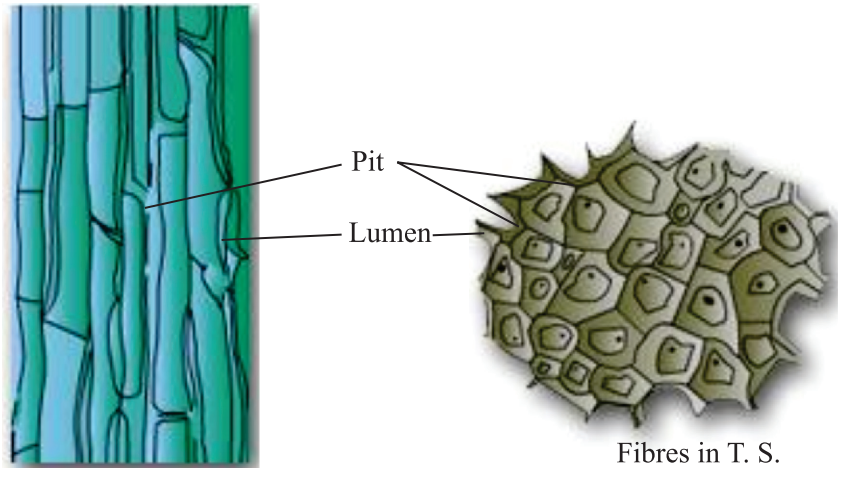
(ii) Collenchyma : It is the living mechanical tissue.



Collenchyma

- Elongated cells with thick corners.
- Localized cellulose & pectin thickening.
- Provides flexibility to plant parts & easy bending of various parts of plant.
- Present only in herbaceous dicot stem.
- Present at thin margin of leaves.
- Few chloroplasts may be present.
- Gives mechanical strength & elasticity to the growing stems.

(iii) Sclerenchyma : (Scleras – hard) Strengthening tissue.



Fibres in L. S.

Fibres in T. S.

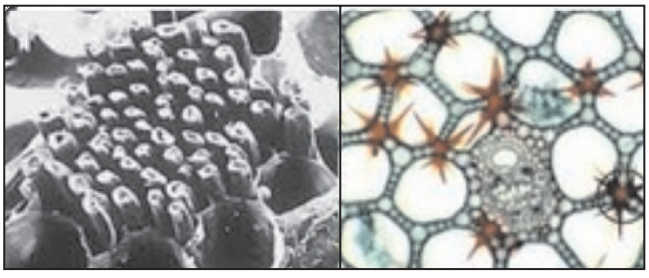
- Composed of extremely thick walled cells with little or no protoplasm.
- Cells are dead & possess very thick lignified walls.
- Lignin is water-proof material.
- Intercellular spaces are absent.

Cells of sclerenchyma are of two types :

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 drup fruit (mango, coconut, walnut) in legume seeds (Macrosclereid).

Fiber Sclereids



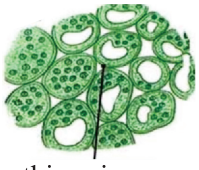
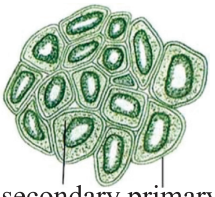
Fibers :

- They are very long, narrow, thick, lignified cells. Lumen is large as compared to sclereids. Generally 1-3 mm long.
- In the thick walls of both the fibres and sclereids are present thin areas called as pits.

Sclrenchyma Fibres

- These are used in the manufacture of ropes, mats & certain textile fibres.
- Jute and coir are obtained from the thick bundle of fibres.

Difference between Parenchyma, Collenchyma and Sclerenchyma

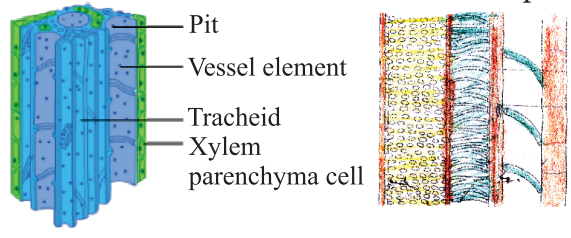
Features	Parenchyma	Collenchyma	Sclerenchyma
	 thin primary cell wall	 irregularly thickened primary cell wall	 thick secondary cell wall primary cell wall

1. Cell shape	Isodiametric cells which are oval, spherical or polygonal in shape.	Circular, oval or polyhedral.	Variable in shape. Fibres and sclereids.
2. Cell wall	Thin cellulosic cell wall.	Uneven thickening on their cell wall.	Lignified secondary cell wall present.
3. Cytoplasm	Abundant	Present	Absent
4. Nucleus	Present (Living tissue)	Present (Living tissue)	Absent (Dead tissue)
5. Vacuoles	Large vacuole	Vacuolated	Absent
6. Intercellular spaces	Present	Absent	Absent
7. Occurrence	Basically packing tissue, all soft part of plant- pith, cortex, medullary rays.	Dicot stems, petiole and beneath the epidermis. Absent in monocot and roots.	Dicot hypodermis, bundle sheath, pericycle, seed, pulp of fruits.
8. Functions	Food storage, photosynthesis.	Provide tensile strength, mechanical support, photosynthesis.	Protection from stress and strain, mechanical strength.

(B) Complex Permanent Tissues

- It consists of more than one type of cells which work together as a unit.
- It helps in transportation of organic materials, water & minerals.
- It is also known as conducting or vascular tissue.
- Xylem & phloem together form vascular bundles.

Xylem : Also known as wood and is a vascular and mechanical tissue. Thick walled cells are found in the form of tubular passages.



Xylem consists of four types of cells called as elements :

(i) Tracheids :

- They are elongated angular dead cells (primitive elements) mainly involved in conduction of water and minerals in gymnosperms.

(ii) Vessles : They are advance element (generally found in angiosperms).

- Vessels are cylindrical tube like structures placed one above the other end to end which form a continuous channel for efficient conduction of water.

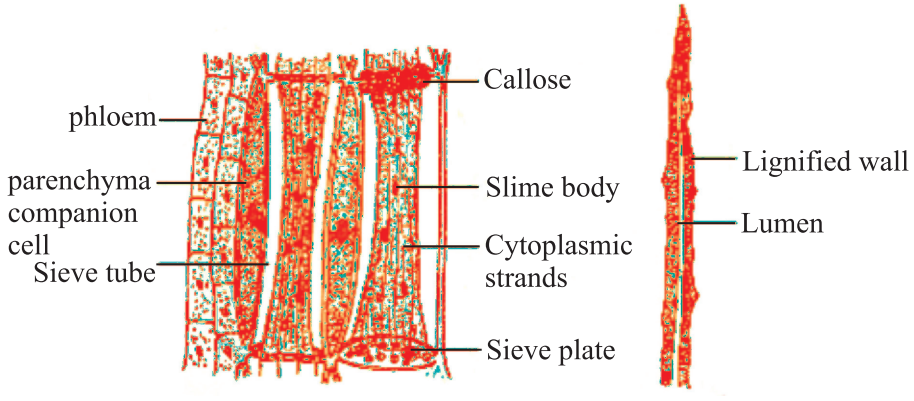
(iii) Xylem parenchyma :

- They are small & thick walled parenchymatous cells subjected for storage of starch (food).

(iv) Xylem sclerenchyma :

- Thy are non-living fibres with thick walls and narrow cavities provide mechanical support.
- Except xylem parenchyma all other xylem elements are dead.
- The annual rings present in the trunk of a tree are xylem rings.
- By counting the number of annual rings, we can determine the age of a tree.

Phloem : They also consist of both parenchymatous and schlerenc--hymatous cells.



Phloem fibre (bast fibre)

Phloem consists of four types of element :

(i) Sieve tubes :

- 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 as sieve plates.
- 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 growth and repair of sieve cells.

(ii) **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 cell.*

(iii) **Phloem fibre :**

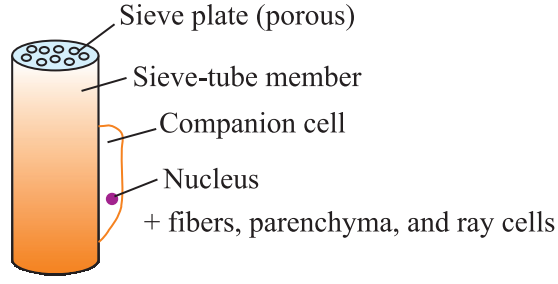
- They give mechanical support to sieve tubes.

(iv) **Phloem parenchyma :**

- They store food and help in radial conduction of food.

(v) **Leptome :**

- Main part of phloem involved in conduction of food, which is sieve tube.
- In xylem, only unidirectional movement is possible while in phloem bidirectional movement can occur.
- In phloem, except phloem sclerenchyma all elements are living.



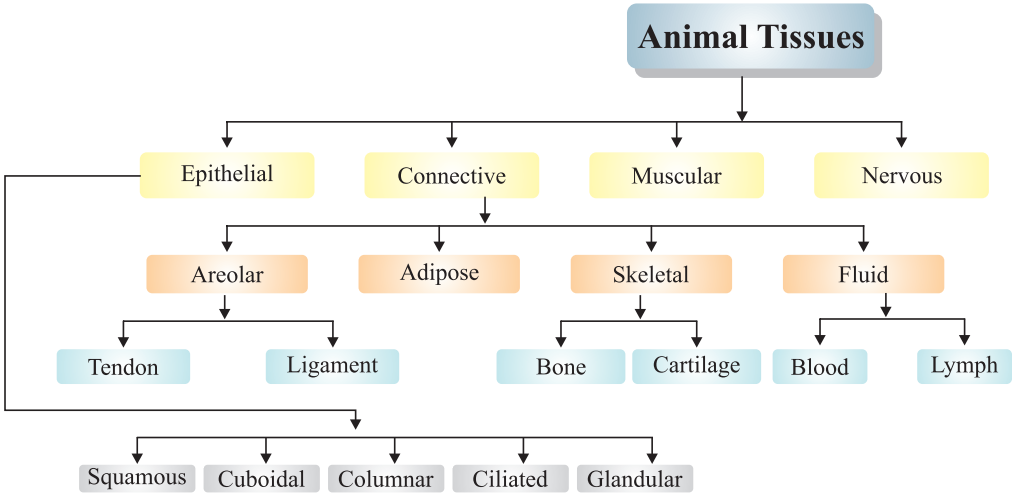
Components of Phloem

Xylem and Phloem

Features	Xylem	Phloem
Cells : Living/dead	Dead	Living
Cell walls :		
Thickness	Thick	Thin
Material	Lignin	Cellulose
Permeability	Impermeable	Permeable
Cross walls	None	Sieve plates
Cytoplasm	None	Yes
Function	Carries water and salts	Carries sugars

Direction of flow	Upwards	Down and up
Special features	Fibres	Companion cells

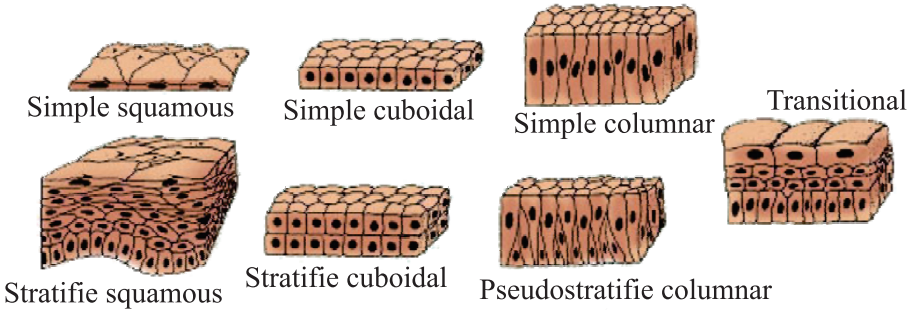
ANIMAL TISSUE



EPITHELIAL TISSUE

- Always grows on some other types of tissue.
- Cells of epithelium are set very close to each other and the tissue rests on a non-cellular basement membrane.
- Consists of single layer of cells.
- Blood vessels are absent and non-nervous in nature.
- It covers all the organs and lines the cavities of hollow organs like stomach.
- It is primarily protective in function.

Types of Epithelium



Epithelium tissues are classified as :

(a) *Squamous epithelium :* Also called pavement epithelium.

- Cells arranged end to end like tiles on a floor.

- Cells are polygonal in surface view.
- It forms the delicate lining of cavities (mouth, oesophagus, nose, pericardium, alveoli etc.) blood vessels and covering of the tongue and skin.
- Epithelial cells are arranged in many layers (stratum) to prevent wear and tear in skin. This pattern is stratified squalors epithelium.

(b) Cubical epithelium :

- They are cube like cells that fit closely, cells look like squares in section, but free surface appears hexagonal.
- It is found in kidney tubules, thyroid vesicles & in glands (salivary glands, sweat glands).
- It forms germinal epithelium of gonads (testes & ovaries).
- It involves in absorption, excretion & secretion. It also provides mechanical support.

(c) Columnar epithelium :

- Columnar means 'pillar-like' epithelium. It forms lining of stomach.
- Small intestine & colon, forming mucous membranes.
- Border of micro villi is present at the free surface end of each cell which increases absorption efficiency in small intestine.

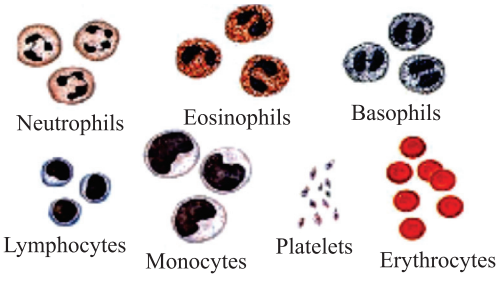
(d) Ciliated epithelium :

- Cells may be cubical or columnar.
- On its free surface are present protoplasmic outgrowths called cilia.
- It helps in the movement of ova in the fallopian tube.

CONNECTIVE TISSUE

- The cells of the connective tissue are widely spaced and embedded in an intercellular matrix.
- The mature of matrix decides the function of tissue.
- White and yellow fibres are present in the matrix.
- Their basic function is to provide support to different organs & keeping them in place.

(a) Fluid or vascular tissue :



Blood and lymph

- Blood is a connective tissue, fluid matrix of blood is plasma having wandering or floating cells, called corpuscles, blood helps in the transportation of various materials such as nutritive substances, gases, excretory products, hormones etc.

Plasma

- Form 55% part of blood. Constitution : 90-91% : water, 7% : protein (Albumin, fibrinogen, globulin), 0.9% : inorganic salt etc.

Corpuscles

- Forms 45% part of blood.

RBCs

- They are also called as erthyrocytes, containing red coloured respiratory pigment called haemoglobin that helps in transportation of oxygen.

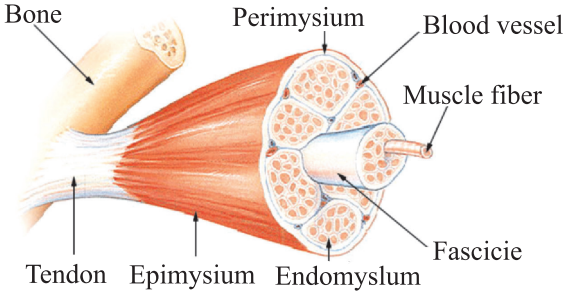
WBCs (Leucocytes : They are also called as 'Soldiers of the body'.)

- They are irregular, amoeboid, phagocyte cells that protect our body by engulfing bacterial & other foreign particles. They are of five types : Monocytes, Lymphocytes, Basophiles, Neutrophiles, Eosinophils.

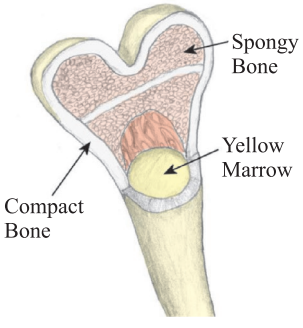
Blood platelets or thrombocytes

- They are spindle shaped cells which are involved in clotting of blood.

(b) Skeletal Tissue

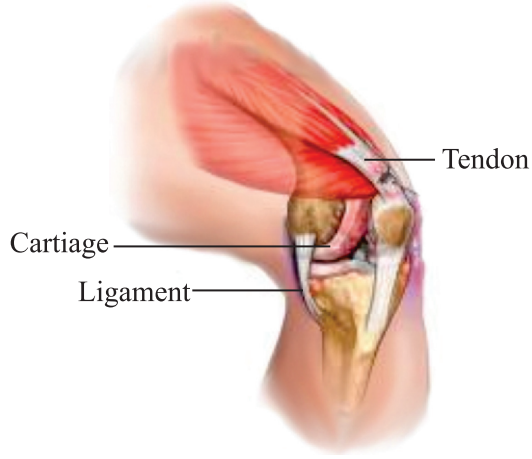


It is hard connective tissue that forms supportive framework of the body. It is of two types :



Bone

- Matrix of bone is very hard because of salts such as calcium phosphate, $CaCO_3$ (60-70%) etc. and a protein ossein.
- Bone cells (osteoblasts) are embedded in this hard matrix.
- Matrix is deposited in the form of concentric layers of lamellae formed round a central canal, the done cells occupy small spaces between the concentric layers of matrix.
- The long bones are usually hollow containing cavity called as marrow cavity. It is full of bone marrow.



Cartilage

- This tissue is elastic, less harder as compared to bones.
- Elasticity is due to presence of chondrin (protein). Cells are called as chondroblast, which are widely spaced and matrix is reinforced by fibres.
- It occurs at joint of bones, in the nose, ear, trachea & larynx.
- It provides flexibility and great tensile strength.

(c) Connective tissue

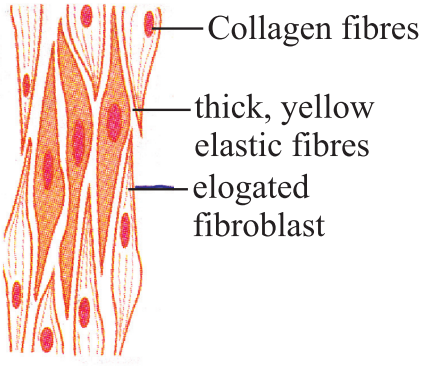
It is the most abundant type of connective tissue. It is further divided into following types :

(i) Yellow fibrous connective tissue

- They are very elastic due to the presence of a network of yellow fibres in its matrix called as ligament which attaches bone to bone.

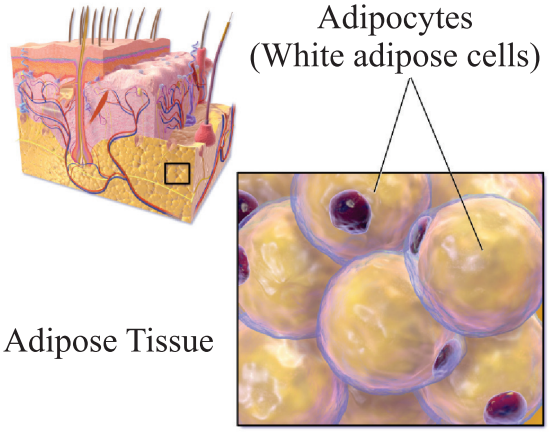
(ii) White fibrous connective tissue

- They are very little matrix containing abundant white fibres forming layers.
- Bundles of this tissue are called as tendons, which attaches muscles to the bones.



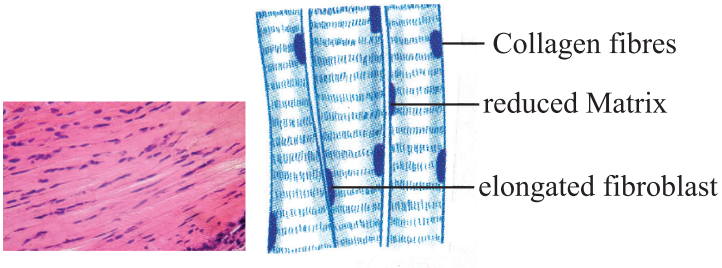
(d) *Aerolar tissue :*

- It is the most distributed connective tissue in the body.
- This tissue fills spaces inside organs and is found between the skin & muscles, around blood vessels, nerves and in the bone marrow.



(e) *Adipose tissue :*

- These are oval and round cells, filled with fat globules.
- The cells are called as adipocytes.
- It is found in subcutaneous layer below the skin, around the heart, brain and below the eyeballs. It acts as an insulator and prevents loss of heat from the body.



MUSCULAR TISSUE

- Movements are brought about in our body with the help of muscular tissues.
- They are long fibre-like cells called muscle fibres.
- They are capable of contraction or relaxation.

Types of Muscular Tissue

Skeletal Muscle

Cardiac Muscle

Smooth Muscle

(a) Striated muscles

- They are also called as voluntary muscles because these are under the control of one's will.
- Muscle fibres or cells are multinucleated and unbranched.
- Each fibre is enclosed by thin membrane which is called as sarcolemma. Cytoplasm is called as sarcoplasm.
- These muscles get tired and need rest.

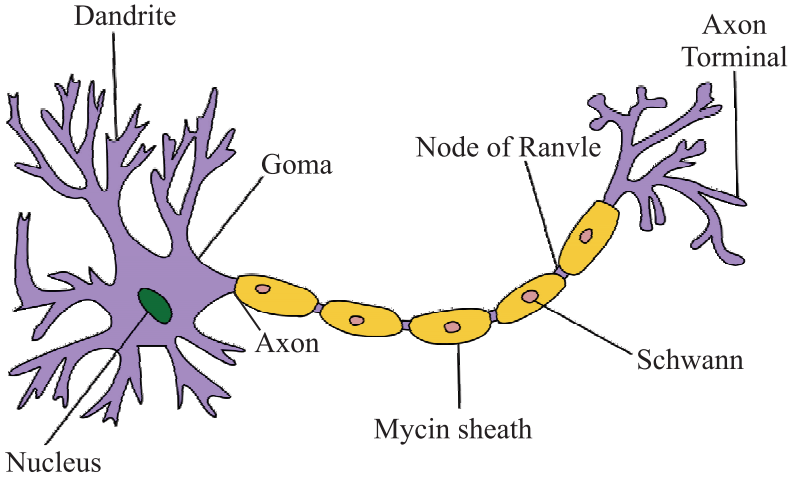
(b) *Cardiac muscle fibres*

- They are only involuntary muscles.
- Only found in the walls of heart.
- Their structure is in between the striated and non-striated muscles.
- They are uninucleated and branched. Branches are united by intercalated disc.
- In these muscles rhythmic contraction and relaxation occurs throughout the life.

(c) *Non-striated muscles*

- They are involuntary muscles also called as smooth muscles.
- These muscle fibres are uninucleated and spindle shaped.
- They are not enclosed by membrane but many fibres are joined together in bundles.
- Such muscles are found in the walls of stomach, intestine, urinary bladder, bronchi, iris of eye etc.
- Peristaltic movements in alimentary canal are brought about by smooth muscles.

NERVOUS TISSUE



- They are highly specialized tissue due to which the animals are able to perceive and respond to the stimuli.
- Their functional unit is called as nerve cell or neuron.
- Cell body is cyton covered by plasma membrane.
- Short hair like extensions rising from cyton are Dendron which are further subdivided into dendrites.
- Axon is long, tail like cylindrical process with fine branches at the end. Axon is covered by a sheath.

- Axon of one neuron is very closely placed to the dendrons of another neuron to carry impulses from one to another neuron in the form of electrochemical waves. This close proximity is called as synapse.

QUESTIONS

VERY SHORT ANSWER TYPE QUESTIONS (1 Mark)

1. The tissue derived directly from the meristem of embryo is called as..... .
2. A group of cells with similar structure organized to do a common function is called as..... .
3. Which plant tissue remains in active metabolic state always ?
4. Sieve tubes and companion cells are found in.....tissue. (Xylem/ phloem/collenchyma)
5. Long, narrow, dead cells having a thick deposition of lignin in the cell wall are called.....cells. (Parenchyma/cambium/sclerenchyma)
6. Which tissue is responsible for transport of water in plants ?
7. The special property of muscle fibres to contract forcefully and return to relaxed state is called..... . (excitability/contractibility/flexibility)
8. A branch of science dealing with the study of bones is called..... . (Ornithology/physiology/osteology)
9. The fluid matrix of blood is called..... . (plasma/lymph/serum)
10. Spindle-shaped, non-striated, involuntary muscle fibres present in hollow internal organs like urinary bladder are called..... . (smooth muscle fibres/striated muscle fibres/cardiac muscle fibres)

SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. Define tissue.
2. What do you mean by division of labour ?
3. Name the different elements of xylem and phloem.
4. In hydrophytes xylem is less developed. Why ?
5. Write the composition of mammalian blood.
6. What is the function of nervous tissue ?
7. State the main features of muscular tissue.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. What is tissue ? Explain meristematic plant tissue.
2. Mention the role of parenchyma, collenchyma and sclerenchyma.
3. Give summarized classification of animal-tissue.
4. Describe the structure of neuron with labelled diagram.