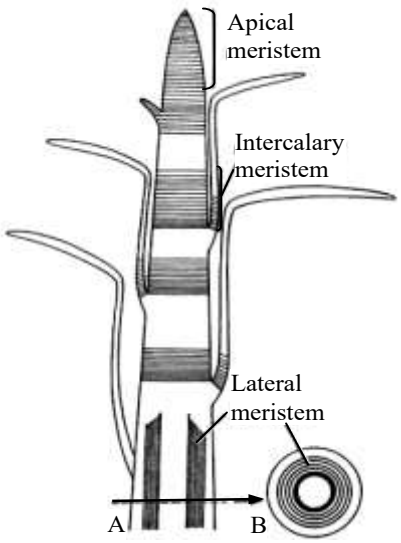
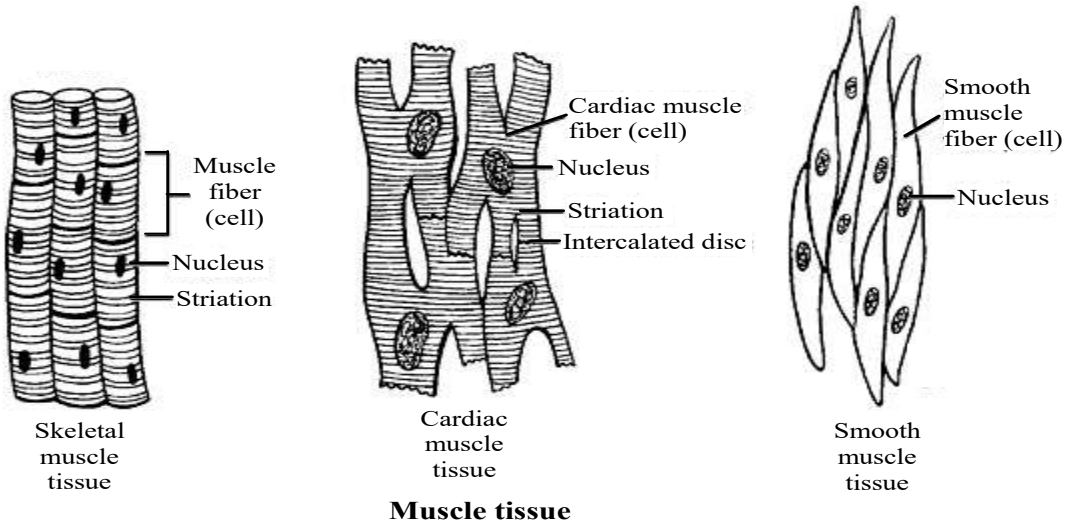
Tissues in Action

Chapter Out Line

- ✧ **Tissue**
- ✧ **Plant tissue**
- ✧ **Classification of plant tissue**
- ✧ **Animal tissue**
- ✧ **Classification of animal tissue**





Muscle tissue

INTRODUCTION

The living organisms are either unicellular like amoeba or multicellular like human beings. In unicellular organism all the life processes are carried out within a single cell.

In multicellular organisms, because of 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. Like in human beings nerve cells carry messages, blood flows to transport oxygen, food, hormones and waste materials. In plants vascular tissues conduct food, water and minerals from one part of the plant body to other part. So multicellular organism perform division of labour.

TISSUE

"A tissue may be defined as a group or collection of similar or dissimilar cells that perform a common function & have a common origin."

- Thus we can say that tissue provide a organization to the organism and in it also there is a division of labour can be seen
- In case of multi-cellular organisms specialized functions are performed by a different types of cells. As blood flows for transportation of O_2, CO_2, food, hormones and waste material, muscle cells are involved in movement etc so cells make a group called **tissue**.

– Boost your knowledge

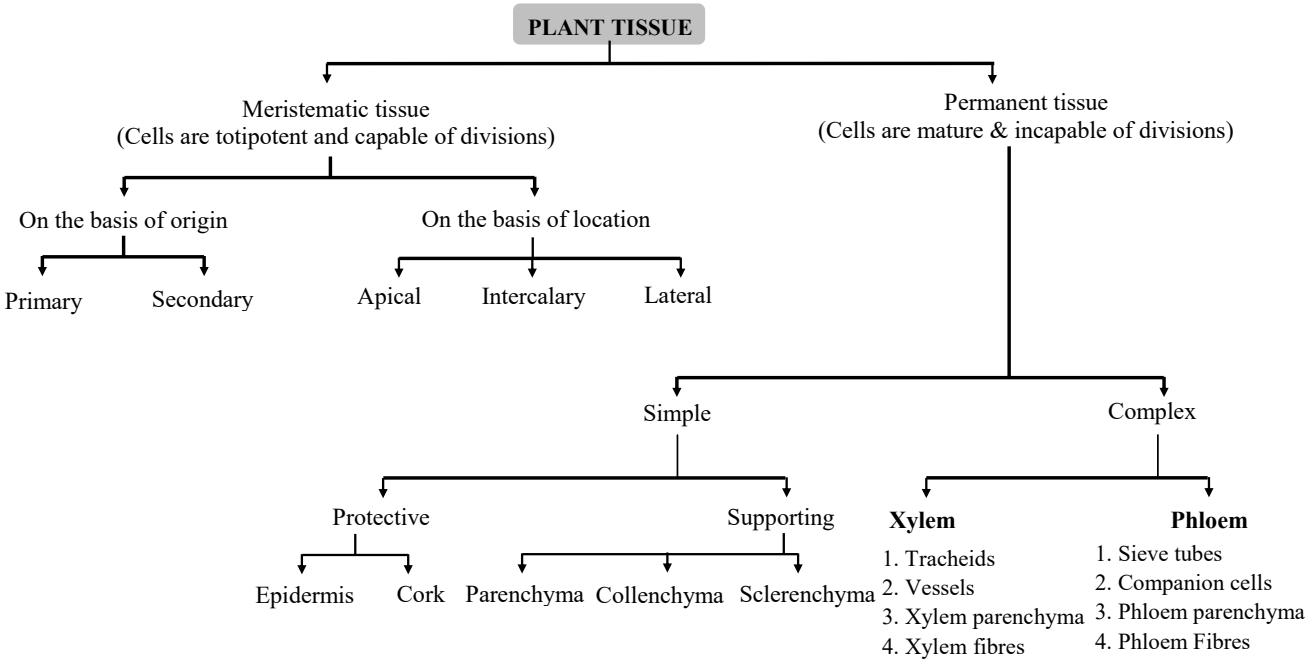
- **The study of tissue with the help of microscope is called histology.**
- **Term histology was coind by Mayer.**
- The term tissue was coined by **Bichat**.

◈ Importance of tissues :

- Workload of individual cell has decreased.
- Tissues become organized to form organs and organs into organ systems.
- Formation of tissues has brought about division of labour in multicellular organisms.
- Multicellular organisms have higher survival due to improved body organization and higher efficiency of functions.

PLANT TISSUE

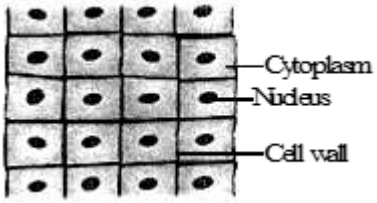
Classification of Plant Tissues :



◈ **Meristematic tissue :** Meristematic tissues may be defined as a group or collection of living cells which are located at specific locations and divide continuously to add new cells to the plant body.

Characteristics of Meristematic tissues :

- The cells of meristematic tissues are similar in structure and have thin and elastic primary cell walls made up of cellulose.
- These meristematic cells may be rounded, oval, polygonal or rectangular in shape.
- They are compactly arranged without intercellular spaces between them.
- Each cell contains dense or abundant cytoplasm and a large prominent nucleus.
- The dense protoplasm of meristematic cell contains few small vacuoles or no vacuoles at all.



Meristematic Tissue

Classification of meristematic tissue :

(i) Classification on the basis of location :

(A) Apical meristem : It is present at the growing tips of stems and roots.

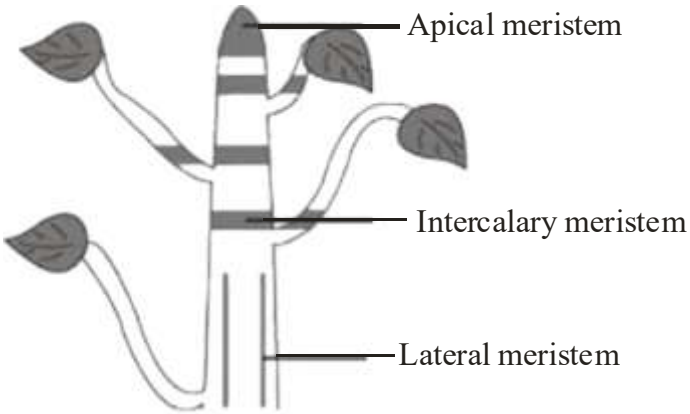
- Cell division in this tissue leads to the elongation of stem & root thus it is involved in primary growth of the plant.

(B) Intercalary meristems :

- It is the part of apical meristems which is left behind during growth period.
- These are present at the base of leaf & inter-node region. These lead to the increase in the length of leaf 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 and causes growth in girth of stem & root.
- Lateral meristem is of two types, vascular cambium and cork cambium. Vascular cambium produces secondary phloem and secondary xylem. Cork cambium (phellogen) produces a protective cork on the outside.



LONGITUDINAL SECTION OF STEM SHOWING
LOCATIONS OF MERISTEMS

(ii) Classification on the basis of origin :

(A) Primary meristem : Derived directly from the meristems of embryo (Promeristem).

- They add to primary growth of plants.

(B) Secondary meristem : Formed by permanent tissues.

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

Primary Meristematic Tissue $\xrightarrow{\text{Differentiation}}$ Permanent Tissue

Permanent Tissue $\xrightarrow{\text{Dedifferentiation}}$ Secondary Meristem

$\xrightarrow{\text{Redifferentiation}}$ Secondary permanent tissue

◈ **Permanent Tissues :**

Definition : These tissues are derived from the meristematic tissues but their cells have lost the ability of division.

- 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 and differentiation of the cells of meristematic tissues give rise to permanent tissues.
- In cell differentiation, developing tissues and organs change from simple to more complex forms to become specialized for specific functions.

Types of Permanent Tissue :

The permanent tissues are classified into two types on the basis of cell wall composition –

(A) Simple Permanent Tissue : These tissues are made up of same type of cells which are similar structurally and functionally.

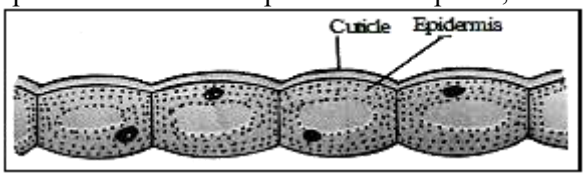
They include two types of tissue :

(I) Protective Tissues : These tissues are primarily protective in function.

They consist of :

(1) Epidermis : Its forms the outer most layer of plant organs such as leaves, flowers, roots etc.

- In cell differentiation, developing tissues and organs change from simple to more complex forms to become specialized for specific functions.
- Epidermis is covered outside by cuticle in leaves, young shoot and other aerial organs without plant cork.
- **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.



Epidermis

◈ **Functions & Uses :**

- The main function of epidermis is to protect the plant from dessication 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 and respiration.
- Transpiration (loss of water in the form of water vapours) takes place through stomata.
- It protects the internal tissues from injuries and invasion by pathogens.

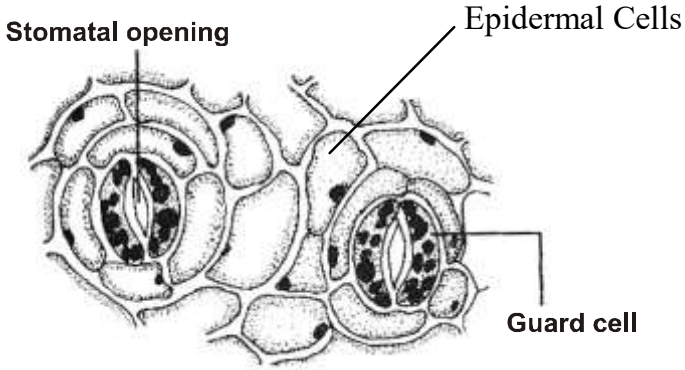
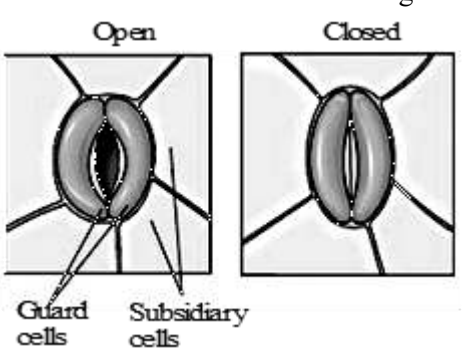


Fig : showing the structure of Stomata

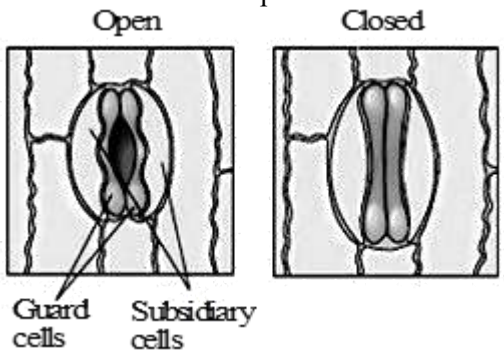
Structure of Stomata :

- Guard cells regulate opening and closing of stomata.
- Stomata opens in presence of light, at high temperature & at low CO_2 concentration.
- When guard cells becomes **turgid** stomatal pore **opens**, while when they becomes **flaccid** stomatal pore **closes**.

- Due to **endo-osmosis** guard cells becomes **turgid** while due to **exo-osmosis** guard cells becomes **flaccid**.
- Due to increase in the amount of osmotically active sugars in guard cells, their osmotic pressure increases and water enters inside the cells increasing the turgidity of cells and hence stomata opens.



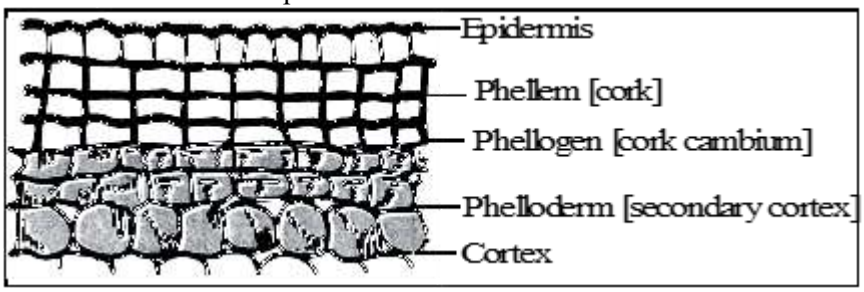
(a) Guard cells of dicots are bean shaped.



(b) Monocot guard cells are narrow in the center and thicker at each end (dumbbell shape).

(2) Cork or phellem : Cork is the peripheral tissue of old stems and roots of woody trees and is formed due to activity of cork cambium or phellogen (secondary lateral meristem).

- Cork cambium produces new cells on its both sides, thus, forming cork (phellem) on the outer side and the secondary cortex or phelloderm on the inner side.
- It is made up of dead cells with thick wall but no intercellular spaces.
- Cell wall of the cork has the deposition of a substance called **suberin**.



Cork

Functions :

- 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, and as shock absorber.
- Cork is used in the making of a variety of sport goods such as cricket balls, table tennis, shuttle-cocks, wooden paddles etc.

(II) Supporting tissue : These are supportive in function and of three types.

1. Parenchyma –

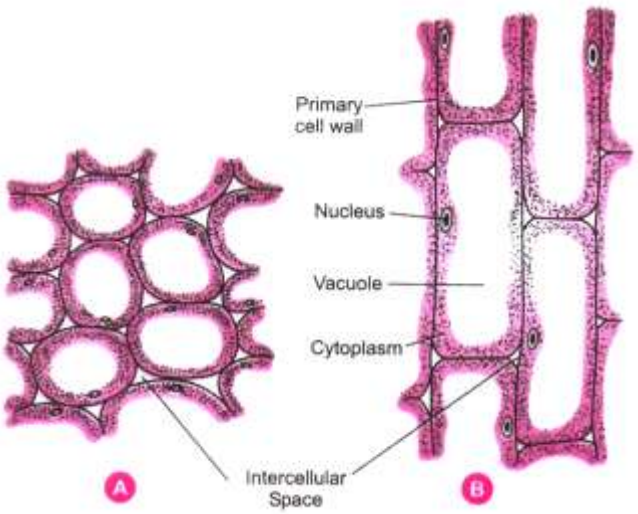


Figure : Parenchyma; A-Transverse section
B-Longitudinal section

- They are living cells having inter cellular space.
- They gives structure and provide food for the plant.
- The cells having thin cell wall is made up of cellulose, have nucleus and large vacuoles.
- They are usually loosely packed because intercellular spaces are present between cells.
- **Types of Parenchyma –**
  (a) Aerenchyma – It is present in aquatic plants or phytoplankton. In this type of parenchyma large air spaces are there which helps in exchange gases and provide buoyancy to plant.
  (b) Chlorenchyma : It is a kind of parenchyma which stores large amount of chloroplast. It is present in leaf of mesophyll, sepals, phylloclades, phyllodes, cladodes etc. They perform photosynthesis.
  (c) Prosenchyma – Parenchyma which stores food is called as prosenchyma.
  (d) Idioblast – Parenchyma involved in excretory substance storage are called as idioblast. They help in storing materials like resin, tannin, gums or oils.

  Functions : The tissue provides support to the plant and helps in storage of food.

2. Collenchyma :

- It was discovered and coined by schleiden (1839).
- The cells are living with or without intercellular spaces.
- Thickenings in the wall corners are made up of cellulose and pectin.
- Generally they are longer than parenchyma.
- Usually they are known as living mechanical tissue owing to their supportive functions.
- It is present below the epidermis in dicot stem and also present at leaf stalk and leaf margin.

Functions :

- It provides flexibility and strength to young plant organs.

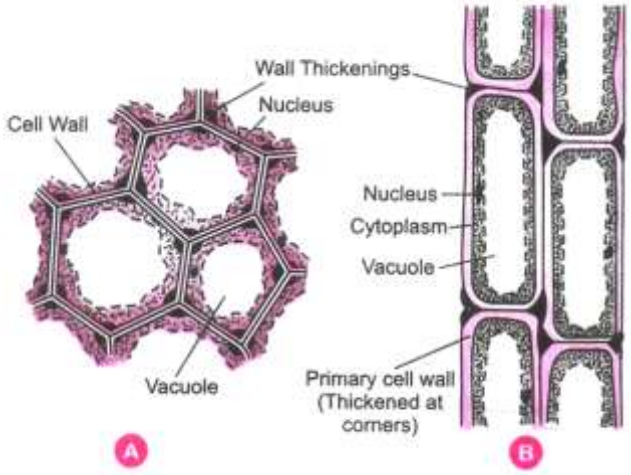


Figure : Collenchyma; A-Transverse section; B-Longitudinal section

– Boost your knowledge

☛ Collenchyma are usually absent in all the woody parts, roots, stem and leaves of monocots and roots of dicot plant while present in herbaceous stem and leaves of dicot plant.

3. Sclerenchyma :

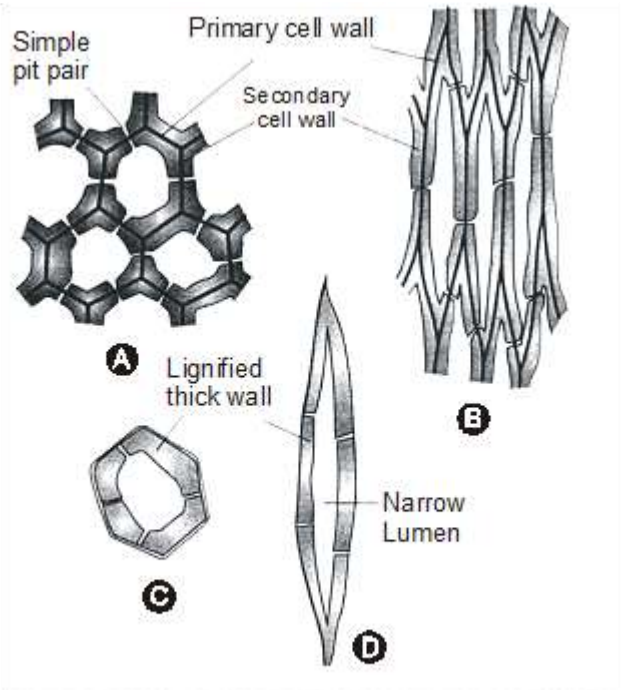
- They were discovered and coined by **Mettenius** (1805).
- The cells are long, narrow, pointed at ends, thick walled and lignified. They are the dead cells.
- The cells of sclerenchyma are closely packed without intercellular spaces. They are found in stems, roots, veins of leaves, hard covering of seeds and nuts

Functions : It is the main mechanical tissue which provides strength to the plant. Its cells are of two types in structure.

(i) Fibres **(ii)** Sclereids

(i) Sclerenchyma fibres : They constitute the major mechanical tissue of the plants. Commercial fibres obtained from plants (e.g. Jute, flax, hemp, husk of coconut) usually are sclerenchymatous fibres.

(ii) Sclereids (grit or stone cells) : They are highly thickened and irregularly shaped dead cells. Sclereids provide strength to seed covering and are present in drupe fruit (Mango, Coconut, Walnut). Provide grittiness to the pulp of many fruits, such as guava, apple and pear.



SCLERENCHYMA, A. TRANSVERSE SECTION; B. LONGITUDINAL SECTION; C. SINGLE CELL IN T.S.; D. SINGLE CELL IN L.S

– **Boost your knowledge**

☛ *Lignin is a complex polymer which acts as a cement and hardens 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).*

Difference between parenchyma, collenchyma and sclerenchyma

S. No	PARENCHYMA	COLLENCHYMA	SCLERENCHYMA
1.	It consists of living cells.	It consists of living cells	It consists of dead cells.
2.	Intercellular spaces are present.	Intercellular spaces may or may not be present	Intercelluar spaces are absent.
3.	Cell wall is thin without having secondary deposition.	Cell wall is thick as it has pectin deposition.	Cell wall is thick as it has lignin deposition.
4.	Cells contain cytoplasm.	Cells contain cytoplasm	Cells are devoid of cytoplasm.
5.	They have vital functions like synthesis and storage of food.	They have both vital as well as mechanical function, providing support and elasticity of plant body.	It is chiefly a mechanical tissue.

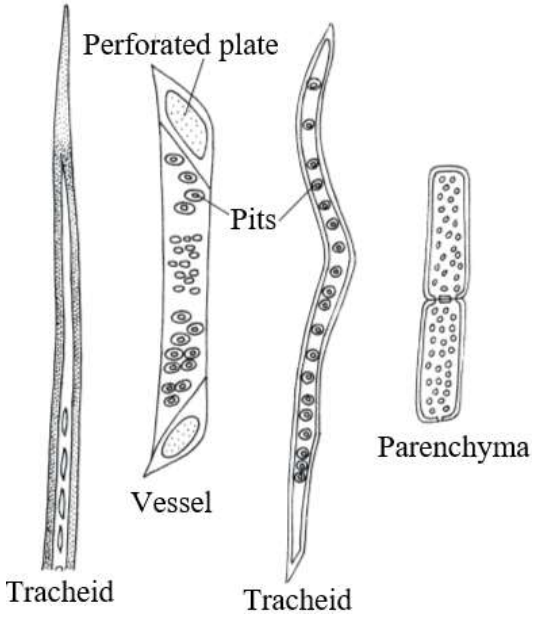
◈ **Complex Permanent Tissues :-**

- A complex tissue can be defined as a collection of different types of cells that help in the performance of a common function.
- The important complex tissues in vascular plants are xylem and phloem. Both of these are together called as vascular tissues.
- Both these tissues are an assemblage of living and dead cells and may be primary or secondary, depending upon their mode of origin.
- Complex tissue transport water, mineral salts (nutrients) and food material to various parts of plant body.

Complex tissues are of following two types :

(I) Xylem :

- It is also known as wood. Its main function is conduction of water and mineral salts from root to the top of plant.
- Primary xylem elements originate from procambuim of apical meristem.
- Secondary xylem elements originate from the vascular cambium of lateral meristem.
- The xylem elements are of 4 types: tracheids, vessels, xylem parenchyma, xylem sclerenchyma (xylem fibers).



(i) Xylem Tracheids :

- These are elongated, tubular, dead cells with narrow, blunt ends. They possess hard lignified walls and wide lumen. Some unthickened areas called pits are present for movement of sap from one cell to another. Tracheids are chief water conducting elements in non flowering plants.

(ii) Xylem Vessels :

- These are much elongated tubular channels with wide lumen. A vessel is composite structure made up of number of vessel elements. These are joined together and allow quick movement of water or sap. End walls of xylem vessels are highly perforated hence they form a channel which allows continuous rise of water. They are present only in flowering plants.

(iii) Xylem Fibers or Xylem Sclerenchyma :

- Long and narrow sclerenchymatous fibers with tapering ends. The wall is heavily lignified leaving a very narrow lumen.
- It provides tensile strength and mechanical strength.

(iv) Xylem Parenchyma :

- They are thin walled living cells present in both primary and secondary xylem.
- They help in storage of food materials.

Functions

- The main function of xylem is the upward movement of water and dissolved minerals (ascent of sap) from the roots to different parts of shoots.
- Tracheids, vessels and xylem sclerenchyma provide mechanical strength to the plant body.

(II) Phloem : Phloem is a living conducting or vascular tissue.

- The dead matter in them is known as **bast**.
- Its main function is conduction of food material from leaves to other plant parts.
- The phloem elements are of four type : Sieve tubes, Companion cells, phloem parenchyma, (phloem fibers), phloem sclerenchyma.

(i) Sieve Tubes :

- These are living but lack nucleus at maturity.
- Cell wall is thin and made up of cellulose.
- These are elongated tubular channels. Each sieve tube is made up of several cells called sieve tube members, joined end to end. The end walls have many large pores known as sieve plates. Each sieve tube is always associated with a companion cell. Sieve elements take part in the transport of organic food. It is usually found in pteridophytes & gymnosperms.
- A mature sieve tube has a peripheral cytoplasm without nucleus. So it is living cell without nucleus.

(ii) Companion Cells :

- The cells are living, thin walled, narrow and found attached to the lateral side of sieve element.
- They are closely associated with sieve tube by plasmodesmata so with the death of one, the other cell dies. Nuclei of companion cells control the metabolic activities of sieve tube. In non-flowering plants companion cells are absent, they have albuminous cells.

(iii) Phloem Fibers (bast fibers) :

- These are sclerenchymatous fibers having thick wall and narrow lumen.
- They provide mechanical support to the plant.

(iv) Phloem Parenchyma -

- The chief function of parenchyma is to store food material and other substances like mucilage, tanins and resins.
- Phloem parenchyma is absent in most monocots and some herbaceous dicots.
- In phloem except phloem sclerenchyma all elements are living.

- **Function :** Phloem helps in the transportation of organic food (photosynthesized by the leaves) to all the parts of a plant.

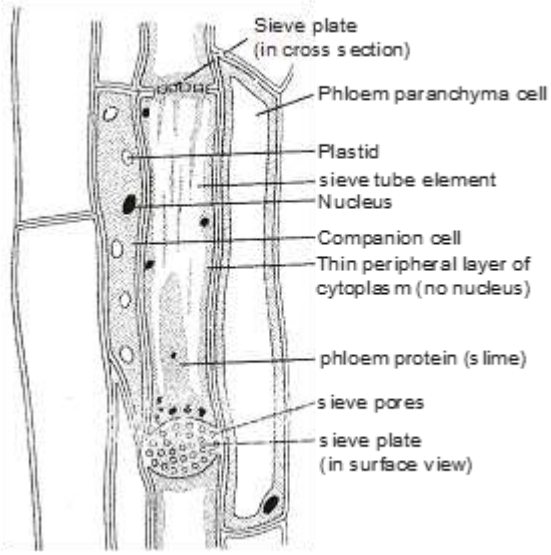


Figure. Phloem

DIFFERENCES BETWEEN XYLEM & PHLOEM		
S.N.	**Xylem**	**Phloem**
1.	Xylem parenchyma is only living, remaining cells are dead.	Phloem sclerenchyma only dead, remaining all cells are living.
2.	It carries minerals, salts and water.	An organic solution of sugars is translocated.
3.	The movement is only upward.	The movement can be upward or downward.

Differences Between Meristematic and Permanent Tissue

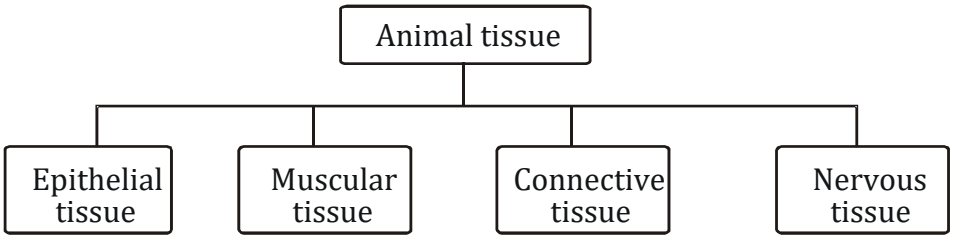
S.no.	Meristematic tissue	Permanent tissue
1.	Cells are small and may be rounded, oval, rectangular or polygonal.	Cells are large and of different shapes according to the type of tissue.
2.	Cells are thin-walled.	Cells are thin or thick-walled.
3.	Cells are rich in cytoplasm.	Cytoplasm is present as a layer along the cell wall.
4.	A prominent nucleus is present.	Nucleus is relatively small in size.
5.	Vacuoles are small; may even be absent.	Usually a large central vacuole is present.
6.	Intercellular spaces are absent.	Intercellular spaces are often present.
7.	Cells are undifferentiated and give rise to different permanent tissues.	Cells are differentiated.
8.	Power of cell division is present.	Lacks the power of cell division.
9.	Always living.	May be living or dead.

– **Boost your knowledge**

- **Hadrome** – It is a water conduction component (tracheids & vessels) of plant body.
- **Leptome :** Main part of phloem involved in conduction of food, which is sieve tube.
- Sieve tube and companion cells are termed as sister cells.

ANIMAL TISSUE

Based upon the structure and functions, simple tissues in multicelluar animals are categorized into four types. These are :

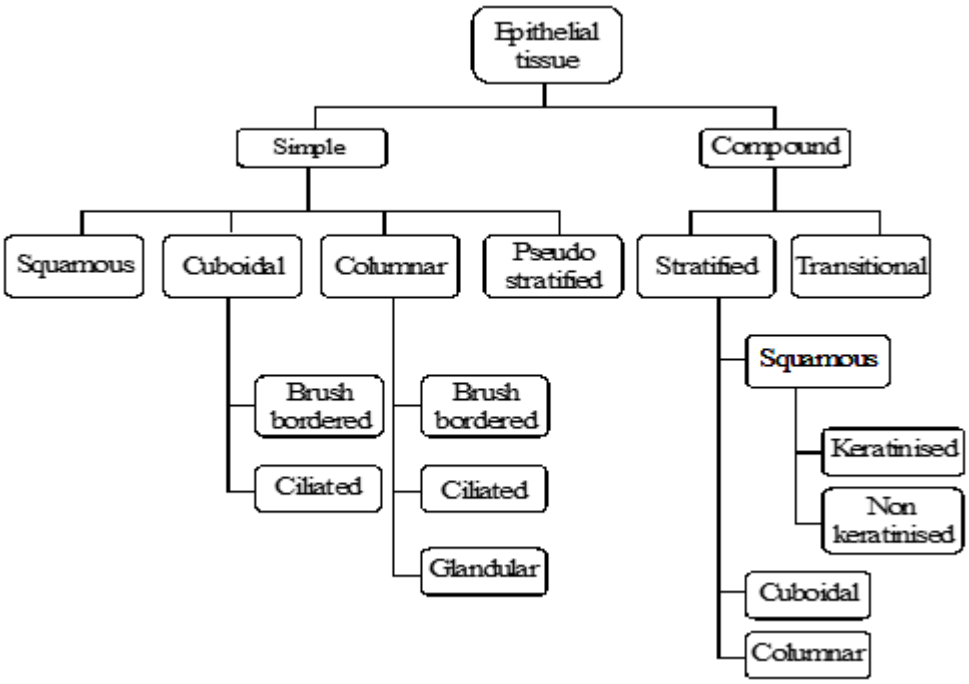


(I) Epithelial Tissue
(II) Nervous Tissue
(III) Muscular Tissue
(IV) Connective Tissue

(I) Epithelial Tissue :

(Epi means above & thelial means to growing layer)

- Always grows on some other types of tissues. Cells of epithelium are set very close to each other and the tissue rests on a non-cellular basement membrane.
- It covers most organs and cavities within the body.
- It also forms a barrier to keep different body systems separate.
- Epithelial cells are closely packed and have small amount of cementing material, so there are very little inter-cellular spaces present between the cells. Due to absence or less of intercellular spaces; blood vessels, lymph vessels and capillaries are unable to pierce this tissue, so blood circulation is absent in epithelium. Hence cells depend for their nutrients on the underlying connective tissue.
- It always rest upon underlying connective tissue. At the junction of the epithelial tissue and connective tissue a layer is present which is called basement membrane (extra cellular fibrous), which is formed of mucopolysaccharides and collagen fibrils.

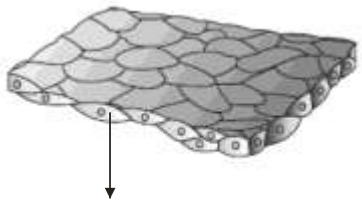


Function :

- Epithelial tissue cover the body surface as an outer layer of skin and provide protection to the underlying tissues from mechanical injury, drying up, entry of germs (viral or bacterial pathogens), and harmful chemicals.
- Epithelia forms inner lining of mouth, alimentary canal and other internal organs inside the body and protect these organs.
- Epithelial lining of the intestine absorbs water and digested food.
- Epithelial tissues help in the elimination of nitrogenous and other waste products.
- Epithelial lining of the cavities give rise to glands that provide valuable secretions such as mucus, gastric juice, etc.

◈ **Simple Epithelial Tissue :**

(i) Simple Squamous epithelium : It is also called pavement epithelium because it is a compact structure.



FLATTENED CELL

SQUAMOUS EPITHELIUM

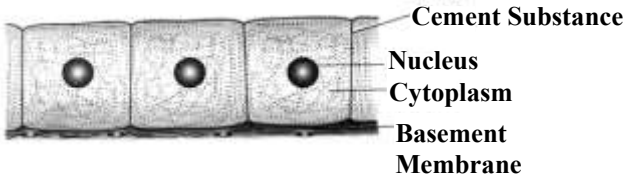
- **Structure** :- Cells are polygonal in surface view.
- **Occurrence :-** It forms the delicate lining of cavities (mouth, oesophagus, nose, pericardium, alveoli) blood vessels and covering of the skin.
- **Function :-** Its function is protection from mechanical and chemicals injury, filtration and diffusion

(ii) Simple Cuboidal epithelium: They are cube like cells that fit closely, cells look like squares in section, but free surface appears hexagonal.

- **Structure:** This epithelium consists of cube-like cells which are about as tall as wide. The outline of cells is polygonal in surface view and square in section.
- **Occurrence:** Germinal layer of sex organs, thyroid vesicles, small salivary gland duct, sweat gland, mammary gland duct.
  Epithelium is also called as germinal epithelium in gonads as cells divide to form sperm and egg.
- **Function:** It helps in protection , secretion, excretion and gamete formation.
- **Modifications of simple cuboidal epithelium :**

(i) Their free surface may have microvilli so they are called brush-bordered cuboidal epithelium. Microvilli increase the surface area. e.g. found in PCT of nephron.

(ii) Cuboidal epithelium may bear hair like cilia on their free ends and helps in the transport of materials. e.g. found in neck part of nephron.



CUBOIIDAL EPITHELIUM

(iii) Simple Columnar epithelium

- **Structure :-**This epithelium consists of tall or pillar-like cells that are much taller than wide. The nuclei are generally elongated along the long axis of cells.
- **Occurrence:** The columnar epithelium lines the stomach, intestine and gall bladder. It also lines mammary gland ducts and parts of urethra.

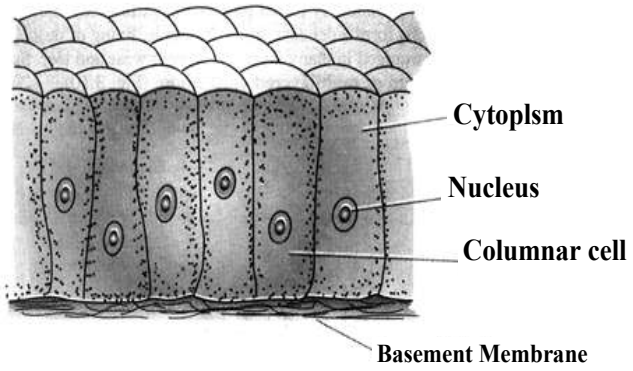


Figure : COLUMNAR EPITHELIUM

- **Function:** It helps in protection, absorption and secretion. Columnar epithelium of intestine is specialized for the absorption of water and digested food.
- **Modification of Simple columnar epithelium**

(i) When microvilli are present on free end of columnar epithelium. e.g., Gall bladder.

(ii) When microvilli are present on free end of columnar cells and in between these cells goblet cells are also present. e.g., Small intestine.

(iii) When cilia are present on free end of columnar cells. e.g., Fallopian tubes and trachea.

(iv) **Pseudostratified epithelium :** This epithelium is made up of a single layer of columnar or cuboidal epithelium but it appears two layered because some cells are shorter than the others and have their nuclei at different level. e.g. trachea, bronchi, respiratory epithelium of nasal chambers.

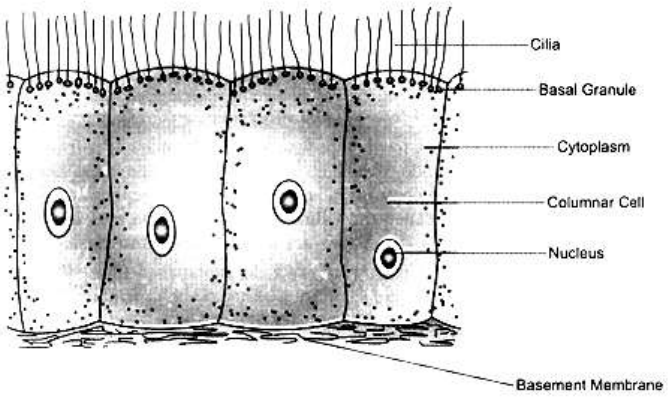


Figure : CILIATED COLUMNAR EPITHELIUM

(v) Glandular epithelium :

- **Structure :-**This epithelium consists of columnar cells modified to secrete chemicals.
- **Occurrence :-**It lines the glands such as gastric glands, pancreatic lobules, intestinal glands, etc.
- **Functions :-** It helps in release of different secretory products such as sweat, saliva, breast milk, digestive enzymes and hormones among many other substances.

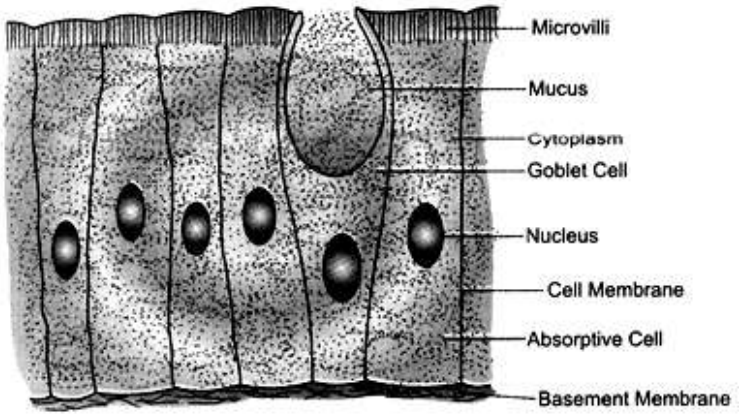


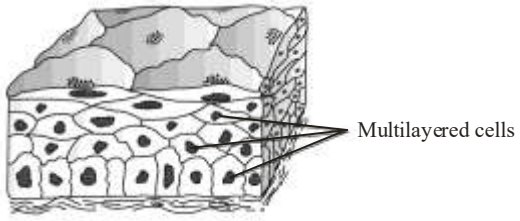
Figure : GOBLET CELLS IN COLUMNAR EPITHELIUM

◈ **Compound Epithelium Tissue**

The compound epithelium is made up of more than one layer of cells. Only the cells of the deepest layer rest on basement membrane. Main function of these epithelia are secretion or absorption, protection against mechanical, chemical, thermal or osmotic stress.

(i) **Stratified epithelium :** It consist of many layers of the cells. Uppermost may have columnar or cuboidal or squamous cells.

Squamous stratified may have waterproof protein called keratin or horn which replaces the cytoplasm, this process is called cornification or keratinization which makes them hard and water proof. If keratin is not formed than it is called non-keratinised epithelium. **Keratinised stratified squamous epithelium** is found in skin, hair, horn, hooves, scales, feathers and **non-keratinised stratified squamous epithelium** form the lining of buccal cavity, oesophagus, cheeks, vagina etc.



STRATIFIED SQUAMOUS

(ii) Transitional epithelium : Multilayered and more stretchable than the stratified epithelium. It is found in urinary bladder, urethra and renal pelvis.

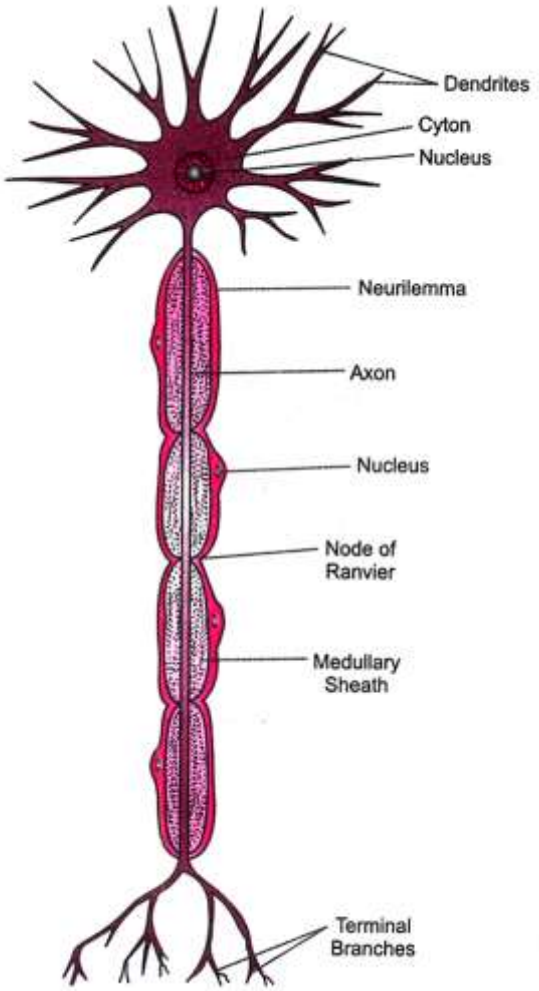
(II) Nervous Tissue :

- The nervous tissue, which contains densely packed nerve cells, called **neurons** (Gk. *neuro* = nerve), is present in the brain, spinal cord and nerves. The neurons are specialized for conduction of nerve impulses. They receive stimuli from within or outside the body and conduct impulses (signals) which travel from one neuron to another neuron. Each neuron is composed of the following three parts.

  (i) Cyton or cell body: The cell body contains the major concentration of the cytoplasm and the central nucleus of the neuron. The cell body also contains **Nissl's granules**, which are groups of ribosomes and endoplasmic reticulum.

  (ii) Dendrons: These are short much-branched and tapering projections arising from the cell body. The dendrons are further branched into dendrites. They provide a large surface area for synaptic connections with other neurons. They conduct nerve impulses towards the cell body.

  (iii) Axon (Nerve fibre). The axon is a long cylindrical process of uniform diameter that arises from the axon hillock of the cyton. It shows fine branching at the terminal end. Each branch ends in a swollen structure, called synaptic knob The axons carry impulses always from the cell body to other neurons. The synaptic knobs of terminal branches of neuron are connected with dendrite branches of an adjacent neuron. Each such junction, in fact, has minute gap called **synapse**. It is meant for the transmission of nerve impulse from one neuron to the other.



A Neuron

- **Types :** Nerve fibres are of two types :

Myelinated (covered with myelin sheath)	Non Myelinated (not covered with myelin sheath)
• Myelinated neuron are white in colour	• Non Myelinated neuron are grey in colour

Functions:

- They control all the body activities
- They co-ordinate between various body parts during any body function.
- Spinal cord and brain are made up of nervous tissue.

(III) Muscular Tissue :

- Muscular tissue is distinguished from other tissues by its unique ability to contract & relax and thereby perform mechanical work. It is responsible for movement of body organs and locomotion of body.

General structure

- The structural unit of muscular tissue is the muscle cells which because of its elongated shape is also called muscle fibre.
- The contractility is due to the presence of contractile proteins (actin & myosin) in the muscle fibre.
- The plasma membrane of muscle cells is called sarcolemma and endoplasmic reticulum of muscle cell is called sarcoplasmic reticulum.

General functions of muscular tissue

(i) It supports the bones and other organs of the body.
(ii) Muscles causes peristalsis of gut, heart beat, production of sound, etc.
(iii) Muscles causes movements of body parts and locomotion of the animals.
(iv) Facial expression also depends on muscles.
(v) Contraction of muscles helps in delivery of a baby.

(i) Straited muscles : They are also called as **voluntary muscles** because these are under the control of one's will.

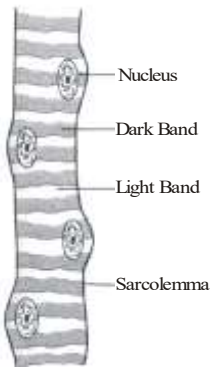
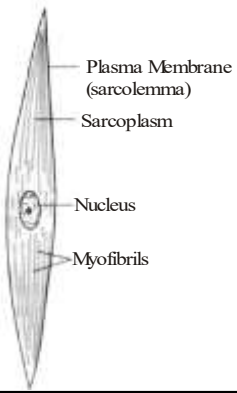
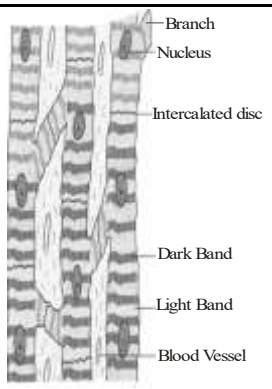
- Muscle fibres or cells are multinucleated and unbranched.
- These muscles get tired & need rest.
- They are found in limbs, neck, facial muscles etc.

(ii) Non striated muscles : They are **involuntary muscles** also called as **smooth muscles**.

- These muscle fibres are uninucleated & unbranched spindle shaped.
- Spindle shaped muscles.
- They are not enclosed by sarcolemma 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.

(iii) Cardiac muscle fibres : They are also **involuntary muscles**.

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

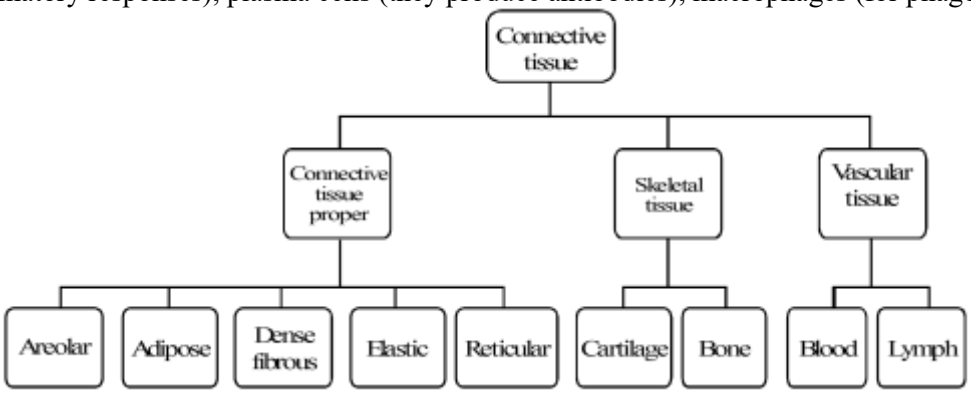
Striated muscle	Non-striated muscle	Cardiac muscle
		

Differences between Skeletal muscle tissue, Cardiac muscle tissue, Smooth muscle tissue

Type of Muscle Tissue	Skeletal Muscle Tissue	Cardiac Muscle Tissue	Smooth Muscle Tissue
Location in body	Attached to bones of the skeleton. In the case of facial muscles, attached to other tissues including skin-hence also called as "muscles of facial expression".	Wall of the heart only	Walls of hollow internal structures, including- Blood Vessels Stomach Intestines Gall bladder Urinary Bladder Airways to the lungs Iris of eye
Voluntary or involuntary	Voluntary	Involuntary	Involuntary
Striations (alternate light and dark bands)	Yes, Striated muscle	Yes, Striated muscle	No, Nonstriated muscle
Cell Nuclei	Many nuclei (located at periphery of long cylindrical muscles fibre)	One (centrally located) nucleus	One (centrally located) nucleus
Cell Shape	Elongated cylindrical and unbranched	Cylindrical and branched	Spindle shaped and unbranched

(IV) Connective Tissue :

- It is the most abundant tissue found in the human body. This tissue is specialized for connecting various tissues and organs.
- The connective tissues consist of variously shaped cells and fibers, lying wide apart in the extra cellular or intracellular material. It is composed of three components-intracellular medium, cells and fibers. Intracellular matrix is nonliving, transparent semi fluid made up of glycosaminoglycans and structural glycoprotein.
- Cells are-fibroblast (it forms white fibers called collagen, yellow fibres called elastin and reticular fibers), mast cells (they produce histamine, heparin and serotonin which are responsible to show inflammatory responses), plasma cells (they produce antibodies), macrophages (for phagocytic action).



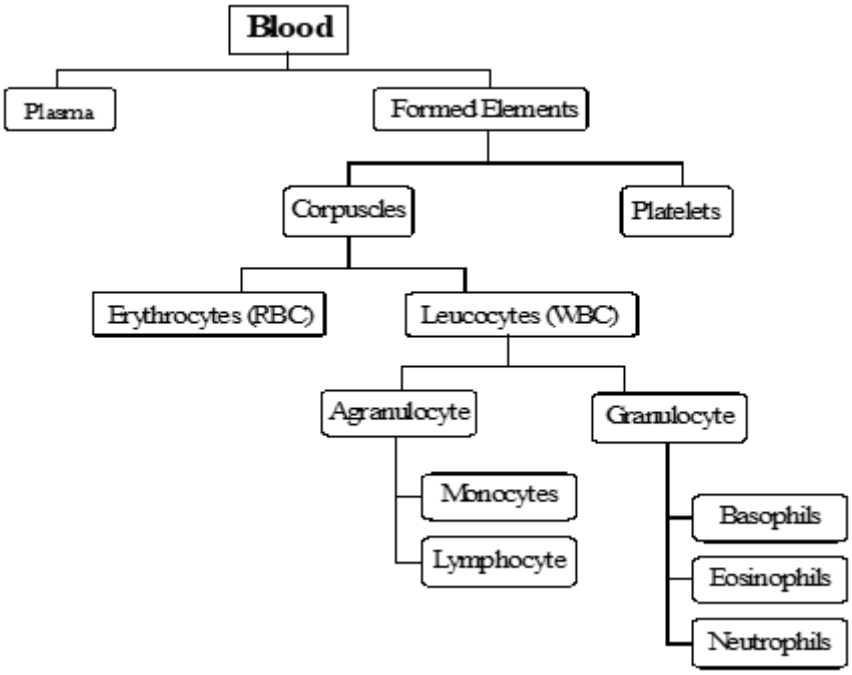
- **Types of connective tissue :**
  The connective tissues are of ***three*** major types

(I) Fluid or vascular tissue : It is two types

(A) Blood **(B)** Lymph

(A) Blood: Blood is a fluid connective tissue.

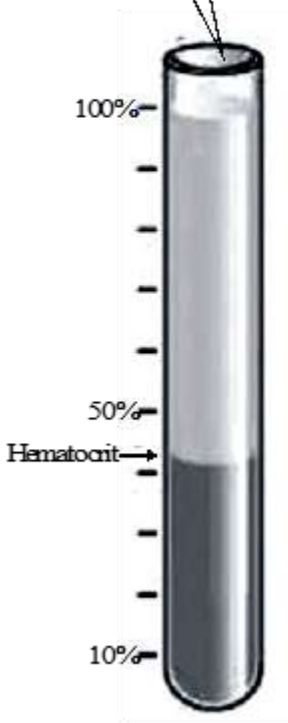
- It is softest connective tissue.
- Matrix of blood is called plasma, having wandering or floating cells, called corpuscles.
- **Blood composition :**



◈ **Corpuscles :**

- **RBCs (erythrocytes):** They are 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, phagocytic cells that protect our body by engulfing bacteria & other foreign particles.
- They are of two types : Granulocyte (Eosinophil, Basophil, Neutrophil) and Agranulocyte (Monocyte, Lymphocyte).
- **Blood platelets or thrombocytes :** They are spindle shaped cells which are involved in clotting of blood.

Blood is withdrawn from the arm placed in a test tube and centrifuged



Composition of Blood : Blood consists of a complex aqueous solution (the plasma), and of numerous cell types and cell fragments. The hematocrit is a measure of the cellular portion as a percentage of the total blood volume.

PLASMA

Components	Water	Salts Sodium, potassium, calcium, magnesium, chloride, bicarbonate	Plasma proteins Albumin Fibrinogen Immunoglobulins	Transported by blood nutrients (eg. glucose, vitamins) Waste products of metabolism Respiratory gases (O_2 and CO_2) Hormones
Functions	Solvent	Osmotic balance, pH buffering, regulation of membrane potentials	Osmotic balance, pH buffering, clotting, immune responses	

CORPUSCLES

Components	Erythrocytes (red blood cells)	Leukocytes (white blood cells) Basophil Eosinophil Neutrophil Lymphocyte Monocyte	Platelets
Number per mm^3 of blood	5-6 million	5,000 – 10,000	250,000 400,000
Function	Transport oxygen and carbon dioxide	Destroy foreign cells, produce antibodies roles in allergic responses	Blood clotting

- **Function of Blood :**
  (i) Transportation of digested food.
  (ii) Transportation of oxygen to body cells.
  (iii) Transportation of carbon dioxide from body cells to lungs.
  (iv) Transportation of excretory substances to kidneys for elimination.
  (v) Transportation of hormones.
  (vi) WBC help in fighting against diseases.
  (vii) Platelets help in clotting of blood.

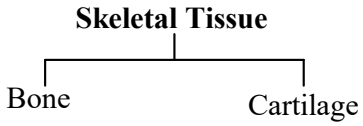
(B) Lymph : It is colourless fluid that bathes all the body organs and is filled in spaces between them. It is blood without the RBC's and platelets. Lymph is made up of plasma and lymphocytes.

– **Boost your knowledge**
- **Serum** - In blood, the **serum** is the component that is neither a blood cell (**serum** does not contain white or red blood cells) nor a clotting factor; it is the blood plasma not including the fibrinogens.
- **Haemocytometer -** An instrument for visual counting of the number of cells in a blood sample or other fluid under a microscope.
- **Haemopoiesis -** haemopoiesis is the formation of blood.

- **Functions :** It acts as a "middle man" for the exchange of various materials between the blood and various body tissues.

S. No	Character	Blood	Lymph
1.	Type of tissue	Red vascular tissue	White vascular tissue.
2.	Occurrence	In blood vessels.	In lymph vessels and around the body tissues.
3.	Composition	Formed of plasma, erythrocytes, leucocytes and platelets.	Formed of plasma and only leucocytes. Erythrocytes and blood platelets are absent.
4.	Haemoglobin	Present in RBC's	Absent.
5.	Nature of Plasma	With more proteins, calcium and phosphorus.	Less.
6.	Function	Transportation of materials, defence, blood clotting etc.	Acts as middle man between blood and body cells.

(II) Skeletal tissue : It is hard connective tissue that forms supportive frame work of the body. It is of two types :



– **Boost your knowledge**
- The cells of bone are termed as 'Osteocytes'
- The tooth is the only part of the human body that can't repair itself.
- Bone is the hardest tissue of our body but the hardest substance in our body is **enamel**, found as covering of teeth.
- A new born baby loses about half of their nerve cells before they are born.

(A) Bone : Matrix of bone is very hard because of salts such as calcium phosphate, $CaCO_3$ (60–70%) etc. and a protein ossein.
- The long bones are usually hollow containing a cavity called bone marrow cavity.
- It is full of bone marrow.

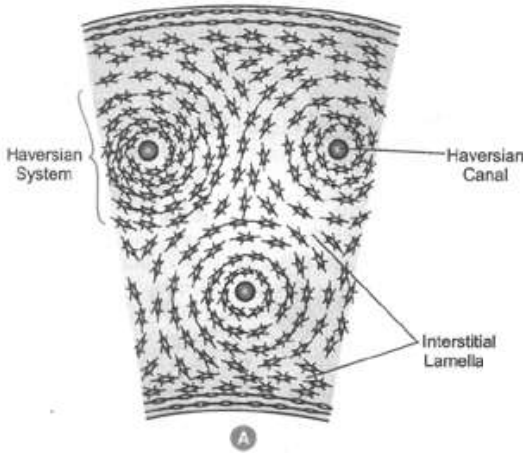


Figure : T.S. Of LONG BONE

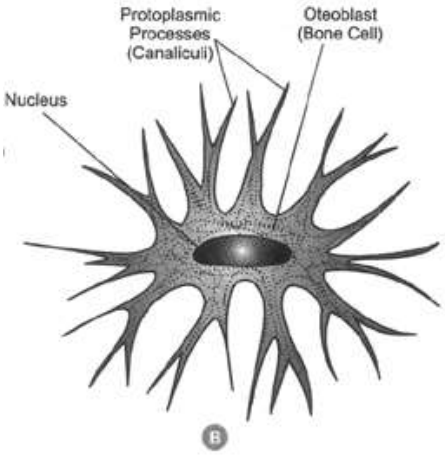


Figure : OSTEOBLAST

- In the solid matrix are present longitudinal canals called haversian canals.
- The matrix is present in the form of layers called lamellae.
- These lamellae are present in the form of concentric rings around the marrow cavity and around the canals.
- In these lamellae there are present ring shaped fluid filled spaces called lacunae.
- The lacunae contain bone forming cells called, osteocytes.

(B) Cartilage : This tissue is elastic and strong but softer than bone.

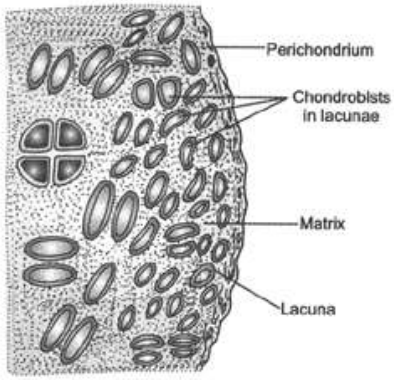


Figure : CARTILAGE

- The cartilage is a solid but semi-rigid and flexible connective tissue, containing a clear matrix called chondrin made of proteins and sugars. Cells are called as chondrocyte, which are widely spaced and matrix is reinforced by fibres.
- It forms the embryonic skeleton of vertebrates and the adult skeleton of sharks and rays.
- It also occurs in the human body in the ears, tip of the nose, trachea, ribs and surrounding ends of joints such as knees.

Differences between Cartilage & Bone

S. No	Character	Cartilage	Bone
1.	Chemistry	Formed of organic matter, called chondrin protein.	Formed of both organic matter (ossein protein) and inorganic matter (calcium phosphate)
2.	Nature of cells	Chondroblasts presents in group of 2 or 4	Irregular cells osteocytes that occur singly in lacunae.
3.	Nature of lacunae	With no canaliculi	With canaliculi
4.	Canals	With no canals	With Haversian canal and Volkmann's canal.
5.	Arrangement of matrix	Not arranged in rings	In rings called lamellae.
6.	Cavity	Solid internally	With marrow cavity

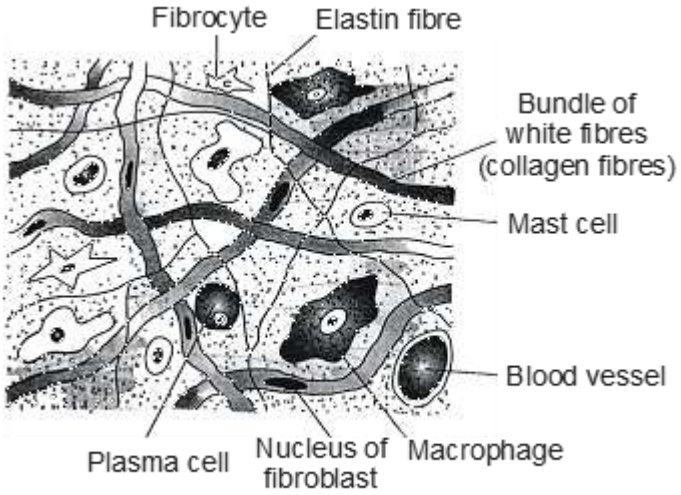
– **Boost your knowledge**
- **Osteoclast** – A large multinucleate bone cell which reabsorbs bone tissue
- **Osteoblast -** Immature bone cell.
- **Osteocytes :** Mature bone cell.

(III) Connective tissue proper : It is the most abundant type of connective tissue.

- It is further divided into following types :

(a) Areolar tissue : It is the most widely distributed connective tissue in the body.

- This tissue is essentially connective in function. It occurs beneath the epithelium of many hollow visceral organs, skin and walls of arteries and veins. The areolar tissue joins different tissues, forms the packing between them and helps to keep the organs in place and in normal shape. It consist of matrix, fibroblasts, mast cells, plasma cells and macrophages.

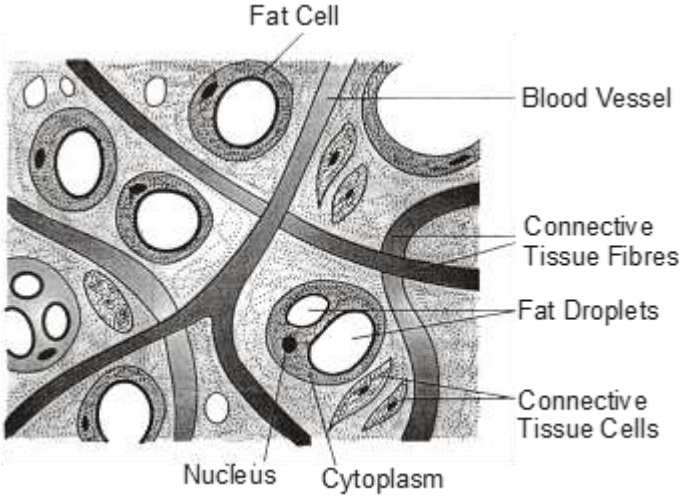


AREOLAR CONNECTIVE TISSUE

- **Function :**
  (i) It helps to hold various organs in place. It is considered as the packing tissue.
  (ii) It helps to repair body tissues after injury.
  (iii) Mast cells in this tissue are concerned with allergy.
  (iv) It binds skin with underlying tissues.

(b) Adipose tissue : These are oval & round cells, filled with fat globules.

- The cells are called as adipocytes.



ADIPOSE TISSUE

- **Function :**
  (i) It acts as insulator and prevents loss of heat from the body.
  (ii) It helps in the storage of food in the form of fats.
  (iii) It forms cushion like shock-absorbing structures below vital organs such as heart, kidney, eye balls etc.

(c) White fibrous connective tissue : They are very little matrix containing abundant non-elastic white fibres forming layers.

- Bundles of this tissue are called as tendons, which attaches muscles to the bones.

(d) Yellow fibrous connective tissue : They are very elastic due to the presence of a network of yellow fibers in it's matrix called as ligament which attaches bone to bone.

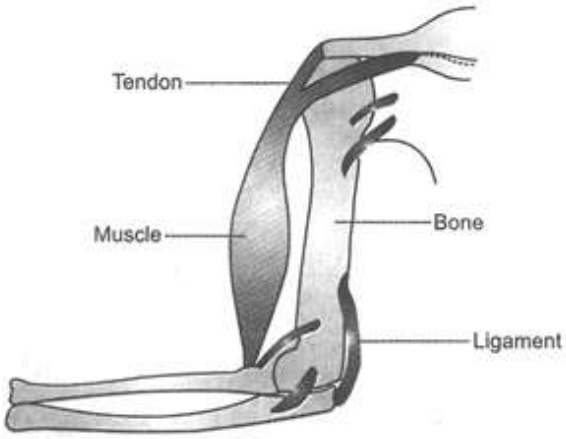


Figure : ATTACHMENT OF TENDONS AND LIGAMENTS

Differences between Tendon and Ligament		
S. No	**Tendon**	**Ligament**
1.	It is made up of white fibrous tissue.	It is made up of yellow elastic tissue.
2.	Fibroblasts lie in almost continuous rows.	Fibroblasts lie scattered.
3.	Tendon connects a skeletal muscle to a bone.	Ligament connects a bone to another bone.
4.	It is tough and inelastic.	It is strong but elastic.

(e) Reticular tissue : The cells in this tissue are star-shaped and form a network-like structure. Reticular fibres are made of Reticulin protein. It is found in the spleen, lymph nodes, tonsils etc.

- **Functions :**
  (i) It forms lymphoid tissues in the body.
  (ii) Reticular tissue in bone marrow helps in the formation of blood corpuscles.

Differences between plant and animal tissue

S.no.	Plant tissue	Animal tissue
1.	Most of the plants are stationary and remain fixed, i.e., they do not move from place to place (except aquatic plant).	Animals are not stationary and can move from one place to another in search of food, mates and shelter.
2.	They need comparatively less energy, (as most of the cell/tissue are dead).	They need more energy as compared to plants.
3.	Some of these tissues are thick-walled, lignified, and dead i.e. they do not contain living protoplasm.	They are made up of living cells.
4.	Growth of plant is indefinite.	Growth of animals is definite.
5.	The structural organization of plant is not complex as compared to animals.	The structural organization of organs and organ system of animal is much more complex as compared to plants.
6.	E.g.- sclerenchyma, xylem-tracheids and vessels, cork etc.	E.g.- nervous tissues, muscular tissues, connective tissue etc.