1. WHAT IS A TISSUE?

A group of similar or dissimilar cells that perform or help to perform a common function and have a common origin forms a **tissue.**

The basic cell structure in plants and animals is the same but there are noticeable differences as far as organization at the tissue level is concerned. The structural organisation is far more specialized and localized in animals than in plants.

1.1 DIFFERENCES BETWEEN THE TISSUES OF PLANTS AND ANIMALS

S.No.	Plant tissues	Animal tissues
1.	Most of the plants remain fixed at one place (sedentary) and need less energy. Therefore the tissues are thick – walled and dead to provide mechanical support. E.g., Sclerenchyma.	Animals show active locomotion and hence need more energy. Therefore the tissues are made up of living cells. E.g. – Nervous tissue.
2.	Growth in plants is indefinite. Certain tissues (meristematic) in root and shoot apex divide throughout life and add new cells. These cells differentiate and stop dividing to form permanent tissues.	Growth in animals is definite. In other words, they do not posses dividing and non-dividing tissues. The animal organs grow more or less uniform.
3.	Plant tissues are not much complicated.	Animal tissues are much more complicated.

A multicellular organism (plants and animals) develops from single 'initial cell' which undergoes repeated cell division. The large number of cells so formed undergo cellular differentiation (a process of qualitative changes in the cells to perform different functions in the living organisms). Cell division and differentiation leads to the development of specific organs, each, consisting of specific groups of cells to perform specific functions in the body. With the increase in complexity of organisms, the level of organization also becomes complex.

Cell ⟶ Tissue (group of cells) ⟶ Organ (group of tissues) ⟶ Organ system (group of organs) ⟶ Organism (group of organ system)

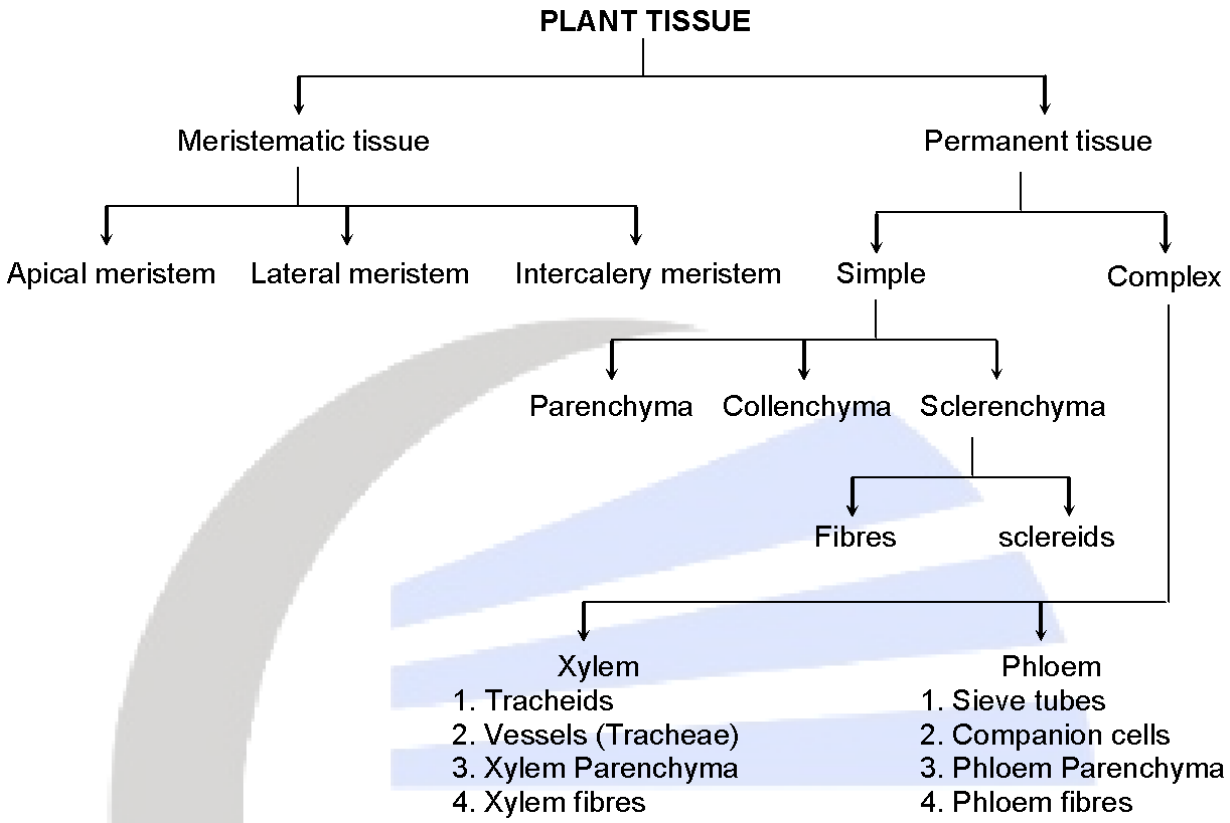
2. PLANT TISSUES

Plant tissues are of two types

- **Meristematic** tissue
- **Permanent** tissue

This differentiation is based on the ability of the mature cells of the tissue to divide and produce new cells. Meristematic tissue cells are capable of dividing, while permanent tissue cells are not.

2.1 CLASSIFICATION OF PLANT TISSUES



2.2 MERISTEMATIC TISSUES

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

2.2.1 Characteristics of Meristematic tissues

(a) The cells may be oval, rounded, polygonal or rectangular in shape.
(b) The cells of the tissue are compactly arranged without intercellular spaces between them.
(c) Each cell has a thin cell wall, dense cytoplasm with few or no vacuoles and a large prominent nucleus.

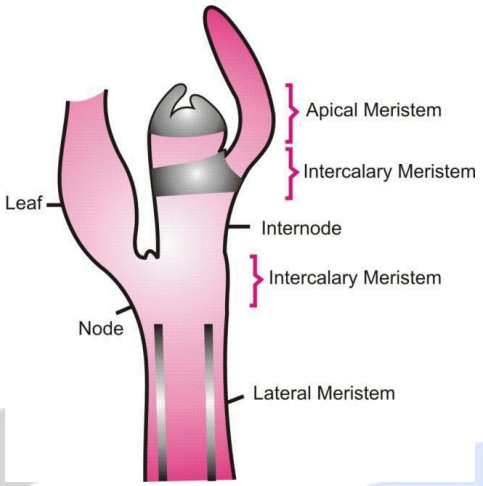
2.2.2 Types of Meristematic tissues

Depending upon the occurrence and position in the plant body, meristems are classified as

(a) Apical meristem : Apical or Primary meristem is present at the growing tips of main and lateral shoots and roots. Cells derived from apical meristem differentiate into Permanent tissues.

(b) Lateral meristem : This tissue occurs along the sides of the central axis of the plant. Lateral meristems usually occur beneath the bark in the form of cork cambium and in vascular bundles in the form of vascular cambium. Lateral meristems are secondary meristems.

(c) Intercalary meristem : This tissue is present at the base of internode or leaf.



Stem tip showing location of different types of meristematic tissue

2.2.3 Functions of Meristematic tissues

(a) Apical meristem is responsible for the linear growth of an organ (e.g. root and shoot)
(b) Lateral meristem cause the organ (like stem or trunk) to increase in diameter and girth.
(c) Intercalary meristems are responsible for growth in length.

2.3 PERMANENT TISSUES

Cells of meristematic tissue give rise to permanent tissues. The cells of this tissue are mature and have undergone growth and differentiation.

2.3.1 Characteristics of Permanent tissues

(a) The cells have lost their power of division.
(b) The cells possess definite shape, size and function.
(c) They may be living or dead.
(d) The living permanent cells are large, thin walled with a vacuolated cytoplasm.
(e) Dead permanent cells are thick walled without cytoplasm.

2.3.2 Types of Permanent tissues

The permanent tissues are classified on the basis of their composition into two types.

(a) Simple Permanent tissue : These tissues are composed of similar types of cells which have common origin and function. They are further classified as

(i) Parenchyma : It forms the major vegetative ground tissue and is widely distributed in various plant organs (e.g., root, stem, leaves, etc.).

Characteristics

- The cells of parenchymatous tissue may be isodiametric, spherical, oval, etc.
- The cells are closely packed.
- The cells have thin walls, vacuolated cytoplasm and a prominent nucleus.

Modification of Parenchyma

- **In Storage parenchyma**, cells enlarge to store nutrients and water.
- In **Aerenchyma,** large air cavities are present to store gases and provide buoyancy to aquatic plants.
- In **Chlorenchyma**, the cells contain chloroplasts and perform photosynthesis.

Functions

- Its main function is assimilation and storage of reserve food materials.
- It also stores waste products such as tannin, gum, resins, etc.

- It serves as a packing tissue.

(ii) Collenchyma : This tissue is usually found in leaf stalk and stem.

Characteristics

- It is a living tissue.
- The cells may be circular or polygonal.
- The cells are thin-walled with thickenings at the corners.
- The cells are compact with no intercellular spaces.
- The cells are generally elongated with oblique end walls.

Functions

- It provides flexibility and mechanical strength to plant parts.

Differences between parenchyma and collenchyma

S.No.	Parenchyma	Collenchyma
1.	It consists of thin-walled living cells.	It consists of cells with localized thickenings.
2.	It is distributed in all plant parts.	It is found in aerial parts and restricted to outer layers.
3.	The cells of parenchyma assimilate, store food and waste products.	Collenchyma forms the mechanical tissue in young parts of the plants.

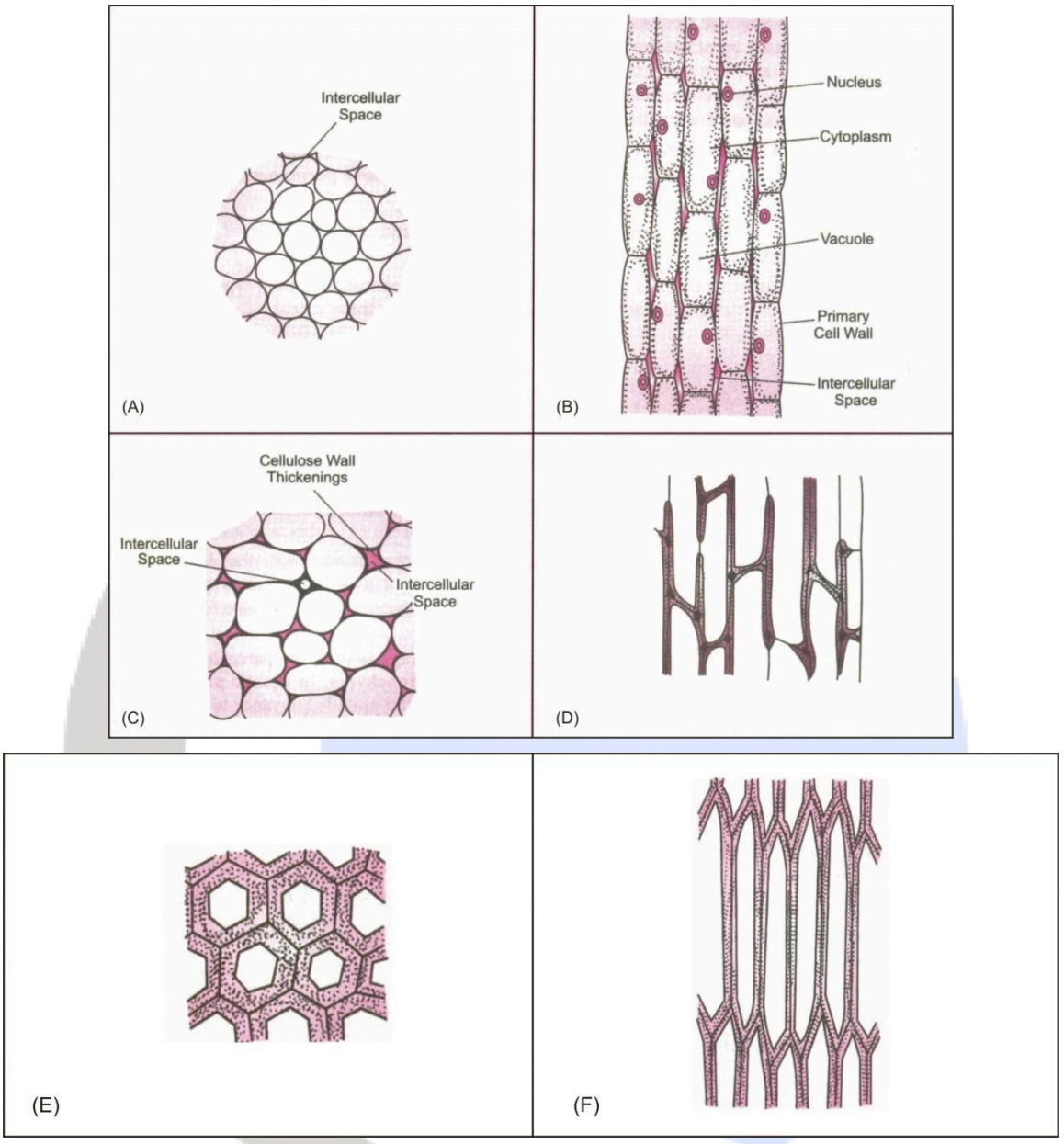
(iii) Sclerenchyma : It is the tissue which makes the plant hard and stiff. It is found in stem, veins of leaves, hard covering of seeds and nuts, husk of a coconut, etc.

Characteristics

- The sclerenchymatous tissue appears as hexagonal net in transverse section.
- The cells are thick-walled and dead due to deposition of **lignin** (a chemical substance meant for hardening).
- The cell lumen (internal space) is nearly absent.

Function

Schlerenchyma provides mechanical support to plant parts.



Simple permanent tissues: A-B Parenchyma; C-D Collenchyma; E-F Sclerenchyma

Differences between collenchyma and sclerenchyma

S.No.	Collenchyma	Schlerenchyma
1.	Cells of collenchyma are living	Cells of sclenenchyma are dead.
2.	Cells have thin walls.	Cells have thick and hard walls.
3.	Cells have localized thickenings at corners.	Cells have uniform thickening.
4.	Cells are filled with protoplasm.	Cells are empty with narrow lumen.
5.	Collenchyma provides mechanical strength and elasticity.	Sclerenchyma provides mechanical support.

(b) Complex Permanent Tissue

They are a group of different types of cells having a common origin and working together as a unit. They are of two types, xylem and phloem. Both are conducting and together constitute the vascular bundle.

(i) Xylem: Xylem consist of four types of cells

- Tracheids
- Vessels
- Xylem Parenchyma
- Xylem fibres.

Tracheids are elongated, tube-like dead cells with oblique end walls. The walls are lignified and cavities are empty (dead cell).

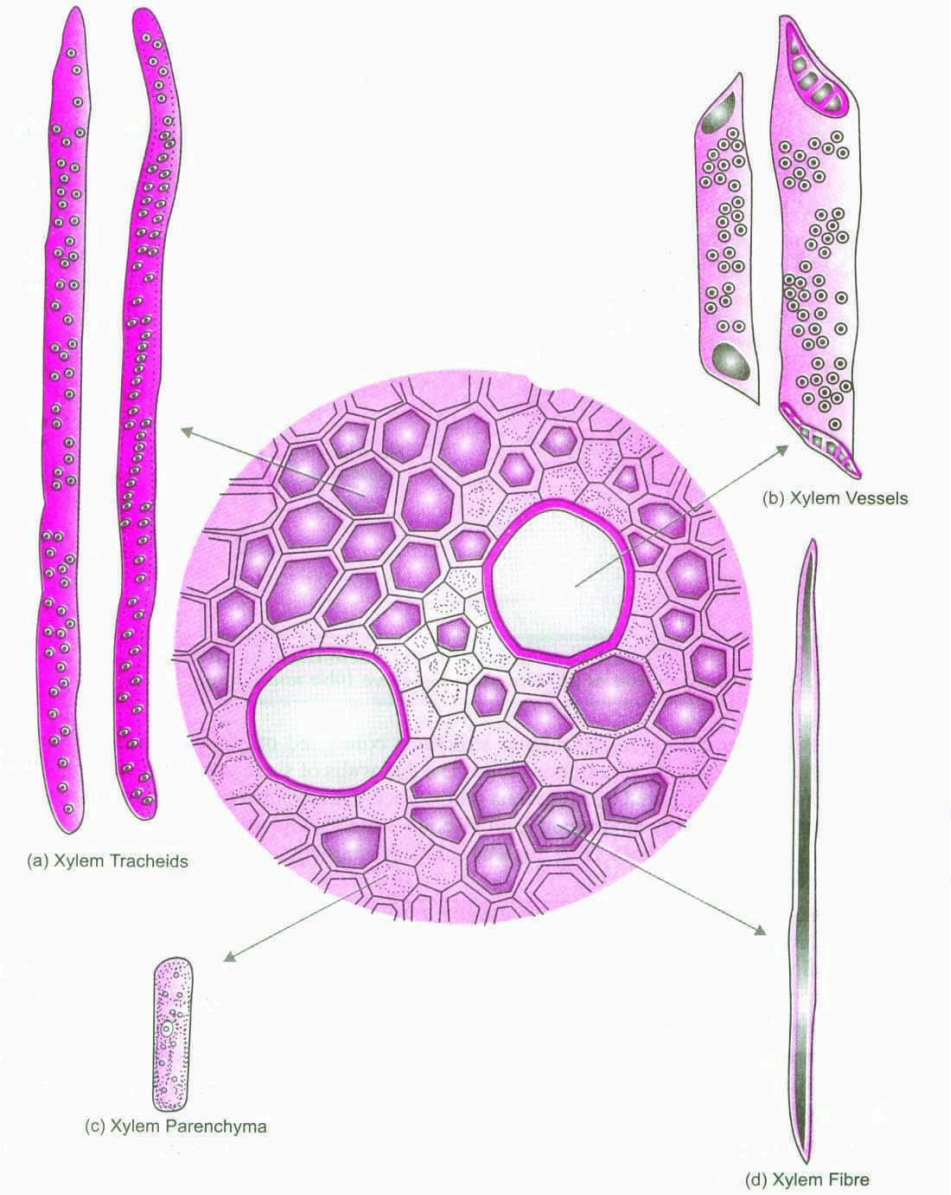
Vessels form long tubes fitting together end to end with perforated or no end walls. Vessels are absent in ferns.

Xylem parenchyma stores food and help in lateral conduction of water or sap.

Xylem fibres are supportive in function. Except xylem parenchyma, other xylem cells are dead cells.

Function

- It serves for the upward movement of water and mineral salts from root to different aerial parts of the plant.
- Xylem gives strength to the plant body.



Component cells of Xylem tissue

(ii) Phloem : Phloem consists of four types of cells.

- Sieve tubes
- Companion cells
- Phloem Parenchyma
- Phloem fibres.

Sieve tubes are tubular structures with perforated walls (called sieve plates). The sieve elements (cells) have thin lining of cytoplasm with no nucleus.

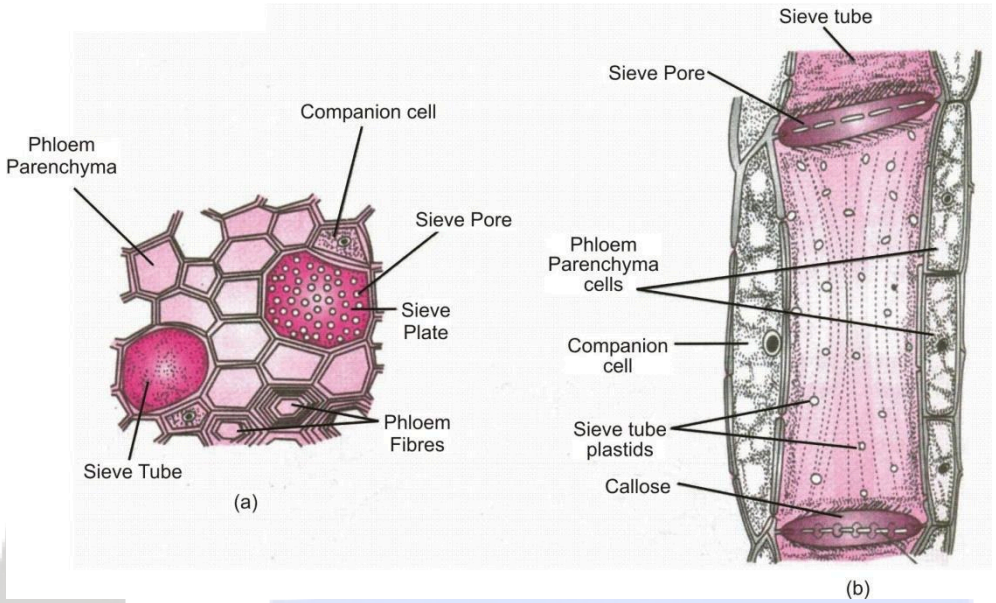
Companion cells are living cells associated with the sieve tubes. They have dense cytoplasm and elongated nucleus. Ferns and pines do not have companion cells.

Phloem Parenchyma store food and help to conduct it.

Phloem fibres are dead sclerenchymatous cells associated with phloem. Except phloem fibres, other phloem cells are living cells.

Function

- Phloem helps in translocation of organic solutes from leaves to the storage organs and then to growing regions.



(a) Component cells of phloem tissue (b) L.S. of phloem showing sieve tube and companion cell

2.4 EPIDERMIS (PROTECTIVE TISSUE) :

Epidermis forms the outermost protective layer of all plant parts like leaf, stem, root, etc. It is a single continuous layer made up of flat cells with their outer and side walls thicker than the inner wall. There is no intercellular space between the cells.

Epidermal cells on aerial parts of the plant secrete a waxy, water resistant layer called cutin on its outer surface. It protects against loss of water, mechanical injury and invasion by parasitic fungi.

Epidermal cells of leaf bear small pores called stomata. Each is enclosed by two modified epidermal cells called guard cells which are kidney-shaped.

Epidermal cells of the roots bear long thread like structures called root hairs. They increase the absorptive surface area.

As stems and roots grow older, a strip of secondary meristem replaces the epidermis. The cells on the outer side of the meristem divide to form several layered cork or bark. The cork cells are dead and compactly arranged in radial rows without intercellular spaces. Suberin (a waxy substance) gets deposited in their walls making them impervious to water and gases.

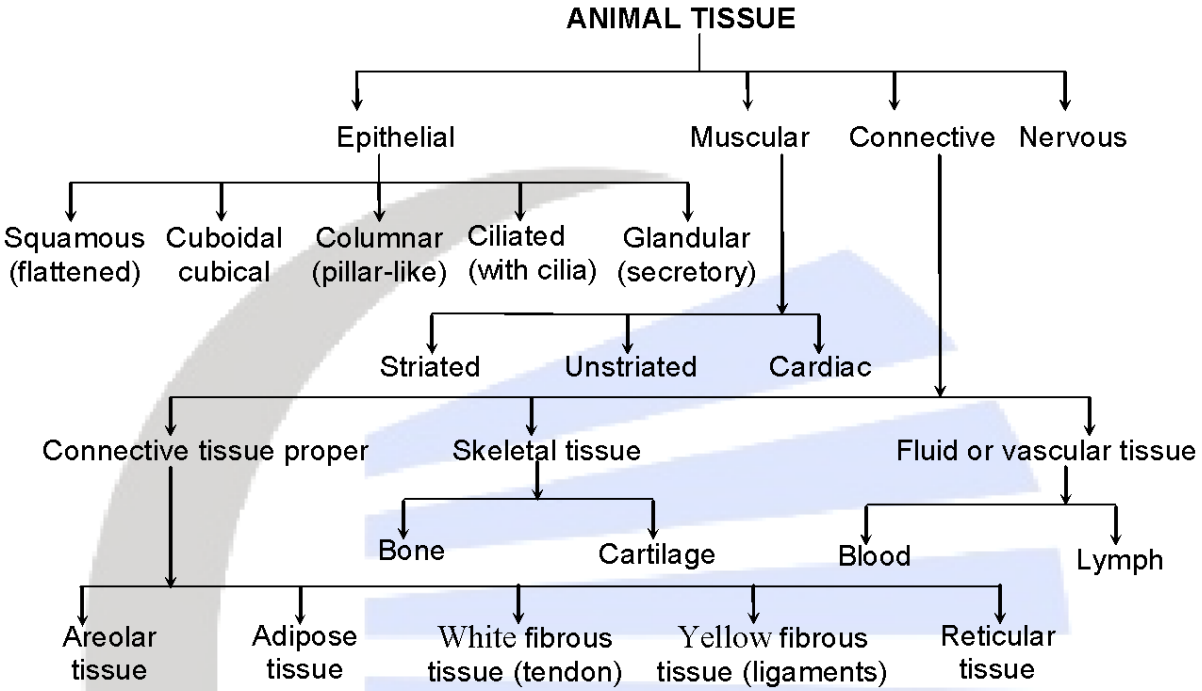
Function of Epidermis (Protective tissue)

- Epidermal cells of aerial plant parts with cutin and bark of older roots and stems with suberin aid in protection against water loss, mechanical injury and invasion by parasitic fungi.
- Epidermal cells (guard cells) of leaf bearing stomata help in gaseous exchange and transpiration (loss of water in the form of water vapour)
- Epidermal cells of roots helps in water absorption.

3. ANIMAL TISSUES

Animals, like plants are made up of different types of tissues which perform specific functions. For example, muscles contract and relax to bring about movement, blood carry substances (O_2, CO_2, food and waste materials), nerve cells respond to stimuli etc. Thus muscles, blood, nerves, etc are examples of tissues in our body.

On the basis of functions they perform, animal tissues are classified as follows :



3.1 EPITHELIAL TISSUES

3.1.1 General Characteristics

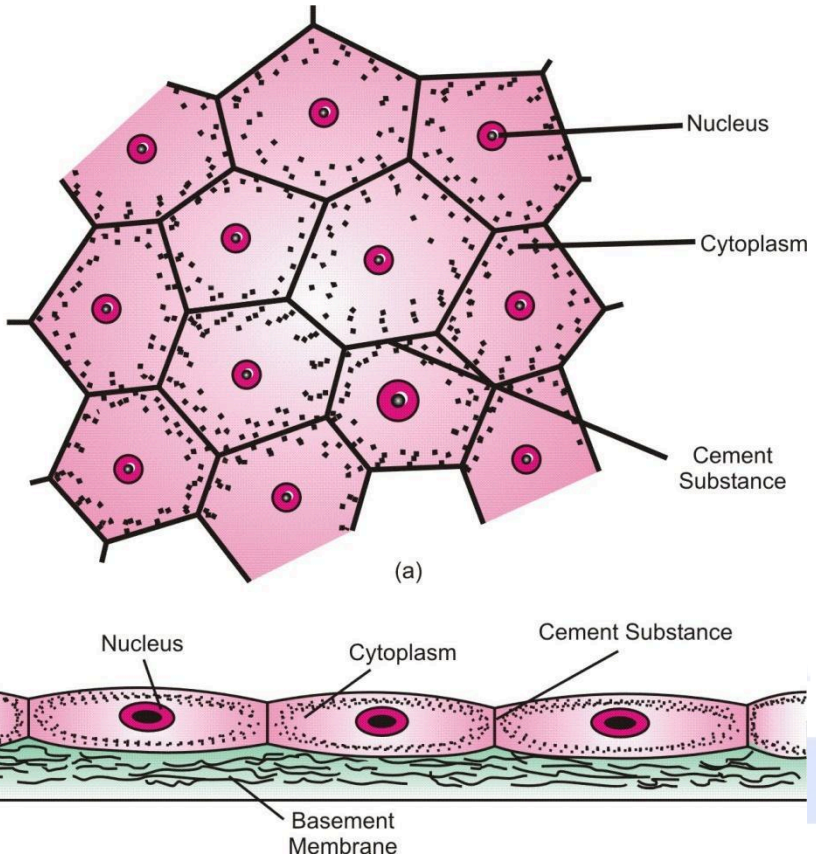
(a) It occurs as a protective covering and consists of one or more layers of cells.
(b) The cells are closely packed and held together by intercellular junctions.
(c) The epithelial tissue rests on non-cellular basement membrane.
(d) The epithelium is not traversed by blood vessels.

3.1.2 Types of epithelial tissue

Based on cell layers and shape, epithelial tissues are further classified.

(a) Squamous Epithelium

(i) Structure : This consists of thin and flat cells closely packed like the tiles in the floor. Squamous epithelium is **simple** when it forms a single layered delicate lining and called **stratified** when cells are arranged in many layers.



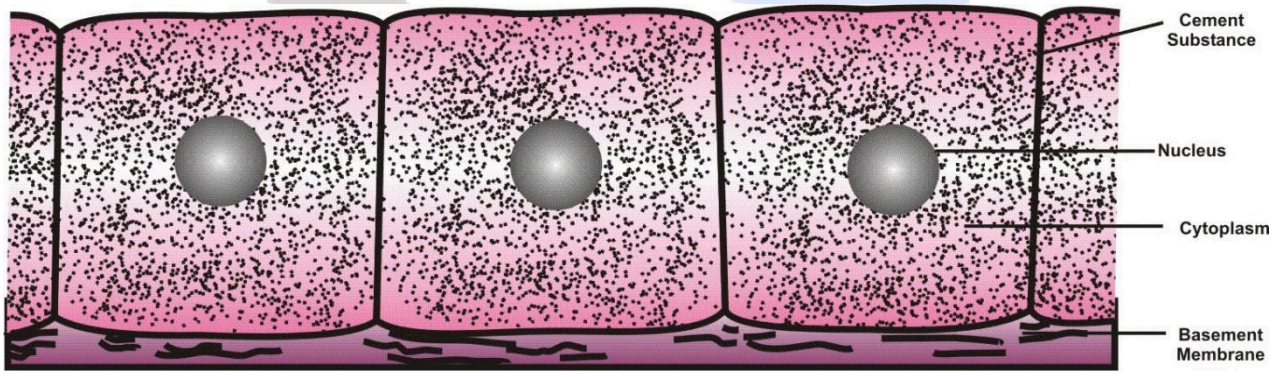
Squamous epithelium (a) Surface view (b) Vertical section.

(ii) Occurrence : Simple squamous epithelium lines the blood vessels, urinary tubules, alveoli of lungs, etc. Stratified squamous epithelium forms epidermis of skin, lining of pharynx, oesophagus, etc.

(b) Cuboidal epithelium

(i) Structure : It consists of cube-like cells which looks like square in section but free surface appears hexagonal.

(ii) Occurrence : Cuboidal epithelium lines the small salivary ducts, pancreatic ducts, sweat glands, etc.

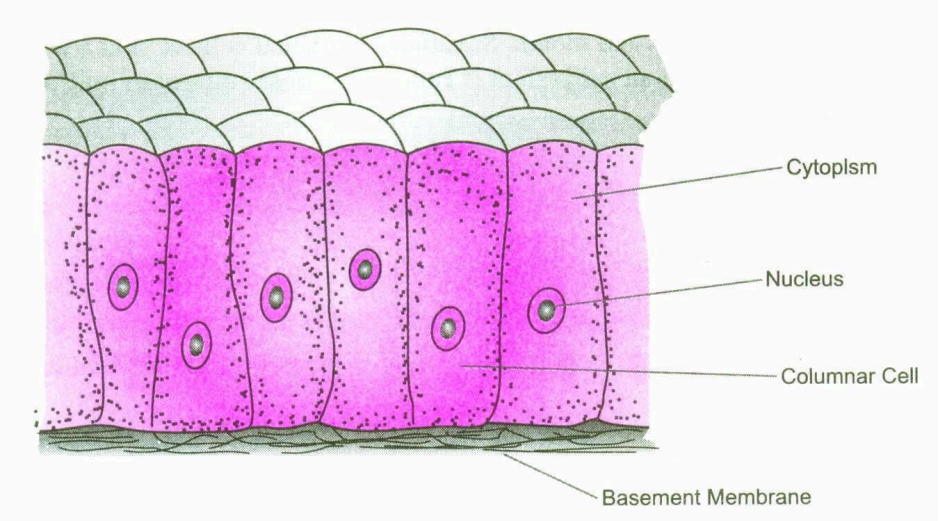


Cuboidal epithelium

(c) Columnar epithelium

(i) Structure : It consists of single layer of pillar-like cells.

(ii) Occurrence : The columnar epithelium lines the stomach, intestine, gall bladder, etc.

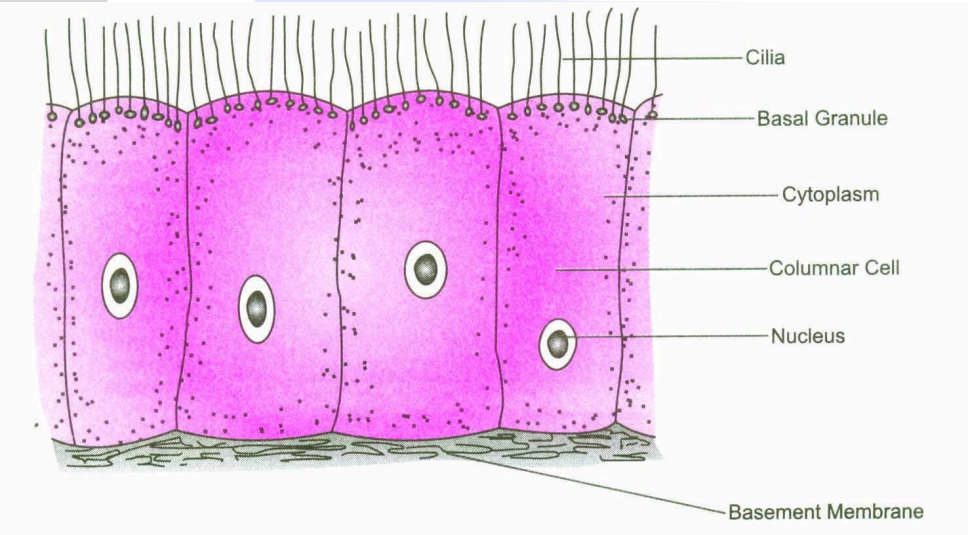


Columnar epithelium

(d) Ciliated epithelium

(i) Structure : It consists of cuboidal or columnar cells that develops protoplasmic outgrowth called cilia on their free surfaces.

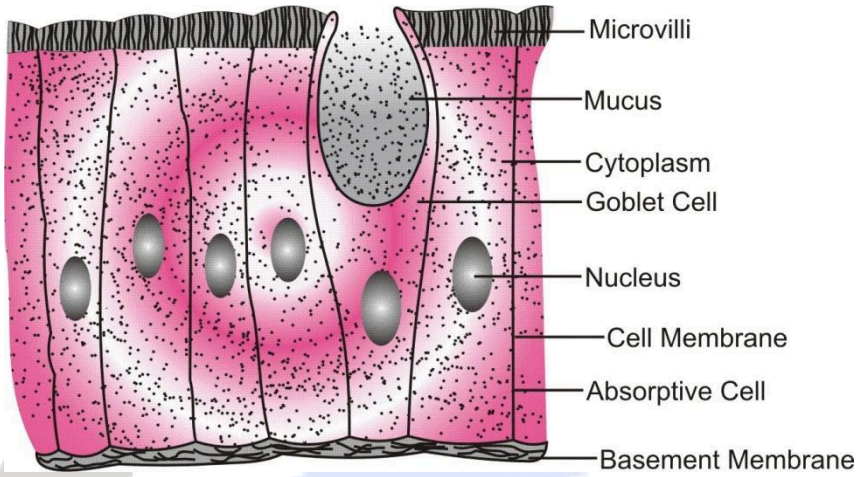
(ii) Occurrence : Cuboidal ciliated epithelium lines certain parts of urinary tubules of the kidney. Columnar ciliated epithelium lines the nasal passage, oviducts, etc.



Ciliated columnar epithelium

(e) Glandular epithelium

This epithelium consists of columnar cells modified to secrete chemical. It lines the glands such as gastric glands, intestinal glands, etc.



Glandular epithelium

3.1.3 Functions of Epithelial Tissue

(a) Squamous epithelium (both types) provides protection to underlying parts (organs) against mechanical injury, drying up, entry of germs, etc. It also helps in excretion, gaseous exchange, etc.

(b) Cuboidal epithelium helps in protection, secretion, absorption, excretion, etc.

(c) Columnar epithelium helps in absorption, secretion and protection. Columnar epithelium of intestine is meant for absorption of water and digested food.

(d) Ciliated epithelium helps in movement of mucus, urine, eggs, sperms, etc.

3.2 MUSCLE TISSUE

3.2.1 Characteristics

Muscles or muscle tissues consists of long cells. They are also called muscle fibres due to their elongated structure. The muscle cells are arranged parallely and contract in a definite direction which cause movement of body parts or limbs and locomotion of organism.

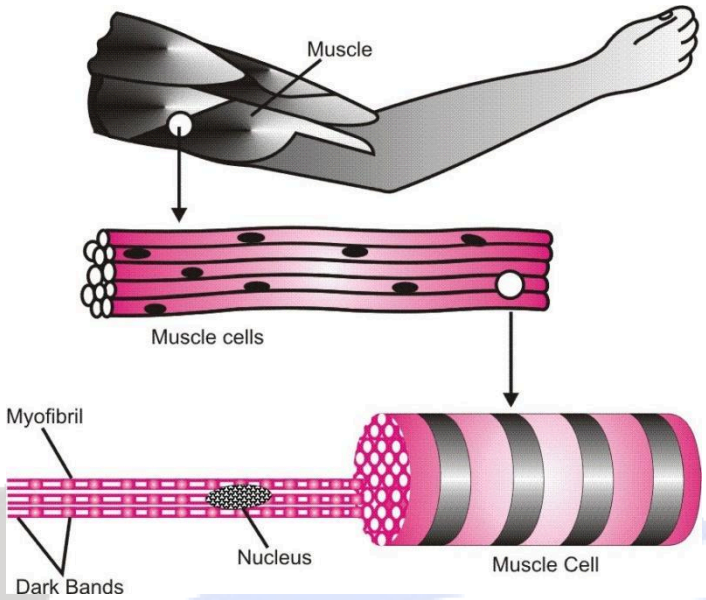
3.2.2 Types of Muscle Tissue

The muscle fibres are classified into three types.

(a) Striated Muscle or Skeletal Muscle

(i) Structure

- These muscles show alternate dark and light bands (striations) hence they are called striated muscles.
- The striated muscle consists of long, narrow, cylindrical and un-branched fibres with blunt end.
- Each fibre has a distinct plasma membrane (sarcolemma) and many nuclei towards the periphery.
- The contraction and relaxation of these muscles are under the control of the animal and hence they are called voluntary muscles.



Striated muscles

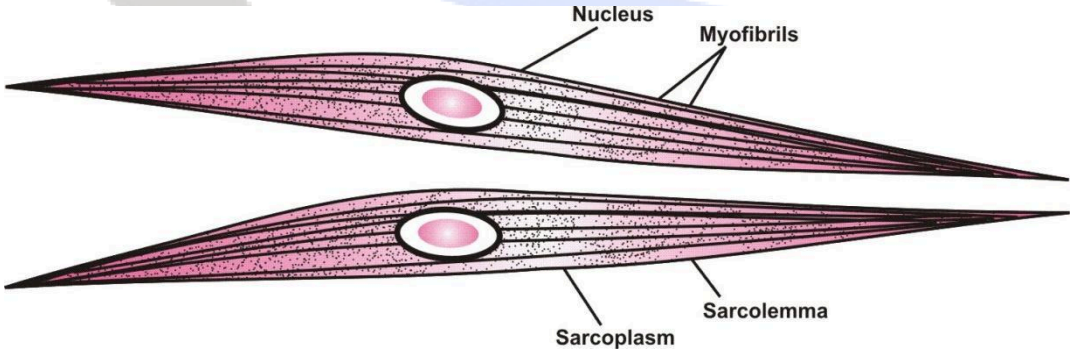
(ii) Occurrence : The striated muscles are found in the body wall and the limbs attached to the bones. They also occur in tongue, pharynx, beginning of oesophagus.

(b) Unstriated Muscle (Smooth Muscle)

(i) Structure

- These muscles do not show any striations and hence called unstriated muscles.
- Each cell is narrow, spindle shaped with pointed ends. The end of these cells may be branched.
- The cells are uninucleate.
- These muscles are not under the control of the animal and hence called involuntary muscles.

(ii) Occurrence : The smooth muscles occur within the walls of visceral organs like alimentary canal, urinary bladder, blood vessels, etc. They also occur in the dermis of the skin, iris of eye, etc.



Smooth muscle fibres

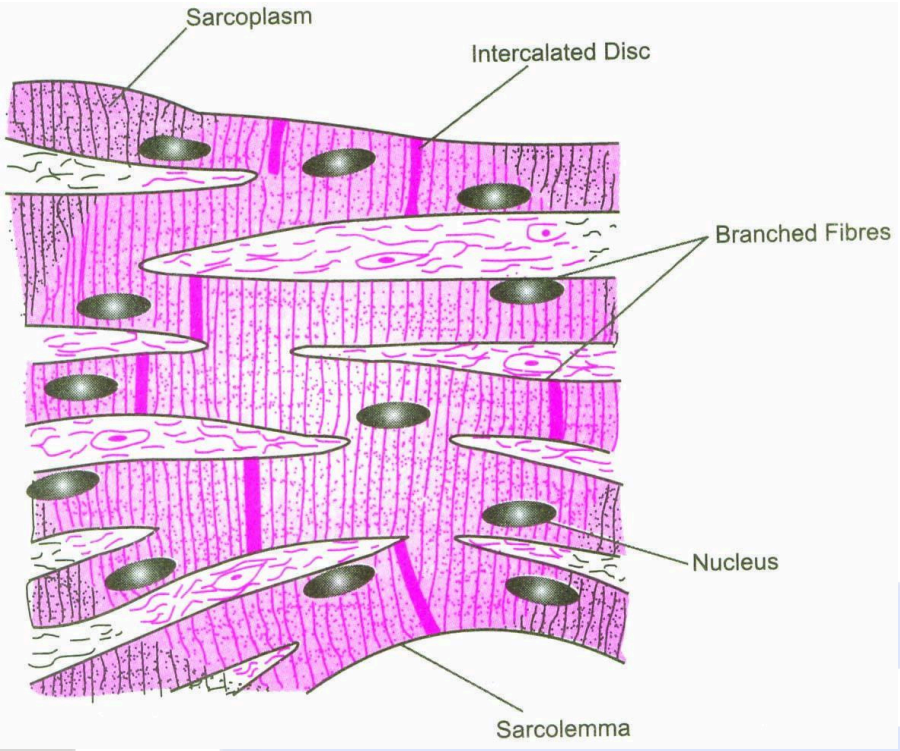
(c) Cardiac Muscles

(i) Structure

- They are so called because they are present only in the wall of the heart. They show striations.
- The fibres are short, cylindrical, branched and joined end to end to form a network.

- Each fibre is surrounded by sarcolemma and has a centrally located nucleus.
- Inter calated discs occur between the ends of fibres.
- Cardiac muscles are involuntary muscles.

(ii) Occurrence : They are found in the wall of heart only.



Cardiac muscles

3.2.3 Functions of Muscle Tissue

(a) Striated muscles help in the movement of the body parts (arms, legs, neck) and locomotion.

(b) Unstriated muscles help in involuntary activities like passage of food through alimentary canal, flow of air through respiratory tract, flow of blood through the vessels, extrusive movements in urinary bladder, etc.

(c) Cardiac muscles bring about beating of heart and pumping of blood.

3.3 CONNECTIVE TISSUE

3.3.1 Characteristics

The name connective tissue suggests that it serves binding and joining of one tissue to another so that there in no interference between activities of different organs. The cells of connective tissue are living and slightly spaced, which is filled with non-living gel-like matrix.

3.3.2 Types of Connective Tissue

Depending on the type of the matrix, solid, semi-solid and liquid, connective tissue is further classified.

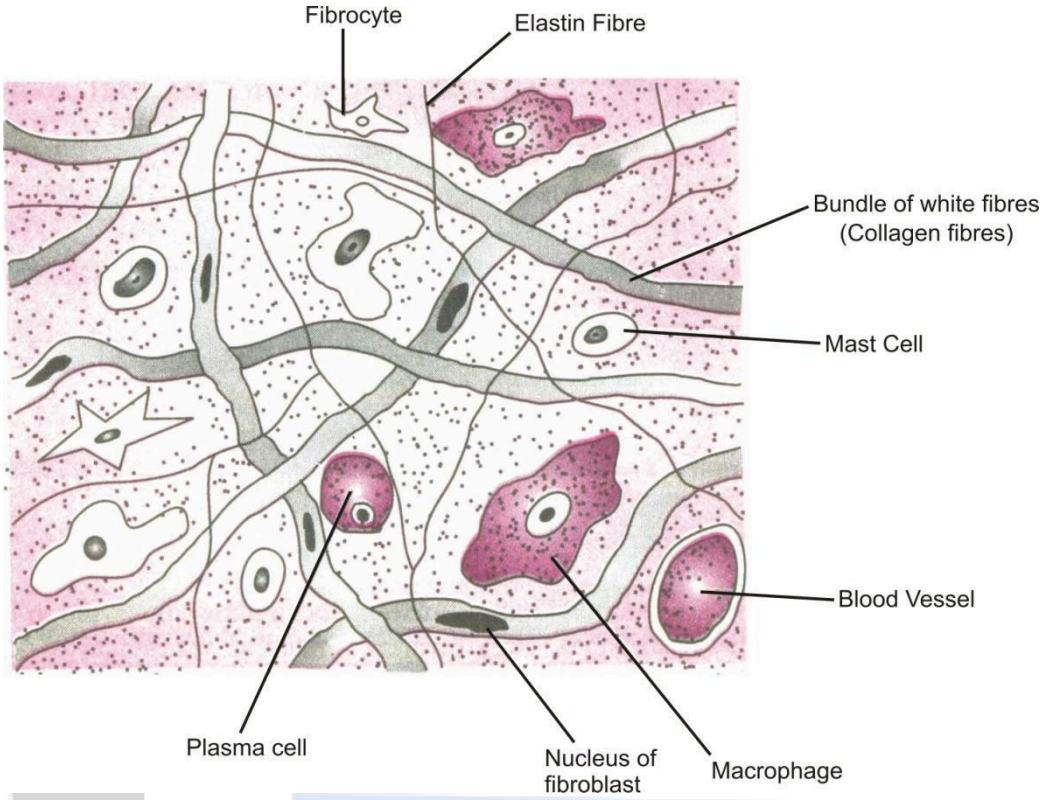
(a) Connective Tissue Proper (semi-solid matrix)

It is further divided.

(i) Areolar Tissue

- It is the most widely distributed connective tissue.
- It consists of jelly-like matrix, numerous fibres (white collagen fibres and yellow elastic fibres) and cells.

- This tissue fills spaces inside organs and is also found around blood vessels, between skin and muscles, etc.



Areolar connective tissue

(ii) Adipose Tissue

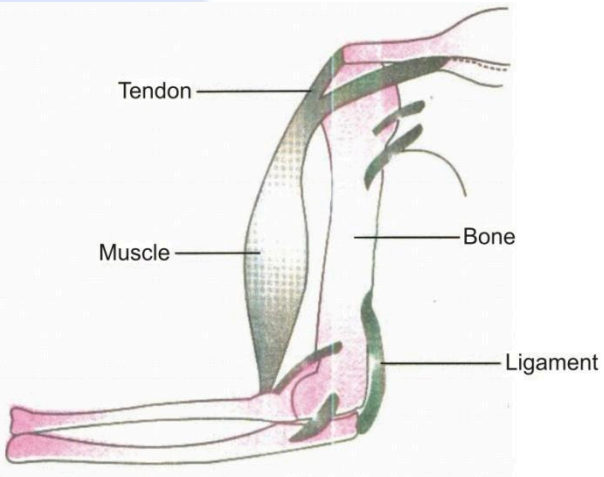
- This tissue consists of matrix packed with large, spherical fat cells (adipocytes) filled with fat globules.
- The matrix also contains macrophages, collagen and elastic fibres.
- Adipose tissue is found beneath the skin, in the covering of heart, kidney, etc.

(iii) White Fibrous Tissue

- The matrix has compactly arranged white fibres forming parallel bundles.
- There are few cells lying between the fibres.
- This tissue forms tendons which connect muscles with bones and has great strength but limited flexibility.

(iv) Yellow Elastic Tissue

- This tissue has abundant yellow fibres and a few cells in the matrix.
- It form ligaments, which join bones together and has



Attachment of tendons and ligaments

considerable strength and elasticity.

(v) Reticular Tissue

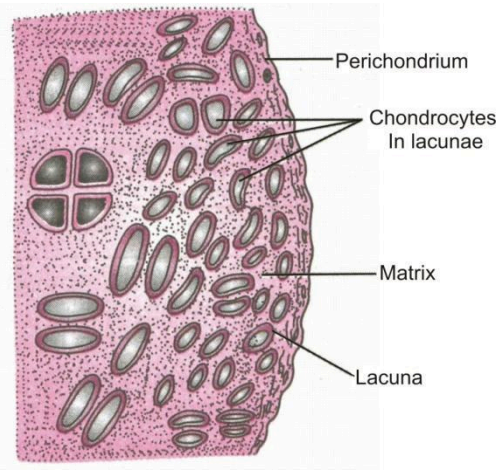
- The matrix has network of thin fibres.
- The matrix also contains star-shaped cells with protoplasmic processes.
- This tissue is found in the spleen, liver, bone marrow, etc.

(b) Skeletal Tissue (solid matrix)

It is further classified into two types

(i) Cartilage

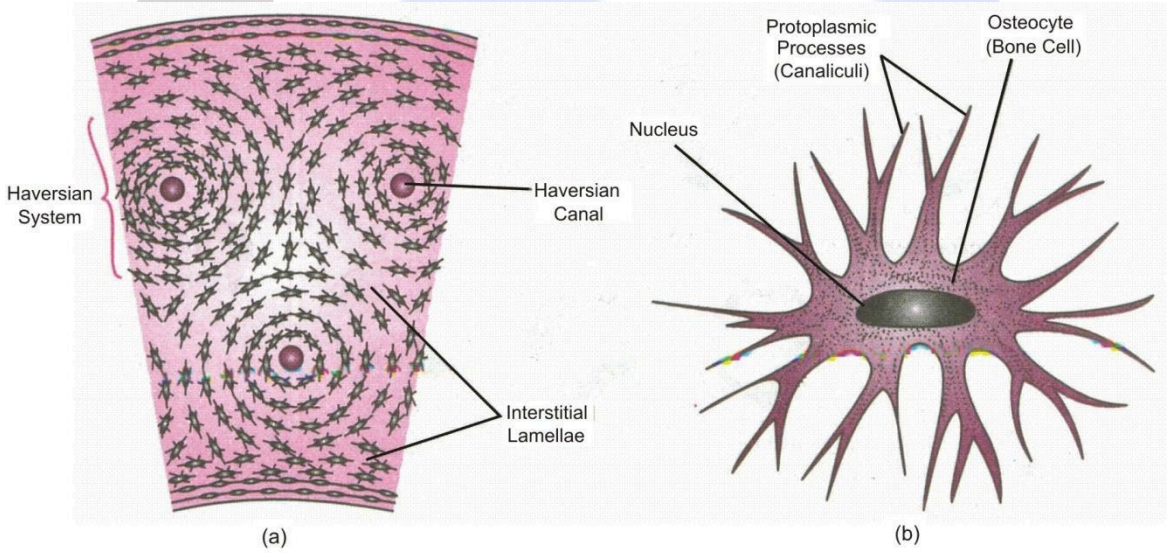
- The matrix is composed of proteins slightly hardened by calcium salts.
- The cells get surrounded with fluid filled chambers called lacunae. Cartilage cells are called chondrocytes.
- The surface of cartilage has irregular connective tissue called perichondrium.
- Blood vessels and nerves are absent in the matrix of the cartilage.
- It occurs at the end of long bones, pinnae, end of nose, etc.



Cartilage

(ii) Bones

- The hard matrix of bone is strengthened by fibres and hardened by calcium and phosphorus salts.
- Bone cells (osteocytes) are contained in lacunae which are arranged in concentric circles.
- The lacunae are traversed by nerves and blood vessels.
- Bones form the endoskeleton of vertebrates.



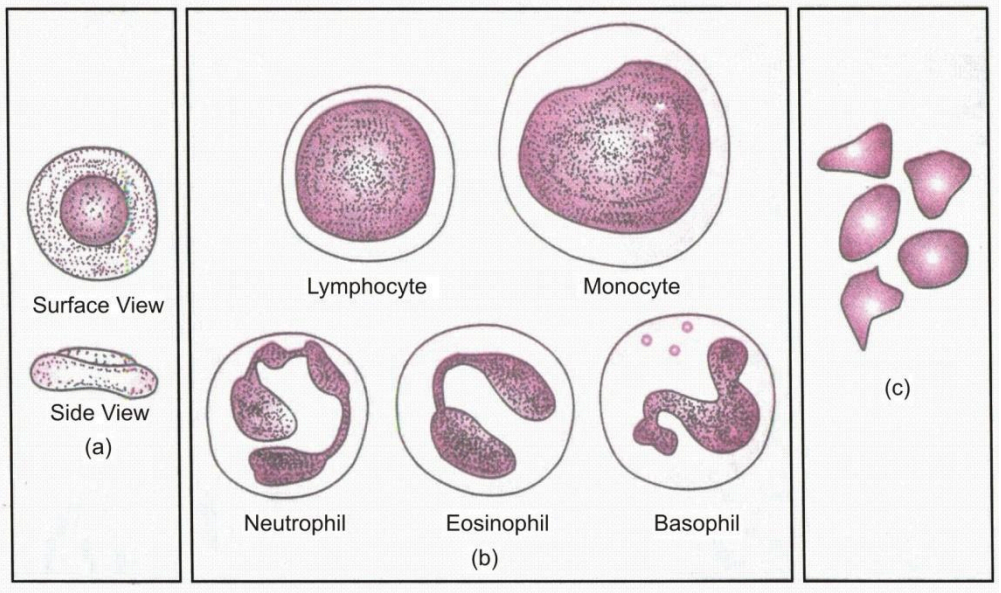
(a) T.S of long bone; (b) A bone cell

(c) Fluid or Vascular Tissue (liquid matrix)

It is further classified as

(i) Blood

- It is the most important fluid connective tissue.
- The matrix of this tissue is called plasma which is a straw coloured fluid. The plasma contains 90% water and 10% of various organic and inorganic substances. The organic substances include proteins (albumin, globulin and fibrinogen), carbohydrates, lipids, etc.
- The blood has three types of cells.
- The **Erythrocytes** or **Red blood corpuscles** (RBC) are small biconcave cells without nucleus. They are packed with a transport protein called haemoglobin (red in colour) which carry O_2 and CO_2 to different parts of the body.
- The **Leucocytes** or **White blood corpuscles** (WBC) are round or irregular in shape. They possess lobed nucleus. They are colourless and may or may not have granules in their cytoplasm. There are five types of leucocytes-Eosinophil, Basophil, Neutrophil, Lymphocyte and Monocytes.
- The platelets are irregularly shaped, non-nucleated fragments of giant cells.



Human blood corpuscles (a) Erythrocytes (RBC); (b) Leucocytes (WBC); (c) Platelets

(ii) Lymph

- Lymph is a colourless fluid similar in composition to blood except that it lack RBC's, proteins and contains less calcium and phosphorus. In lymph, WBCs are found in abundance.

3.3.3 Functions of connective Tissue

(a) Connective Tissue Proper

(i) Areolar tissue supports internal organs and helps in repair of tissues.
(ii) Adipose tissue stores fat, acts as an insulator.
(iii) White fibrous tissue (tendons) and yellow elastic tissue (ligaments) serve to bind muscles to bones and bone to bone respectively.
(iv) Reticular tissue provides support.

(b) Skeletal Tissue

(i) Cartilage absorbs stresses, provides flexibility to the body parts and smoothens surface at joints.

(ii) Bones provide levers for movement, support for soft body parts and protect many delicate tissues and organs.

(c) Vascular Tissue

(i) Blood

- Plasma serves the function of transport (nutrients, waste products, CO_2, etc), regulates water-balance and body temperature.
- RBC helps in transport of O_2.
- WBC acts as soldiers and scavengers.
- Platelets help in blood clotting.

(ii) Lymph protects the body against infection and also transports nutrients.

3.4 NERVOUS TISSUE

3.4.1 Characteristics

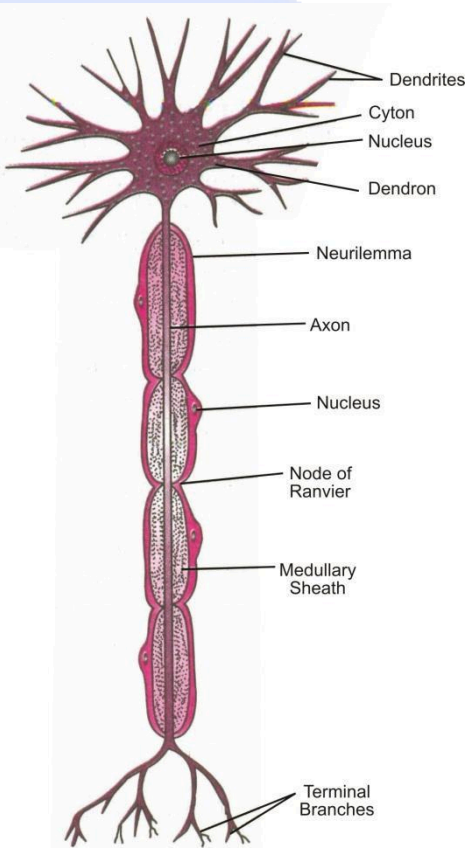
(a) This tissue consists of elongated cells called neurons.

(b) Each neuron is composed of two parts.

(i) Cyton or cell body : It contains cytoplasm and a central nucleus. The cell body also contains Nissl's granules (group of ribosomes and RER). Short, hair-like projections called dendrons arise from the cyton which further branch into thin dendrites. The dendrites provide surface for synaptic connections with other neurons.

(ii) Axon : It is the long cylindrical process arising from the cyton. It shows branching at the terminal end.

(c) The spinal cord, brain and different types of nerves arising from them are made of nervous tissue.



A neuron

3.4.2 Function of Nervous Tissue

Cells of Nervous tissue receive and transmit stimulus from sense organs to brain and spinal cord in the form of impulses. This message is interpreted by the brain and spinal cord and the message for response is transmitted to the organs.