Chapter-6

TISSUES

STUDY NOTES

What are tissues?

A group of cells similar in structure that work together to perform a particular function forms a tissue.
All types of tissues have two basic components:

Cells: having common origin and function.

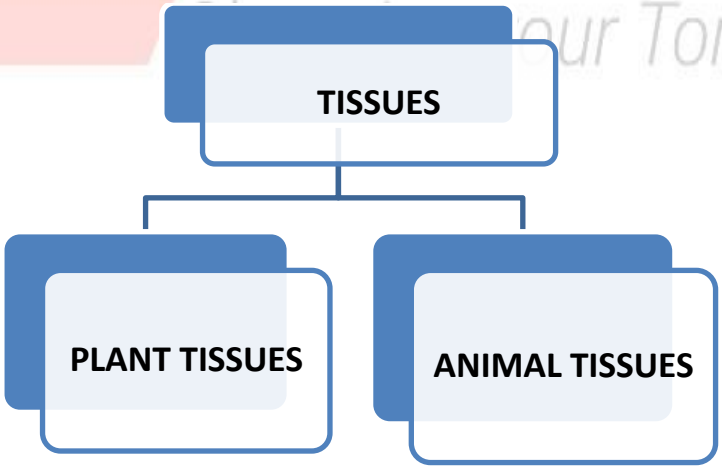
Inter-cellular substances: Are nonliving, fibrous, jelly-like substances.

Importance of tissues

- Formation of tissues has brought about division of labor in multicellular organisms.
- Tissues become organized to form organs and organs into organ systems.
- Workload of individual cell has decreased due to origin of tissues.
- As a result of improved organization and higher efficiency, multicellular organisms have higher survival.

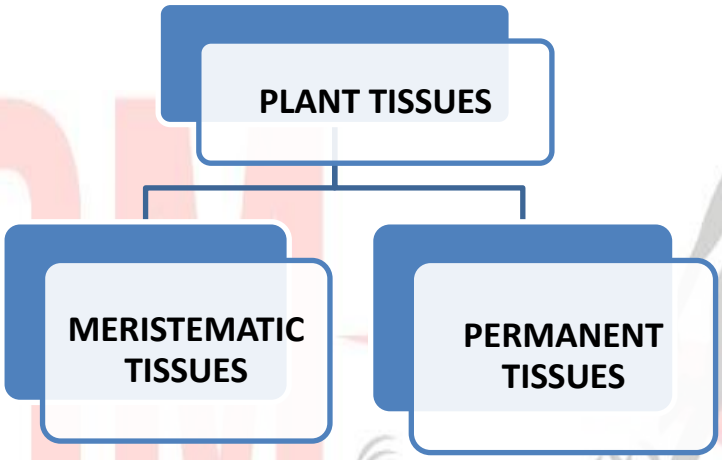
Classification of tissues

Tissues are broadly classified as



Plant Tissues

Plant tissues can be broadly divided into two main types. These are



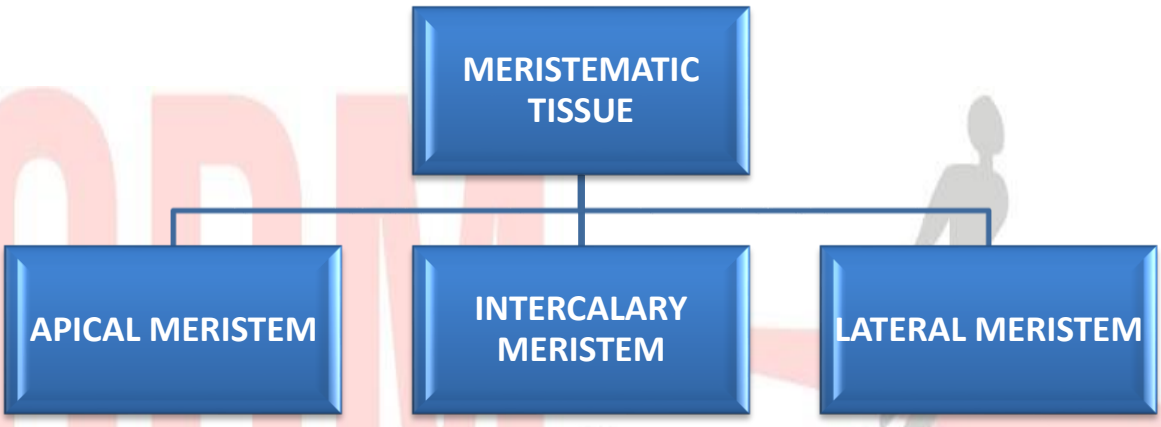
Meristematic Tissues:

- A meristematic tissue constitutes a group of actively dividing cells present in the growing region of plant, e.g., the tips of roots and stems.
- These tissues are responsible for increasing the length and girth of the plant.

Characteristics of meristematic tissues:

- The cells of the meristematic tissue are similar in structure and have thin cellulose cell walls.
- The cells may be spherical, oval, polygonal or rectangular in shape.
- The cells of tissue are compactly arranged and do not have intercellular space.
- The cells have dense protoplasm with prominent nuclei.
- Vacuoles in these cells are either small or absent.

On the basis of their position in the plant body, meristematic tissues are classified into three types: -



Apical meristems:

These are present at the tips of roots, shoots, branches and leaves.

It brings about the elongation of the root and stem. It results in increase in the height of the plant, which is called primary growth.

Lateral meristems:

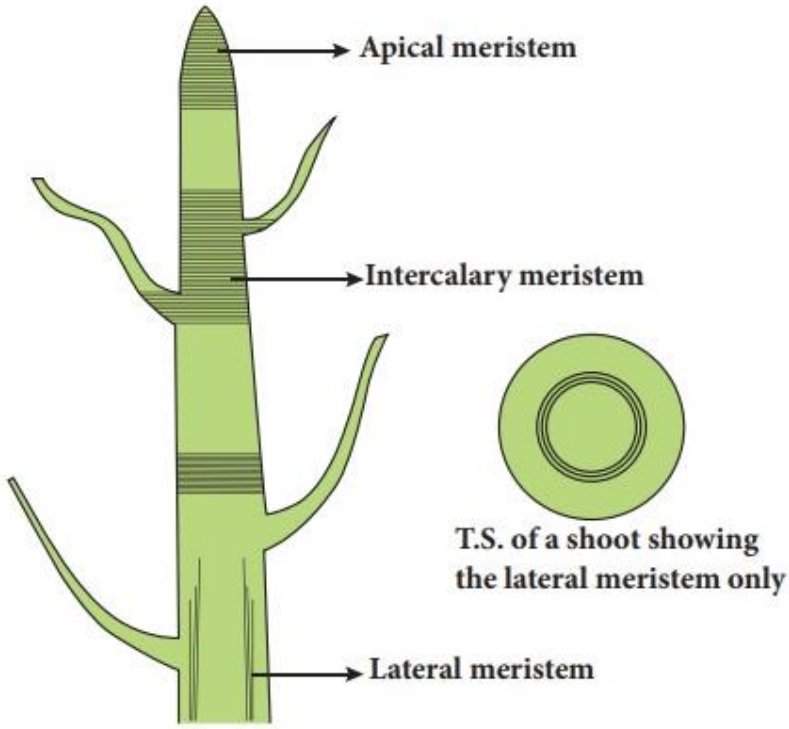
These are present along the lateral side of the stems and roots. For example: cork cambium.

It causes the organ (stem or root) to increase in diameter and girth. This is called secondary growth.

Intercalary meristems:

They are located at the base of leaves or internodes, e.g., stems of grasses and other monocots and below the nodes (e.g., mint).

It produces an increase of length of organ such as leaves and internodes.



NOTE- Questions usually are asked to label the different types of meristematic tissues.

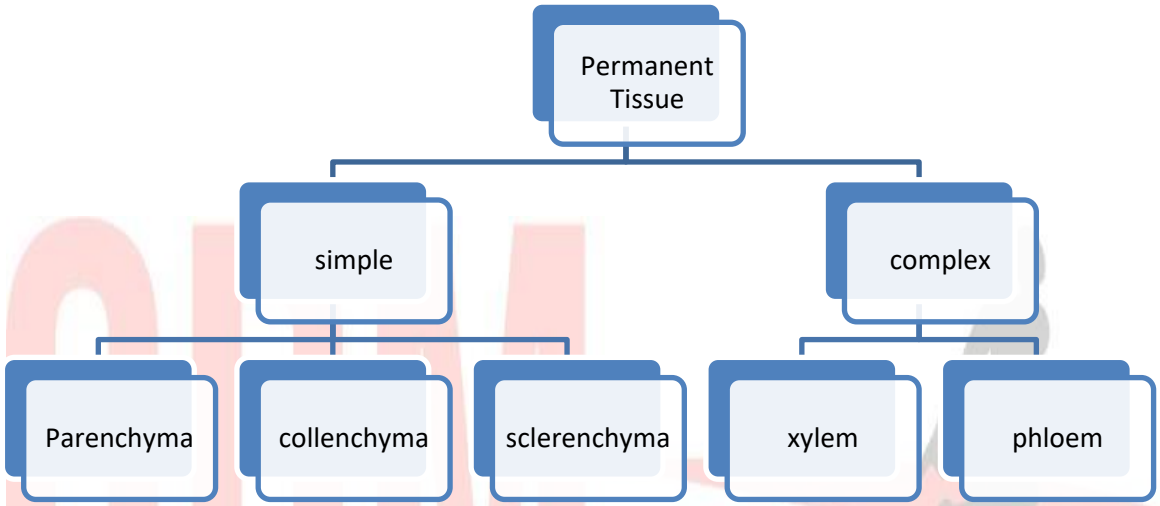
Functions of Meristematic tissue

- Meristematic tissue acts as a parent tissue from which other tissues develop.
- These tissues take part in growth by formation of new cells.
- The place of injury in plants is healed up by the formation of new cells by meristems.

Permanent tissues:

- A permanent tissue is a group of cells, which is derived from the meristematic tissues, but these cells have lost the power of division temporarily or permanently.
  Note: The development process by which cells which have been derived from meristematic tissue, take up a permanent shape, size and function is called differentiation.

- Permanent tissues are of two types: -



Simple permanent tissues:

These tissues are composed of cells which are structurally and functionally similar. These tissues are of three types:

- parenchyma
- collenchymas and
- sclerenchyma

Parenchyma:

- Parenchyma forms the bulk of plant body. It consists of thin walled living cells.
- The cells are isodiametric, i.e., equally expanded on all sides.
- The cell wall is thin and encloses a dense cytoplasm which contains a small nucleus and a large central vacuole.
- The intercellular spaces are abundant.
- The parenchyma is present in all the organs of the plants, i.e., roots, stems, leaves, flowers, fruit and seeds.

Functions of Parenchyma

- The main function of parenchymatous tissue is storage of food, e.g., starch in the parenchyma of cortex of potato tuber.
- Parenchyma forms the framework of all the plant organs and tissues like cortex. Pith etc.
- Parenchyma serves as packing tissue to fill the spaces between other tissues.
- It stores waste materials of plants such as gum, crystals etc.
- The intercellular air spaces of parenchyma cells allow gaseous exchange.
- If chloroplast is present, the parenchyma tissue is called chlorenchyma and it performs photosynthesis.
- In aquatic plants, large air cavities are present in parenchyma to give buoyancy to the plants to help them float. Such a parenchyma type is called aerenchyma.

Collenchyma:

- Collenchyma is usually found in 3-4 layers beneath epidermis in stem, petioles and leaves of herbaceous dicot plants.
- The cells of this tissue are living, elongated and irregularly thickened at the corner.
- In collenchymas, intercellular spaces are generally absent.

Functions of Collenchyma

- It provides the mechanical support, protection, flexibility and elasticity to the plants organs.
- It allows easy bending in various parts of the plant (leaf, stem) without breaking.
- When cells of collenchymas contain some chloroplasts, they manufacture sugar and starch.

Sclerenchyma:

- Sclerenchyma cells are dead cells and they are devoid of protoplasm.
- They are long and narrow as the walls are thickened due to lignin, such cell walls are called lignified.
- The cells of sclerenchyma are closely packed without intercellular spaces.
- Cells of sclerenchyma are of two types: fibers and sclereids.

- Fibers consist of very long, narrow, thick and lignified cells. Sclereids are irregular shaped.
- This tissue is present in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts. Husk of coconut is made of sclerenchymatous tissue.

Functions of Sclerenchyma

- The sclerenchyma is mainly mechanical and protective in function.
- It gives strength, rigidity, flexibility and elasticity to the plant body and, thus, enables it to withstand various strains.

Complex Permanent Tissues:

The complex tissue consists of more than one type of cell having a common origin. All these cells coordinate to perform a common function.

Complex tissues are of two types: Xylem or wood and phloem or bast.

Xylem and phloem are both conducting tissues and also known as vascular tissues; together both them constitute vascular bundles.

Xylem:

Xylem is a vascular and mechanical tissue.

Xylem is composed of cells of four different types:

1. Tracheids 2. Vessels 3. Xylem Parenchyma 4. Xylem sclerenchyma (or fibers).

Except xylem parenchyma, all other elements are dead and bounded by thick lignified wall.

Tracheids and vessels are tubular structures.

Functions of Xylem:

- The main function of xylem is to carry water and mineral salts upward from the root to different parts of shoots, hence also called water conducting tissue.
- Since walls of tracheids, vessels and sclerenchyma of xylem are lignified, they give mechanical strength to the plant body.
- The parenchyma stores food and helps in the sideway conduction of water.

Phloem:

Phloem (bast) is a living conducting tissue. It also contains tubes just like xylem but does not perform mechanical function.

Phloem is composed of following four elements or cells:

1. Sieve tubes 2. Companion cells 3. Phloem parenchyma 4. Phloem fibers.

Sieve tubes are slender, tube like structures with perforated walls.

Companion cells are living parenchymatous cells lying on the sides of the sieve tubes.

Sieve tube and companion cells have close cytoplasmic connection with each other through fine pits.

Phloem fibres are thick walled fibres with simple pits.

Phloem parenchyma is thin walled, living cell of parenchyma of phloem.

Function of Phloem:

Phloem transports (conducts) photosynthetically prepared food materials from the leaves to the storage organs and later from storage organs to the growing regions of the plant body.

Protective tissues:

- Protective tissues are a part of plant tissue system. Protective tissues include
- epidermis and
- cork

Epidermis:

- It is the outermost protective layer of plant organs.
- The epidermis is usually made of a single layer of cells.
- Cells of epidermis are elongated and flattened, without intercellular space. They are living cells but their inner contents are similar to parenchyma cells.
- In leaves, epidermis bears small pores called stomata.

In some plants living in very dry habitats, the epidermis may be thicker since protection against water loss is critical.

Functions of Epidermis:

The function of epidermis is the protection of plant from injury and infection.

Cuticle of epidermis also helps to reduce water loss by evaporation to prevent dessication.

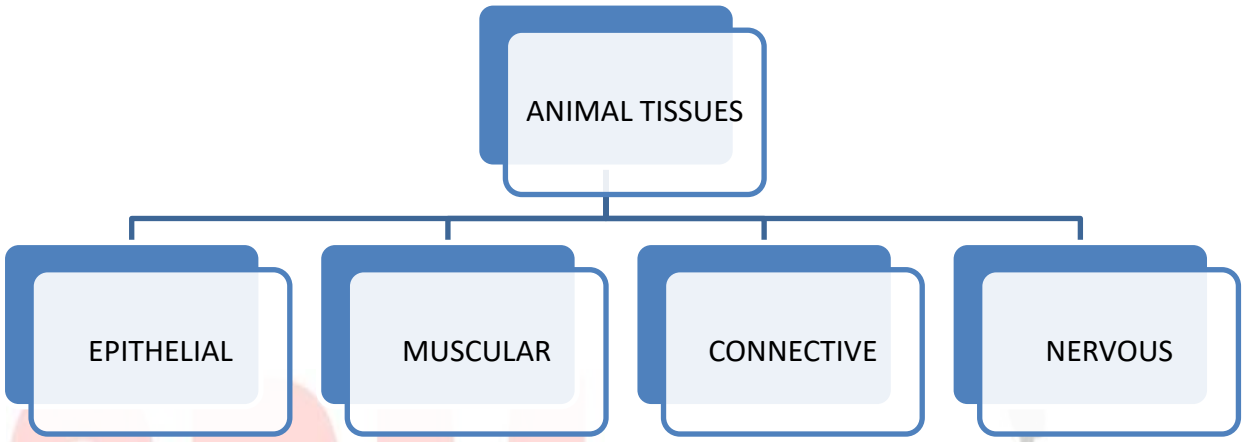
- Stomata present in the epidermis allow gaseous exchange to occur during photosynthesis and respiration.
- It also facilitates transpiration.
- Cork (or phellem):
- Cork cells are dead cells without having intercellular spaces.
- They appear at the periphery of roots and stems when they grow older and increase in girth.
- They also have a chemical called suberin in their walls that makes them impervious to gases and water.

Functions of Cork:

- The function of cork in plant body is to provide protection. It protects plants from external injury and infection.
- It also prevents desiccation.
- Since cork does not catch fire easily, it is used for insulation, shock-absorber, linoleum.
- It is also used for making sports goods, such as shuttle-cock, table tennis paddles, crcket balls, etc.

Animal Tissues

On the basis of the structure of cells and their function, animal tissues are classified into four major types:



Epithelial Tissue:

- The covering or protective tissues in the animal body are animal tissues.
- The cells of this tissue are tightly packed and it forms continuous sheet. Indeed cells of epithelium contain very little or no intercellular matrix.
- The skin and lining of buccal cavity, blood vessels, alveoli of lungs and kidney tubules are made of epithelial tissue.
- Epithelial cells lie on a delicate non-cellular basement membrane which contains a special form of matrix protein, called collagen.

Functions of Epithelial Tissue:

- Epithelial cells protect the underlying cells from mechanical and chemical injuries and bacterial or viral infection.
- It covers most organs and cavities within the body. It also forms a barrier to keep different body system separate.
- Epithelial tissues help in absorption of water and nutrients
- Epithelial tissues help in elimination of waste products.
- Some epithelial tissues secrete secretion, such as sweat, saliva etc.

Note: Epithelial tissue may be simple, i.e., composed of a single layer of cells, or stratified, i.e., made up of several layers of cells.

Types of epithelial tissue

Depending upon the shape and function of the cells, the epithelial tissues are classified as follows:

- **Squamous epithelium**
- **Cuboidal epithelium**
- **Columnar epithelium**
- **Glandular epithelium**
- **Ciliated epithelium**

Differences between different types of epithelial tissues:

S. No.	Characteristic property	Squamous epithelium	Cuboidal epithelium	Columnar or glandular epithelium	Ciliated epithelium
1.	Shape of cells	It consists of thin, flat. Disc like polygonal or irregular-shaped cells with round and flat nucleus.	It consists of cube-like cells of almost equal height and width.	It consists of tall, cylindrical, pillar-like cells. Basal part of cell bears oval nucleus	It consists of tall cells with cytoplasmic hair like cilia at free ends.
2.	Appearance of cells	Adjacent cells fit together like tiles on a pavement or floor.	Cells appear square-like in vertical section but their free surface seems to be hexagonal.	The free end of the cells consists of finger-like projections called microvilli.	Cells may be cuboidal or columnar and are, therefore , also called ciliated cuboidal epithelium or ciliated columnar epithelium.

3.	Place of occurrence	Forms the lining of nose, pericardial cavity, blood vessels, lung alveoli etc.	Present in kidney tubules, salivary glands etc.	Present in the inner surface of stomach, intestine, gall bladder etc.	Present in the lining of trachea, fallopian tube, nasal passage etc.
4.	Functions	Protects the underlying parts of the body from mechanical injury. Prevent the entry of germs inside our body. Prevent desiccation of organs. Facilitates diffusion of gases.	Provide mechanical support to the organs. Secretion of gastric juices. Absorption and excretion.	Helps in absorption of nutrients. Secretion of gastric juices. Provide mechanical support to the organs.	Causes movement of small solid particles or mucus in a specific direction through the ducts. Causes movement of ovum and zygote towards the uterus. Helps in removing unwanted particles from trachea.

Muscular tissue:

- Muscular tissue constitutes all the muscles of the body of an animal.
- Muscle cells are elongated and large sized, so they are called muscle fibres.
- Muscle cells are typically arranged in parallel arrangement allowing them to work together effectively.
- This tissue is responsible for movement in our body. Muscles contain special proteins called contractile proteins, which contract and relax to cause movement.

On the basis of their location, structure and function, there are following three types of muscle fibers:

- **Striated muscles (stripped, skeletal or voluntary muscles)**
- **Smooth muscles (unstriated, visceral or involuntary muscles)**
- **Cardiac muscles**

S.No.	Unstriated muscles	Striated muscles	Cardiac muscles
1.	Present in the wall of alimentary canal, blood vessels, respiratory tract, urinary bladder etc.	Present in limbs, tongue, body wall and pharynx.	They are present in the wall of heart.
2.	Muscle fibres are spindle-shaped.	Muscle fibres are cylindrical.	Muscle fibres are cylindrical.
3.	Fibres are unbranched.	Fibres are unbranched.	Fibres are branched.
4.	Muscle cells are multinucleate.	Muscle cells are uninucleate.	Muscle cells are uninucleate.
5.	Nerve supply from autonomous nervous system.	Nerve supply from central nervous system.	Nerve supply from both autonomous and central nervous system.
6.	Cross striations absent.	Dark and light bands (cross striations) present.	Cross striations and intercalated disc present.
7.	Exhibit slow contraction.	Exhibit rapid contraction.	Exhibit rapid contraction.
8.	Involuntary.	Voluntary.	Involuntary.
9.	Do not get fatigued.	Get fatigued.	Do not get fatigued.
10.	Function: Cause contraction and mobility in visceral organs and involuntary muscles.	Function: Cause movement of limbs and locomotion.	Function: cause heartbeat.

Connective Tissue:

- The connective tissue is specialized to connect and anchor various body organs. As such, it connects one bone with another and a bone with a muscle.
- Three components are present in all the connective tissues. These are intercellular medium, connective tissue cells and fibers.
- The cells of connective tissue are loosely spaced and embedded in an intercellular matrix. The matrix may be jelly like, fluid, dense or rigid.
- The nature of matrix decides the function of connective tissue.

General functions:

- Connective tissue binds other tissues together in the organs.
- Connective tissue also provides the structural framework and mechanical support to different tissues.
- It is also concerned with body defense, fat storage, repair etc.
- The main functions of connective tissue are binding, supporting and packing together different organs of the body.

Types of connective tissue:

In animals, there are following five types of connective tissues:

- **Areolar (loose) connective tissue**
- **Dense connective tissue**
- **Adipose connective tissue**
- **Skeletal tissue**
- **Fluid connective tissue**

Aerolar (loose) connective tissue:

- It is a loose and cellular connective tissue. Its matrix consists of two kinds fibers: white collagen fibers and yellow elastic fibers.
- Aerolar connective tissue is found between the skin and muscles, around blood vessels and nerves and in the bone marrow.
- It fills the spaces between different tissues and organs, hence called packing tissue.

Functions of Aerolar

- It acts as supporting and packing tissue between organs lying in the body cavity.
- It provides rapid diffusion of oxygen and nutrients from blood vessels.
- It helps in repair of tissues after an injury.
- It helps in fighting foreign antigen and toxin.

Dense connective tissue:

- It is a fibrous connective tissue. It is characterized by ordered and densely packed collection of fibers and cells.
- It is the chief component of ligaments and tendons.
- **Ligaments**: These are elastic structures made up of yellow elastic fibrous tissue s which connect bone to another. It has considerable strength. Ligaments contain very little matrix. Ligaments strengthen the joint and they permit normal movement but prevent over-flexing or over-extension. Sprain is caused by excessive pulling (stretching) of ligaments.
- **Tendons**: Tendons are cord like, strong inelastic structures that join skeletal muscles to bones. They are composed of white collagen fibrous tissue.
- It has great strength but its flexibility is limited.

Adipose tissue:

- It consists of large number of oval and rounded adipose cells (adipocytes) filled with fat globules.
- The adipose tissue is abundant below the skin, between the internal organs (e.g., around the kidney) in yellow bone marrow.

Functions of Adipose tissue:

- It serves as a fat reservoir.
- Adipose tissue acts as food reservoir by storing fat.
- It acts as an insulator and regulates body temperature.

Skeletal tissue:

Skeletal connective tissue forms the endoskeleton of the body of vertebrates. It includes cartilage and bone.

S.No.	Bone	Cartilage
1.	They are hard and flexible endoskeleton.	They are soft and flexible endoskeleton.
2.	Porous in nature.	Non-porous in nature.
3.	Blood vessels are present.	Blood vessels are absent.
4.	Matrix not arranged in lamellae.	Matrix (chondrin) arranged in lamellae.
6.	Bone cells are known as osteocytes.	The cells in matrix are called chondriocytes.
7.	Matrix contains protein and mineral salts.	Matrix made up mainly of protein.
8.	Long bones contain bone marrow in hollow, narrow cavity.	Bone marrow absent. Cartilage is always solid.
9.	Bones are present in the whole body forming internal skeletal framework.	Cartilage are present at the joints of bones, in external ear (pinna), nose tip, epiglottis, trachea etc.
10.	Functions: It provides shape to the body. It provides skeletal support to body. It protects vital body organs such as brain, lungs etc.	Functions: Cartilage provides support and flexibility to the body parts. It smoothens body surfaces at joints.

Fluid connective tissue:

Fluid connective tissue links the different parts of the body and maintains continuity in the body. It includes blood and lymph.

Blood:

Blood is fluid connective tissue. In this tissue cells move in a fluid or liquid matrix or medium called blood plasma.

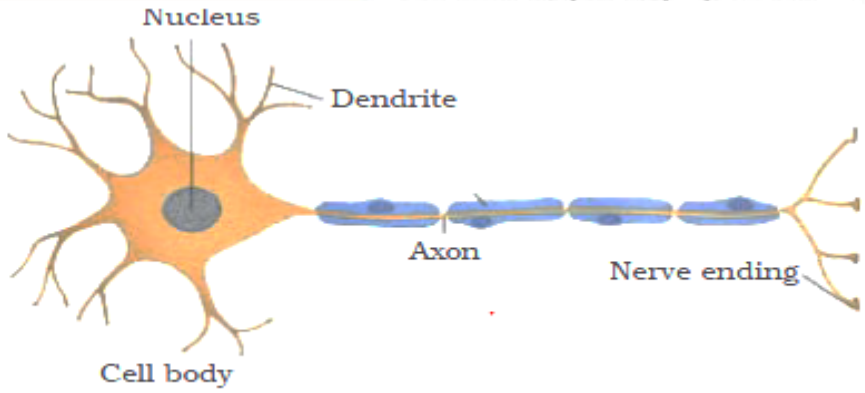
The blood plasma does not contain protein fibres but contain cells called blood corpuscles or blood cells. These blood corpuscles and cells are:

- Red blood corpuscles (RBC) or erythrocytes
- White blood corpuscles (WBC) or leucocytes
- Platelets

RBCs and WBCs are living, while plasma and platelets are non-living.

Nervous tissue:

- A tissue which is specialized to transmit messages in our body is nervous tissue. Brain, spinal cord and nerves are all composed of nervous tissue.
- Nervous tissue contains highly specialized unit cells called nerve cells or neurons.
- These cells are specialized for the conduction of impulse over great distance at great speed.
- A neuron consists of a cell body (cyton or soma) with a nucleus and cytoplasm, from which long thin hair- like parts arise called dendrons.
- Dendrons further branched out to form dendrites. From the distal part of cyton arises a very long process called axon.



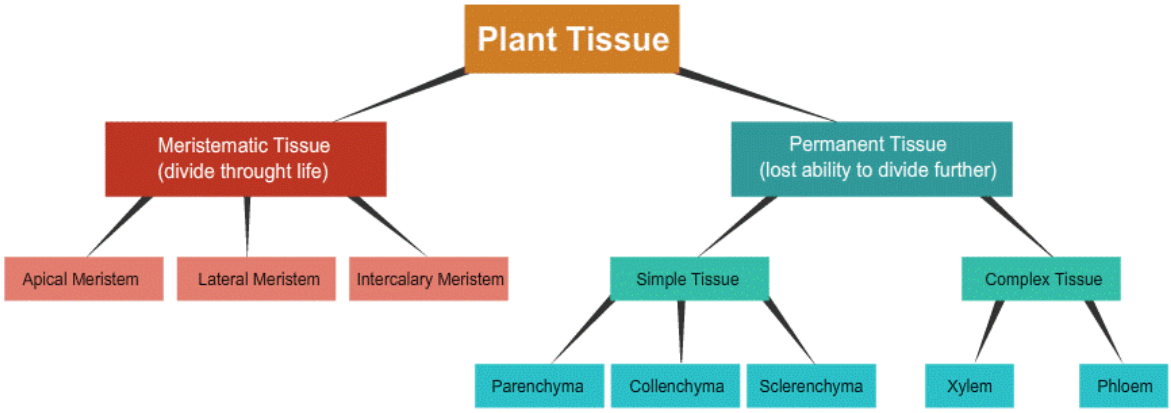
Functions:

The nervous tissue is responsible for the reception and transmission of information between different parts of the body.

The dendrites receive impulses and the axon takes impulses away from the cell body.

CONCEPT MAP-

PLANT TISSUE-



ANIMAL TISSUE-