


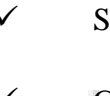




UNIT:1

TISSUES

TISSUES:

- A group of cells with similar structure and function is called a tissue.
- A tissue is a group of cells that usually have a common embryonic origin and function together to carry out specialized activities.
- Tissues may be hard (bone), semisolid (fat), or even liquid (blood) in their consistency
- The tissues in the human body contribute to homeostasis by providing diverse functions including

- ✓  Protection,
- ✓  Support
- ✓  Communication among cells, and
- ✓  Resistance to disease

TYPES OF TISSUE

Body tissues can be classified into four basic types according to structure and function:

- Epithelial tissue
- Connective tissue
- Muscular tissue
- Nervous tissue

Epithelial tissue:

- Covers body surfaces and lines hollow organs, body cavities, and ducts. It also forms glands.

Connective tissue:

- Protects and supports the body and its organs. Various types of connective tissue bind organs together, store energy reserves as fat, and help provide immunity to disease-causing organisms.

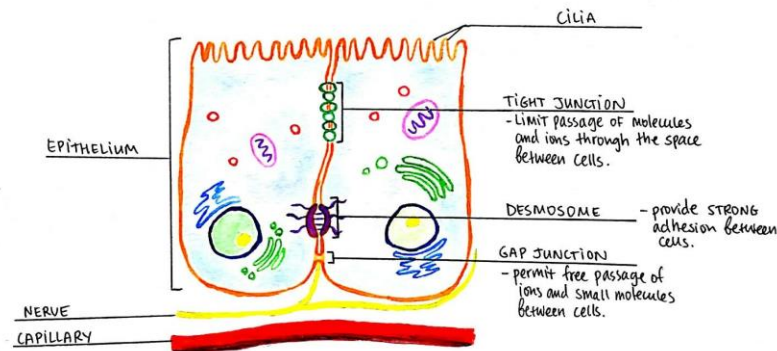
Muscular tissue:

- Generates the physical force needed to make body structures move and generates body heat.

Nervous tissue:

- Detects changes in a variety of conditions inside and outside the body and responds by generating action potentials (nerve impulses) that activate muscular contractions and glandular secretions.
- Consists of cells arranged in continuous sheets, in either single or multiple layers.
- The cells are closely packed and are held tightly together by many cell junctions, there is little intercellular space between adjacent plasma membranes.
- Epithelial tissue forms coverings and linings throughout the body.
- It is never covered by another tissue, so it always has a free surface.

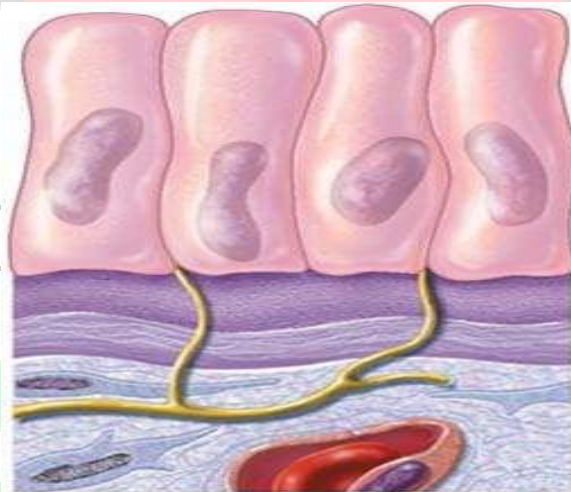
EPITHELIA - CELL JUNCTIONS



KATERINA TANNUK

Epithelial tissues have three major functions:

- Selective barriers that limit or aid the transfer of substances into and out of the body;
- Secretory surfaces that release products produced by the cells onto their free surfaces; and
- Protective surfaces that resist the abrasive influences of the environment.



Epithelial tissue may be divided into two types.

- ✓ **Covering and lining epithelium** forms the outer covering of the skin and some internal organs. It also forms the inner lining of blood vessels, ducts, and body cavities, and the interior of the respiratory, digestive, urinary, and reproductive systems.
- ✓ **Glandular epithelium** makes up the secreting portion of glands such as the thyroid gland, adrenal glands, and sweat glands.

Covering and Lining Epithelium

They are classified according to characteristics:

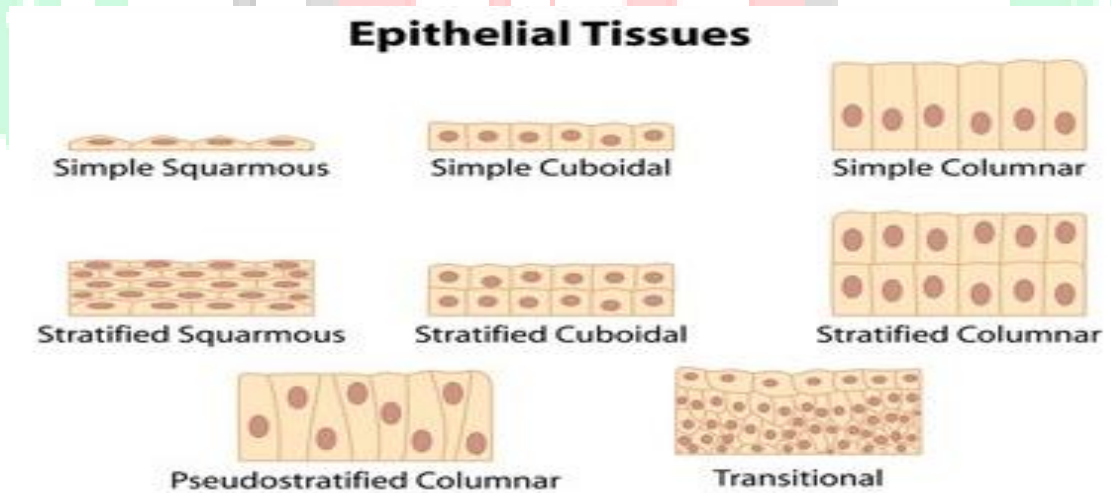
- ✓ Arrangement of cells into layers
- ✓ Shapes of the cells

Arrangement of cells into layers

- ✓ Simple epithelium
- ✓ Pseudostratified epithelium
- ✓ Stratified epithelium

Based on the shapes of the cells

- ✓ Squamous cells
- ✓ Cuboidal cells
- ✓ Columnar cells
- ✓ Transitional cells



Types of **covering and lining epithelia** are as follows:

I. Simple epithelium

A. Simple squamous epithelium

B. Simple cuboidal epithelium

C. Simple columnar epithelium (nonciliated and ciliated)

D. Pseudostratified columnar epithelium (nonciliated and ciliated)

II. Stratified epithelium

A. Stratified squamous epithelium (keratinized and nonkeratinized)*

B. Stratified cuboidal epithelium

C. Stratified columnar epithelium

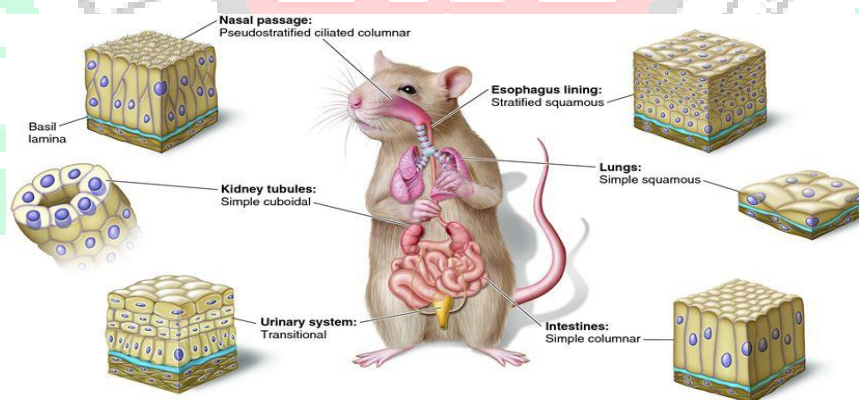
D. Transitional epithelium

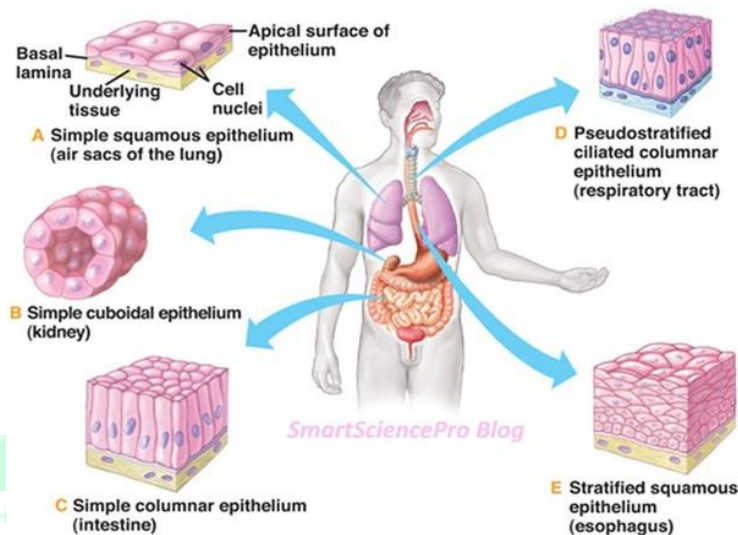
Simple squamous epithelium:

Location: Lining of blood and lymphatic vessels (endothelium) and small ducts, alveoli of the lungs, Bowman's capsule, loop of Henle in kidney tubules, lining of serous membranes (mesothelium), and inner surface of the eardrum.

Structure: Single layer of flat, often hexagonal cells. The nuclei appear as bumps when viewed as a cross section because the cells are so flat.

Function: Diffusion, filtration, some protection against friction, secretion, and absorption.





Simple cuboidal epithelium Kidney

Location: Kidney tubules, glands and their ducts, choroid plexus of the brain, lining of terminal bronchioles of the lungs, and surface of the ovaries.

Structure: Single layer of cube-shaped cells; some cells have microvilli (kidney tubules) or cilia (terminal bronchioles of the lungs).

Function: Active transport and facilitated diffusion result in secretion and absorption by cells of the kidney tubules; secretion by cells of glands and choroid plexus; movement of particles embedded in mucus out of the terminal bronchioles by ciliated cells.

Simple columnar epithelium

Location: Glands and some ducts, bronchioles of lungs, auditory tubes, uterus, uterine tubes, stomach, intestines, gallbladder, bile ducts, and ventricles of the brain.

Structure: Single layer of tall, narrow cells. Some cells have cilia (bronchioles of lungs, auditory tubes, uterine tubes, and uterus) or microvilli (intestines).

Function: Movement of particles out of the bronchioles of the lungs by ciliated cells; partially responsible for the movement of the oocyte through the uterine tubes by ciliated cells. Secretion by cells of the glands, the stomach, and the intestine. Absorption by cells of the intestine.

Stratified squamous epithelium

Location: Moist—mouth, throat, larynx, esophagus, anus, vagina, inferior urethra, and cornea.
Keratinized—skin.

Structure: Multiple layers of cells that are cuboidal in the basal layer and progressively flattened toward the surface. The epithelium can be moist or keratinized. In moist stratified squamous epithelium the surface cells retain a nucleus and cytoplasm. In keratinized stratified epithelium, the cytoplasm of cells at the surface is replaced by keratin, and the cells are dead.

Function: Protection against abrasion and infection.

Stratified cuboidal epithelium

Location: Sweat gland ducts, ovarian follicular cells, and salivary gland ducts.

Structure: Multiple layers of somewhat cube-shaped cells.

Function: Secretion, absorption, and protection against infection.

Stratified columnar epithelium

Location: Mammary gland duct, larynx, and a portion of the male urethra.

Structure: Multiple layers of cells, with tall, thin cells resting on layers of more cuboidal cells. The cells are ciliated in the larynx.

Function: Protection and secretion

Pseudostratified columnar epithelium

Location: Lining of nasal cavity, nasal sinuses, auditory tubes, pharynx, trachea, and bronchi of lungs.

Structure: Single layer of cells; some cells are tall and thin and reach the free surface, and others do not; the nuclei of these cells are at different levels and appear stratified; the cells are almost always ciliated and are associated with goblet cells that secrete mucus onto the free surface.

Function: Synthesize and secrete mucus onto the free surface and move mucus (or fluid) that contains foreign particles over the surface of the free surface and from passages.

Transitional epithelium

Location: Lining of urinary bladder, ureters, and superior urethra.

Structure: Stratified cells that appear cuboidal when the organ or tube is not stretched and squamous when the organ or tube is stretched by fluid.

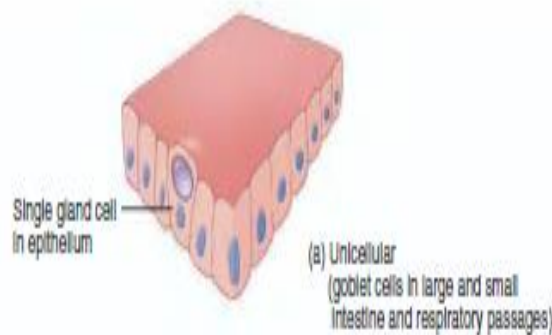
Function: Accommodates fluctuations in the volume of fluid in an organ or tube; protection against the caustic effects of urine.

Glandular epithelium

Glandular epithelium is specialised for performing secretory activity. Cells of glandular epithelium may be present as a single unicellular gland or as a multicellular gland in the form of hollow follicles, clusters or solid cords.

Glands can be categorized into

- a) Exocrine gland
- b) Endocrine gland



Exocrine glands:

They discharge their secretory products (secreted elsewhere in the gland) into ducts, which can further be carried away to the target sites (or organs). Eg: Secretions of Salivary glands are released into the mouth via salivary duct.

Endocrine glands:

They secrete their secretory products (secreted elsewhere in the gland) directly into the blood or interstitial fluid. Hence they are referred as ductless glands. Eg: Pituitary, Thyroid, Adrenal glands.

CONNECTIVE TISSUE

- There are several kinds of connective tissue, some of which may at first seem more different than alike. The types of connective tissue include **areolar, adipose, fibrous, and elastic tissue, as well as blood, bone, and cartilage.**
- A characteristic that all connective tissues have in common is the presence of a matrix in addition to cells. The matrix is a structural network or solution of nonliving intercellular material. Each connective tissue has its own specific kind of matrix.
- It is the most abundant and widely distributed tissues in the body.

It has a variety of functions.

- It binds together, supports, and strengthens other body tissues;
- Protects and insulates internal organs;
- Compartmentalizes structures such as skeletal muscles;
- Serves as the major transport system within the body (blood, a fluid connective tissue);
- The primary location of stored energy reserves (adipose, or fat, tissue); and
- The main source of immune responses.

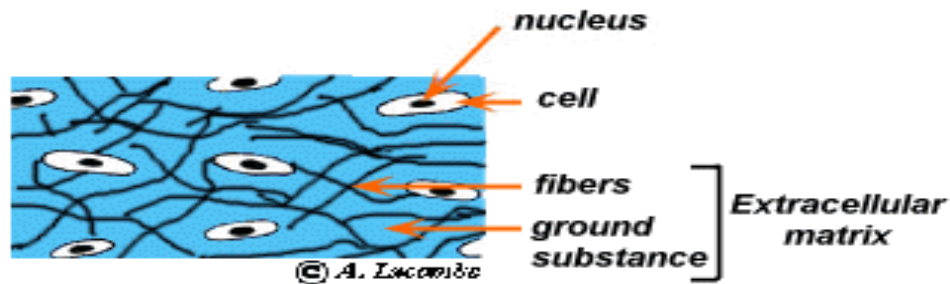
Consists of two basic elements:

Extracellular matrix and cells

Extracellular matrix is the material located between its widely spaced cells.

- ✓ It consists of protein fibers and ground substance, the material between the cells and the fibers.
- ✓ It is secreted by the connective tissue cells and determines the tissue's qualities. E.g. in cartilage, the extracellular matrix is firm but pliable.

- ✓ But the extracellular matrix of bone, by contrast, is hard and inflexible.
- ✓ Do not usually occur on body surfaces, are highly vascular.



The types of connective tissue cells are

- Fibroblasts
- Adipocytes
- Mast cells
- White blood cells
- Macrophages
- Plasma cells

Extracellular Matrix

The extracellular matrix consists of two major components:

- (1) **ground substance**
- (2) **fibers.**

Ground substance is the component of a connective tissue between the cells and fibers.

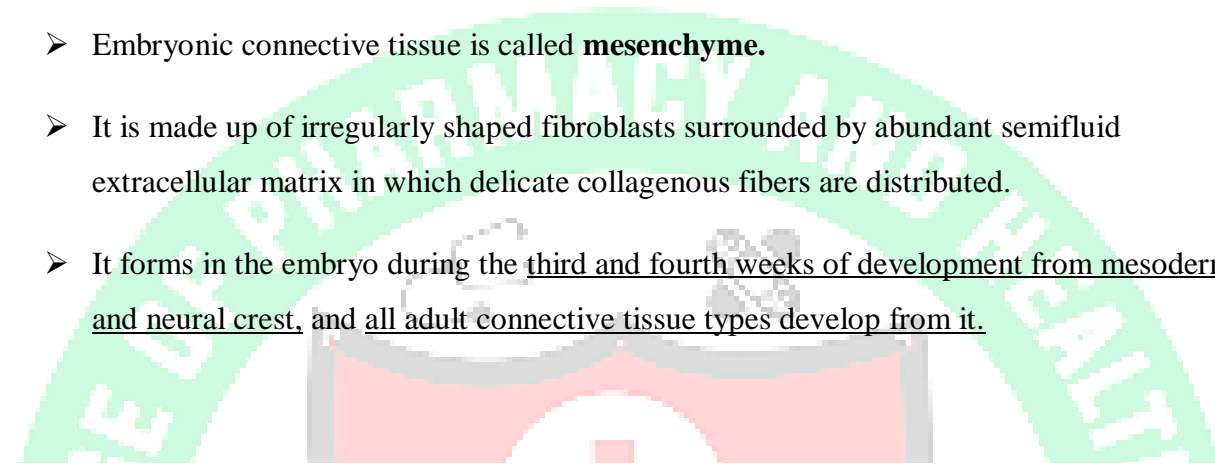
- It may be fluid, semifluid, gelatinous, or calcified.
- It plays an active role in how tissues develop, migrate, proliferate, and change shape, and in how they carry out their metabolic functions.

Three types of fibers are embedded in the extracellular matrix between the cells:

- ✓ Collagen fibers
- ✓ Elastic fibers
- ✓ Reticular fibers

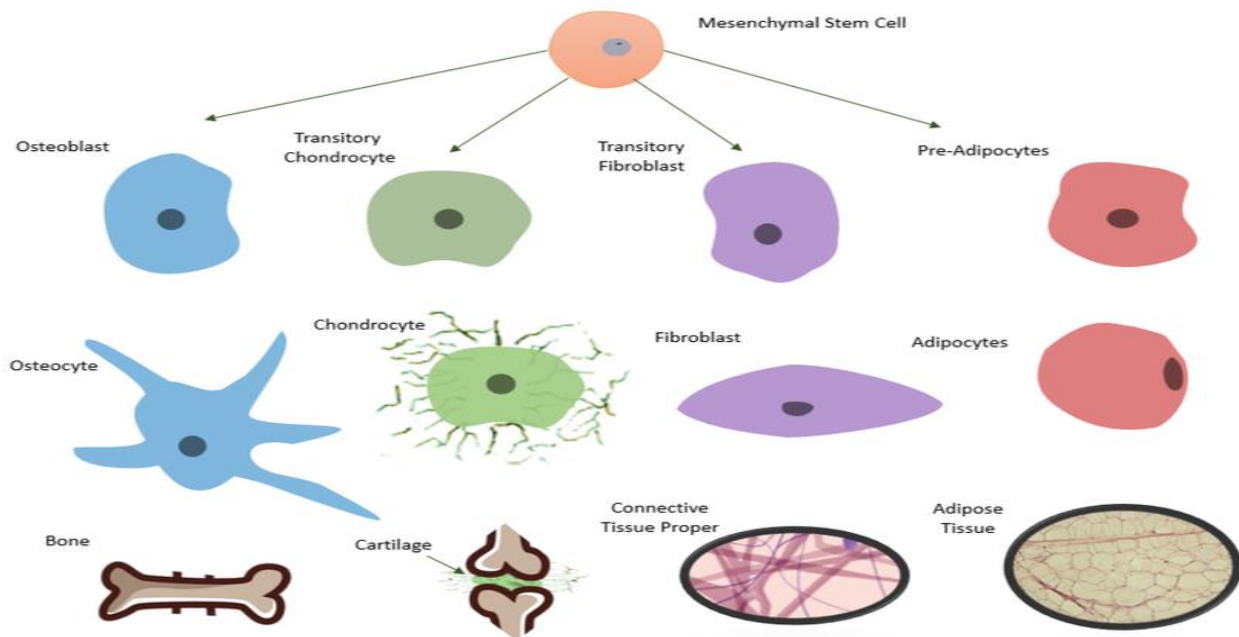
Embryonic Connective Tissue

- Embryonic connective tissue is called **mesenchyme**.
- It is made up of irregularly shaped fibroblasts surrounded by abundant semifluid extracellular matrix in which delicate collagenous fibers are distributed.
- It forms in the embryo during the third and fourth weeks of development from mesoderm and neural crest, and all adult connective tissue types develop from it.



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Mesenchymal Stem Cell Differentiation Into Connective Tissue Cells



By 8 weeks of development most of the mesenchyme has become specialized to form types of connective tissue seen in adults as well as muscle, blood vessels, and other tissues.

The major source of remaining embryonic connective tissue in the newborn is found in the umbilical cord, where it is called mucous connective tissue or Wharton's jelly.

The structure of mucous connective tissue is similar to mesenchyme.

Adult Connective Tissue

Adult connective tissue consists of six types: loose, dense, connective tissue with special properties, cartilage, bone, and blood.

Loose Connective Tissue

- ✓ Loose connective tissue which is sometimes referred to as areolar tissue, consists of protein fibers that form a lacy network with numerous fluid-filled spaces.
- ✓ Areolar tissue is the “loose packing” material of most organs and other tissues, and attaches the skin to underlying tissues. It contains collagen, reticular, and elastic fibers and a variety of cells.
- ✓ The loose packing of areolar tissue is often associated with other connective tissue types such as reticular tissue and fat (adipose tissue).

Connective tissue can be classified as

1) **Fibrous (connective tissue proper)**

I. Loose fibrous (areolar)

II. Dense – a. Regular b. Irregular (Elastic, Collagenous)

III. Reticular

IV. Adipose

2) **Bone**

I. Spongy (cancellous)

II. Compact

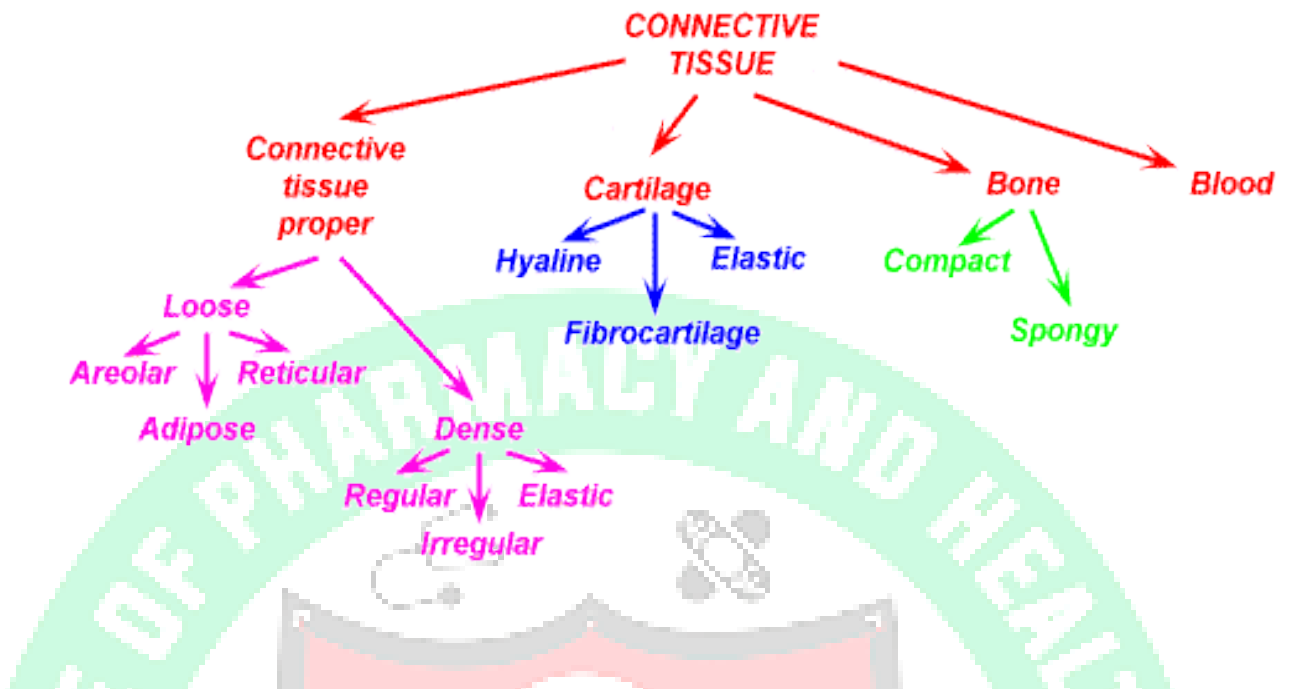
3) **Cartilage**

I. Hyaline

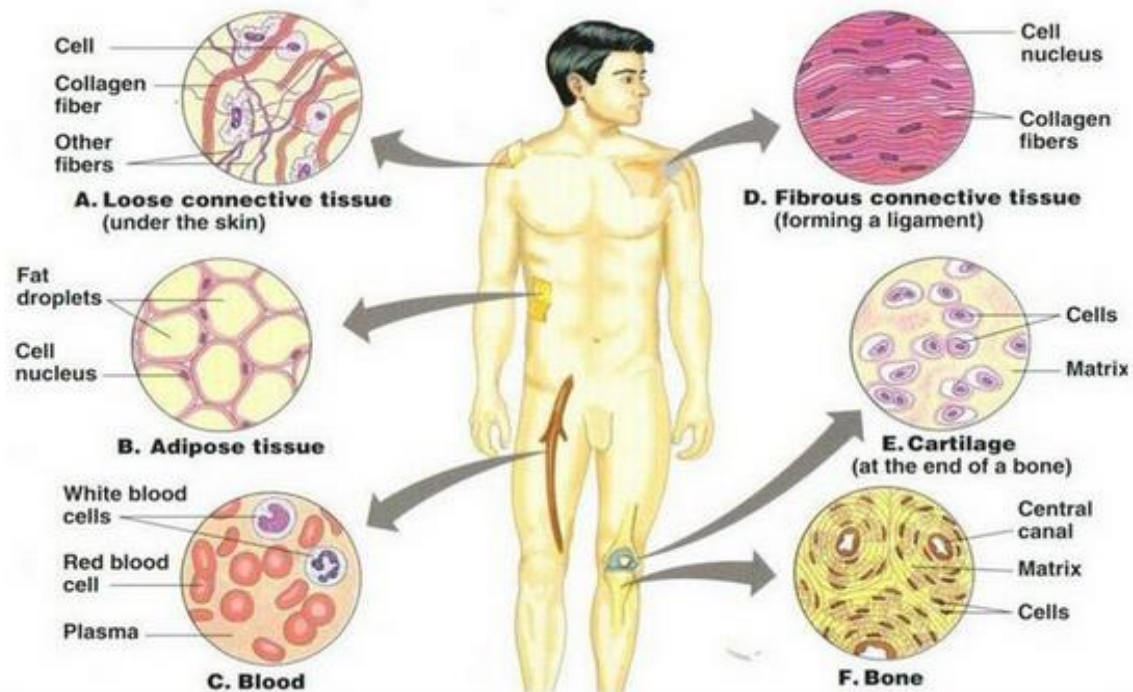
II. Fibrocartilage

III. Elastic

4) **Blood**



Connective tissue

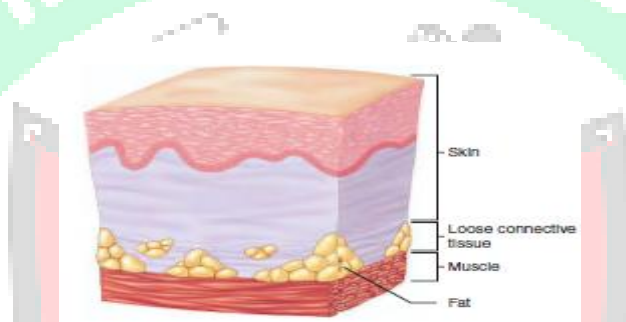


(a) Loose, or areolar, connective tissue

Location: Widely distributed throughout the body; substance on which epithelial basement membranes rest; packing between glands, muscles, and nerves. Attaches the skin to underlying tissues.

Structure: Cells (e.g., fibroblasts, macrophages, and lymphocytes) within a fine network of mostly collagen fibers. Often merges with denser connective tissue.

Function: Loose packing, support, and nourishment for the structures with which it is associated.

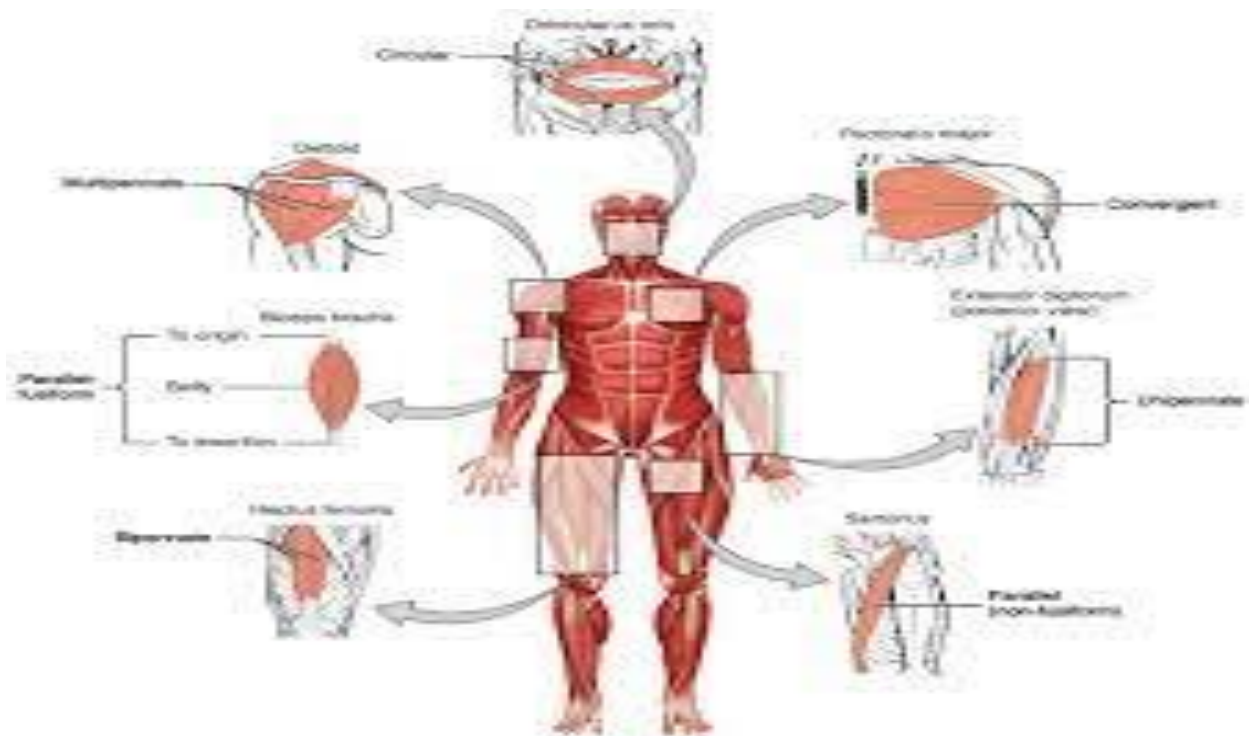


(b) Dense regular collagenous connective tissue

Location: Tendons (attach muscle to bone) and ligaments (attach bones to each other).

Structure: Matrix composed of collagen fibers running in somewhat the same direction.

Function: Ability to withstand great pulling forces exerted in the direction of fiber orientation, great tensile strength, and stretch resistance.



(c) Dense regular elastic connective tissue

Location: Ligaments between the vertebrae and along the dorsal aspect of the neck (nucha) and in the vocal cords.

Structure: Matrix composed of regularly arranged collagen fibers and elastin fibers.

Function: Capable of stretching and recoiling like a rubber band with strength in the direction of fiber orientation.

(d) Dense irregular collagenous connective tissue

Location: Sheaths; most of the dermis of the skin; organ capsules and septa; outer covering of body tubes.

Structure: Matrix composed of collagen fibers that run in all directions or in alternating planes of fibers oriented in a somewhat single direction.

Function: Tensile strength capable of withstanding stretching in all directions.

(e) Dense irregular elastic connective tissue

Location: Elastic arteries.

Structure: Matrix composed of bundles and sheets of collagenous and elastin fibers oriented in multiple directions.

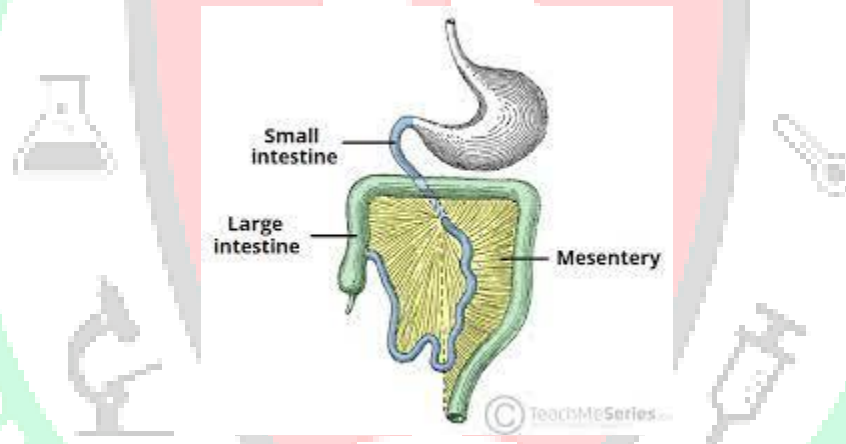
Function: Capable of strength with stretching and recoil in several directions.

(f) Adipose tissue

Location: Predominantly in subcutaneous areas, mesenteries, renal pelvis, around kidneys, attached to the surface of the colon, mammary glands, and in loose connective tissue that penetrates into spaces and crevices.

Structure: Little extracellular matrix surrounding cells. The adipocytes, or fat cells, are so full of lipid that the cytoplasm is pushed to the periphery of the cell.

Function: Packing material, thermal insulator, energy storage, and protection of organs against injury from being bumped or jarred.



(g) Reticular tissue

Location: Within the lymph nodes, spleen, and bone marrow.

Structure: Fine network of reticular fibers irregularly arranged.

Function: Provides a superstructure for the lymphatic and hemopoietic tissues.

(h) Hyaline cartilage

Location: Growing long bones, cartilage rings of the respiratory system, costal cartilage of ribs, nasal cartilage, articulating surface of bones, and the embryonic skeleton.

Structure: Collagen fibers are small and evenly dispersed in the matrix, making the matrix appear transparent. The cartilage cells, or chondrocytes, are found in spaces, or lacunae, within the firm but flexible matrix.

Function: Allows growth of long bones. Provides rigidity with some flexibility in the trachea, bronchi, ribs, and nose. Forms rugged, smooth, yet somewhat flexible articulating surfaces. Forms the embryonic skeleton.



(i) Fibrocartilage

Location: Intervertebral disks, symphysis pubis, articular disks (e.g., knee and temporomandibular [jaw] joints).

Structure: Collagen fibers similar to those in hyaline cartilage. The fibers are more numerous than in other cartilages and are arranged in thick bundles.

Function: Somewhat flexible and capable of withstanding considerable pressure. Connects structures subjected to great pressure.

(j) Cancellous bone

Location: In the interior of the bones of the skull, vertebrae, sternum, and pelvis; also found in the ends of the long bones.

Structure: Lattice like network of scaffolding characterized by trabeculae with large spaces between them filled with hemopoietic tissue. The osteocytes, or bone cells, are located within lacunae in the trabeculae.

Function: Acts as a scaffolding to provide strength and support without the greater weight of compact bone.

(K) Compact bone

Location: Outer portions of all bones and the shafts of long bones.

Structure: Hard, bony matrix predominates. Many osteocytes (not seen in this bone preparation) are located within lacunae that are distributed in a circular fashion around the central canals. Small passageways connect adjacent lacunae.

Function: Provides great strength and support. Forms a solid outer shell on bones that keeps them from being easily broken or punctured.



1) Blood

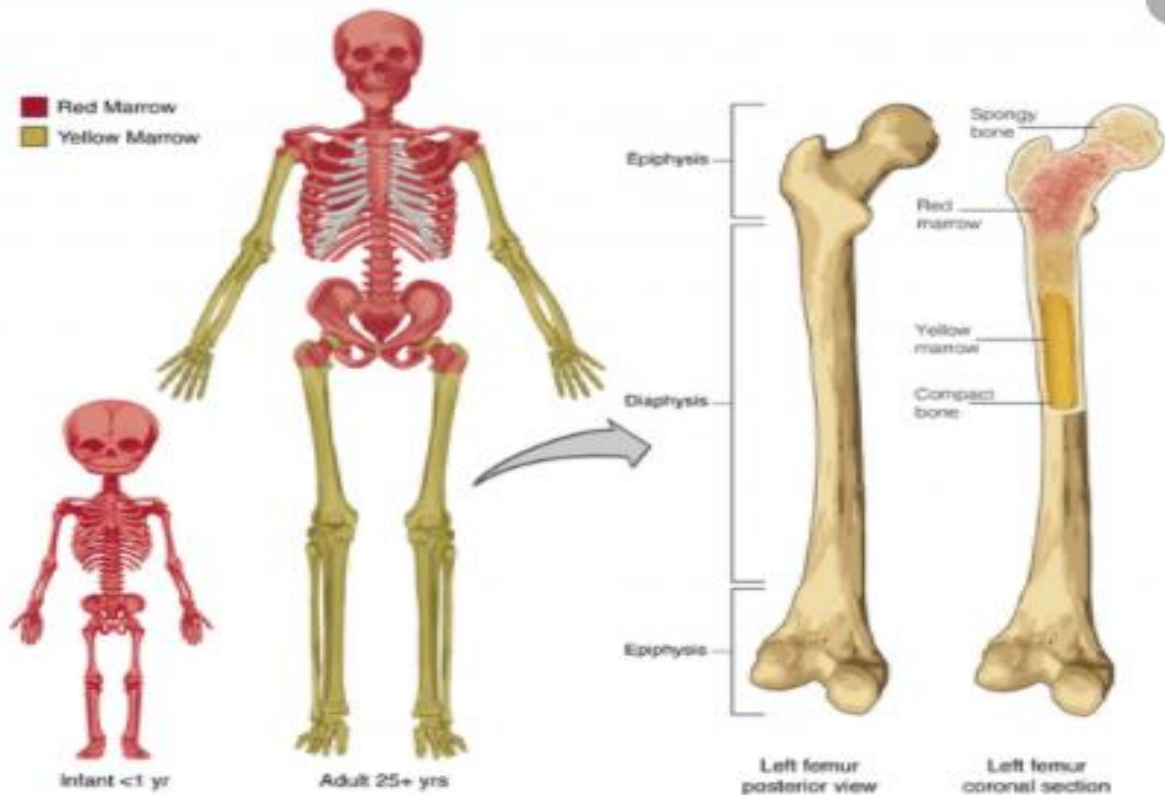
Location : within the blood vessels. Produced by the hemopoietic tissues. White blood cells frequently leave the blood vessels and enter the interstitial spaces.

Structure: blood cells and a fluid matrix.

Function: Transports oxygen, carbon dioxide, hormones, nutrients, waste products, and other substances. Protects the body from infections and is involved in regulation of temperature.

(m) Bone marrow

Location: Within marrow cavities of bone. Two types are yellow marrow (mostly adipose tissue) in the shafts of long bones; and red marrow (hemopoietic or blood-forming tissue) in the



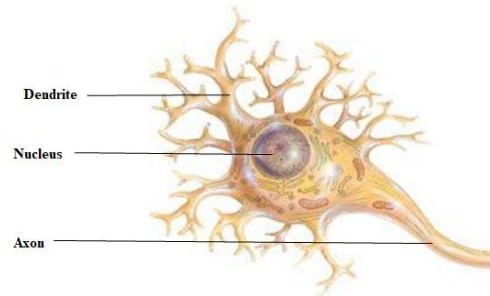
NERVOUS TISSUE

Consists of only two principle types of cells - Neurons and neuroglia (glial cells).

Neurons, or nerve cells, are sensitive to various stimuli.

- ✓ They convert stimuli into electrical signals called **action potentials** (nerve impulses) and conduct these action potentials to other neurons, to muscle tissue, or to glands.
- ✓ Most neurons consist of three basic parts: a cell and two kinds of cell processes – dendrites and axon.

Neuron of spinal cord

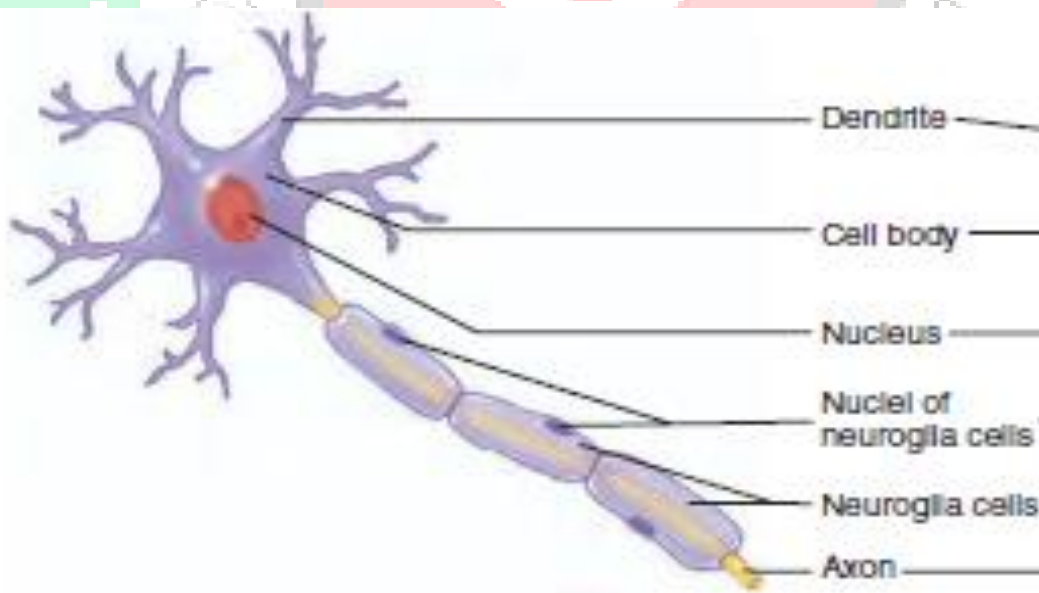


(a) Multipolar neuron

Location: Neurons are located in the brain, spinal cord, and ganglia.

Structure: The neuron consists of dendrites, a cell body, and a long axon. Neuroglia, or support cells, surround the neurons.

Function: Neurons transmit information in the form of action potentials, store "information," and in some way integrate and evaluate data. Neuroglia support, protect, and form specialized sheaths around axons.



(b) Unipolar neuron

Location: Cell bodies are located in ganglia outside of the brain and spinal cord.

Structure: The neuron consists of a cell body with one axon.

Function: Conducts action potentials from the periphery to the brain or spinal cord.

Glial cells (non-Neuronal cells)

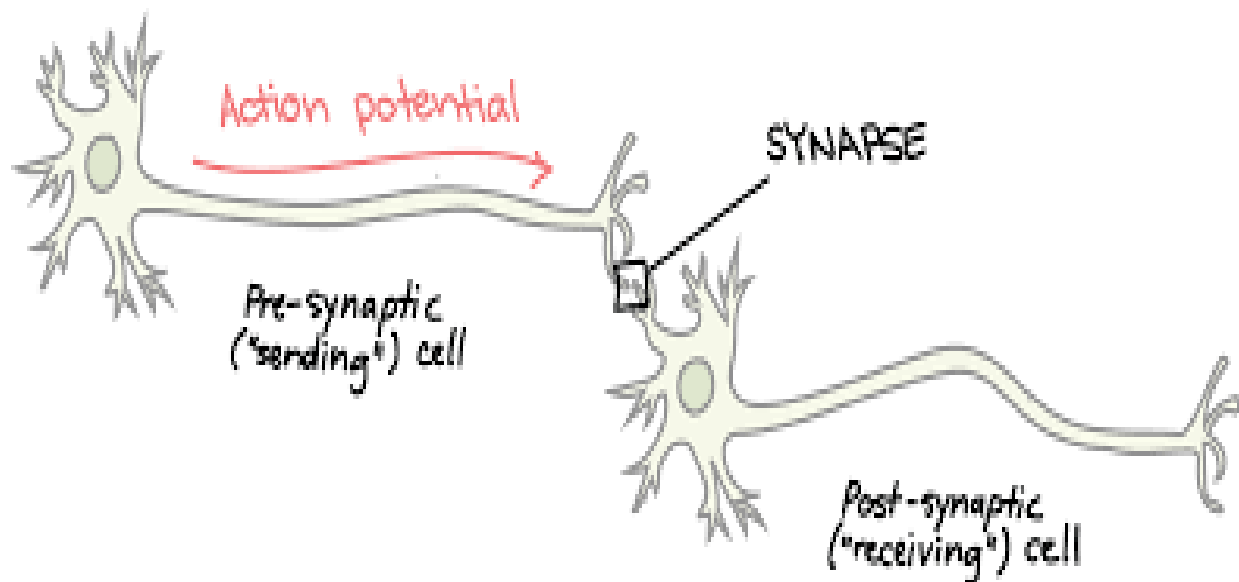
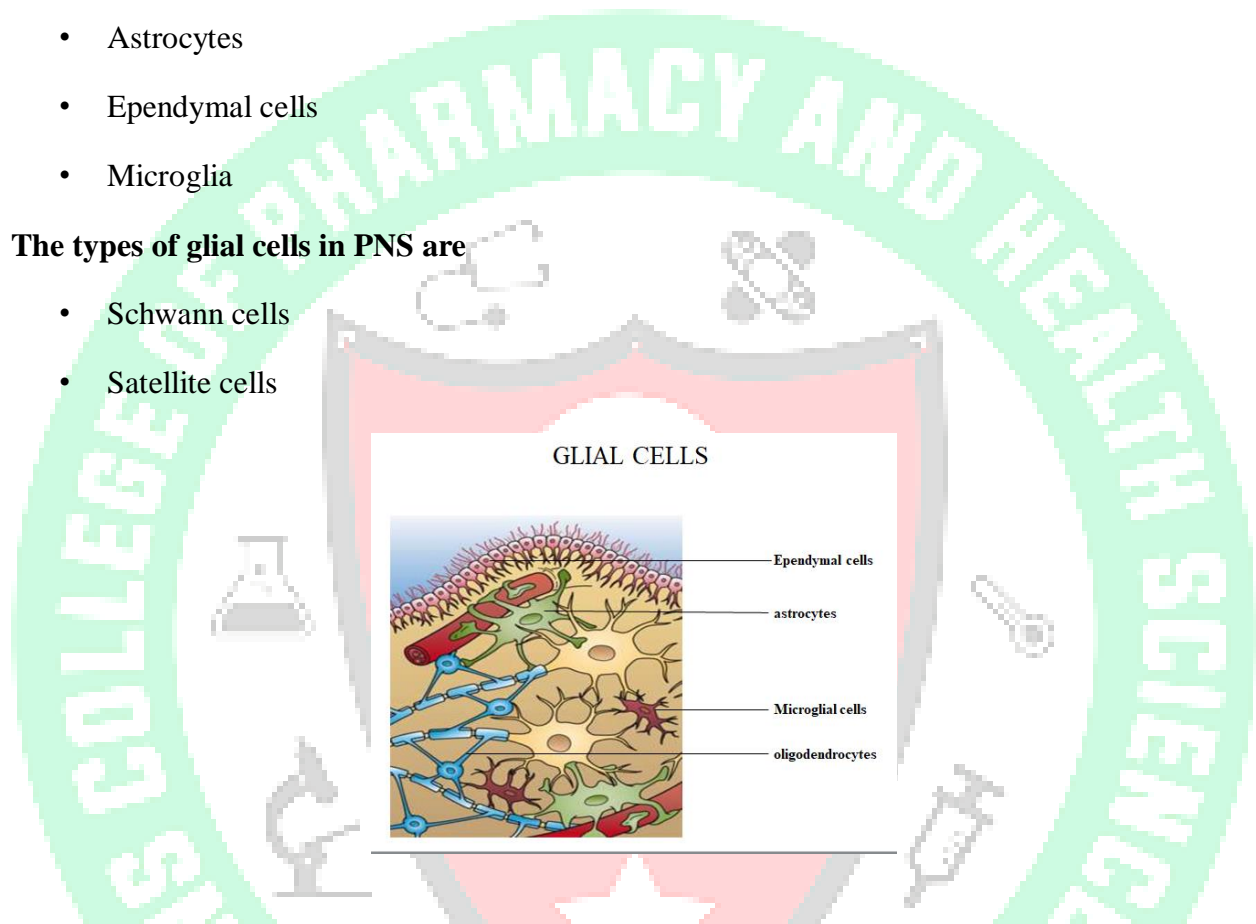
Maintains homeostasis, forms myelin and provides support and protection for neurons in central and peripheral nervous systems.

The types of glial cells in CNS are

- Oligodendrocytes
- Astrocytes
- Ependymal cells
- Microglia

The types of glial cells in PNS are

- Schwann cells
- Satellite cells



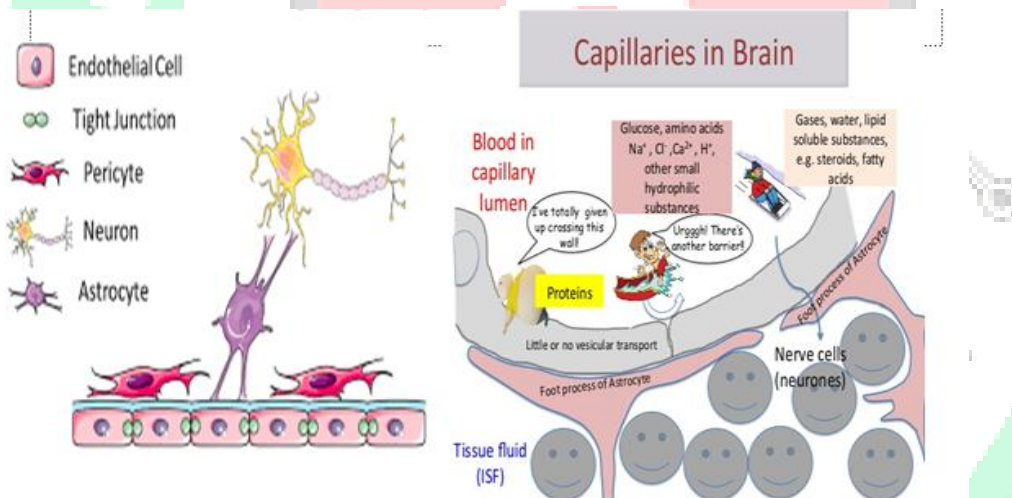
Astrocytes

Astrocytes are star-shaped neuroglial cells present in all the parts of the brain. Two types of astrocytes are found in human brain:

- Fibrous astrocytes
- Protoplasmic astrocytes

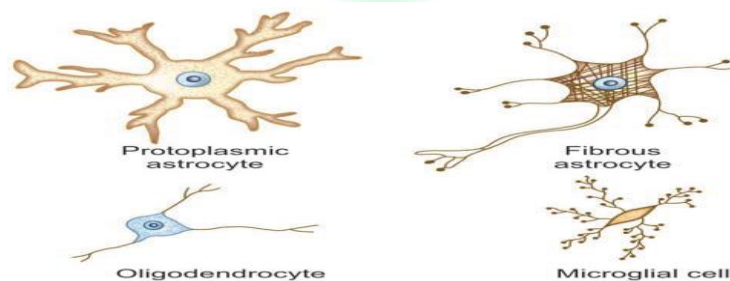
Fibrous Astrocytes

- ✓ Fibrous astrocytes occupy mainly the white matter.
- ✓ Few fibrous astrocytes are seen in gray matter also.
- ✓ The processes of these cells cover the nerve cells and synapses. This type of astrocytes play an important role in the formation of **blood-brain barrier** by sending processes to the blood vessels of brain, particularly the capillaries, forming tight junction with capillary membrane. **Tight junction** in turn forms the blood-brain barrier.



Protoplasmic Astrocytes

Protoplasmic astrocytes are present mainly in gray matter. The processes of neuroglia run between nerve cell bodies.



Functions of Astrocytes

- Twist around the nerve cells and form the **supporting network** in brain and spinal cord
- Form the **blood-brain barrier** and thereby regulate the entry of substances from blood into brain tissues
- Maintain the **chemical environment** of ECF around CNS neurons
- Provide calcium and potassium and regulate neurotransmitter level in synapses
- Regulate **recycling of neurotransmitter** during synaptic transmission.

Microglia

Microglia are the smallest neuroglial cells. These cells are derived from monocytes and enter the tissues of nervous system from blood. These **phagocytic cells** migrate to the site of infection or injury and are often called the **macrophages of CNS**.

Functions of Microglia

- Engulf and destroy the microorganisms and cellular debris by means of **phagocytosis**
- Migrate to the injured or infected area of CNS and act as miniature macrophages.

Oligodendrocytes

Oligodendrocytes are the neuroglial cells, which produce myelin sheath around the nerve fibers in CNS. Oligodendrocytes are also called **oligodendroglia**. Oligodendrocytes have only few processes, which are short.

Functions of Oligodendrocytes

- **Provide myelination** around the nerve fibers in CNS where Schwann cells are absent
- **Provide support** to the CNS neurons by forming a semi-stiff connective tissue between the neurons.

Peripheral neuroglial cells

Neuroglial cells in PNS are of two types:

- Schwann cells
- Satellite cells.

Schwann cells

Schwann cells are the major glial cells in PNS.

Functions of Schwann Cells

- **Provide myelination** (insulation) around the nerve fibers in PNS
- Play important role in **nerve regeneration**
- Remove cellular debris during regeneration by their phagocytic activity.

Satellite cells

Satellite cells are the glial cells present on the exterior surface of PNS neurons.

Functions of Satellite Cells

- Provide **physical support** to the PNS neurons
- Help in regulation of chemical environment of ECF around the PNS neurons.

MUSCLE TISSUE

- The main characteristic of **muscle tissue is that it contracts** or shortens with force, and therefore is responsible for movement.
- The three types of muscle tissue are **skeletal, cardiac, and smooth muscle**. The types of muscle tissue are grouped according to both structure and function.
- Muscle tissue grouped according to structure is either **striated**, (in which microscopic bands or striations can be seen in muscle cells), or **nonstriated**

When classified according to function, a muscle is voluntary, meaning that it is usually consciously controlled, or involuntary, meaning that it is not normally consciously controlled.

Thus the three muscle types are

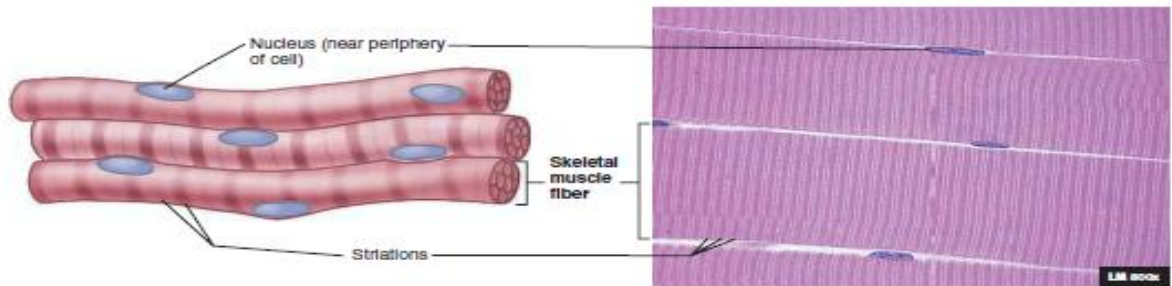
- **Striated voluntary, or skeletal muscle;**
- **Striated involuntary, or cardiac muscle and**
- **Nonstriated involuntary, or smooth muscle**

(a) Skeletal muscle

Location: Attaches to bone.

Structure: Skeletal muscle cells or fibers appear striated (banded). Cells are large, long, and cylindrical, with many nuclei located at the periphery.

Function: Movement of the body; under voluntary control.

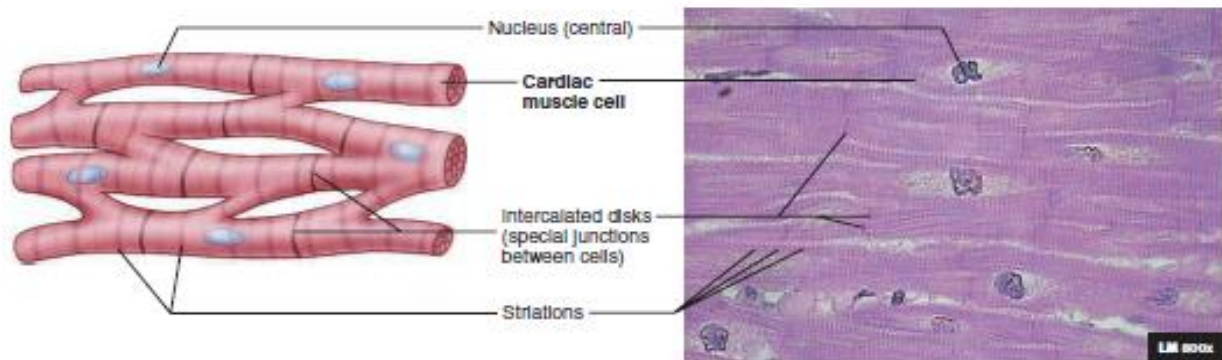


(b) Cardiac muscle

Location: Cardiac muscle is in the heart.

Structure: Cardiac muscle cells are cylindrical and striated and have a single, centrally located nucleus. They are branched and connected to one another by intercalated disks.

Function: Cardiac muscle is in the heart. Pumps the blood; under involuntary control.



(c) Smooth muscle

Location: Smooth muscle is in hollow organs such as the stomach and intestine.

Structure: Smooth muscle cells are tapered at each end, are not striated, and have a single nucleus.

Function: Regulates the size of organs, forces fluid through tubes, controls the amount of light entering the eye, and produces “goose flesh” in the skin; under involuntary control.

