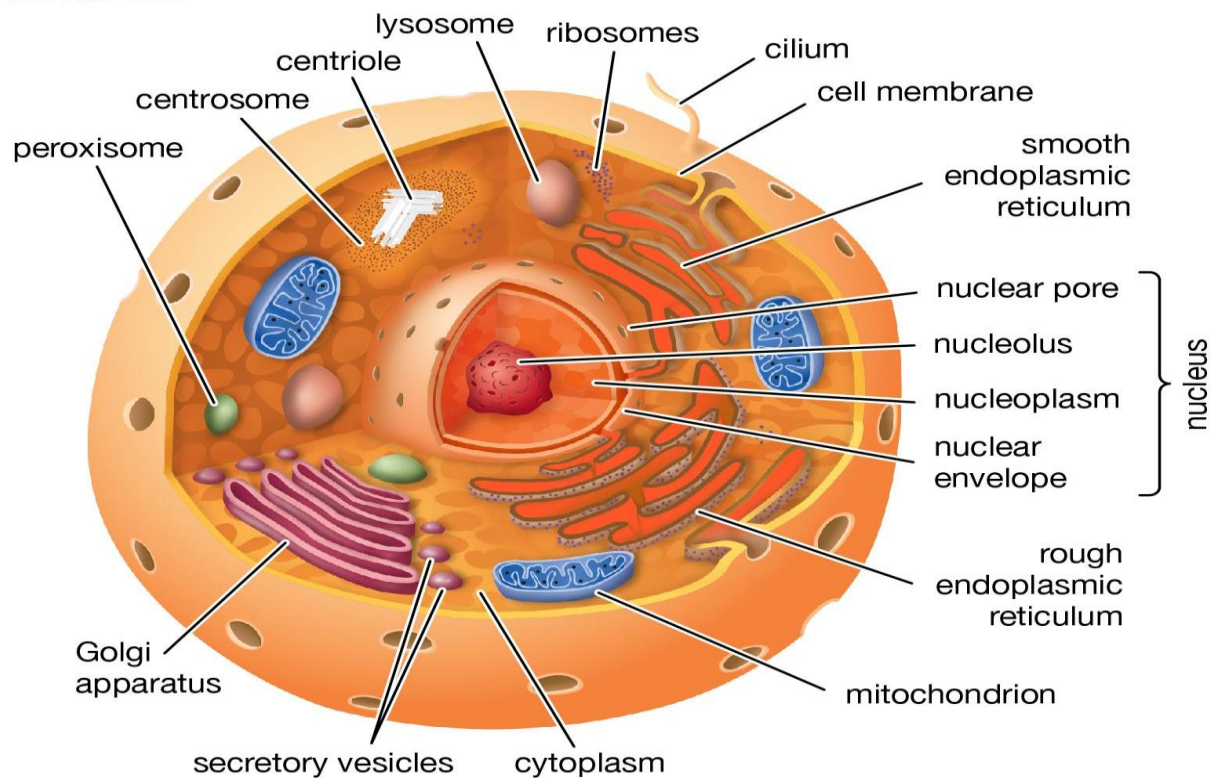


Lec1. General description of the cells

Cell Structure and Function

A cell is the basic unit of life. All living organisms are made up of cells.

Animal cell



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All cells contain cytoplasm and are surrounded by a membrane, and contain the following structures of organelles:

1. **Plasma Membrane:** The plasma membrane isolates the interior of the cell from the external environment and is a selectively permeable membrane, made up of a double-layered sheet called a lipid bilayer. This membrane surround and envelops every eukaryotic cell consists of phospholipids, cholesterol, and proteins.

2. The Nucleus: stores the genetic information as DNA organized into linear structures called chromosomes. Located on the chromosome are collections of genes. Genes are segments of DNA that contain information for the production of specific proteins. These proteins have many functions in cells, and they help determine a cell's specificity.

Chromatin is the combination of DNA molecules and proteins that make up the chromosomes. The chromosomes are responsible for transmitting genetic information from one generation to the next. Chromatin can coil tightly to form visible chromosomes during cell division. The nucleus is separated from the cytoplasm by a double membrane known as the nuclear envelope. This is continuous with the endoplasmic reticulum (ER), a membranous system of saccules and channels. The nuclear envelope has nuclear pores of sufficient size to permit the passage of ribosomal subunits out of the nucleus and proteins into the nucleus.

3. Ribosomes: are organelles composed of proteins and rRNA. Protein synthesis occurs at the ribosomes. Ribosomes are often attached to the endoplasmic reticulum, but they also may occur free within the cytoplasm, either singly or in groups called polyribosomes.
4. The endoplasmic reticulum (ER) has two portions. a. Rough ER is studded with ribosomes on the side of the membrane that faces the cytoplasm. The proteins that are synthesized at these ribosomes enter the interior of the ER for additional processing and modification. b. The smooth ER is continuous with the rough ER, but it does not have attached ribosomes. Smooth ER synthesizes the phospholipids and other lipids that occur in membranes. It also has various other functions,

depending on the particular cell. For example, it helps detoxify compounds (such as drugs) in the liver.

The ER forms transport vesicles in which large molecules are transported to other parts of the cell. Often these vesicles are on their way to the plasma membrane or the Golgi apparatus.

5. The Golgi apparatus consists of a stack of slightly curved saccules, here proteins and lipids received from the ER are modified. The vesicles that leave the Golgi apparatus move to other parts of the cell. Some vesicles proceed to the plasma membrane, where they discharge their contents. In all, the Golgi apparatus is involved in processing, packaging, and secretion. Lysosomes, membranous sacs produced by the Golgi apparatus, contain enzymes.
6. Lysosomes: are small organelles filled with enzymes. Lysosomes break down lipids, carbohydrates, and proteins into small molecules that can be used by the rest of the cell.
7. Centrioles are located near the nucleus and help organize cell division. Centrioles are not found in plant cells.
8. Mitochondria are often called the powerhouses of the cell, producing ATP molecular.

Two Types of Cells:

1. Prokaryotic Cells: Prokaryotic cells are cells without a nucleus. The DNA in prokaryotic cells is in the cytoplasm rather than enclosed within a nuclear membrane. Prokaryotic cells are found in single-celled organisms, such as bacteria, Organisms with prokaryotic cells are called prokaryotes.

2. Eukaryotic Cells Eukaryotic cells are cells that contain a nucleus, Eukaryotic cells are usually larger than prokaryotic cells, and they are found mainly in multicellular organisms. Organisms with eukaryotic cells are called eukaryotes, and they range from fungi to people

Tissue definition & classification

A tissue is composed of specialized cells of the same type that perform a common function in the body.

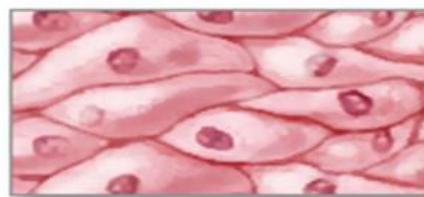
The tissues of the human body can be categorized into four major types:

1. Epithelial tissue covers body surfaces and lines body cavities.
2. Connective tissue binds and supports body parts.
3. Muscular tissue moves the body and its parts.
4. Nervous tissue receives sensory information and conducts nerve impulses

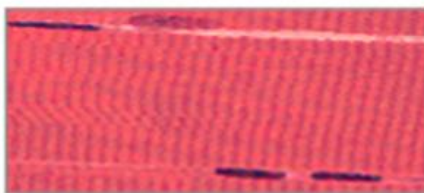
Four types of tissue



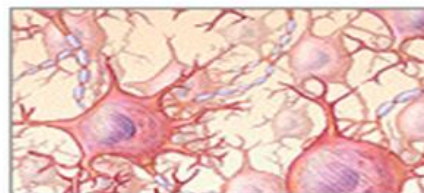
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

Lec2: Epithelial Tissue

Epithelial tissue, also called epithelium (pl., epithelia), consists of tightly packed cells that form a continuous layer, covers surfaces and lines body cavities. It has a protective function. It can also be modified to carry out secretion, absorption, excretion, and filtration. Epithelial cells are named based on their appearance; they are bounded by a basement membrane (is a thin layer that anchors the epithelium to underlying connective tissue).

Characteristic of epithelial tissue

- ❖ It is made up of cells closely packed and ranged in one or more layers.
- ❖ tissue is specialized to form the covering or lining of all internal and external body surfaces.
- ❖ Epithelial tissue that occurs on surfaces on the interior of the body is known as endothelium.
- ❖ Epithelial cells are packed tightly together with almost no intercellular spaces and only a small amount of intercellular substance.
- ❖ Epithelial tissue, regardless of the type is usually, separated from the underlying tissue by a sheet of connective tissue; basement membrane. The basement membrane provides structural support for the epithelium and acts as a selectively permeable membrane that determines which substances will be able to enter the Epithelium.
- ❖ Glandular epithelium: this type of epithelium lining gland.

Functions of Epithelial Tissue:

1. Protection for the underlying tissues from radiation, toxins, and physical trauma.
2. Absorption of substances in the digestive tract lining with distinct modifications.
3. Regulation and exchange of chemicals between the underlying tissues and the body cavity.
4. The secretion of hormones into the blood vascular system. The secretion of sweat, mucus, enzymes, and other products that are delivered by ducts come from the glandular epithelium.
5. Epithelial tissue also has a sensory function as it contains sensory nerves in areas such as the skin, tongue, nose, and ears.

Classification of Epithelial Tissue (types): Based on:

1. Type of cell in which the tissue is made of
2. Number of layers of cells
3. Shape

1.Type of cell in which the tissue is made of

A. Covering and lining epithelium: from the outer layers of the skin; lines open cavities of the digestive and respiratory systems; covers the walls of organs of the closed ventral body cavity.

B. Glandular epithelium: surrounds glands within the body.

2. Number of layers of cells

- A. Simple epithelial tissues: consist of a single layer of cell.
- B. Stratified epithelial tissues: consist of multilayer of cells only the bottom layer touches the basement

3. Shape of cell: (when viewed in profile)

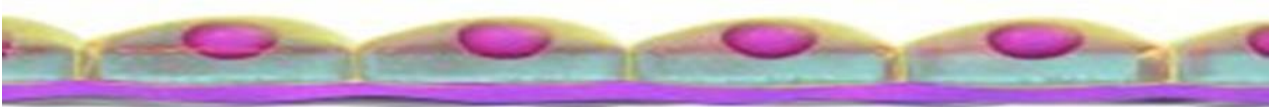
- A. squamous epithelium. Cells appear flattened scale-like.
- B. Cuboidal epithelium. Cell height is same as cell width.
- C. Columnar epithelium. Cell height is greater than cell width.

Types of epithelium tissue

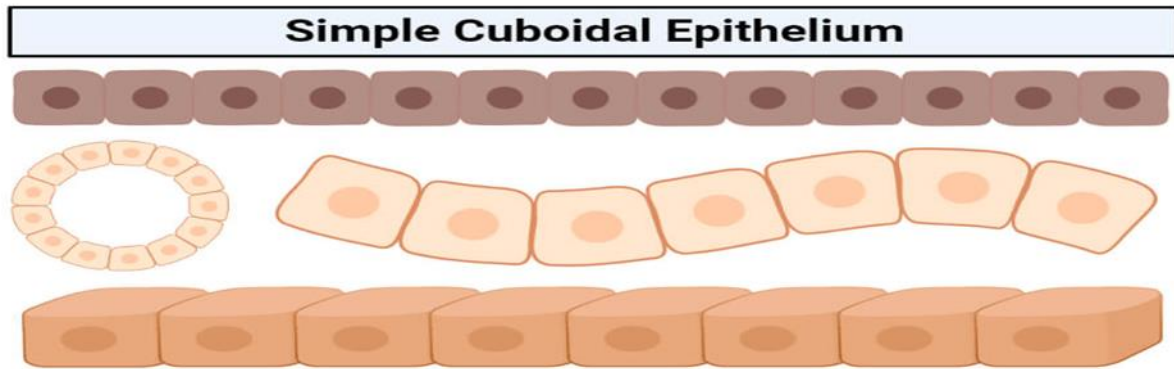
A. Simple epithelium

- 1. Simple squamous epithelium: consist of a single layer of flattened cells with disc shape central nuclei, is found lining sacs of lung and wall of blood vessels, its shape and arrangement permit the exchanges of substance in these locations.

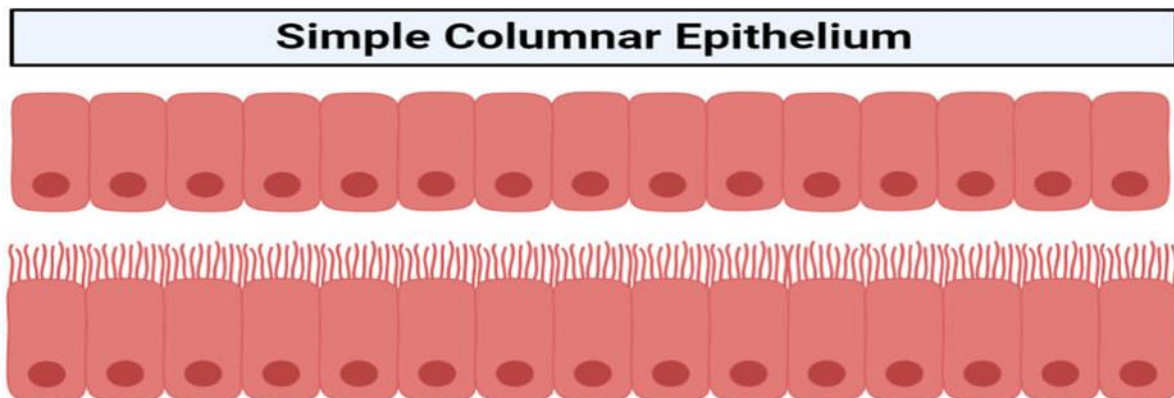
SIMPLE SQUAMOUS EPITHELIUM



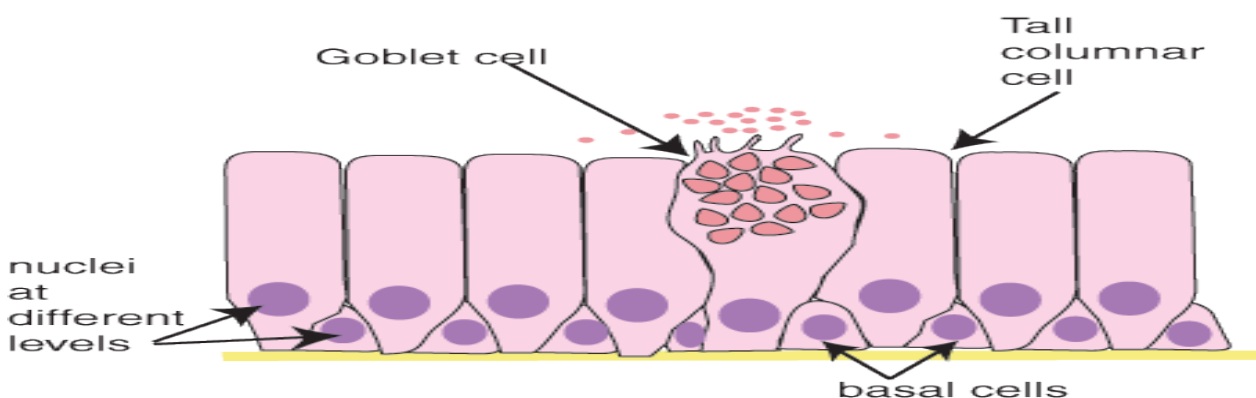
- 2. Simple cuboidal epithelium: consist of single layer of cube like cell with large spherical nuclei, this type is found in glands as salivary gland, or in kidney tubule, its function secretion and absorption.



3. Simple columnar epithelium: consist of single layer of tall cells with round to oval nuclei located near the bottom of each cell, this type of epithelium is found digestive tract as stomach.



4. Pseudostratified ciliated columnar epithelium: one layer of cells, but appears stratified because cells are of different heights. all cells are in contact with the basement membrane. Found in trachea



B. Stratified epithelium

- ❖ Stratified epithelium differs from simple epithelium in that it is multi-layered.
- ❖ The most basal layers the cells can be squamous, cuboidal or columnar.
- ❖ This type of epithelium can be classified into four types.

1. Stratified squamous: has multiple layers of cells, the basal cells are cuboidal or columnar are metabolically active, the surface layer are flattened (squamous) there are two type

nonkeratinized (e.g. lining of oesophagus)

keratinized (e.g. skin).

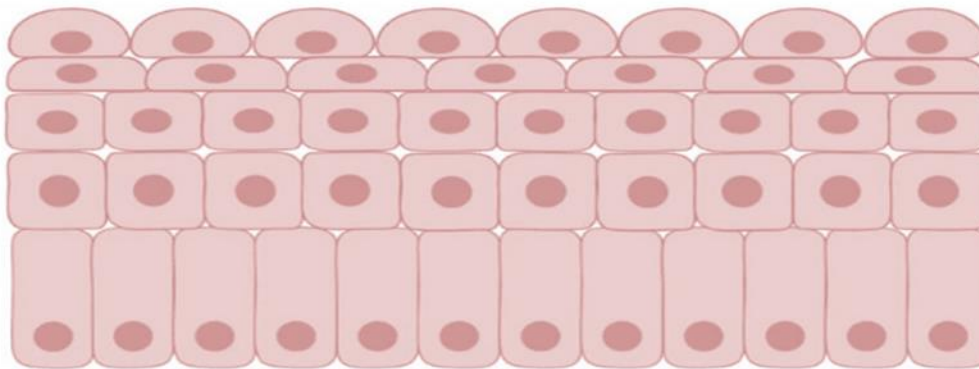
2. Stratified cuboidal: usually has two or three layers of cuboidal cells. This type of epithelium is largely confined to the lining of large ducts (sweat gland).

3. Stratified columnar: has several cell layers, the outermost of which contains columnar cell. This type of epithelium is relatively rare found in male urethra.



4. Transitional epithelium: Is similar to Stratified squamous epithelium except that the outermost cell layer consists of large Rounded cells (dome- like) This type of tissue changes in response to tension. found in urinary bladder.

Transitional Epithelium



Created with Bio Render

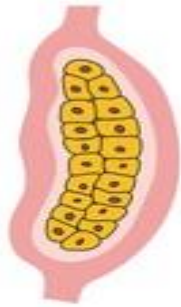
Glandular epithelium

The glandular epithelium is a group of tissues, other than the covering and lining epithelium, which is specialized for the production and secretion of various macromolecules. Because of its primary function, the glandular epithelium is also called the secretory epithelium. This epithelium lies beneath the covering and lining epithelium and either consists of cells with specific functions or comprise specialized organs called glands.

The gland has been classified in many ways: -

1- According to the mode of secretion divided into:

- a. Exocrine gland: are gland with ducts that secrete their product onto the outer surface (sweat gland) or into body cavities (pancreas).
- b. Endocrine gland: are gland without duct secrete hormones internally so they are transported by blood stream (thyroid gland).



Endocrine
gland



Exocrine
gland



Sweat
gland

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2. Glandular epithelium: are classified by the following morphological characteristic to:

- a. Unicellular glands: consisting of only one glandular epithelium cell e.g. goblet cell of digestive system.
- b. Multicellular glands: multiple cell make up one gland; e.g salivary glands

3- According to the nature of secretion :

1.Serous glands:

- A. Secret watery solution of enzyme
- B. Have small lumen
- C. Have round nucleus located in the basal of the cell
- D. Have well stained cytoplasm
- E. The secretory units composed of pyramidal cells with unclear border
- F. e.g parotid gland

2. Mucous glands:

A. produce mucous secretion

B. have large lumen

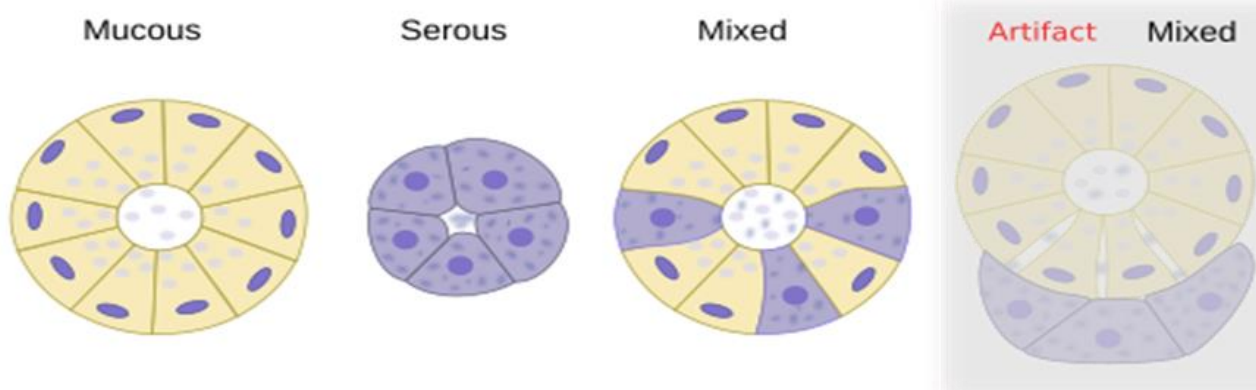
C. have pressed flattened nucleus in the basal limit of the cell

D. have poorly stained cytoplasm

E. the secretory units composed of pyramidal cells with clear border

F. palatine gland

C-Mixed: the part of secretory unit produced mucous and the other unit produced the serous secretion.



4. Classification of glands according of method of secretion:

1. Merocrine (exocytosis)

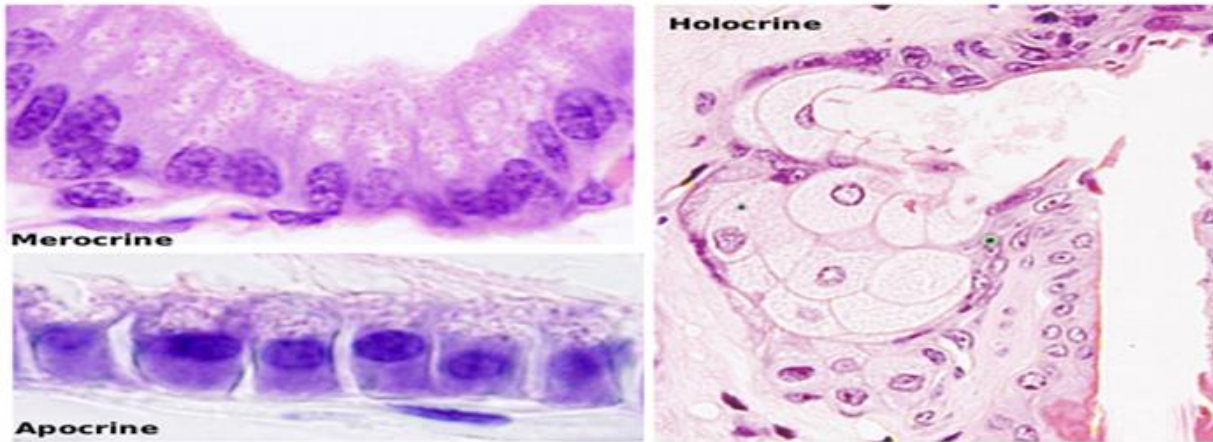
Secretion is released by exocytosis of secretory granules (pancreas, parotid gland, protein component of milk from mammary gland).

2. Apocrine

a portion of the cell membrane that contains the excretion buds off

3. Holocrine

the entire cell disintegrates to excrete its substance; for example, sebaceous glands of the skin and nose.



Lec 3: Connective Tissues

Connective tissues: are group of tissues in the body that maintains the form of the body. Found throughout the body, most abundant and widely distributed in primary tissues. Connective tissue forms a framework upon which epithelial tissue rests and within which nerve tissue and muscle tissue are embedded

Functions of connective tissue include: transport, immunological defense, mechanical support, growth and repair, energy reserve, haemopoiesis, and inflammation.

Characteristics of connective tissue

- 1.All forms of connective tissue share some common structural features and a common embryonic origin.
- 2.Connective tissue consists of individual cells scattered within a matrix.
- 3.Cells of connective tissue are not directly attached to one another.
- 4.Connective tissue is derived from mesoderm (unlike most epithelial tissue which is derived from ectoderm and endoderm).
- 5.Connective tissue has three main components: Ground substance (extracellular matrix), Fibers, Cells.

Cells of the connective tissue include:

Fibroblasts:

- ❖ Are the most common cells in proper connective tissue.
- ❖ Fibroblasts are responsible for secreting collagen and other elements of the extracellular matrix of connective tissue.
- ❖ Are elongated cell with cytoplasmic projections, an ovoid nucleus and one or two nucleoli.

Mast cells

- ❖ Synthesize and release histamine when exposed to allergic
- ❖ Cytoplasm is filled with regular basophilic secretory granules.
- ❖ Closely associated with blood vessel.
- ❖ Release heparin that act locally as an anti-coagulant.
- ❖ Are oval irregular shaped cell with centrally nuclei.
- ❖ Found in skin, respiratory system.

Macrophages (histocytes)

- ❖ Macrophages are avidly phagocytic cells that engulf and digest microbes, cellular debris and foreign substances.
- ❖ They are irregular cells larger than fibroblasts, with more cytoplasm, the nucleus is smaller and darker than fibroblast nucleus, the nucleus eccentric in position.
- ❖ Macrophages contain numerous lysosomes which are used for breaking down ingested material.

Plasma cells

Small round cells with large eccentric nucleus, the nucleus characterized by the big dark masses of chromatin which arranged radically.

Fat cells (Adipocytes)

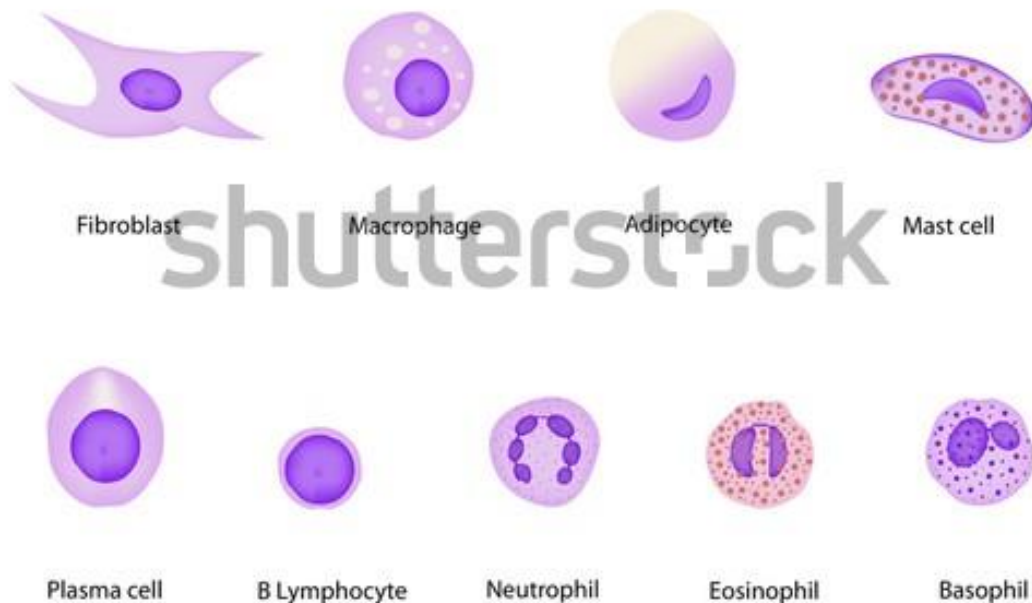
Round cell with packed nucleus in the side of the cell and large droplet of fat, this droplet looks as large cavity occupied the cell.

Reticular cells

The cell has large nucleus and processes attached with the processes of the adjacent cells.

Leucocytes

Including the eosinophils, neutrophils, and lymphocytes, this found in the connective tissue of the intestine.

Connective tissue proper

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Connective Tissue Fibers

There are three main types of connective tissue fibers:

Type	Characters	Component	Location
1.White collagen fibers	<ul style="list-style-type: none"> • Is the main type found in most supporting tissues. •they are seen as wavy bundles of various thickness 	Alpha , polypeptide chain	Tendon, skin, blood vessel, cartilage ,ligaments
2.Yellow (elastic) fiber.	these are usually single thin and branched .they can be stretched	Elastic ,micro fibril, and elastin	Elastic ligaments, large arteries
3.Reticular fibers	They are arranged in a mesh-like pattern form a delicate supporting network around cells	Type III collagen	Liver, bone marrow ,lymphatic organs.

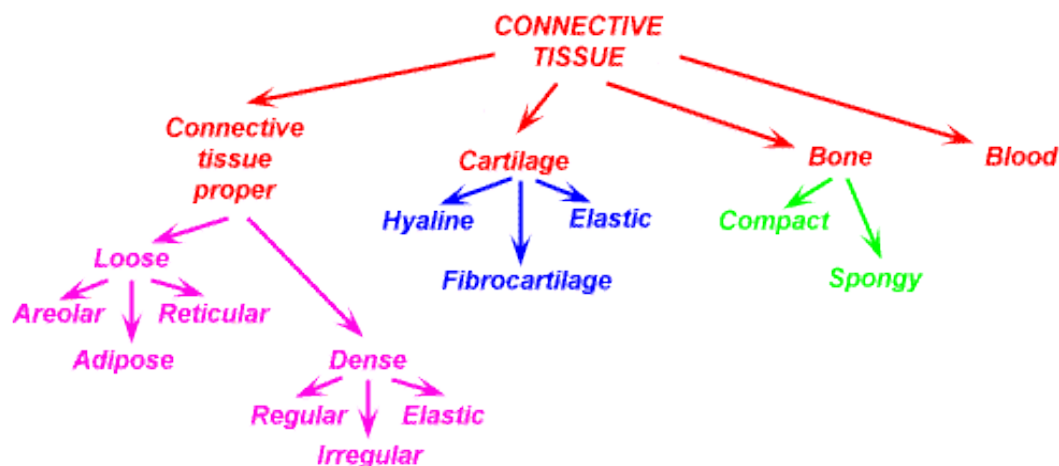
Ground Substance(extracellular matrix)

Ground substance: is the background material within which all other connective tissue elements are embedded. In proper connective tissue, the ground substance consists mainly of water whose major role is to provide a route for communication and transport (by diffusion) between tissues. This water is stabilized by a complex of glycosaminoglycans (GAGs), proteoglycans, and glycoproteins, all of which comprise only a small fraction of the weight of the ground substance.

Ground substance may be highly modified in the special forms of connective tissue.

- ❖ In blood, the ground substance lacks stabilizing macromolecules. We call this free- flowing ground substance plasma.
- ❖ In skeletal tissue, the ground substance may become mineralized by deposition of calcium salts. We call this rigid ground substance bone.
- ❖ In cartilage, the ground substance is much more solid than in proper connective tissue but still retains more resiliency than bone

Classification of Connective Tissues



Proper connective tissues include **loose** and **dense** connective tissues.

A. Loose connective tissue

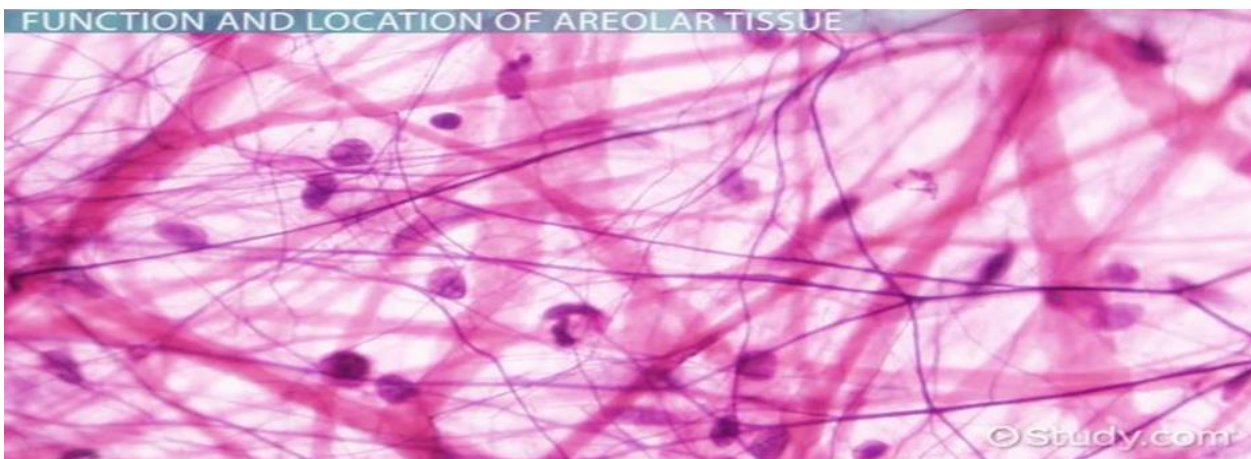
The loose connective tissue contains cells, fibers, and ground substance in roughly equal parts. Among the cells, the fibroblasts are the predominant cells; other types of connective tissue cells are also present, along with nerves and blood vessels. Collagen fibers predominate, but elastic and reticular fibers are also present. The loose connective tissue has moderate amount of ground substance. The combination of

these components gives a delicate consistency to the loose connective tissue making it flexible and not very resistant to stress.

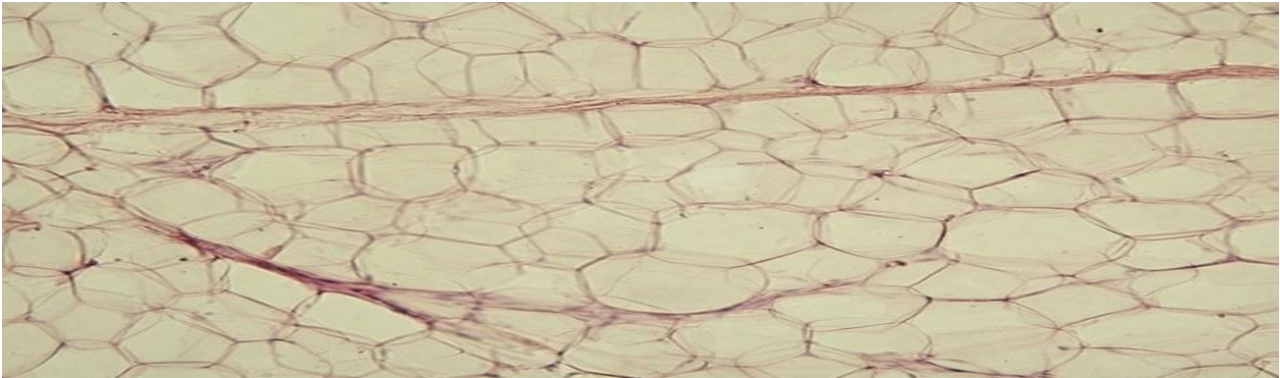
1. Areolar Connective Tissue

These tissues are widely distributed and serve as a universal packing material between other tissues. The functions of areolar connective tissue include the support and binding of other tissues. It also helps in defending against infection.

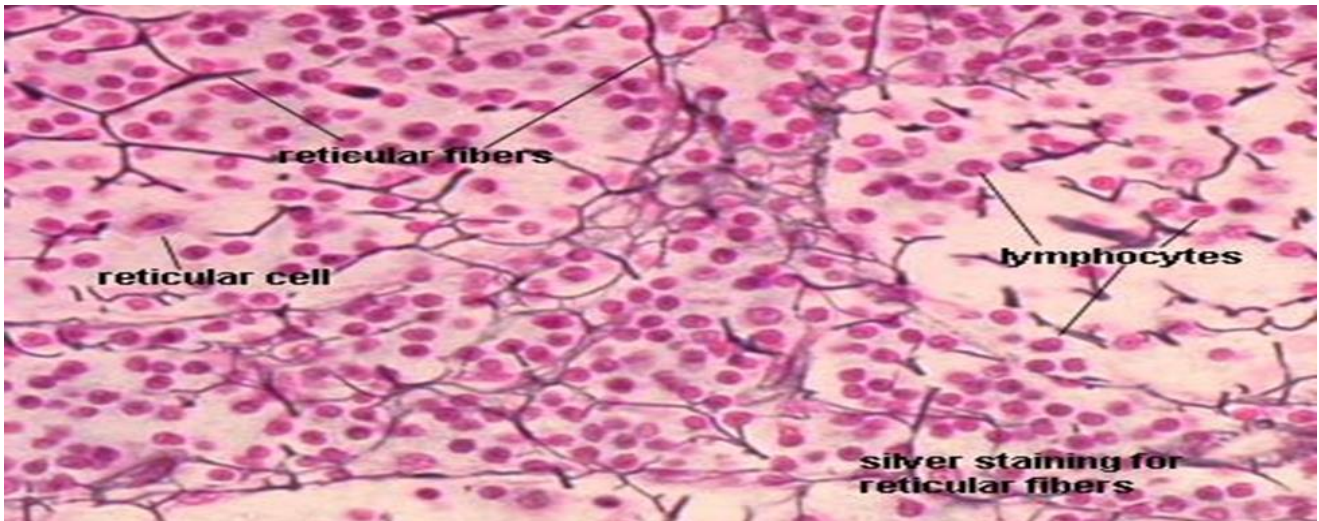
Is a loosely arranged connective tissue that is widely distributed in the body such as in gastrointestinal tract, blood vessels and ducts of glands. The areolar tissue contains collagen fibers, reticular fibers and a few elastic fibers embedded in a thin and almost fluid-like ground substance.



2. **Adipose tissue** is a special type of loose connective tissue in which the cells enlarge and store fat. Adipose tissue has little extracellular matrix. Its cells, which are called adipocytes, are crowded, and each is filled with liquid fat. The body uses this stored fat for energy, insulation, and organ protection. Adipose tissue is primarily found beneath the skin, around the kidneys, and on the surface of the heart.

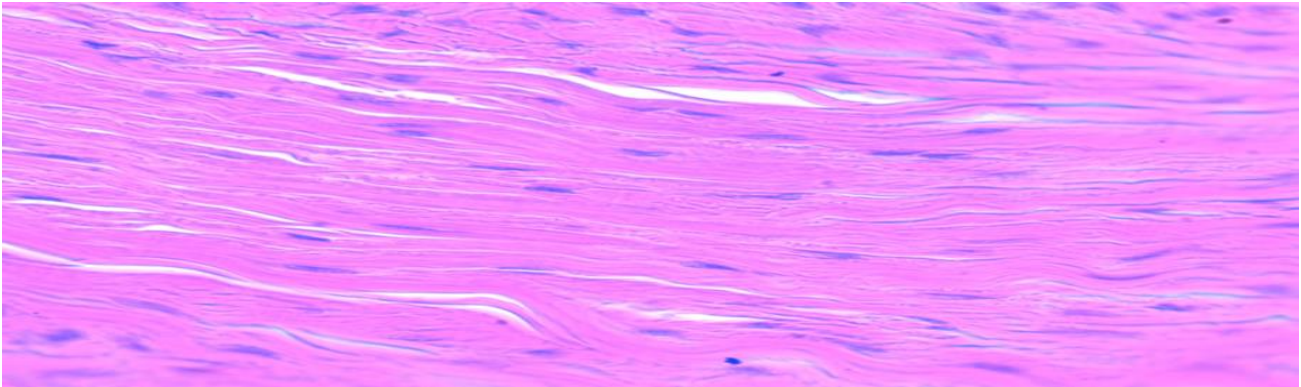


3.Reticular Connective Tissue: The reticular connective tissue is predominantly made up of reticular fibers and characterized by a cellular framework as seen in lymphatic tissues and bone marrow.

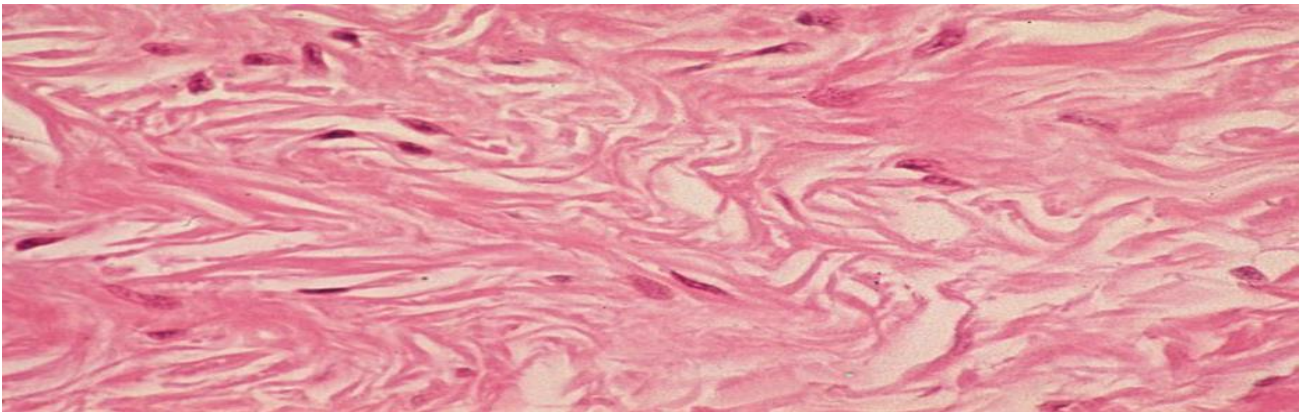


B. Dense connective tissue: This type of tissue is characterized by an abundance of fibers with fewer cells, as compared to the loose connective tissue.

1. Regular connective tissue: It is made primarily of parallel collagen fibers, a few elastic fibers and the major cell type is the fibroblast. found in tendons.

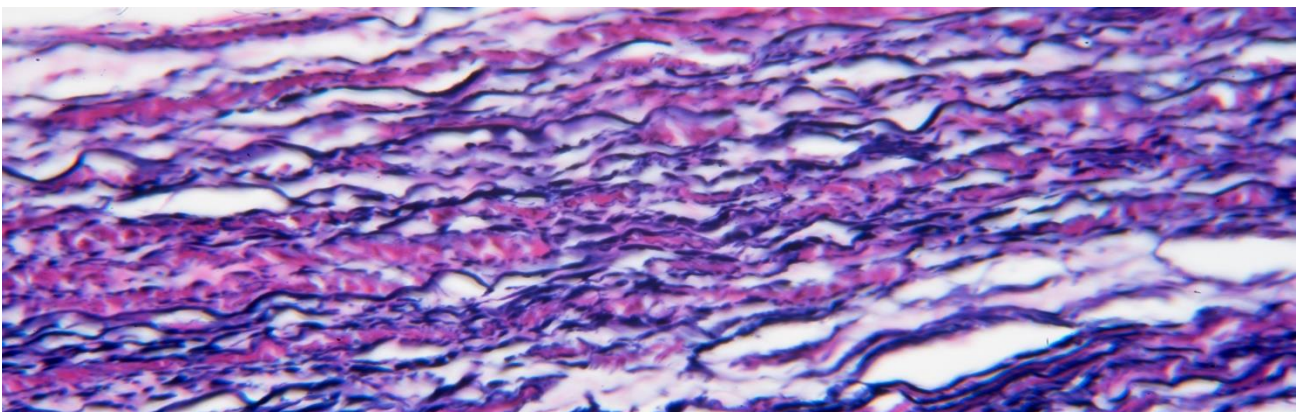


2. **Irregular connective tissue:** It is made primarily of irregularly arranged collagen fibers, some elastic and the major cell type is the fibroblast. found in skin



Irregular connective tissue

3. **Elastic connective tissue** consists of fibroblasts and densely compacted parallel bundles of fibers - mainly elastic fibers with a minor component of collagen fibers. It is found wherever a strong, elastic tissue is needed, such as in the walls of large, elastic arteries.



Lec 4 Specialized Connective Tissue: (Cartilage)

Cartilage and bone are the two main supportive connective tissues. Each provides structure, shape, protection, and movement. Generally, cartilage is more flexible than bone, because it lacks mineralization of the matrix.

Characteristic:

- ❖ supporting connective tissue
- ❖ The abundant ground substance is firm and gel-like (chondrin)
- ❖ resilient
- ❖ without blood vessels (avascular)

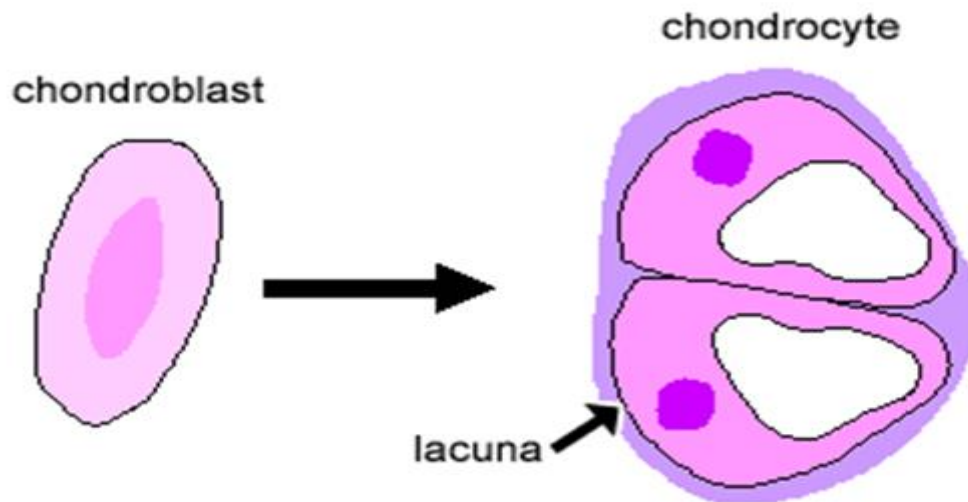
Composition:

A: CELLS:

1. **Chondroblasts** : they are small cells oval or spindle in shape and has oval ,central nucleus they are derived from mesenchymal or chondrogenic cell ,found inner layer of perichondrium , the cytoplasm is rich in organelles ,the functions of these cell are synthesis of collagen type II, proteins of matrix (cartilage forming cells) and responsible or growth of cartilage at its periphery (appositional growth) when the chondroblasts form matrix around themselves , they become imprisoned inside cavities or lacunae and become mature cells (chondrocyte).

2. **Chondrocyte**: they arise from chondroblasts, each chondrocyte is present inside a lacuna. Nucleus is large, central rounded in shape and has prominent nucleolus, cytoplasm is pale basophilic. they maintain cartilage; they form collagen type II and proteins of the matrix and they can divide and form groups of 2,4 or 8 cells inside the same lacunae (cell nests) this process results in growth of the cartilage at its center (interstitial growth)

3. **chondroclasts**: belong to mononuclear phagocyte system involved in destruction of the cartilage.



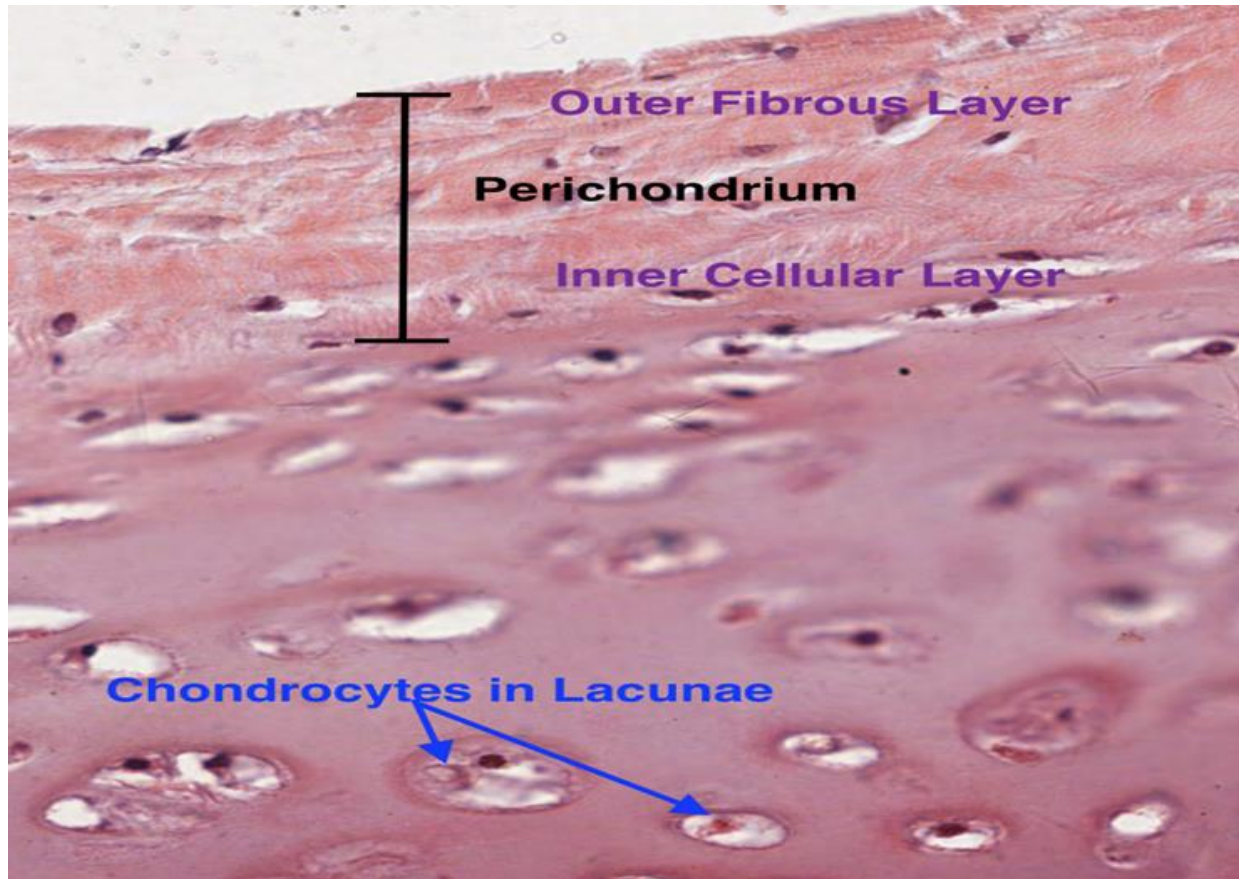
Perichondrium (Blood supply)

All cartilage is avascular and receives nutrients by diffusion from capillaries originating from the perichondrium.

Perichondrium: is a layer of dense connective tissue that surrounds all hyaline cartilage, except in the articular cartilage of movable joints. It is essential for the growth and maintenance of cartilage, as well as its nerves and lymphatic vessels. Although the articular cartilage of movable joints is not covered by perichondrium, they are sustained by diffusion of oxygen and nutrients from synovial fluid. The perichondrium can be subdivided into two layers

- a. **Outer fibrous layer**: type I collagen, fibroblasts, and blood vessels
- b. **Inner cellular layer**: chondrogenic cells are derived from mesenchymal cells and are destined to become chondrocytes. They are spindle-shaped and appear narrow compared to the mature chondrocytes. The chondrogenic cells of the inner cellular layer are stacked above the chondrocytes below and eventually develop into matrix-

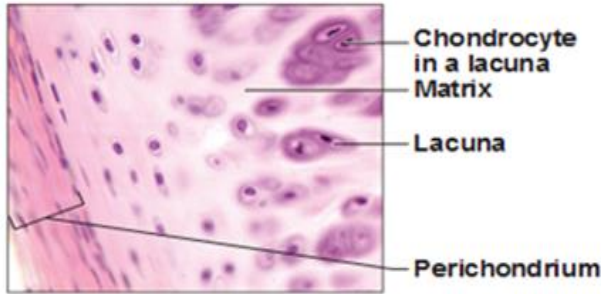
secreting chondrocytes. Therefore, new cartilage matrix is deposited from the outside in, which is known as Appositional Growth.



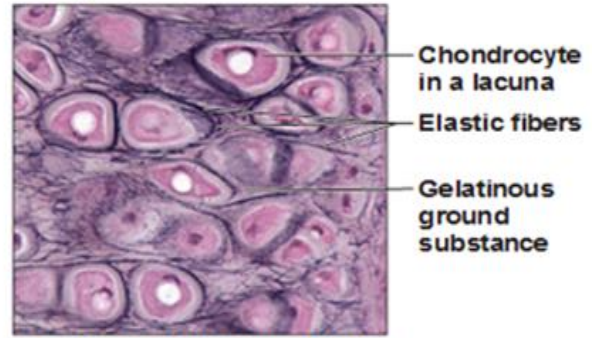
There are three different types of cartilage, each with different characteristics.

1. **Hyaline cartilage:** is the most common type and is found in areas such as the trachea, ribs, and nose. Hyaline cartilage is flexible, elastic, and surrounded by a dense membrane called perichondrium.
2. **Fibrocartilage:** is the strongest type of cartilage and composed of hyaline and dense collagen fibers. It is inflexible, tough, and located in areas such as between vertebrae, in some joints, and in heart valves. Fibrocartilage does not have perichondrium.
3. **Elastic cartilage:** contains elastic fibers and is the most flexible type of cartilage. It is found in locations such as the ear and larynx (voice box).

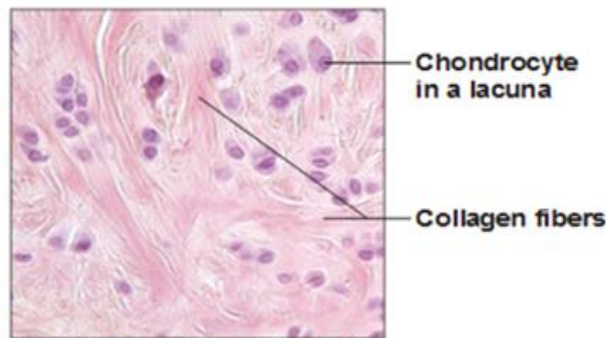
Cartilages in the Adult Body



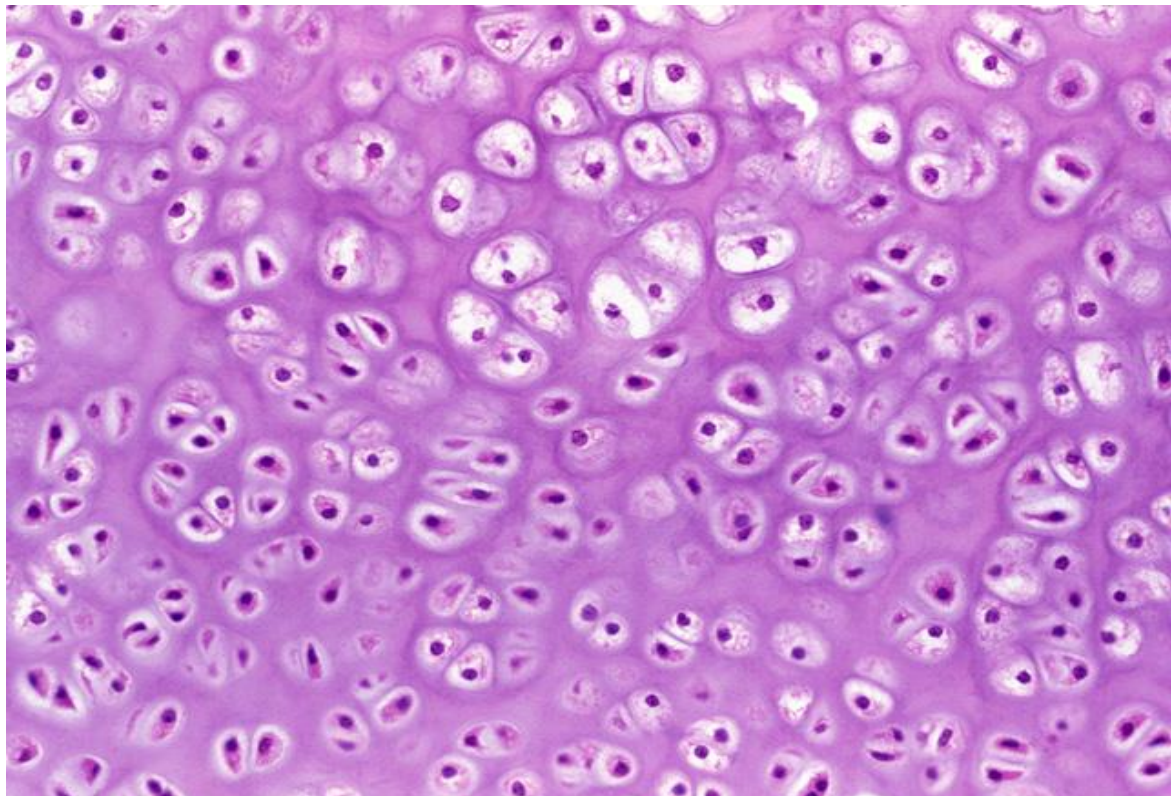
(a) Hyaline cartilage (180x)



(b) Elastic cartilage (470x)



(c) Fibrocartilage (285x)



Hyaline cartilage

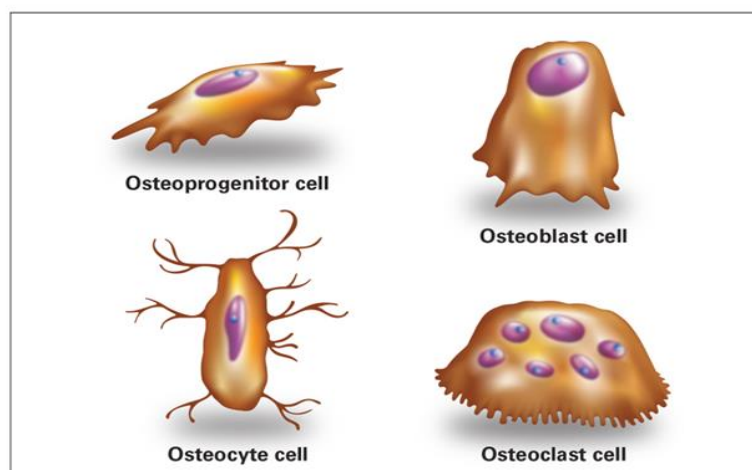
Lec 5: Specialized Connective Tissue: (Bone)

Is a type of mineralized connective tissue that composed of cells and predominantly collagenous extracellular matrix called (osteoid), which become mineralized by deposition of calcium and phosphates.

The bone tissue supports and protection of the vital organs such as those in the cranial and thoracic Cavities. Bone also serves as a reservoir of calcium, phosphate and other ions that can be released or stored in a controlled fashion to maintain constant concentrations of these important ions in body fluid.

Cells of the bone tissue:

- 1. Osteoblasts:** which synthesis osteoid and mediate its mineralization, found lined up along bone surface. They are located at the surface of bone tissue, side by side, in a way that resembles simple epithelium. Osteoblasts have cuboidal to columnar shape. Osteoblast have cytoplasmic processes that bring them into contact with neighboring osteoblasts.
- 2. Osteocytes:** which derive from osteoblasts, lie in the lacunae situated between lamellae. only one osteocyte is found in one lacunae.
- 3. Osteoclasts:** phagocyte cells which are multinucleated cells responsible of remodeling bone tissue. Osteoclasts are very large extensively branched cells.



Bone matrix:

1.organic components (osteoid): The organic components constitute about 50% of bone volume and 25% of bone weight. It is composed of type I collagen fibers and unmineralized ground substance, which is composed of proteins. Carbohydrates, and small amounts of proteoglycans and lipids.

2.The inorganic components (bone mineral): makes up about 50% of bone volume and 75% of bone weight. It is composed of calcium and phosphate, with some bicarbonate, citrate, magnesium and potassium and trace amounts of other metals.

Periosteum and endosteum:

Periosteum – covers the external surface of the bone

- ❖ outer layer: dense connective tissue; (collagen type I)
- ❖ inner layer: osteoprogenitor cells – spindle shaped – can change to active osteoblasts- growth and repair of the bone

Endosteum

- ❖ covers the internal surface of bone marrow cavity, surface of cancellous bone,
- ❖ Haversian canal
- ❖ thin layer of connective tissue and osteoprogenitor cell

Types of bone: There are two types of bone tissue: spongy and compact.

1. Compact bone or cortical bone: is strong, dense, and forms the hard outer bone surface. The compact bone is made up of parallel bony columns. Each column are made of concentric bony layers or lamellae disposed around a central channel containing blood, lymphatic vessels and nerves. These channels are known (Haversian canals).

- ❖ Lamellae: are concentric rings of a strong matrix, In each lamellae, collagen fibers are parallel to each other. Each lamella extended fine cytoplasmic extension consisting canaliculi.
- ❖ Lacunae: are the small space between the lamella in which the osteocytes found between and occasionally within the lamellae.
- ❖ Canaliculi: a minute channels that linked the lacuna together which provide routes for pass the nutrients and waste product for osteocytes.

The bulbous ends of each long bone, known as the Epiphyses (or singularly as an epiphysis), are made up of spongy, or cancellous, bone tissue covered by a thin layer of compact bone. The Diaphysis, or shaft, contains the medullary cavity and blood cell-producing marrow.

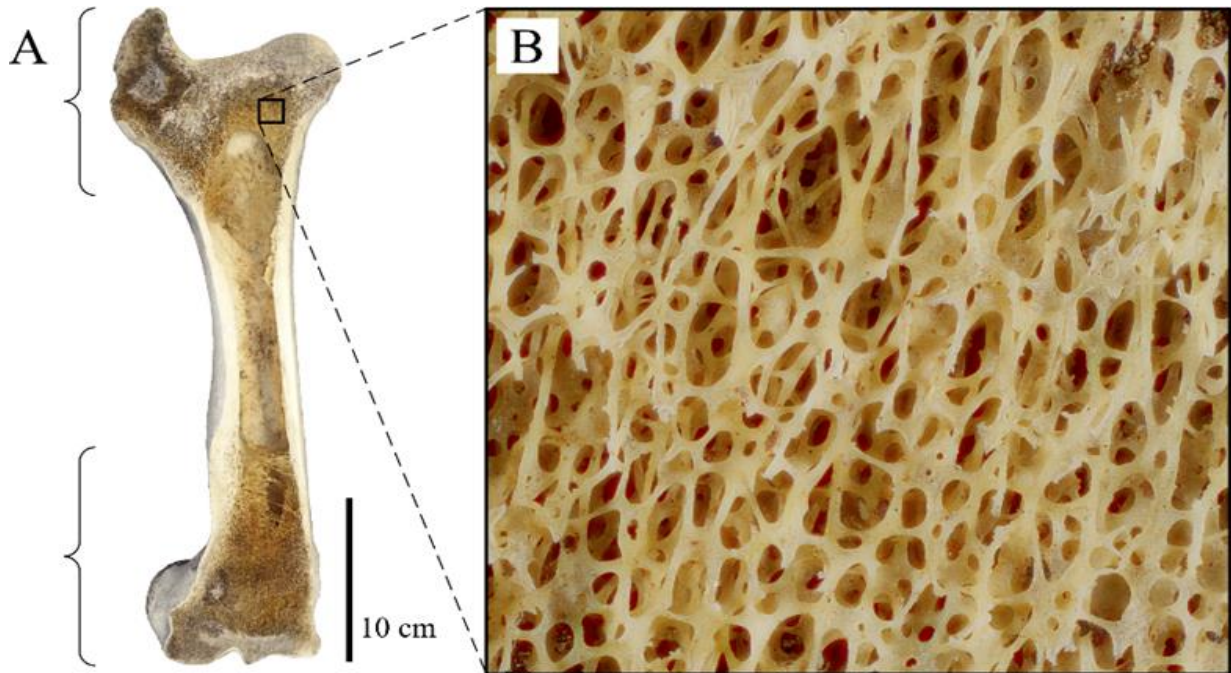


Compact Bone (100x)

2. Spongy bone also called cancellous bone: gets its name because of its spongy appearance. the spongy bone is composed of a network of bony trabeculae separated by interconnection space containing bone marrow. Trabeculae are thin and composed of irregular lamellae of bone with lacunae containing osteocytes. Spongy bone does not contain Haversian system, by the canaliculi osteocytes exchanges metabolic material via

the sinusoid in the bone marrow. The trabeculae lined by layer of endosteum which contain osteoprogenitor cells, osteoblasts, and osteoclasts.

Spongy bone is the first bone type formed during bone formation and is surrounded by compact bone, found at the end of long bones



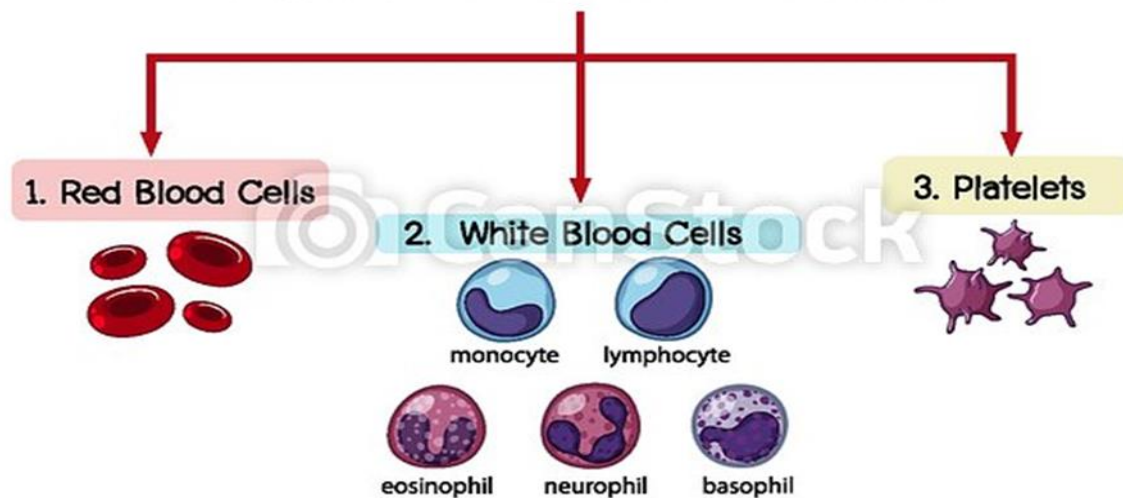
Lec 6: Specialized Connective Tissue: (Blood)

Blood is classified as a specialized form of connective tissue. All connective tissue consists of cells embedded in a matrix which consists of ground substance and fibers. Blood may thus be described as connective tissue whose matrix consists of free-flowing ground substance (plasma) with no fibers. The volume of blood in healthy adult human is about 5 liters.

The cellular element composed of

- Erythrocyte (Red blood cell)
- Leucocytes (White blood cell)
- Platelets or Thrombocytes

TYPES OF BLOOD CELLS



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Blood functions involved:

- Transport of oxygen, carbon dioxide and hormones.
- Maintenance of acid - base balance.
- Removal of waste products of cell metabolism
- Temperature control of the body
- Defence against infections.

1.Erythrocytes (RBCs): are continually produced in bone marrow and recycled in spleen,In the normal male the average number of (RBC) is about 5-6 million/cubic millimeter, in the female it is about 4.5-5 million /cubic millimeter

- ❖ The life span of RBC is 4moths.
- ❖ Mature RBCs are flexible and oval biconcave disk.
- ❖ They lack a cell nucleus and most organelles, in order to accommodate maximum space for hemoglobin.

Erythrocytes function involved:

1. Transport oxygen from the lungs to the tissues.
2. Transport carbon dioxide from the tissue to the lungs.

2.White blood cells (WBCs, also called leukocytes):

include several distinct cell types, neutrophils, eosinophil, basophils, lymphocytes and monocytes. Certain developmental and morphological similarities permit the first three these cells to grouped together as granulocytes. The latter two types are then categorized as a granulocytes or mononuclear leukocytes.

2.Leukocytes are colorless because they do not have hemoglobin however each cell has a nucleus. In the blood stream leukocyte are spherical in shape and capable of amoeboid movement

WBCs fight infection in two ways*

1. Some white blood cells are phagocytic and engulf pathogens.
2. Other white blood cells either produce antibodies, molecules that combine with foreign substances to inactivate them or they kill cells outright.

According to the type of cytoplasmic granules and the shape of nuclei Leukocyte are classified into:

- a. granular leukocytes.
- b. A granular leukocyte.

Granular leukocytes

They contain specific granular and lobulated nuclei. this type of leukocytes involved:

A. Neutrophils

- ❖ Compose 60 to 70% of the blood leukocytes.
- ❖ Nuclei have 3-5 lobes, which are connected together by thin strands of chromatin.
- ❖ Neutrophils take their name from the staining properties of their cytoplasmic lysosomal granules, these granules are neutrophilic, meaning they show no special affinity for either acidic or basic stains but are stained mildly by both.
- ❖ First line of cellular defence against microorganism, especially bacteria phagocyte small particles and microorganisms.

B. Eosinophils

- ❖ Compose 2 to 4% of the blood leukocytes.
- ❖ Eosinophils are identified in a blood smear by their cytoplasm, which is filled with distinct, large eosinophilic (bright pink) granular.
- ❖ Nucleus: is bi-lobed but a small third lobe may be present.
- ❖ The cytoplasm granules are stained red or pink with eosin or other similar dyes.
- ❖ The function of eosinophils remains unclear, although they are known to proliferate in association with allergies and parasites.

C. Basophils

- ❖ nuclei may be band shaped or segmented.
- ❖ The granules are basophil are not as numerous as in eosinophil; however, they are more variable in size, less densely packed, and stain dark blue or brown.
- ❖ These cell carry histamine, heparin and various mediators of inflammation and other protein.

Non Granular Leukocytes

They do not have specific granule with non-lobulated nuclei. this type can be sub divided into:

A. Monocytes

- ❖ Are the largest of the leukocytes, and constitute about 5-10 of the WBC population in peripheral blood.
- ❖ In blood smears, their nuclei have kidney or bean shape.
- ❖ Monocytes/macrophages engulf and digest foreign microorganisms, dead or worn-out cells and other tissue debris. They interact closely with lymphocytes to recognize and destroy foreign substances.

B. Lymphocytes

- ❖ Are small cells, and they are the second most common white blood cell type, comprising about 30% of the leukocyte population in peripheral blood.
- ❖ nucleus surrounded by a relatively thin rim of cytoplasm.
- ❖ Lymphocytes also emigrate from blood in response to inflammation, but they accumulate somewhat later during the inflammatory process than neutrophils. Their presence in large numbers indicates the continuing presence of antigen.

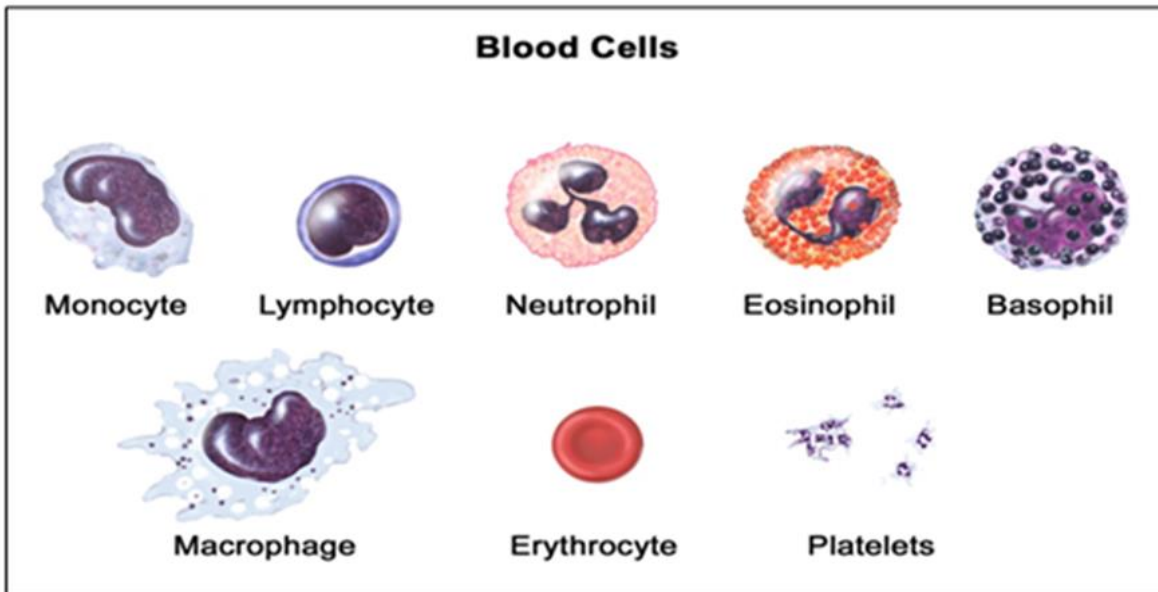
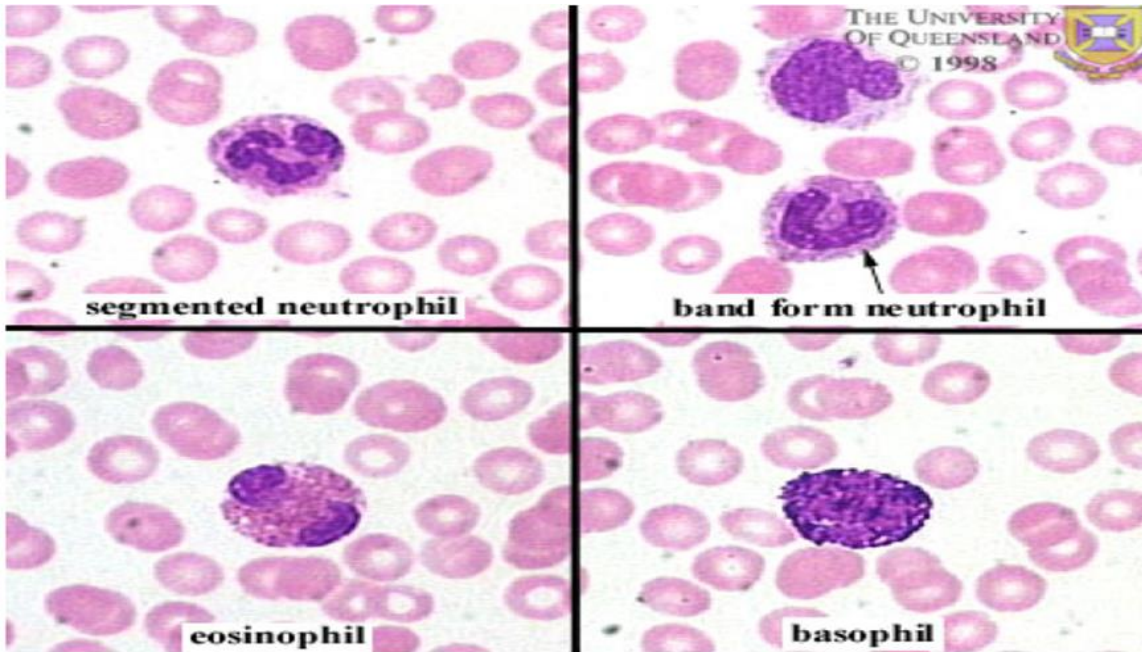
- ❖ Lymphocytes produce the antibody molecules (one specific type of antibody per lymphocyte) which provide the mechanism for chemical recognition of foreign materials.
- ❖ Lymphocytes are found densely packed in lymphoid tissue spleen, lymph nodes, and lymph nodules in mucous membranes (e.g. tonsils, appendix), where they proliferate.

3. Platelets or thrombocytes

- ❖ Platelets or thrombocytes are small fragments of cytoplasm measuring about 2-5 μm in diameter.
- ❖ Blood platelets do not contain nucleus; they are cytoplasmic fragments of very large thrombocyte (megakaryocytes) that are found in the bone marrow.
- ❖ Their number is 150,000-400,000/ mm^3 .
- ❖ They are rounded or oval, biconvex discs.
- ❖ The cytoplasm is divided into two zones: an outer hyalomere, and an inner granulomere, which contains bluish staining granules.
- ❖ The hyalomere contains cytoskeletal fibers, which include actin and myosin.
- ❖ Their cytoplasm is purple-staining, granular, organelles concentrated toward center; granules constitute about 20% volume.

Plasma is the extracellular matrix of blood with red blood cells white blood cells, and platelets suspended in the plasma.

1. water (90%)
2. Proteins (7%)
3. Organic salt (1%)
4. organic compound (2%) such as amino acids, lipid and vitamins.



Lec 7: Muscular tissues

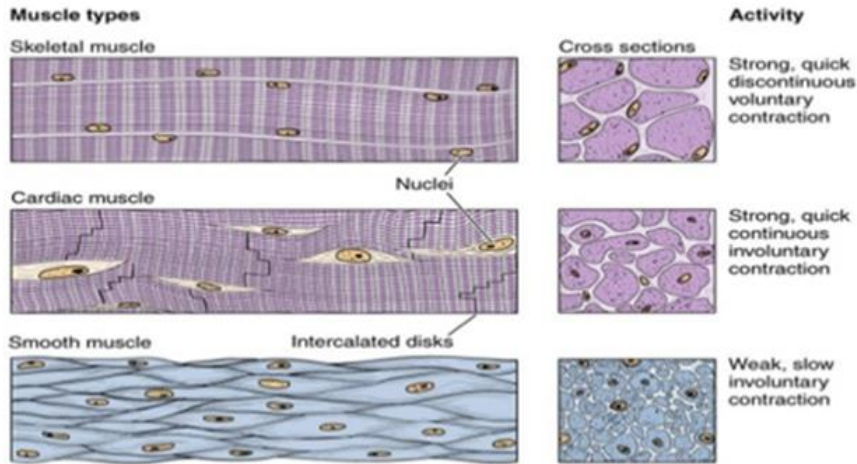
General characteristics of muscles:

1. The structural and functional units of muscles are formed of special elongated cells known as muscle fibers.
2. A muscle fiber is enclosed by plasma membrane called the sarcolemma.
3. The cytoplasm of these muscle fibers is known as sarcoplasm.
4. Within the sarcoplasm, the T-tubules allow transport of substances throughout the muscle fiber and sarcoplasmic reticulum stores calcium.
5. The structure and functional subunits are myofibrils which found in sarcoplasm.
6. Two types of myofilaments, thin (protein actin) and thick (protein myosin), associated with muscle contraction.
7. This tissue is responsible for:
 - a. Movement of the body and its parts.
 - b. Changes the size and shape of internal organs.
8. The fibers rest on the basement membrane.

There are three types of muscle tissue:

1. **Skeletal muscle**—Skeletal muscle tissue moves the body by pulling on bones of the skeleton.
2. **Cardiac muscle**—Cardiac muscle tissue pushes blood through the arteries and veins of the circulatory system.
3. **Smooth muscle**—Smooth muscle tissues push fluids and solids along the digestive tract and perform varied functions in other systems.

MUSCLE TISSUE



1. Skeletal muscle:

- ❖ It acquires its name because most of the muscles involved are attached to skeleton, and make it move.
- ❖ Also known as Striated muscle -because its cells (fiber) are composed of alternating light and dark band (stripe).
- ❖ Also known as voluntary muscle.

Structure:

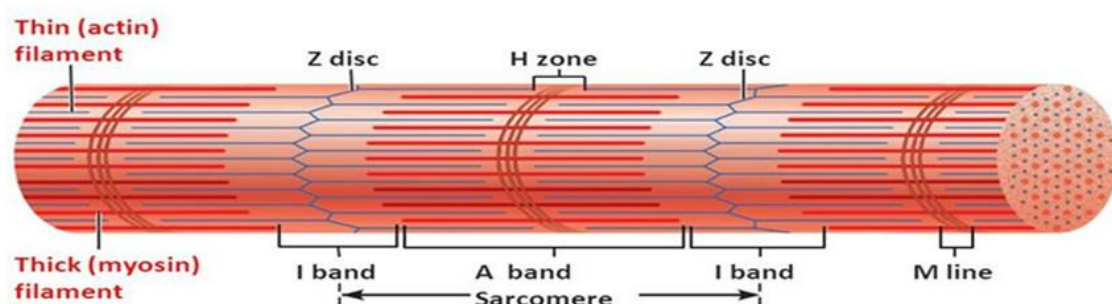
1. Composed of muscle fibers. Each muscle fiber is long, cylindrical shaped with multinucleate with peripheral location immediately beneath the sarcolemma.
2. Each fiber contains numerous myofibrils, which are made up of thick and thin threads.
3. found: attached to the bones and in some visceral organs.
4. voluntary contraction.
5. The fibers held together by sheaths (a. Endomysium b. Perimysium, Epimysium).

- Endomysium: is a delicate layer that immediately surround the individual fibers.
- Perimysium: is a thick layer of connective tissue, surround group of fibers that form fascicle.
- Epimysium: is the sheath of dense connective tissue that surround a collection of fascicle.

Structure of skeletal fibers

- Under light microscope the skeletal muscle showed light bands (I- band) and dark bands (A-band).
 - each I-band is bisected by transverse line called Z-line
 - The area between two Z line is known as sarcomere, which is the fundamental contractile unit of myofibril.
 - The A-band has a lighter zone in center called (H-zone) which bisected by M -line.
- ❖ light I band = (isotropic band); allow light to pass.
 - ❖ dark A band = (anisotropic band); doesn't allow light to pass.

Figure 9.2c Microscopic anatomy of a skeletal muscle fiber.

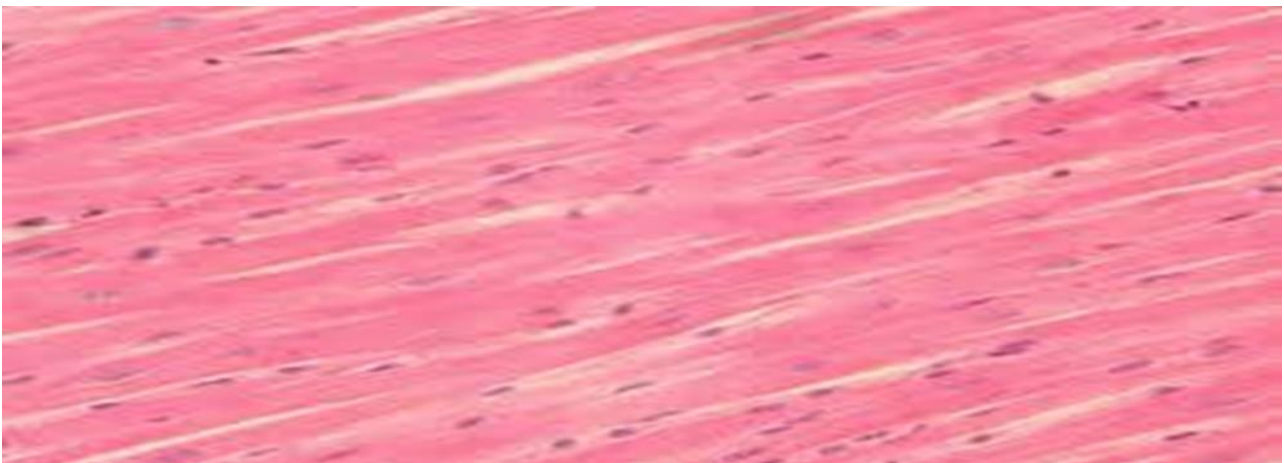


(c) Small part of one **myofibril enlarged to show the myofilaments** responsible for the banding pattern. Each **sarcomere** extends from one Z disc to the next.

2. Smooth muscle: It get its name because it is not striated, and appear smooth under microscope.

Structure

1. Muscle fiber: is long (but not nearly as long as skeletal muscle fiber, spindle shaped and slender. Contain only one nucleus, situated at the center of the fiber at the broadest part.
2. Smooth muscle fiber is enclosed by sarcolemma, and contain numerous longitudinal myofibrils.
3. Actin and myosin myofilaments within myofibrils are very thin and are arranged more randomly than in skeletal muscle, so there is no stripes.
4. found: in vessels and visceral organs as bundles or sheets.
5. involuntary muscle.
6. Endomysium Sheath is present.
7. The cross striation is none.

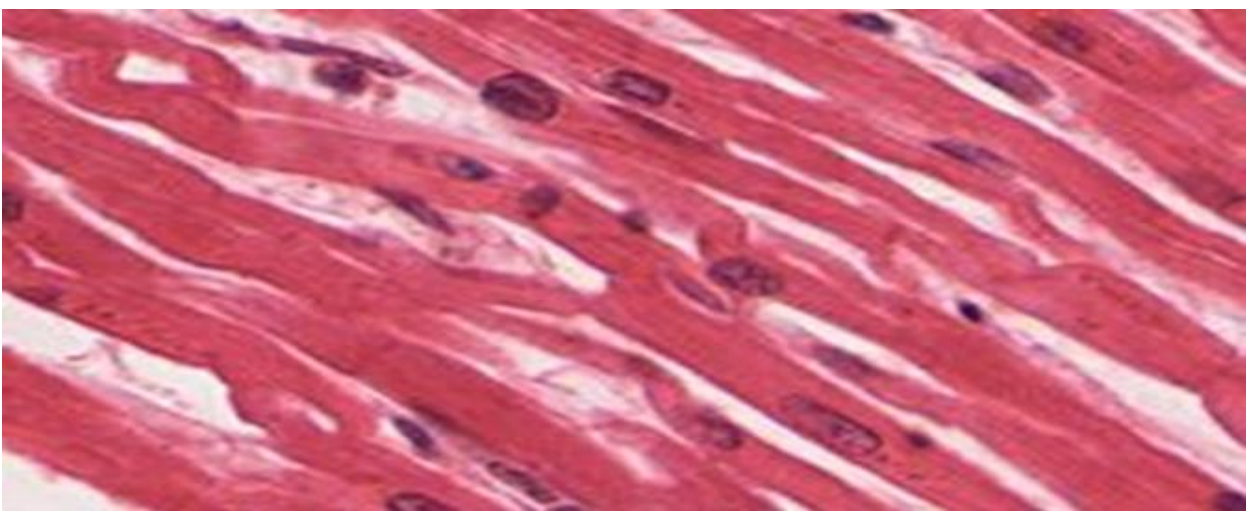


3. Cardiac muscle:

It is present only in heart

Structure

1. Under microscope, they have similar striation as skeletal muscle
2. Cardiac muscle cells are closely packed but each cell is nucleated and separated from each other
3. The cells are joined end to end by the specialized cell junctions called (intercalated disks) that attach one cell to another with desmosomes, connect the myofibril filaments of adjacent cells and contain gap junctions that help to synchronise the contraction of cardiac muscle, by allowing impulse transmission from one cell to another.
4. They contain light I and dark A band, the intercalated disk always occurs at the location of Z-line
5. Purkinje fibers: are specialized and modified cardiac muscle fibers which found in the heart. cardiac muscle has spontaneous rhythmic contraction.
6. Involuntary muscle.



Cardiac muscles

Comparison of Structure and Properties of Muscle Tissue Types

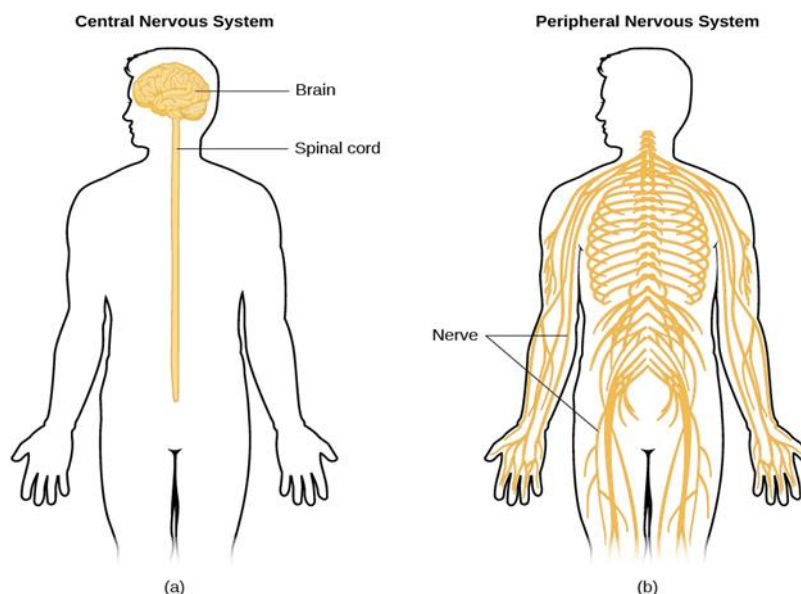
Skeletal muscle fibers	Smooth muscle fibers
The muscle fibers are long cylindrical in shape	The muscle fibers are spindle in shape
Multinucleated cells with spherical nuclei.	Mono-nucleated with central location.
Striated muscles	Non-striated muscles
Voluntary muscles	Involuntary muscles
Conjunction with skeletal bone	Lining of visceral hollow organs and blood vessels

Cardiac muscle fiber	Skeletal muscle fibers
Located in the walls and septa of the heart	Conjunction with skeletal bone
Shorter and branched	Longer and unbranched
Striated muscles	Striated muscles
Contain intercalated discs	Un contain intercalated discs
Contain one or two central nuclei	Contain multinucleated cells with peripheral nuclei
Involuntary muscles	Voluntary muscles

Lec 8: Nervous tissue:

Nervous tissue is the term for groups of organized cells in the nervous system, which is the organ system that controls the body's movements, sends and carries signals to and from the different parts of the body, and has a role in controlling bodily functions such as digestion. Is one of four major classes of tissues. It is specialized tissue found in the central nervous system and the peripheral nervous system. It consists of neurons and supporting cells called neuroglia.

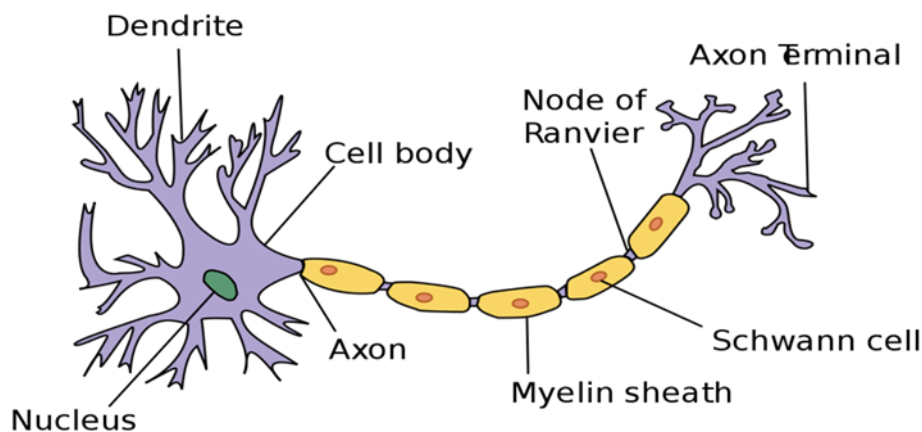
1. **Central nervous system (CNS):** Composed of the brain and spinal cord. Its major functions are to integrate sensory information, and to initiate and coordinate efferent responses.
2. **Peripheral nervous system (PNS):** Composed of all nervous tissue outside the CNS. The PNS is represent by cranial nerves from the brain, spinal nerves from the spinal cord, and nodules known as ganglia, that contain the neural cell bodies.



Neurons (Nerves cell)

Neurons are highly specialized nerve cells that generate and conduct nerve impulses.

A typical neuron consists of dendrites, the cell body, and an axon.



1.Dendrites

- ❖ Numerous short -branched structures emerging from the soma are called Dendrites they are often covered with small, branched projections known as dendritic spines.
- ❖ The function of dendrites are receptor of a neuron that receive electrical signals from other neurons.
- ❖ The function of dendritic spines involved to increase the surface area of the dendrite vastly, thus helping in receiving impulses from other axon.

2. Cell body (perikaryon)

- ❖ Cell body- central unit of neuron.
- ❖ The nucleus is central, large, single.
- ❖ The cytoplasm has granules called (Nissl bodies) which are distributed in the cytoplasm of the cell body except in the region close to the axon called axon hillock.
- ❖ Mitochondria, Golgi complex, lysosomes and other cell organelles are present.

3. Axon

- ❖ Process (a single nerve fiber) that takes impulses away from the cell body. Neurons have at least 1 axon.
- ❖ The cytoplasm of the axon is termed axoplasm.
- ❖ The plasma membrane bounding the axon is called axolemma.
- ❖ The axon is covered with a white fatty layer known as the myelin sheath, this sheath serves two major functions protecting and insulating the axon and accelerating the electrical signals during transmission.
- ❖ The myelin sheath layer has a cellular covering known as the neurilemma or the Schwann cell sheath. this sheath is essential for regeneration of nerves. It is present only in the peripheral nervous system. in the central nervous system, neurilemma is absent, thus nerves here are incapable of regeneration
- ❖ The medullary sheath is not continuous layer on the axon; it has joints or node – type interruptions known as the nodes of Ranvier

Myelin sheath: lipid-rich, segmented covering on an axon. The presence of myelin speeds up the transmission of action potentials along the axon.

Node of Ranvier: a gap in the myelin sheath of a nerve, between adjacent Schwann cells.

Classifications of neuron:

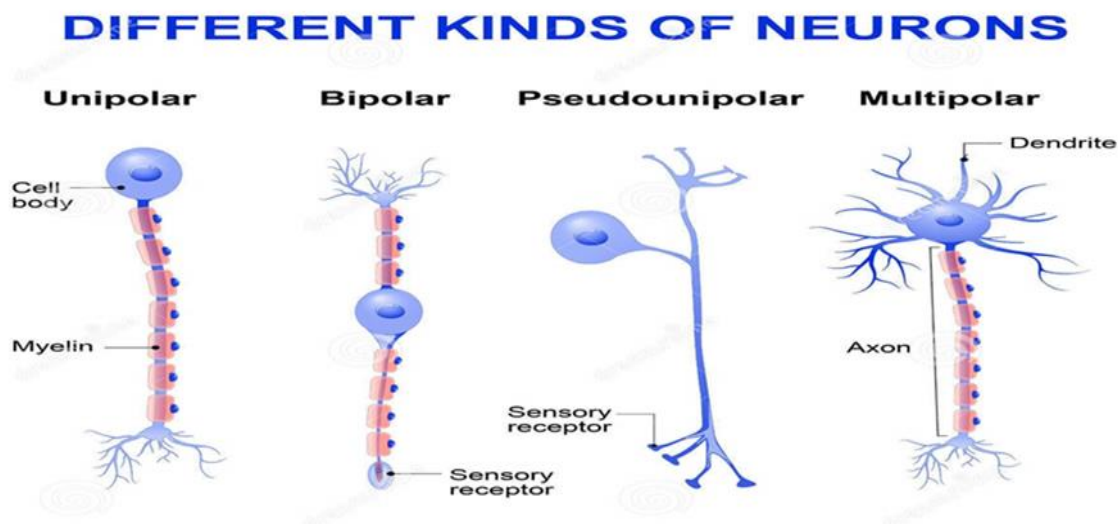
A. according to the number of processes

1. Unipolar neurons – are found during early embryogenesis. They have one axon
2. Pseudounipolar neuron

has one extension from its cell body. This type of neuron contains an axon that has split into two branches.

3. Bipolar neurons

The nerve cell body has spindle shape and has two processes from the two poles, a short dendrite and a long axon.



B. according the functions

1. Motor (Efferent) neurons

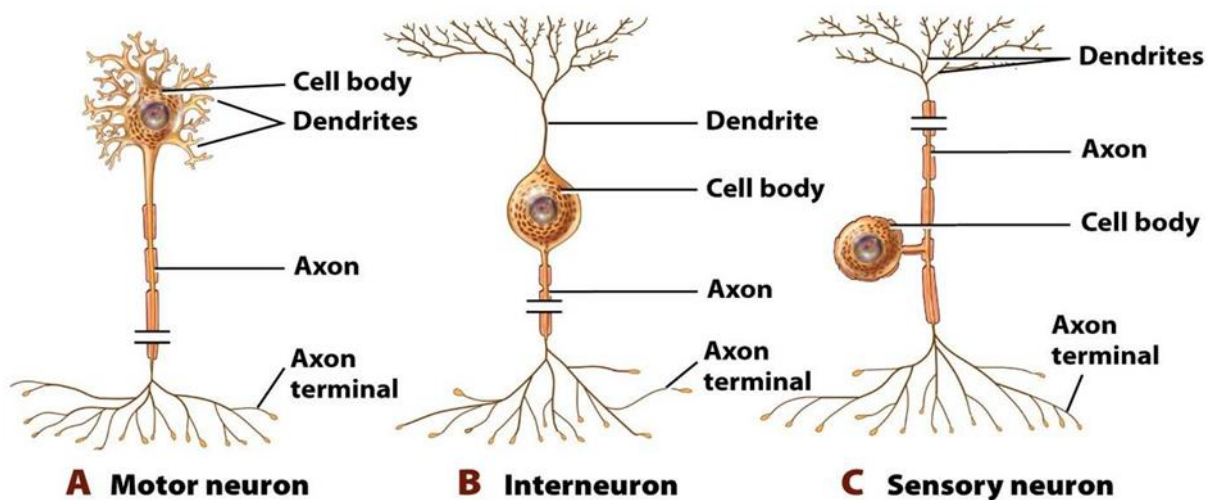
- ❖ This type carries motor impulses from central nervous system (CNS) to peripheral end organ.
- ❖ The site of this type is a motor nucleus in anterior horn cell of spinal cord.

2. Sensory (Afferent) neurons

- ❖ This type receives impulses from peripheral sensory cells and organ and then carry them toward CNS.
- ❖ The site of this type is sensory spinal ganglia.

3. Interneurons

This type have short neurons that connect a sensory and motor neuron, The site of this type is spinal cord in reflex arc .



Neuroglia

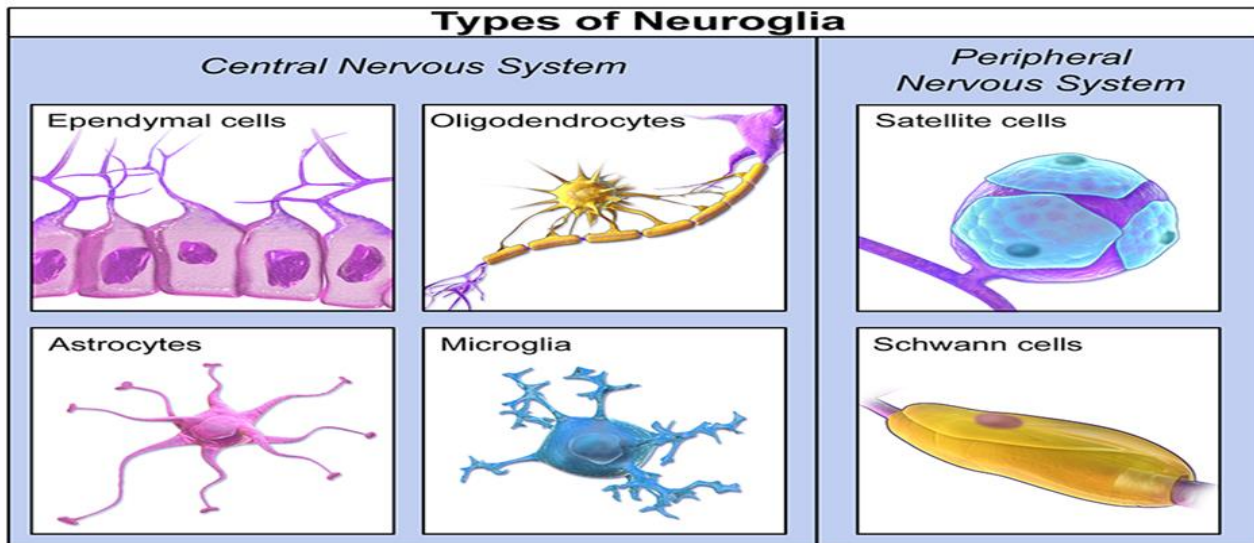
- ❖ Neuroglia or glial cells are protective and support structure of the nervous tissue.
- ❖ They are found in bunches surrounding the neurons and have the ability to regenerate in case of injury.
- ❖ They are located in both peripheral and central nervous system.

Neuroglia of peripheral nervous system (PNS) include:

1. **Schwann cells** - form myelin sheath in the peripheral nervous system
2. **Satellite cells** - surround cell bodies of neurons in sensory ganglia

Neuroglia of central nervous system (CNS)

1. **Astrocytes:** Star-shaped cells have central spherical nucleus and long branched processes, much of their processes have extended ends line every surface where central nervous tissue contacts other body tissues. The main functions of astrocytes are structural support, repair processes, blood brain barrier, and metabolic exchanges
2. **Oligodendroglia:** smaller and have short and less processes than astrocytes, their main function is myelin production in the central nervous system.
3. **Microglia:** small elongated cells with elongated nuclei, their processes are numerous and small so these cells have spiny shape, they comprising about 10% of the total brain cells, they have macrophage activity.
4. **Ependymal cells.** Low columnar epithelial cells line the central canal of the spinal cord and brain ventricles, these cells may be ciliated, also the cerebrospinal fluid (CSF is actively secreted by the ependymal cells).



Nerve fibres:

composed of the axons which are surrounded by sheaths, groups of nerve fibers comprising parts of the brain and the spinal cord, and also comprising the peripheral nerves. The fibers are surrounded by either one fold or many folds of sheath cell (this sheath is called Schwann cell in the peripheral nerve fibers, or neurilemmal sheath in the nerve fibers of the central nervous system, the latter is formed by oligodendrocytes) Nerve fibers that surrounded by thin sheath (composed of one fold) called unmyelinated nerve fibers, while nerve fibers with thick sheath (composed of many fold) are called myelinated nerve fibers. In myelinated fibers the cell membrane of Schwann cell wraps around the axon, the folds of the cell membrane form a myelin sheath, so this sheath composed of lipoprotein, the myelin of one Schwann cell wraps about one or two millimeters of an axon.

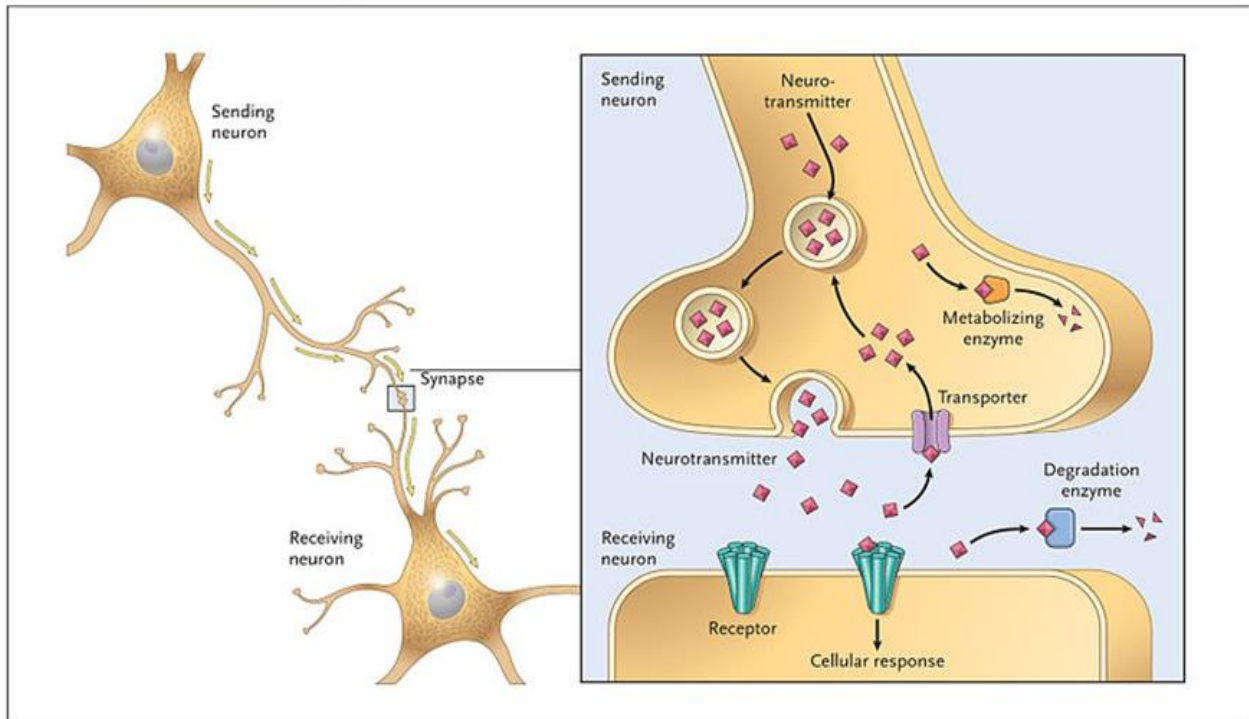
Synapse: Any two neurons are connected together at the site called synapse. Information from one neuron flows to another neuron across a synapse. according to the site, synapse is classified into;

1. Axo-dendritic between axon and dendrite.
2. Axo-somatic between axon cell body (soma)
3. Axo-axonic between axon and another axon.

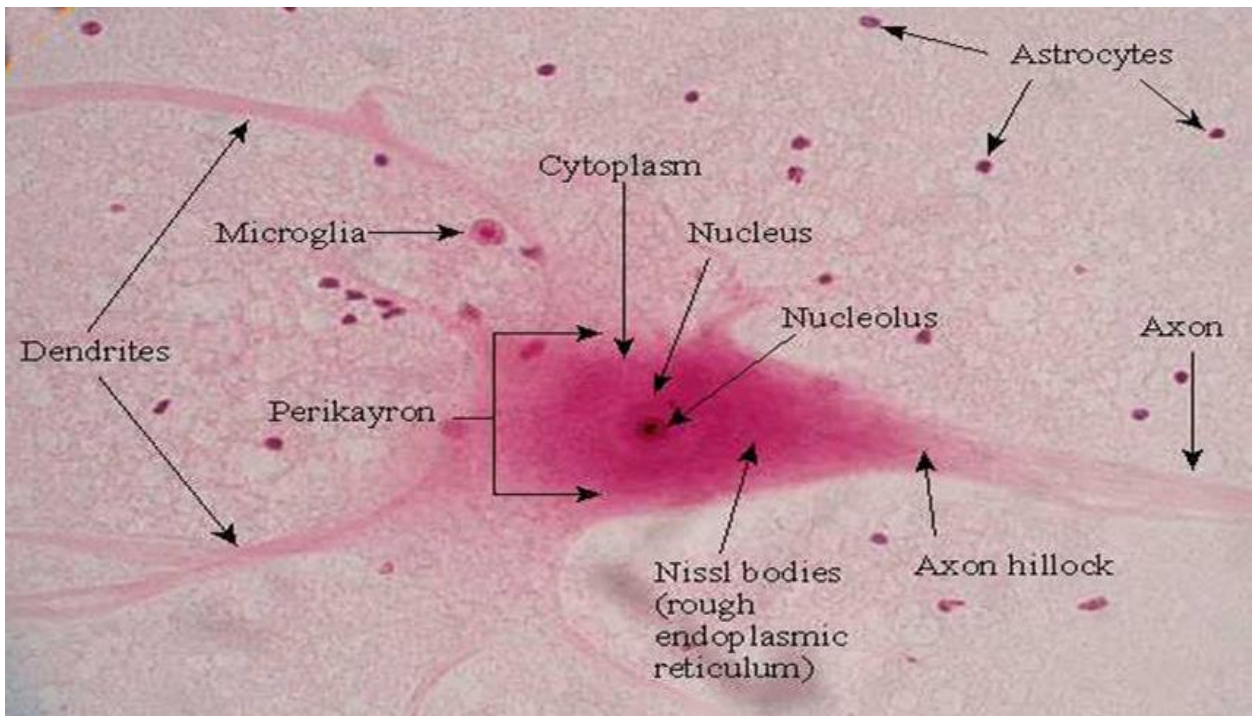
Synapses have 4 main functions

- a. They transmit information between neurons.
- b. They filter out low frequency impulses.
- c. They act as valves to ensure that impulses pass across them in one direction only
- d. they also act as junctions allowing impulses to be divided up along many neuron or merge into one.

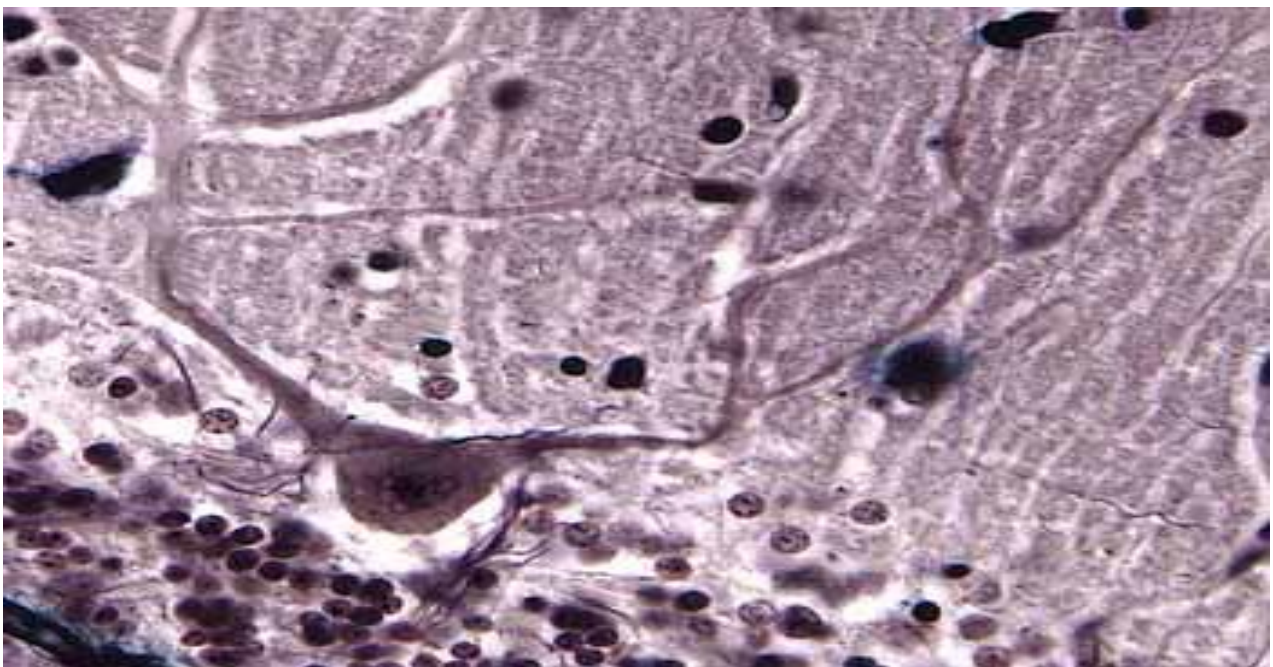
Generic Neurotransmitter System



Synapse



Neuron under microscope



Neuron and Support Cell