Lec 1: Cell structure & Types

Histology is a branch of microscopic anatomy and deals only with the microscopic structure of tissues. Different tissues combine to form and organ and organs are the units of organs systems.

Cells

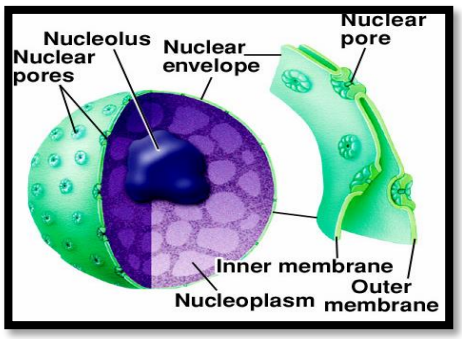
Cells are the tiny living units that form the tissues, organs and structures within the body. In turn, the body is composed of different types and varieties of cells to carry out specific functions, but they all have the same basic structure. All cells contain cytoplasm and are surrounded by a membrane, and contain the following structures of organelles:

1. Cell membrane

- Limiting membrane of eukaryotic cells selective barrier that regulates the passage of material into and out of the cell.
- Recognition and regulatory functions
- Plays an important role in the way the cell interacts with its environment

Molecular structure: Lipids, proteins, saccharides, ions.

2. Nucleus: The nucleus, on the other hand, is considered the largest organelle within a cell. It contains the genetic material in the form of deoxyribonucleic acid (DNA), along with the enzymes necessary for DNA replication and RNA transcription.



3.Nucleolus: Is the structure within the nucleus and help in synthesis of ribosomes. Surround by nuclear membrane .

Nuclear envelope

1. Composed of 2 membranes, between is perinuclear space (cisterna) - to the inner membrane are attached the fibrous laminae composed of polypeptides called lamins (ø 80-300 nm)
2. membranes fuse together and form nuclear pores covered by diaphragm

Structure of diaphragm: 8 peripheral globular proteins molecules + 1 central globular protein

Function: Passage of macromolecules, mRNA, proteins from the cytoplasm, ions-active transport Outer membrane of nuclear envelope is covered by ribosomes, perinuclear cisterna is continuous with lumen of rough endoplasmic reticulum

4. Centrosome: Small body located near the nucleus, its has a dense center and radiating tubules, centrosome play role in cell division.

5. Mitochondria: Spherical or oval organelles in diameter 0,5x10 μm visualized by iron hematoxylin

Function: Transforming of chemical energy into energy easily accessible to the cell (ATP), production and storage of energy.

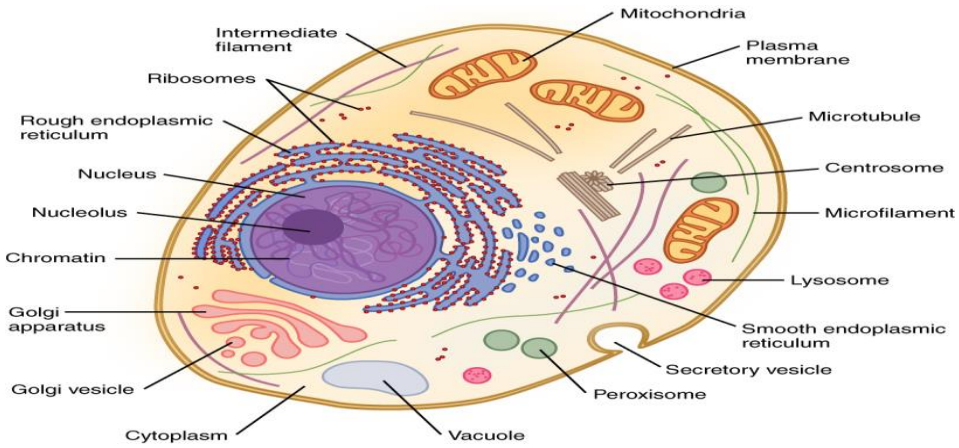
6. Golgi body :(folded membranes that process proteins from the endoplasmic reticulum) .

- Flattened vesicles in stacks which receive protein from ER.
- Form secretory vesicles to transport proteins to different parts of the cell (vacuole, lysosome, etc) or for secretion.
- *cis* face - "receiving" side of Golgi apparatus.
- *trans* face - "shipping" side of Golgi apparatus.

7. Lysosomes: (contain digestive enzymes)

8. Endoplasmic Reticulum : an extensive membranous network continuous with the outer nuclear membrane.

Rough ER - has ribosomes and is involved in secreted protein synthesis
Smooth ER - lacks ribosomes and is involved in membrane lipid synthesis.



cell components

Tissues

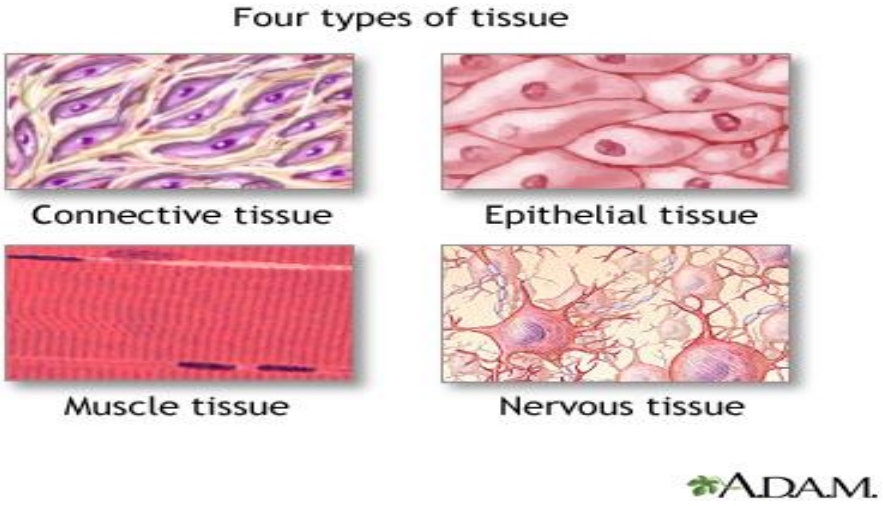
Body tissues : are collections of cells, grouped in the body according to structure and function. In histology, human tissues are separated into four distinct categories:

Muscular: Muscle tissue is made up of long thin muscle cells called myocytes. Their structure and arrangement allows for muscular contraction.

Nervous: Nervous tissue forms the nervous system, and is made up of specialized cells called neurons and neuroglial cells. Neurons conduct nerve signals from one to another in the form of electrical impulses.

Epithelial: Epithelial tissue comprises epithelial cells arranged together in sheets. These sheets serve as protective layers, forming coverings like the skin, and the lining of the small intestine.

Connective: Connective tissue forms a connective web throughout the body. It fills gaps and connects different organs and body parts, so that the carefully arranged structure of the body can be maintained.



body tissues

Lec2: Epithelium (epithelial tissues)

Epithelium tissue: forms continuous layers of cells that cover surfaces and line cavities of the body.

- Covers the outside of the body and lines organs, vessels (blood and lymph), and cavities. Epithelial cells form the thin layer of cells known as the **endothelium,** which is continuous with the inner tissue lining of organs such as the brain, lungs, skin, and heart. The free surface of epithelial tissue is usually exposed to fluid or the air, while the bottom surface is attached to a basement membrane.

- The cells in epithelial tissue are very closely packed together and joined with little space between them. With its tightly packed structure, we would expect epithelial tissue to serve some type of barrier and protective function and that is certainly the case. For example, the skin is composed of a layer of epithelial tissue (epidermis) that is supported by a layer of connective tissue. It protects the internal structures of the body from damage and dehydration.

- Epithelial tissue also helps to protect against microorganisms. The skin is the body's first line of defense against bacteria, viruses, and other microbes.

- Epithelial tissue functions to absorb, secrete, and excrete substances. In the intestines, this tissue absorbs nutrients during digestion. Epithelial tissue in glands secrete hormones, enzymes, and other substances. Epithelial tissue in the kidneys excrete wastes, and in the sweat glands excrete perspiration.

- Epithelial tissue also has a sensory function as it contains sensory nerves in areas such as the skin, tongue, nose, and ears.

- Ciliated epithelial tissue can be found in areas such as the female reproductive tract and the respiratory tract. Cilia are hair-like protrusions that help propel substances, such as dust particles or female gametes, in the proper direction.

Classifying Epithelial Tissue:

Based on:

1) type of cell in which the tissue is made of
2) shape
3) number of layers of cells

1. 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.

2. Glandular epithelium: surrounds glands within the body.

Covering and lining epithelium: they can be classified according to the number of the cell layers into:

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 .

- **Simple epithelial tissues**: they can be classified according to the shape of the constituent cell:

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.

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 off different heights. all cells are in contact with the basement membrane.

b. Stratified epithelial tissues :

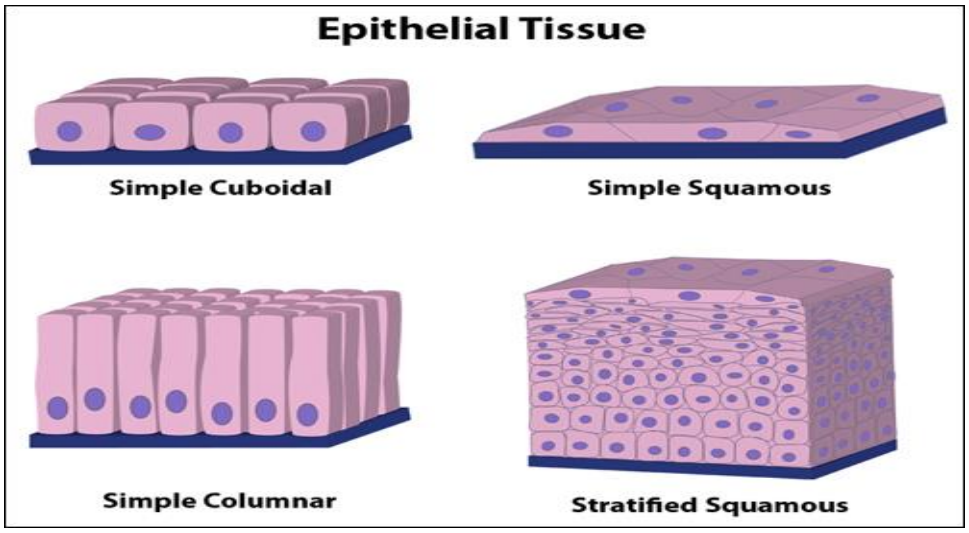
1. Stratified squamous : has multiple layers of cells, the basal cells are cuboidal or columnar are metabolically active , the surface layer are flattened (**squamous**) there are two type

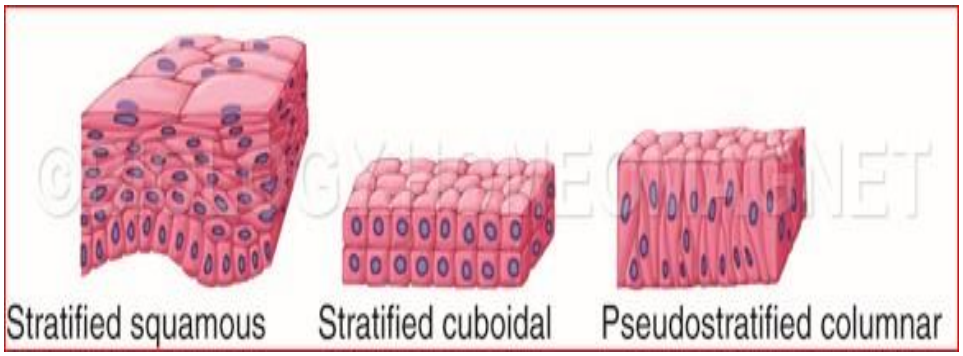
- **nonkeratinized** (e.g. lining of esophagus)
- **keratinized** (e.g. skin) .

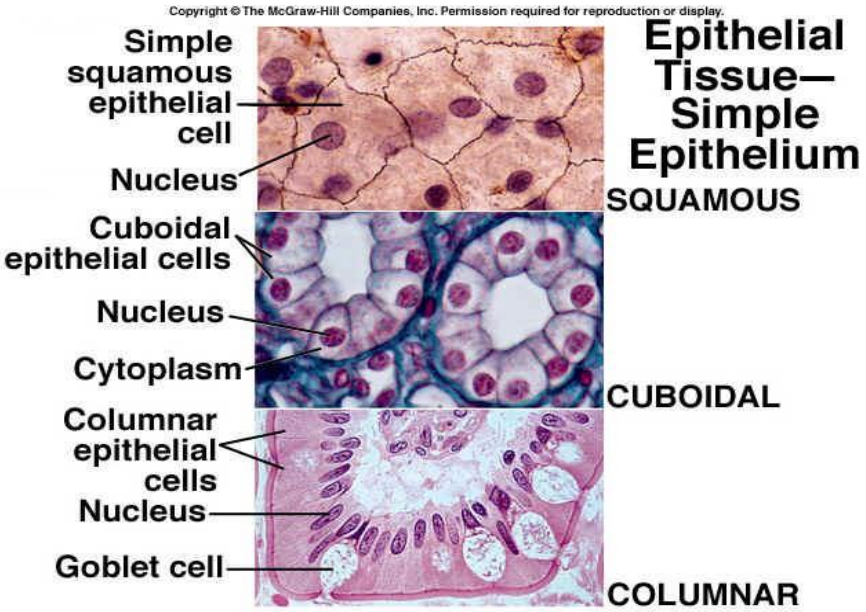
2.Stratified cuboidal: usually has two or three layers of cuboidal cells. This type of epithelium is largely confined to the lining of large ducts (sweat gland).

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 consist of large Rounded cells (dome-like) This type of tissue changes in response to tension . found in urinary bladder.


Epithelial Tissue
Simple Cuboidal
Simple Squamous
Simple Columnar
Stratified Squamous


Stratified squamous
Stratified cuboidal
Pseudostratified columnar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Simple squamous epithelial cell
Nucleus
Epithelial Tissue— Simple Epithelium
SQUAMOUS
Cuboidal epithelial cells
Nucleus
Cytoplasm
CUBOIDAL
Columnar epithelial cells
Nucleus
Goblet cell
COLUMNAR

2.Glandular epithelium: Consist of one or more cells that produce and secrete a specific product. there are two types of glands:

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) .

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

1. **Unicellular glands:** consisting of only one glandular epithelium cell e.g. goblet cell of digestive system.
2. **Multicellular glands**: multiple cell make up one gland; e.g salivary glands

Glands are divided according to type 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

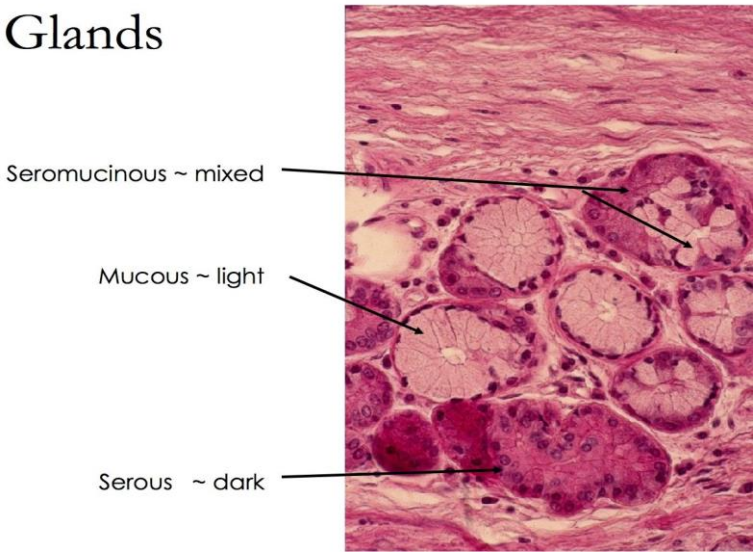
C.have pressed flattened nucleus in the basal limit of the cell

D.have poorly stained cytoplasm

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

F.palatine gland

3. Mixed or seromucous glands : a gland in which some secretory cells are serous and some mucous (salivary glands)



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.

Structure of Connective Tissue

Connective tissue has three main components:

1.Ground substance
2.Fibers
3.Cells

Ground Substance

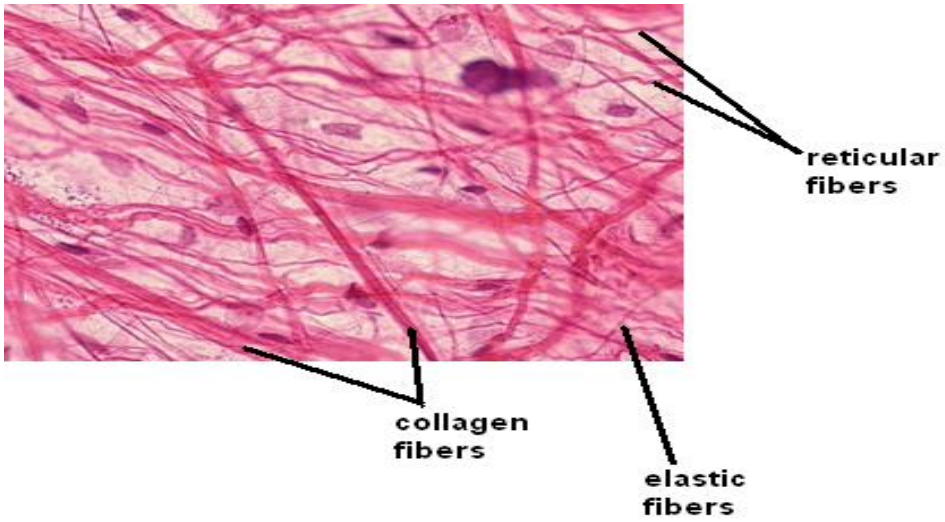
1.Ground substance: is a gel like substance and containing:

- water, salts
- Is found between the different types of cells and fibers.
- 3 kinds of molecules containing carbohydrates:
- glycosaminoglycan or GAG
- proteoglycans and glycoproteins

2. Connective Tissue Fibers

There are three main types of connective tissue fibers:

Type	Characters	Component	Location
1.White collagen fibers	• 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.



Connective Tissue Fibers

3. Cells of connectives tissues

A. Free cells
B. Fixed cells

A. Free cells

1. They are a changing population of motile cells that enter the connective tissue from the blood and wander through its ground substance.

2. Most of these are short lived .

3.They include free: (macrophage**, plasma cells, mast cell, pigment cells)**

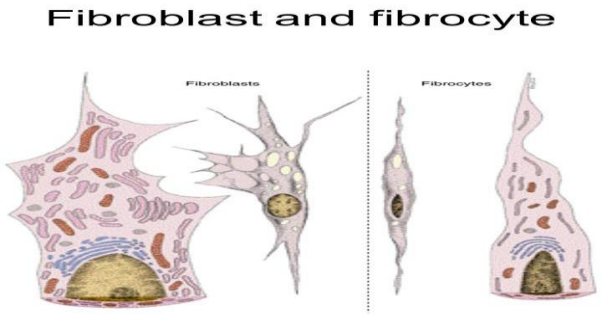
B. fixed cells

1. They are relatively stable population of long lived cells.

2. They include **:(fibroblast, adipose cells, pericytes , reticular cell).**

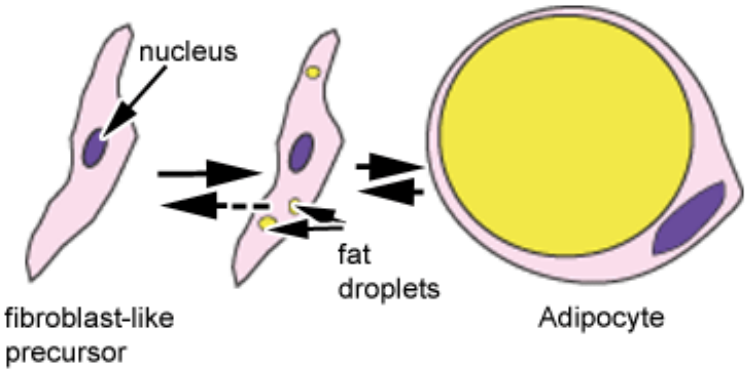
Fibroblast

- Is elongated cell with cytoplasmic projections, an ovoid nucleus and one or two nucleoli.
- Produce fibers and ground substance that form matrix of the tissue.
- The fibrocyte is a more mature, smaller spindle- shape cell cytoplasmic projections, the nucleus is similar but smaller than that in fibroblast.
- found in periodontal ligament.



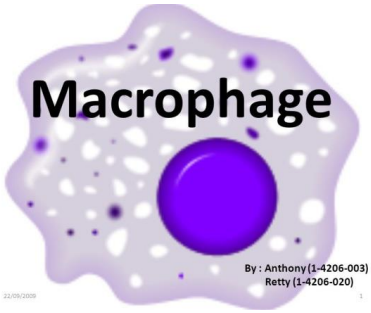
Adipocytes (Fat cells)

- These cells exhibit a narrow rim of cytoplasm and a flattened , eccentric nuclei.
- Store fat (lipid).
- They may occur singly but are more often found as clusters within loose connective tissue.



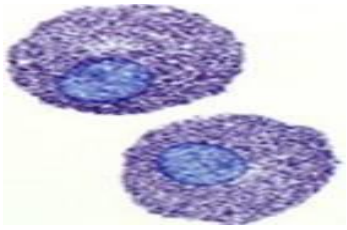
Macrophage

- Have irregular surface with an eccentrically located, oval or kidney shaped nucleus.
- Most numerous in loose connective tissue.
- Monocytes differentiate into macrophages within tissues
- Macrophages are avidly phagocytic cells that engulf and digest microbes, cellular debris and foreign substances.
- found in liver, bone.



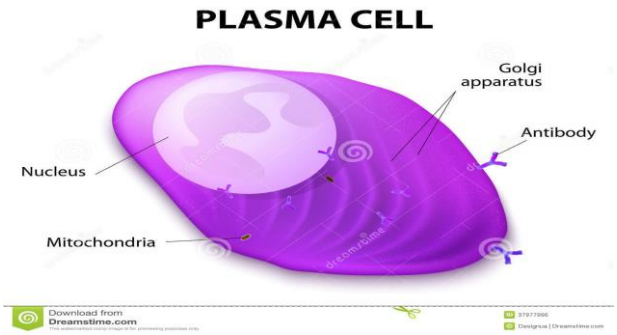
Mast Cell

- 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.

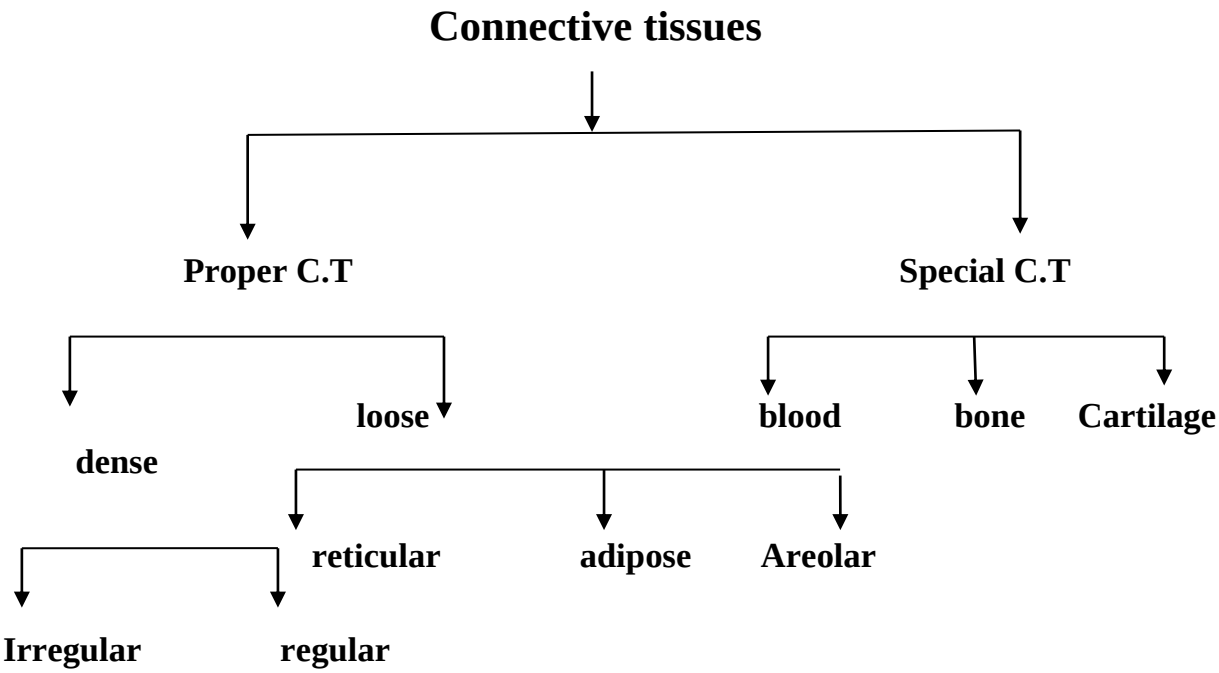


Plasma cells

- Characterized by chromatin distributed in radial pattern.
- The large, ovoid cells with spherical nuclei .
- Produce large quantities antibodies against specific antigens.
- Found in the wall of intestine and in inflamed tissue.



Types of connective tissues



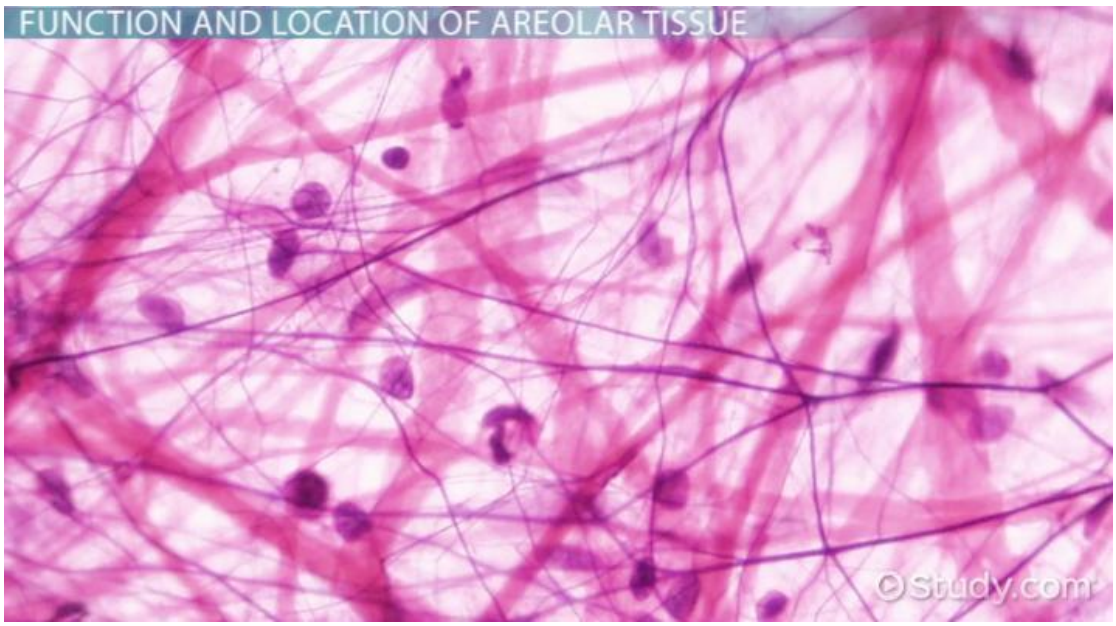
Loose connective tissue

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.

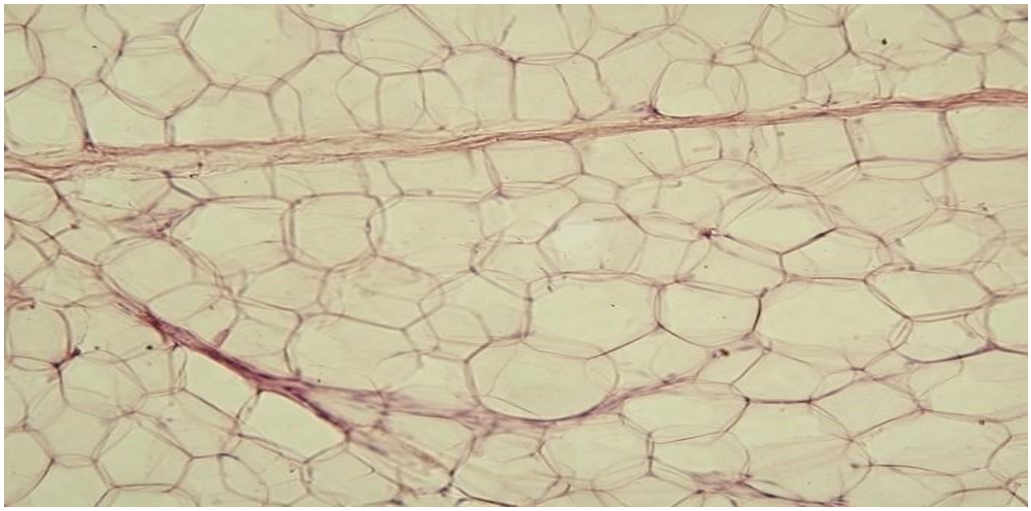
1. Areolar Connective Tissue

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.

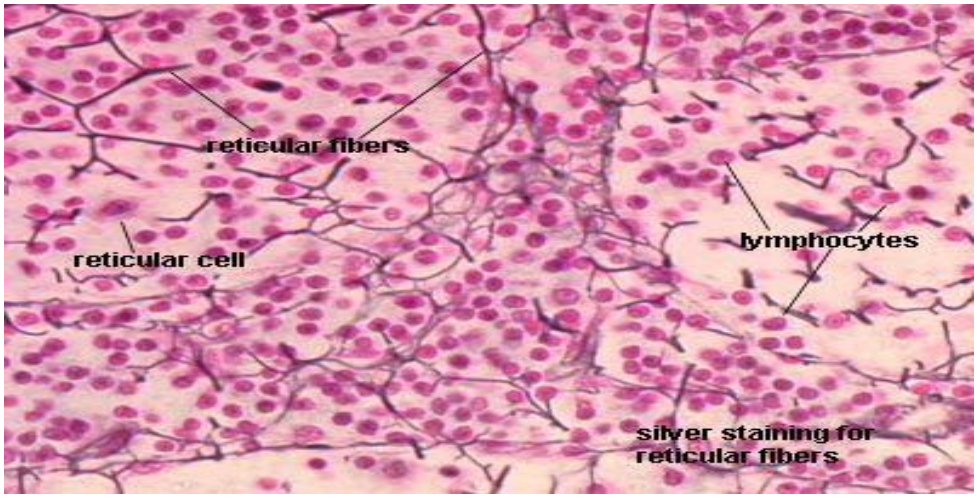
Is a loosely arranged connective tissue that is widely distributed in the body such as in gastrointestinal tract, blood vessels and ducts of glands. The areolar tissue contains collagen fibers, reticular fibers and a few elastic fibers embedded in a thin and almost fluid-like ground substance.



2.Adipose Tissue: this type of tissue differs from other connective tissues in two respects it contains more of fat cells and not the intercellular substances and secondly, each fat cell is surrounded by its own basal lamina**.**

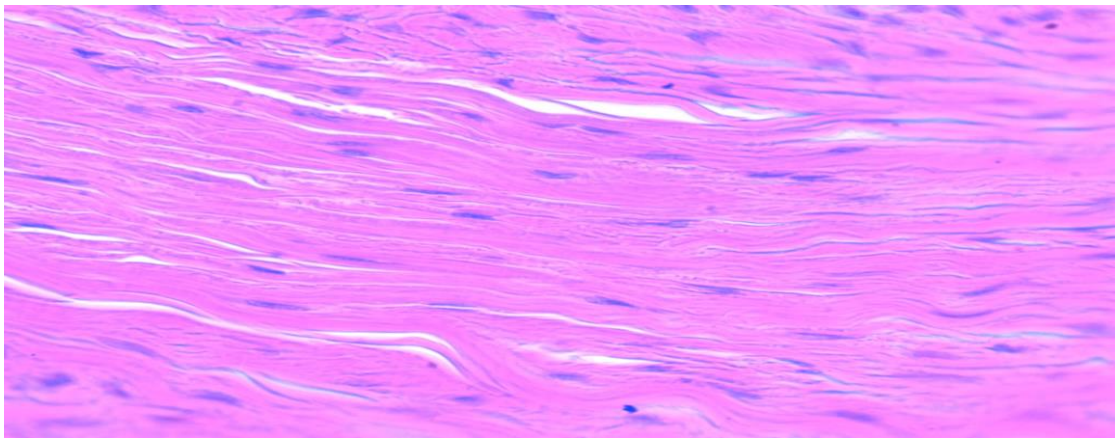


3.Reticular Connective Tissue: The reticular connective tissue is predominantly made up of reticular fibers and characterized by a cellular framework as seen in lymphatic tissues and bone marrow.



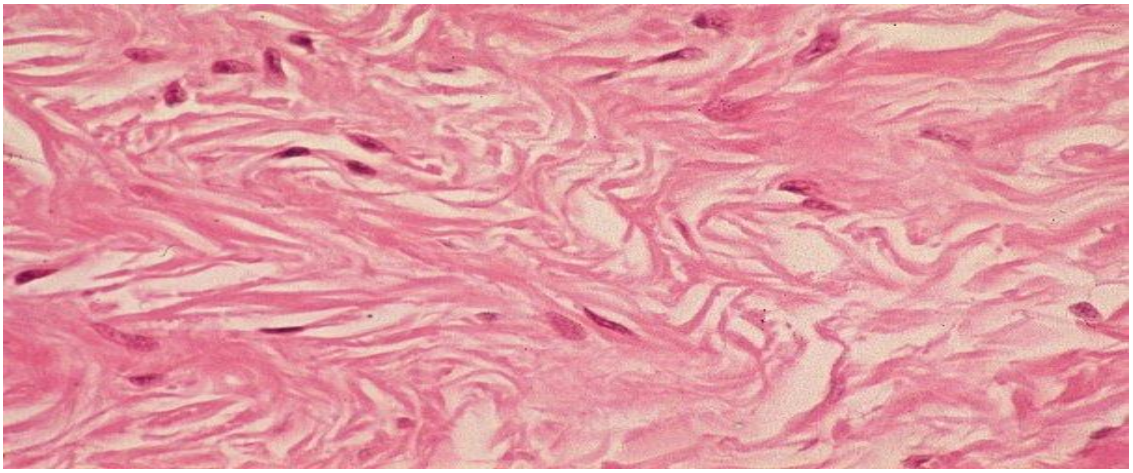
Dense connective tissue: This type of tissue is characterized by an abundance of fibers with fewer cells, as compared to the loose connective tissue**.**

a. 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.



Dense connective tissue (regular)

b.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.



Lec 4: Specialized Connective Tissue: (Cartilage)

Is a form of fibrous connective tissue that is composed of closely packed collagenous fibers in a rubbery gelatinous substance called chondrin.

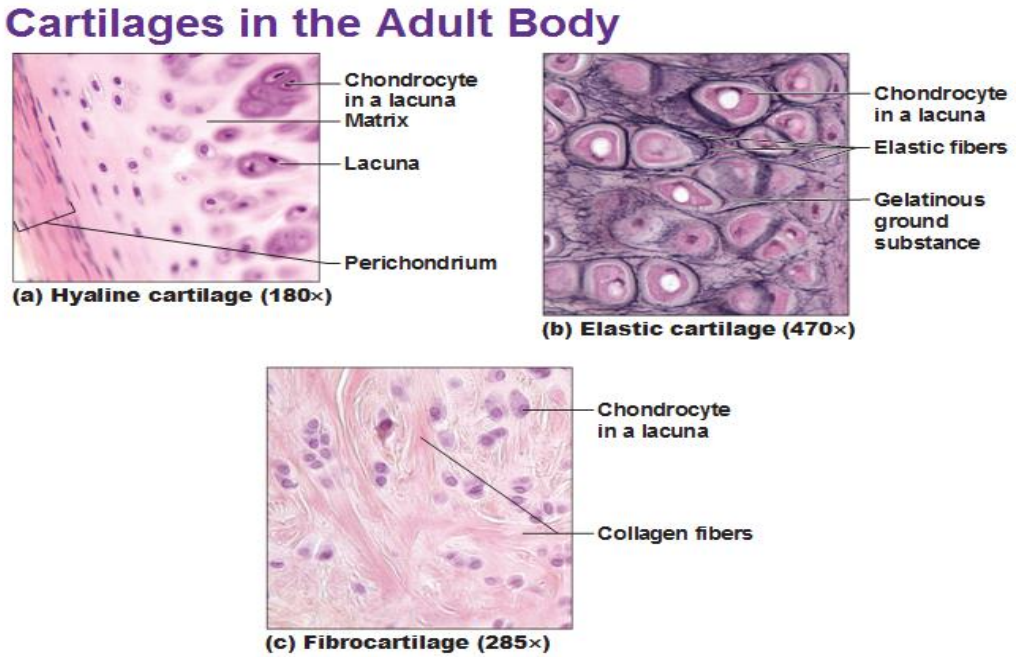
The skeletons of sharks and human embryos are composed of cartilage. Cartilage also provides flexible support for certain structures in adult humans including the nose, trachea, and ears.

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).



Specialized Connective Tissue: (Bone)

Is a type of mineralized connective tissue that contains collagen and calcium phosphate, a mineral crystal Calcium phosphate gives bone its firmness. There are three types of cells:

Osteoblasts : are responsible for the synthesis of the organic components bone matrix , consisting of type I collagen fibers and osteonectin .

Osteocytes: Individual osteoblasts are gradually surrounded by their own secretion and become osteocytes enclosed singly within spaces called lacunae .

Osteoclasts : which are multi-nucleated giant cells involved in the resorption and remodeling of bone tissue.

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

Spongy bone also called **cancellous** bone: gets its name because of its spongy appearance. The large spaces, or vascular cavities, in this type of bone tissue contain blood vessels and bone marrow. Spongy bone is the first bone type formed during bone formation and is surrounded by compact bone, found at the end of long bones.

Compact bone or **cortical** bone: is strong, dense, and forms the hard outer bone surface. Small canals within the tissue allow for the passage of blood vessels and nerves**(Haversian canal).**

Lamellae : are concentric rings of a strong matrix
Lacunae : are the small space between the lamella in which the osteocytes
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.** A membrane called the **periosteum** covers the outer bone to provide nutrients and oxygen, remove waste, and connect with ligaments and tendons.

Compact Bone, Dried: An Osteon (transverse section). High magnification.

Compact Bone (100x)

Ossification of Bone:

Ossification: is the process of the synthesis of bone from cartilage. There are two types of ossification- intramembranous and endochondral ossification.

1. Intramembranous ossification:

Most flat bones are produced by this types of ossification it takes place within condensations of embryonic mesenchymal tissue such as the frontal and parietal bones of the skull, temporal bones and the mandible and maxilla.

2.Endochondral Ossification

In **endochondral ossification**, bone develops by replacing hyaline cartilage. Cartilage does not become bone. Instead, cartilage serves as a template to be completely replaced by new bone. Endochondral ossification takes much longer than intramembranous ossification. Bones at the base of the skull and long bones form via endochondral ossification. This type of ossification is responsible for the formation of short and long bones.

Zone of reserve cells: A thin layer (3 – 6 cells wide) of small, randomly oriented chondrocytes adjacent to the bony trabeculae on the articular side of the growth plate.

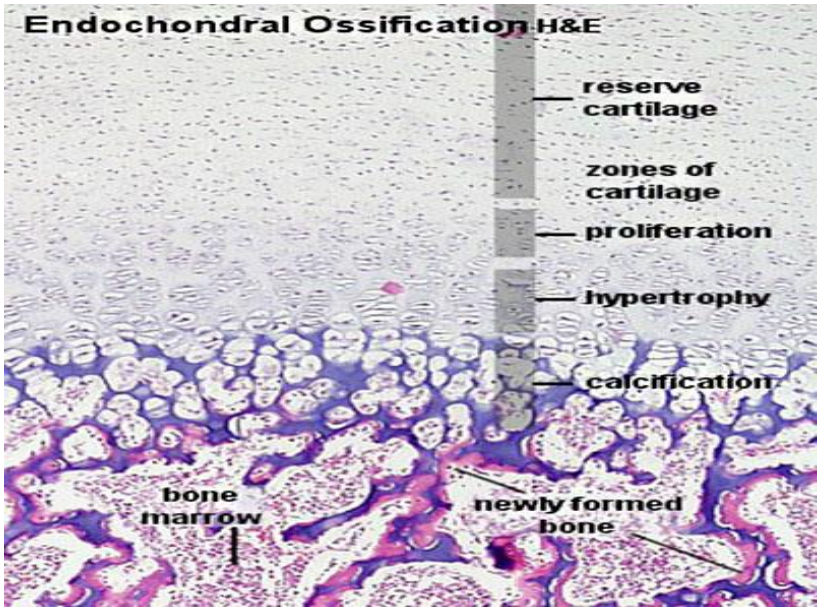
Zone of prolifrration : Chrondrocytes are stacked in prominent rows and the cartilage matrix becomes more basophilic in this zone. Mitotc figures are present and the axis of the mitotic figure usually is perpendicular to that of the row of chondrocytes.

Zone of hypertrophy : Chrondrocytes and their lacunae increase in size

Zone of calcification : Deposition of minerals in the matrix surrounding the enlarged lacunae causing cell death.

Zone of ossification : Osteoblasts deposal bone matrix on the exposed plates of calcified cartilage.

Zone of resorption : Osteoclasts absorb the oldest ends of the bone spicules.



Lec 5 : Specialized connective tissues : (Blood)

Blood: is considered to be a type of connective tissue. Like other connective tissue types, blood is derived from mesoderm, the middle germ layer of developing embryos.

- The blood is composed of elements or cells suspended in a fluid matrix called plasma. the volume of blood in healthy adult human is about 5 liters.

The cellular element composed of

a. Erythrocyte **(Red blood cell**)

b. Leucocytes **(White blood cell)**

c. Platelets or **Thrombocytes.**

Blood functions involved:

1. Transport of oxygen, carbon dioxide and hormones.

2. Maintenance of acid - base balance.

3. Removal of waste products of cell metabolism

4. Temperature control of the body

5. Defense against infections.

***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.

1. Leukocytes (WBC):

- 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**

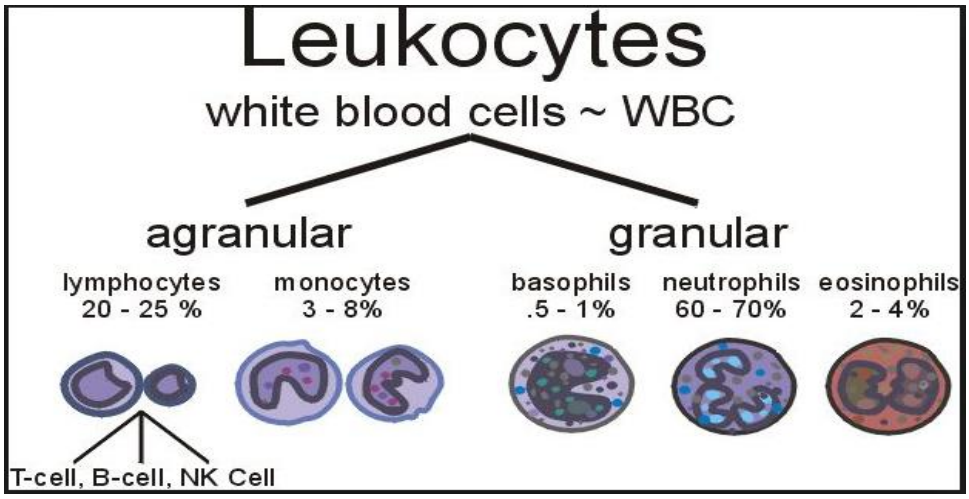
1. Some white blood cells are phagocytic and engulf pathogens.

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 leukocytes.



a. granular leukocytes

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

1. Neutrophils

❖ Compose 60 to 70% of the blood leukocytes.

❖ Nuclei have 3-5 lobes, which are connected together by thin strands of chromatin.

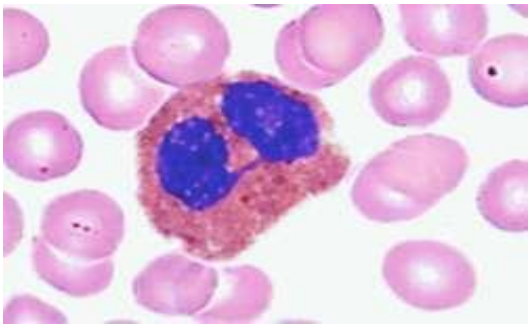
Bar body: is a drumstick chromosome or condensed chromatin visible in neutrophils contain all the organelles that make up a typical cell

The neutrophil cytoplasm contains fine violet or pink granules that are difficult to see with a light microscope. as result, the cytoplasm appears clear or neutral.

- First line of cellular defense against microorganism, especially bacteria phagocyte small particles and microorganisms.

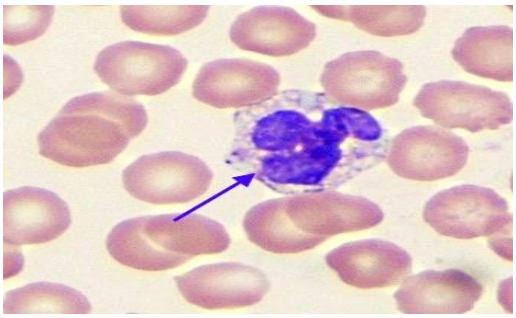
2. Eosinophils

- Compose 2 to 4% of the blood leukocytes.
- Eosinophils are identified in a blood smear by their cytoplasm, which is filled with distinct, large esoinophilic (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.
- Recognize and phagocytosis antigen-antibody complexes, and particle that are associated with these complexes that are found during an immune response.



3. Basophils

- The nucleus is bi-lobed which hidden by the large cytoplasmic granules.
- The granules is 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 chemicals.



b. Non Granular Leukocytes

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

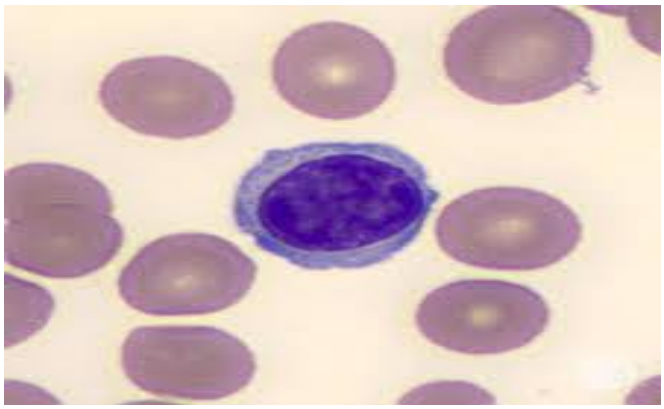
1.Lymphocytes

- Lymphocytes represent 20 to 40 % of the differential white cell count
- There are two structure types:

a. Small lymphocytes: ~5µm in diameter, and represent 3% of lymphocytes in peripheral blood. Most small lymphocytes in the blood stream belong to either the group or B- lymphocytes (~5%)

Or the group of T- lymphocytes (~90%).

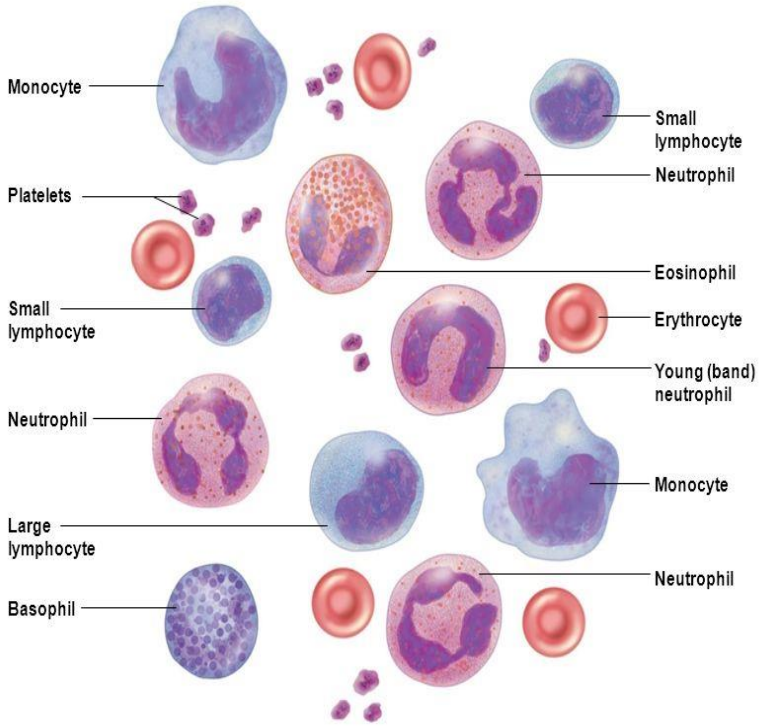
b. Large lymphocytes : 9 to 15µm in diameter, possibly natural killer cells; possibly dividing lymphocytes the cell is rounded with densely stained nucleus, short microvilli ;small amount of pale basophilic cytoplasm with free ribosomes more numerous on B lymphocytes than T lymphocytes, Only blood lymphocyte capable of division outside of bone marrow.



2. Monocytes

- Monocytes are large cells, 12-18µm in diameter; represent 2 to 10% of the differential white cell count.
- Monocytes are highly motile and phagocytic cells; i.e. they are the precursor of tissue phagocytes that migrate into tissues; engulf and destroy tissue debris & foreign material.
- Their nucleus less dense than lymphocytes; deeply indented, C-shaped or kidney shaped.
- Their cytoplasm is pale grayish blue with small pink to purple stained lysosomal granules, and contain cytoplasmic vacuoles (frosted glass).
- Monocytes contain granules (visible in the EM) which are similar to the primary granules of neutrophils, i.e. Lysosomes containing acid phosphatase, aryl granules.
- They contain also secondary granules of unknown function.

Fig. 18.1



1

3. Erythrocytes (RBCs):

- 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 .

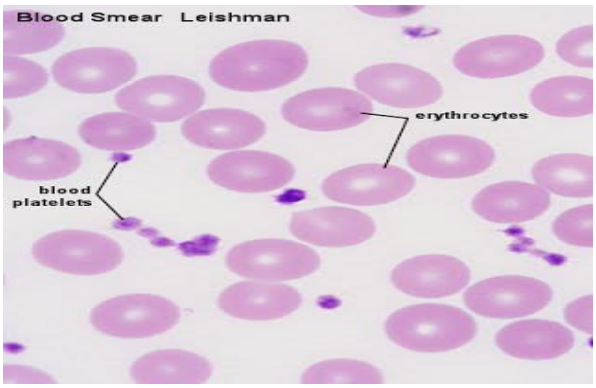
Erythrocytes function involved:

1. Transport oxygen from the lungs to the tissues.

2. Transport carbon dioxide from the tissue to the lungs.

3. Blood 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/mm3.
- 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.



Lec 6: Bone marrow:

- Bone marrow compose 5% of the total body weight .
- It is responsible for the formation of blood cells (hemopoiesis) and store fat.
- There are two type of bone marrow based on their appearance at gross examination :

1. Red bone marrow

2.Yellow bone marrow.

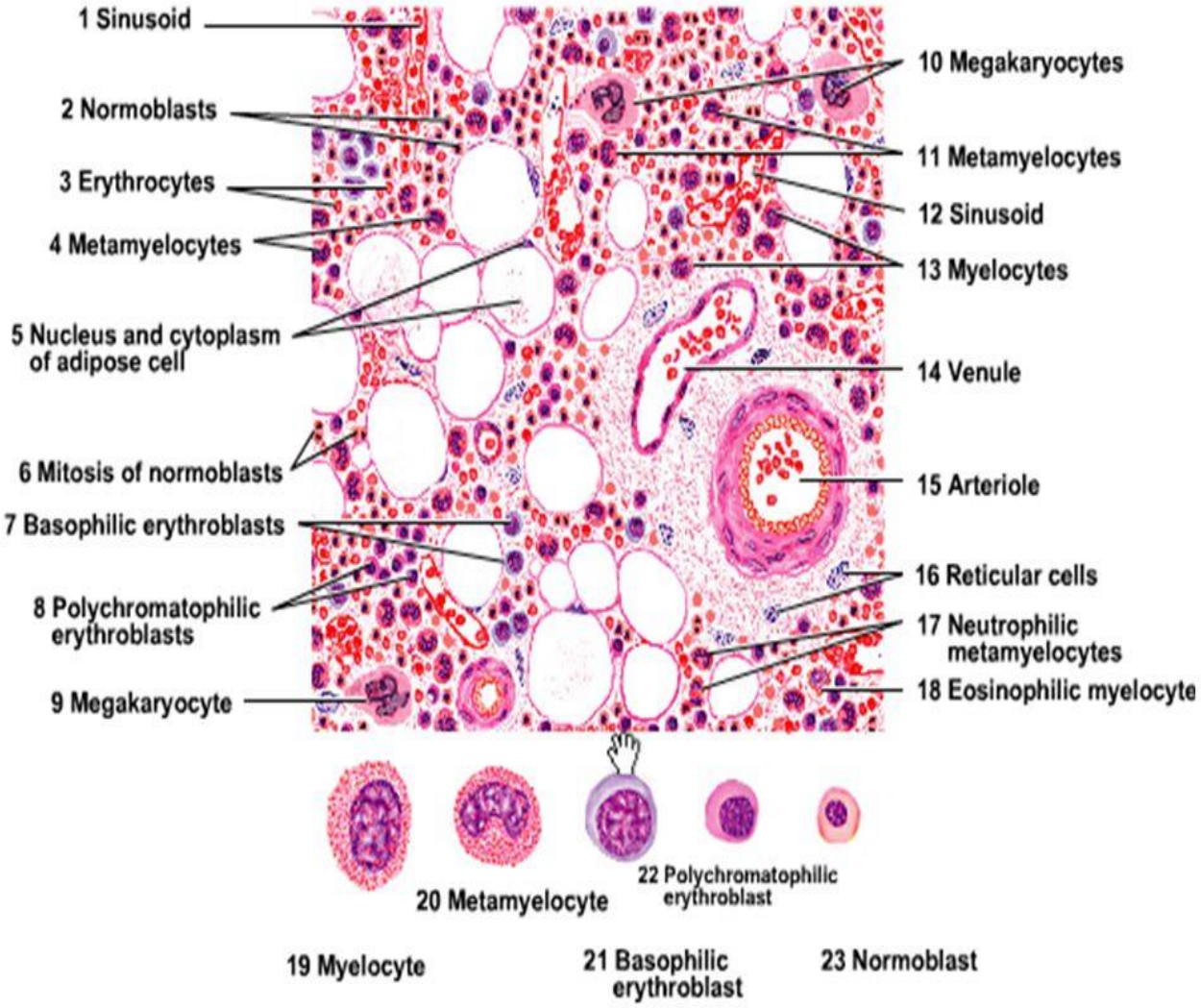
- From birth to early puberty, they majority of the bone marrow is Red marrow.
- As a person grows and matures, increasing amounts of red marrow is replaced by yellow marrow.
- Bone marrow is separated into a vascular section and non-vascular sections.

1.The vascular sections contain blood vessels that supply the bone with nutrients and transport blood stem cells and mature blood cells away from the bone and into circulation.

2. The non-vascular section of the bone marrow are where **hematopoiesis** or blood cell formation occur .This area contains immature blood cells , fat cells, white blood cells (macrophage and plasma cell), and thin , branching fibers of reticular connective tissue.

While all blood cells are derived from bone marrow, some white blood cells mature in other organs such as the spleen , lymph nodes and thymus gland.

Development of Blood Cells in Red Bone Marrow

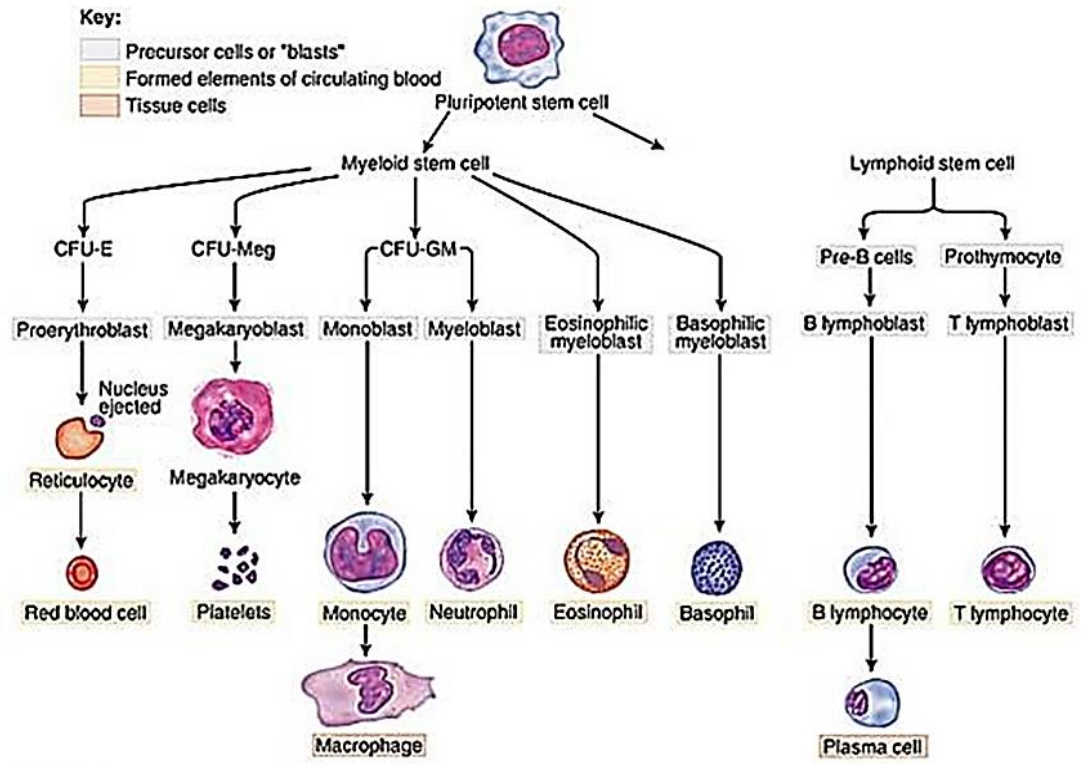


Lec 6: Hemopoiesis

❖ The word Hemopoiesis refers to the production & development" of all the blood cells.

Erythrocytes: Erythropoiesis
Leucocytes: Leucopoiesis
Thrombocytes: Thrombopoiesis.

Or Is the process involved in the production of all blood cells from the pluripotent stem cell; The hematopoietic stem cells (HSC).



Sites of Hemopoiesis:

originate in the bone marrow

Some components (e.g., erythrocytes and platelets) complete their development at medullary (i.e., bone marrow) sites, whereas other components (e.g., T and B cells) complete their development at extramedullary.

Fetus: 0- 2 months yolk sac
0-7 months liver, spleen
5- 9 months bone marrow

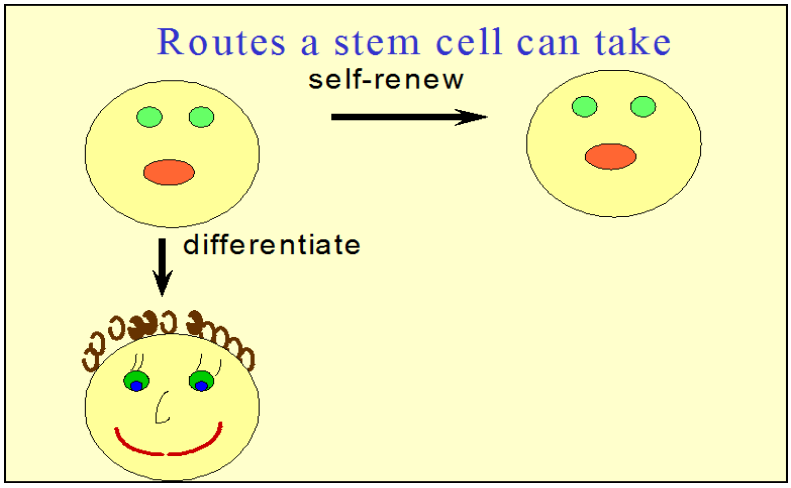
Infants : Bone marrow (practically all bones)

Adults: vertebrae, ribs, sternum, skull, sacrum, proximal ends of femur

☞ The bone marrow also produces cells that migrate to the lymphoid organs, producing the various types of lymphocytes.

Stem cells: are **pluripotential cells** capable of self-renewal.

- ❖ Some of their daughter cells form specific, irreversibly differentiated cell types.
- ❖ Other daughter cells remain stem cells.
- ❖ One stem cell is capable of producing about 10^6 mature blood cells after 20 cell divisions.



Hemopoietic Growth Factors

Hemopoiesis is regulated by a number of cytokines and growth factors, such as interleukins, colony-stimulating factors (CSF, macrophage inhibiting protein-a, and steel factor.

Some of these growth factors also promote the functioning of mature blood cells.

Most hemopoietic growth factors are glycoproteins.

GM-CSF

Granulocyte-Macrophage colony stimulating factor

M-CSF

Macrophage colony stimulating factor

Erythropoietin

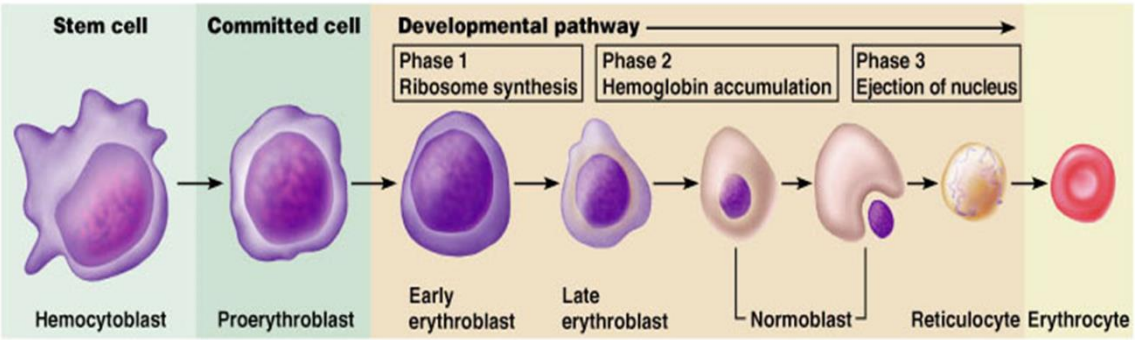
Erythropoiesis stimulating hormone

(These factors have the capacity to stimulate the proliferation of their target progenitor cells when used as a sole source of stimulation).

Thrombopoietin
Stimulates megakaryopoiesis
Cytokines
IL 1 (Interleukin 1)
IL 3
IL 4
IL 5
IL 6
IL 9
IL 11
TGF-β
SCF (Stem cell factor, also known as kit-ligand)

Erythropoiesis:

Erythropoiesis: the formation of red blood cells, is under the control of several cytokines



Development stages of red blood cell

- **Pluripotential hematopoietic stem cell**, **PHSC**
- Committed stem cell that produces erythrocytes is called

Colony-forming unit–erythrocyte, CFU-E

Factors

- Growth inducers
- Differentiation inducer

Erythropoiesis

PHSC

↓

Proerythroblast

Polychromatophil erythroblast

Orthochromatophil erythroblast

↓

Reticulocyte

Erythrocyte

Bone marrow

blood

Proerythroblast:

- No hemoglobin
- Nucleoli
- Nucleus 12 um*

Erythroblast:

- Early normoblast
- Nucleoli disappear
- Show mitosis
- Cytoplasm deep blue
- Increase in RNA
- Hemoglobin starts appearing – Little Hb

Polychromatophil erythroblast:

- Late normoblast
- Nucleus smaller
- Coarse Chromatin
- Hemoglobin increase , Eosinophil Stain
- RNA – Basophil stain

Orthochromatic Erythroblast
Normoblast

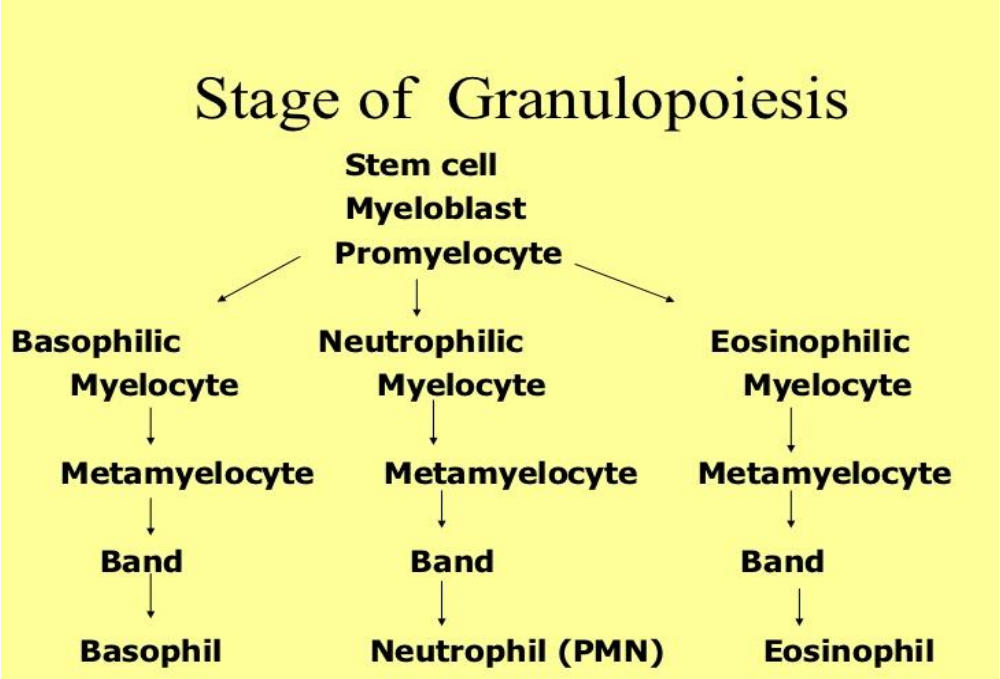
- Nucleus smaller
- Nuclear lysis and
- Nuclear extrusion

Reticulocyte

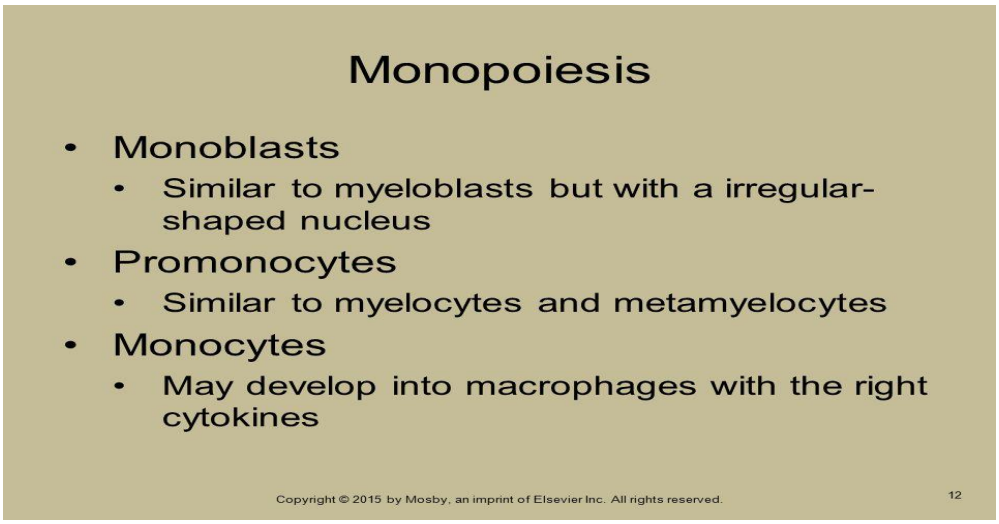
- Reticulum
- Remnant of ER & GA
- Synthesize Hb
- Few Mitochondria
- Young RBCs (34% Hb)
- 1 % of Red Cells

Granulopoiesis: formation of granular leukocytes **(WBSs)**

Granulocytes
Neutrophils
Eosinophils
Basophils
Only mature cells are present in peripheral blood



Monopoiesis: formation monocyte



Thrombopoiesis

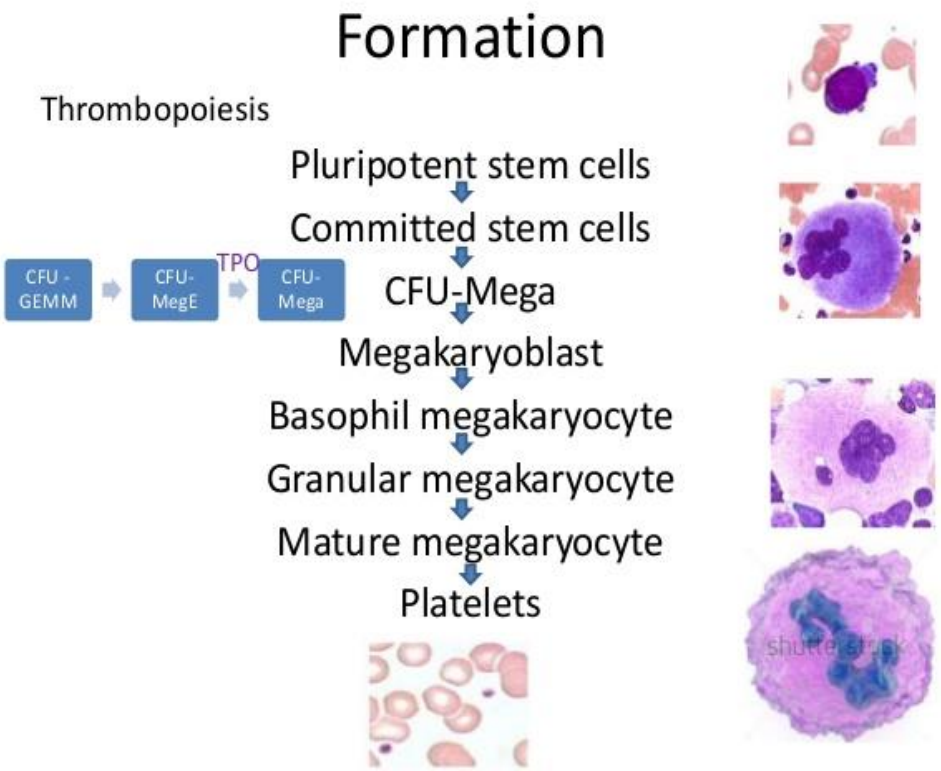
Megakaryocytes differentiate from myeloid stem cell and are responsible for production of platelets.

Three Stages of Maturation of Megakaryocytes

1. Basophilic stage, megakaryocyte is small, has diploid nucleus and abundant basophilic cytoplasm.

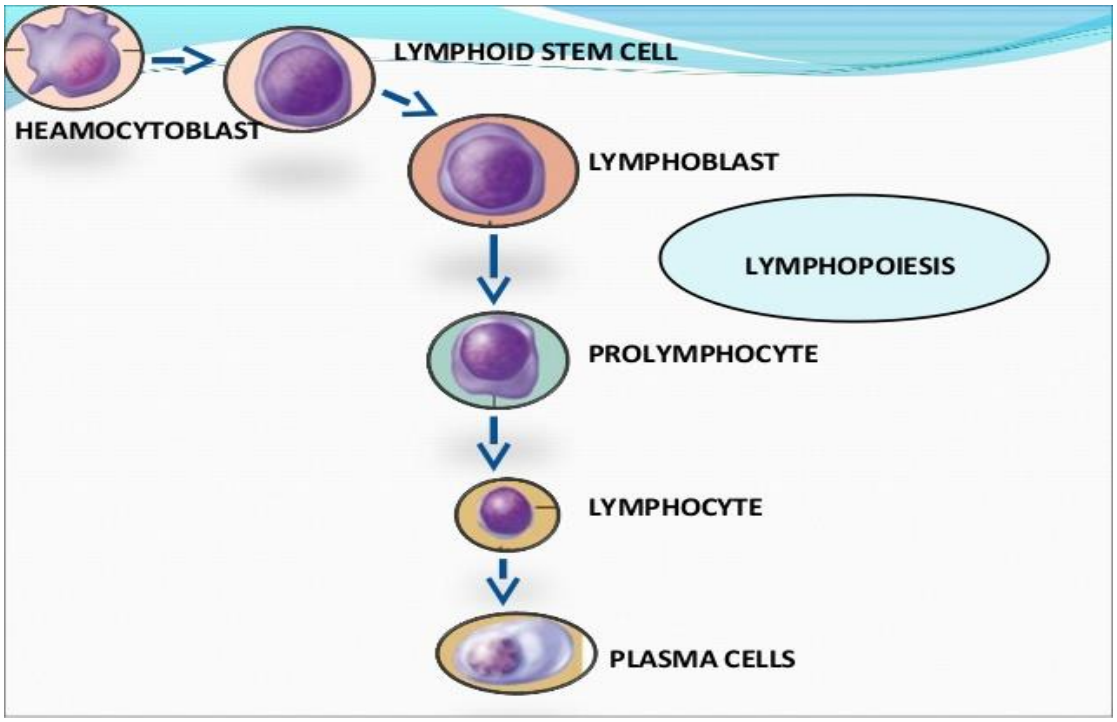
2. Granular stage, here the nucleus is more polypoid, cytoplasm is more eosinophilic and granular

3.Mature stage, megakaryocyte is very large, with approx 16-32 nuclei, abundance of granular cytoplasm. It undergoes shedding to form platelets.



Lymphopoiesis:

- Lymphocytes are derived from primitive bone marrow progenitors that activate a "lymphoid" program
  - e.g. immune receptor gene rearrangement (T and B cells)
- Sites of lymphoid development
  - T cells: thymus
  - B, NK cells: bone marrow
- Morphologically similar, but identification with antibodies directed against proteins on the cell surface.


LYMPHOID STEM CELL
HEAMOCYTOBLAST
LYMPHOBLAST
LYMPHOPOIESIS
PROLYMPHOCYTE
LYMPHOCYTE
PLASMA CELLS

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.

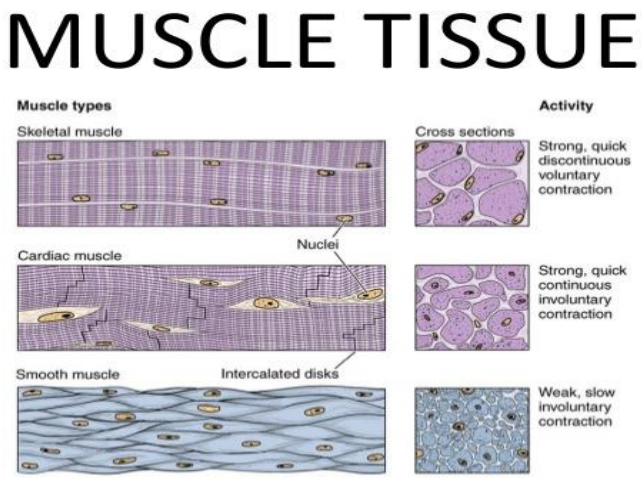
8. The fibers rest on the basement membrane.

There are three types of muscle tissue:

♣ **Skeletal muscle**—Skeletal muscle tissue moves the body by pulling on bones of the skeleton.

♣ **Cardiac muscle**—Cardiac muscle tissue pushes blood through the arteries and veins of the circulatory system.

♣ **Smooth muscle**—Smooth muscle tissues push fluids and solids along the digestive tract and perform varied functions in other systems.



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 it cell (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.

3. Each fiber contains numerous **myofibrils**, which are made up of thick and thin threads.

4. found: attached to the bones and in some visceral organs.

5. voluntary contraction.

6. The fibers held together by sheaths (**a. Endomysium b. Perimysium c. Epimysium) .**

a. Endomysium: is a delicate layer that immediately surround the individual fibers.

b. Perimysium: is a thick layer of connective tissue, surround group of fibers that form fascicle.

C.Epimysium: is the sheath of dense connective tissue that surround a collection of fascicle.

Structure of skeletal fibers

1.Under light microscope the skeletal muscle showed light bands **(I- band)** and dark bands **(A-band)**.

2. each **I-band** is bisected by transverse line called **Z-line**

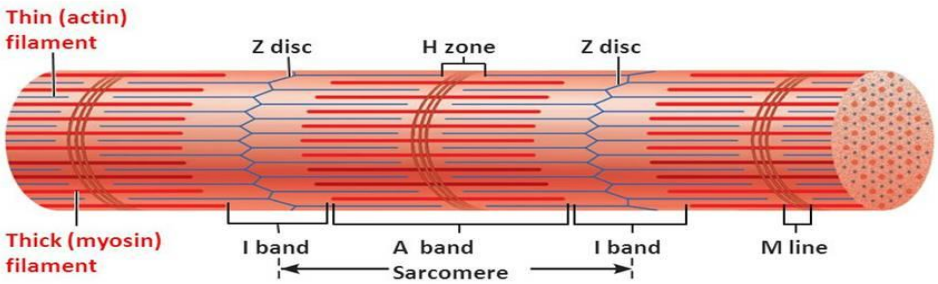
3. The area between two Z line is known as **sarcomere,** which is the **fundamental contractile unit of myofibril.**

4. 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.**

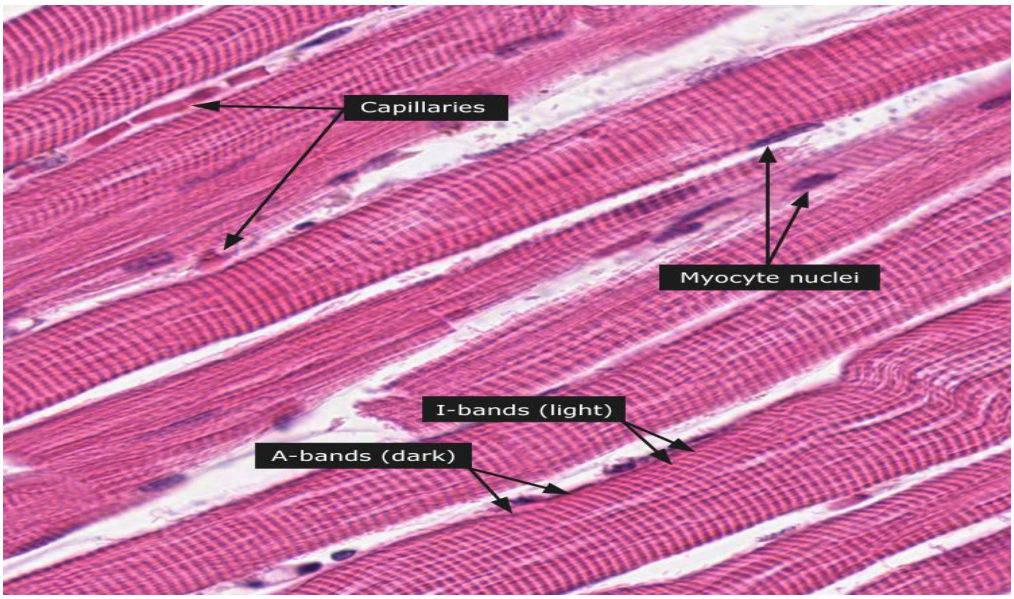
***dark A band (anisotropic band) ; doesn't allow light to pass.**

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.

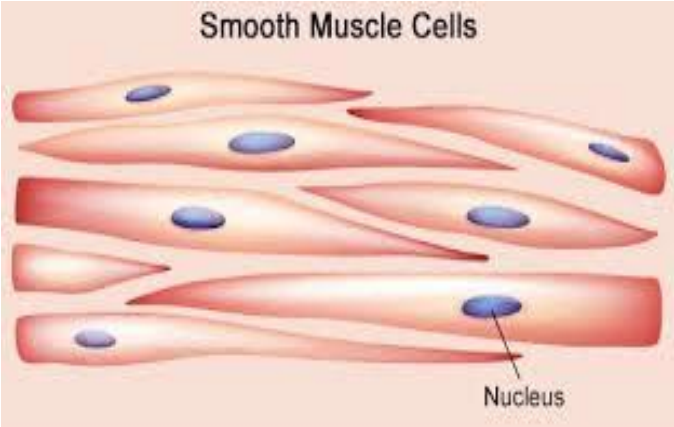
Pg 280



Skeletal muscle under microscope

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.

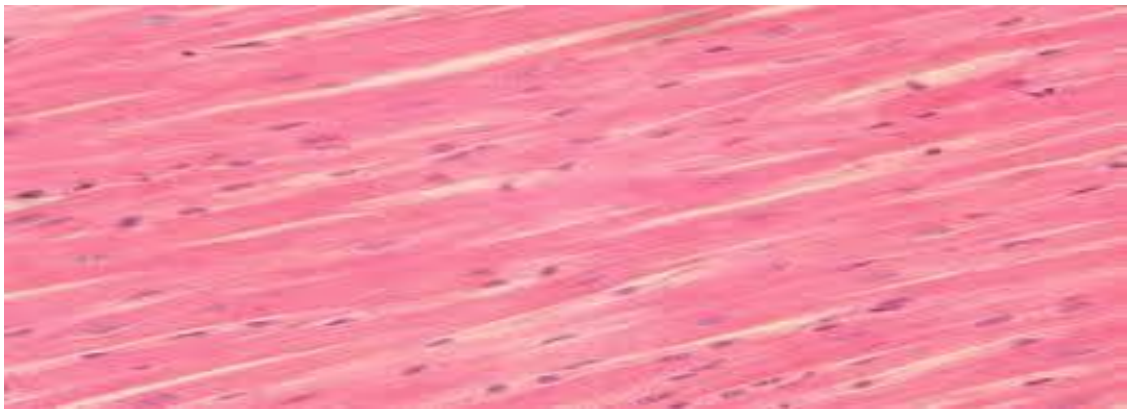
5. involuntary muscle.

6. Endomysium Sheath is present.

7. The cross striation is none.

2.main characteristics

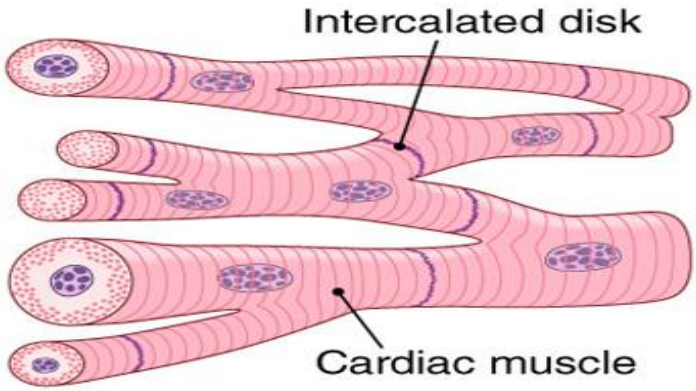
- Its contraction and relaxation period are slower.
- Its action is **rhythemical**. Its contraction may last for 3o sec or more, but it doesn't tire easily. Such sustained contraction plus the **ability to stretch** made it suitable to muscular control of **stomach, intestine, urinary bladder, uterus**.



Smooth muscles

3. Cardiac muscle:

It is present only in **heart**



Structure

1. Under microscope, they have similar striation as skeletal muscle

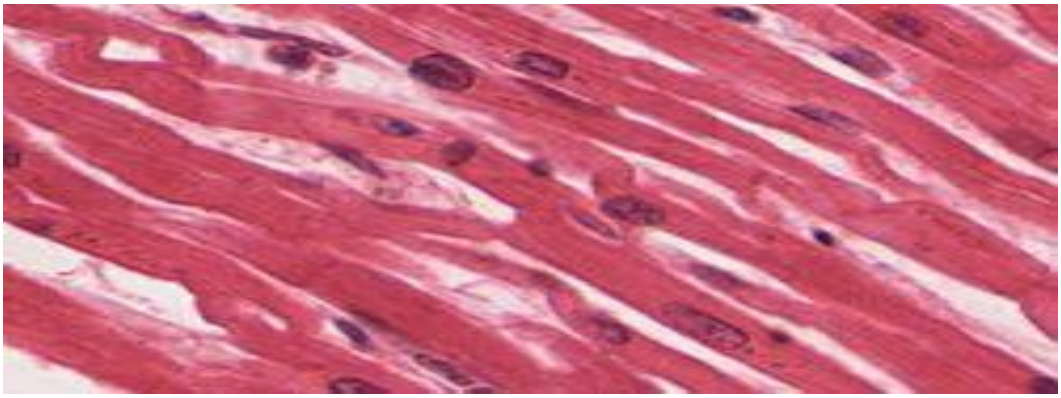
2. Cardiac muscle cells are closely packed but each cell are nucleated and separated from each other

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 syncronise 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 occur 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 muscle

Comparison of Structure and Properties of Muscle Tissue Types

Tissue	Histology	Function	Location
Skeletal	Long cylindrical fiber, striated, many peripherally located nuclei	Voluntary movement, produces heat, protects organs	Attached to bones and around entrance points to body (e.g., mouth, anus)
Cardiac	Short, branched, striated, single central nucleus	Contracts to pump blood	Heart
Smooth	Short, spindle-shaped, no evident striation, single nucleus in each fiber	Involuntary movement, moves food, involuntary control of respiration, moves secretions, regulates flow of blood in arteries by contraction	Walls of major organs and passageways

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

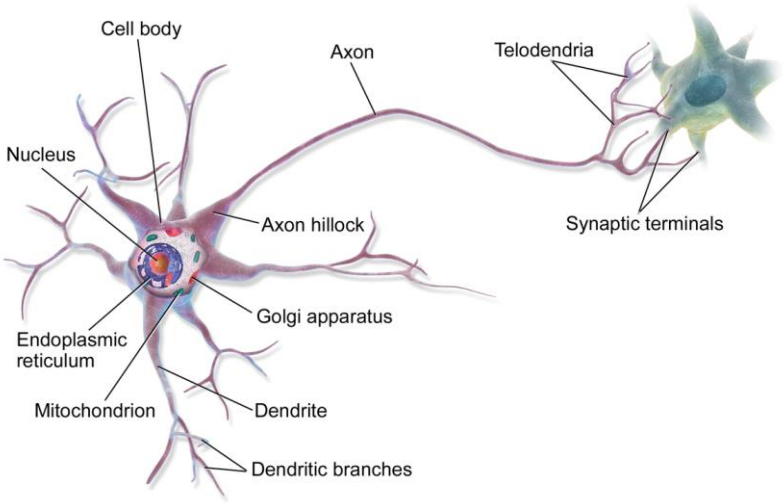
Lec 8: Nervous tissue:

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.

The nervous system is responsible for the control of the body and the communication among its parts. Nervous tissue contains two categories of cells—neurons and neuroglia.

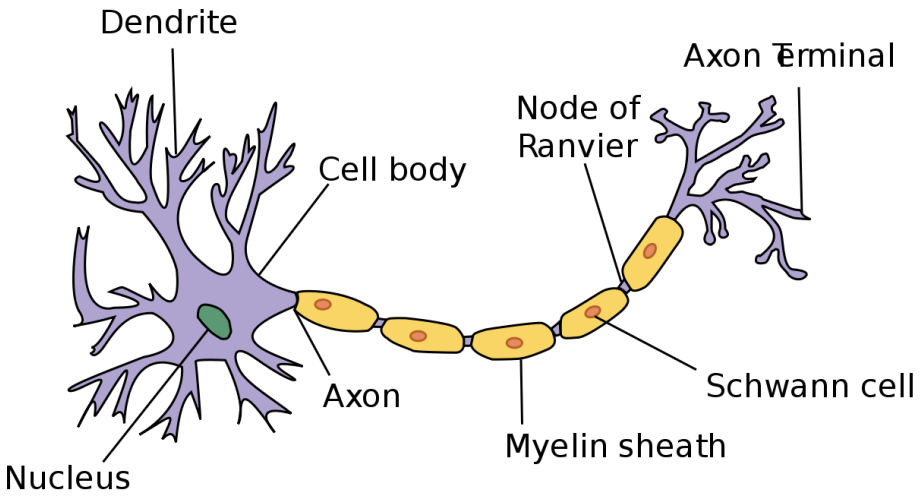
1. Central nervous system (CNS): Composed of the brain and spinal cord. Its major functions are to integrate sensory information, and to initiate and co-ordinate efferent responses.

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.



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. Contains nucleus, cytoplasm, etc.

- 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, nerurilemma 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**

Classifications of neuron:

A. according to the number of processes

1. Pesudounipolar neuron

These neurons consist of one dendrite and one axon.

The nerve cell body has two processes which are adherent to each other forming one pole.

- ❖ It is seen in spinal sensory ganglia.

2. Biopolar neurons

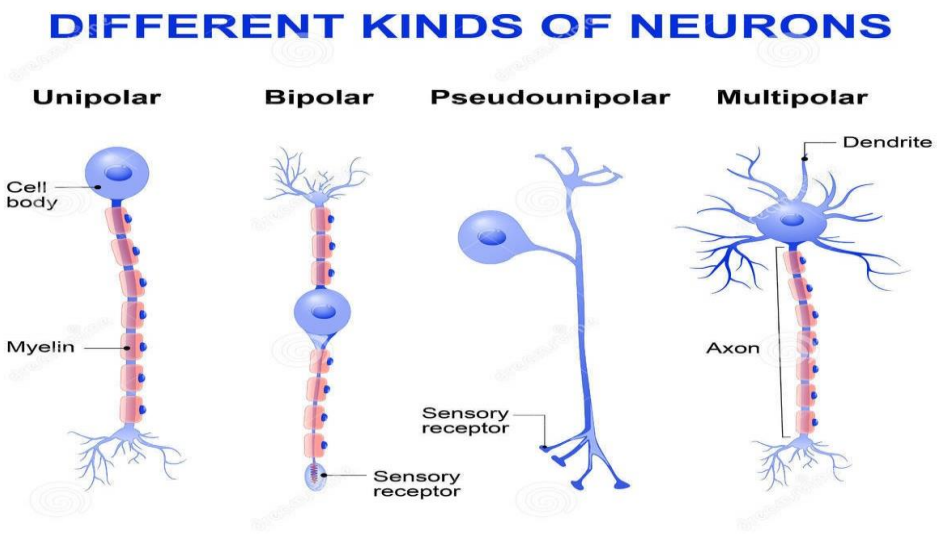
The nerve cell body has spindle shape and has two processes from the two pols, a short dendrite and a long axon.

- ❖ It is seen in the olfactory epithelium of the nasal cavity.

3. Multipolar neurons

The nerve cell has a single long axon and many short dendrites.

They represented most of the neuron in the brain and spinal cord.



B. according the functions

1. Motor (Efferent) neurons

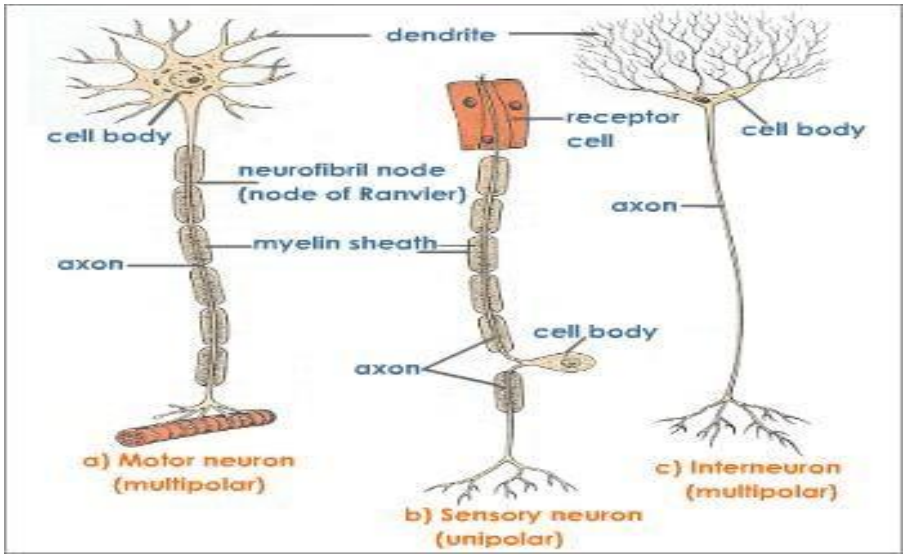
- This type carries motor impulses from central nervous system (CNS) to peripheral end organ.
- The site of this type is a motor nucleus in anterior horn cell of spinal cord.

2. Sensory (Afferent) neurons

- This type receive 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 ad central nervous system .

* Neruroglia of peripheral nervous system (PNS) include:

1. Schwann cell

2. Satellite cell

*** Neruroglia of central nervous system (CNS)**

1. Astrocytes

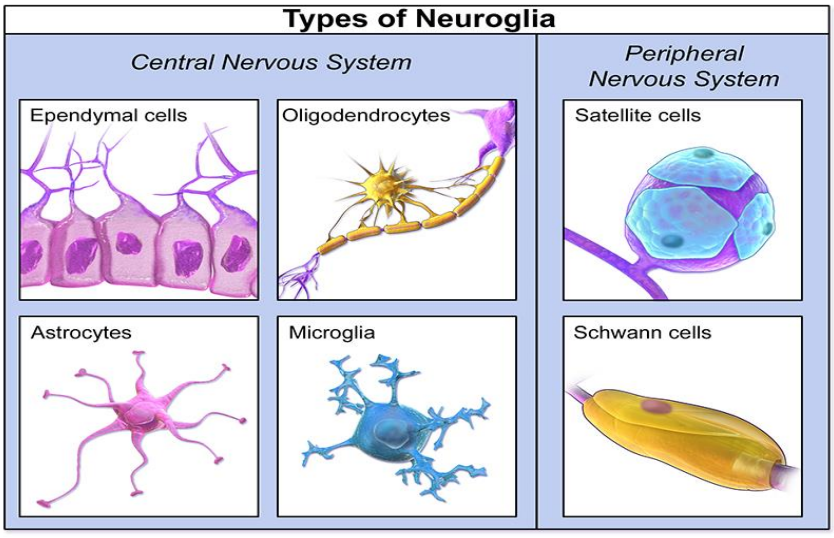
a. fibrous astrocytes.

b. protoplasmic astrocytes.

2. Oligodendroglia

3. Microglia

4. Ependymal cells.



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 are 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.

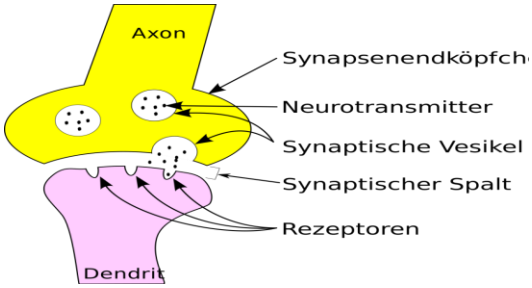
Synapses have 4 main functions

a. They transmit information between neurons.

b. They filter out low frequency impulses.

c. They act as valves to ensure that impulses pass across then in one direction only

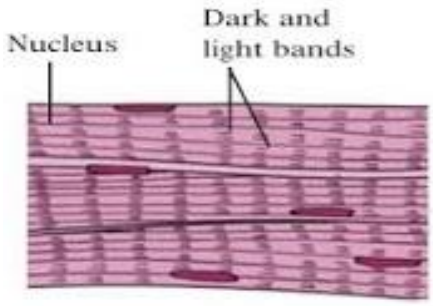
d. they also act as junctions allowing impulses to be divided up along many neuron or merge into one.



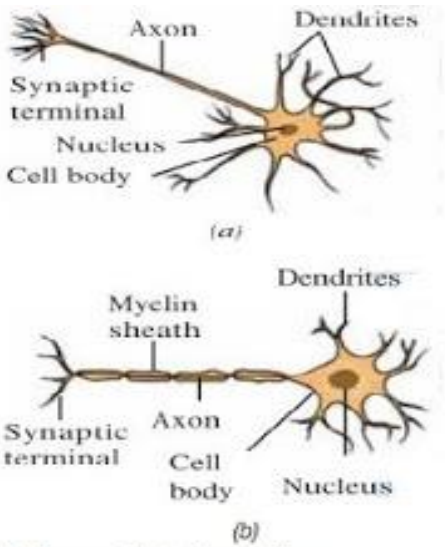
Nerve fibers:

- A nerve fiber is an axon and its sheath.
- Long, peripheral axons are surrounded by a multi-layered with Phospholipid , segmented covering called myelin sheath .
- Axons with the covering are known as myelinated fibers and those without are unmyelinated fibers.
- The functions of the myelin sheath is to increase the speed of nerve impulse conduction.
- Myelin sheaths in the PNS are formed by multiple layers of wrapped Schwann cells.
- The outer surface of the Schwann cells is the neurilemma or sheath of Schwann and is located just beneath the plasma membrane of the cell.

- Between Schwann cells in an unmyelinated gap called the **node of Ranvier**.
- Unmyelinated fibers are also enclosed by Schwann cells, but without multiple wrappings.
- CNS myelin sheaths also lack a neurilemma.



A strained muscle fibre



(a) Non-myelinated nerve fibre
(b) Myelinated nerve fibre