

Ministry of higher Education and Scientific Research

Southern Technical University

Institute of Medical Technology /AMARA

Theoretical lecture

Histology

For

Students of First Class Medical Laboratory



By

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M. Sc. Biology**

weeks	Theoretical lecture	Page. No
1	Microscope	
2	Shape of cell	
3	Epithelial tissue – simple epith. T.	
4	Epithelial tissue – stratified epith. T.	
5	Epithelial tissue – stratified epith. T.	
6	Connective tissue – loose co. T.	
7	Connective tissue – dense co. T.	
8	Connective tissue – the blood	
9	Connective tissue – cartilage	
10	Connective tissue – compact bone	
11	Connective tissue – spongy bone	
12	Muscular tissue (cardiac muscle, skeletal muscle, smooth muscle)	
13+ 14	Examination for mid-year	
15+	Holiday for mid-year	



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Compound Microscope

Microscope

The microscope: is an instrument which is used for examination of fine structure of objects . Micro = small . Scope = to view. It enlarges of the images of the objects which then can be seen by the eye .

Types of Microscope:

1-Simple microscope :It is made of single or combination of lenses which act as single position convex lens .

2-Compound microscope : It is made up of 2 lenses which are fitted in a brass tube , one of the tubes can be slide into the other so that the distance between lenses can be changed and adjusted.

Other types of microscopes :

- 1- **Bright field.** is the simplest of all the optical microscopy illumination techniques. and the most common used microscope in the laboratories.
- 2- **Dark-field.** Dark-field microscope is used to observe live spirochetes.
- 3- **Phase – contrast.** is used in biology to view unstained specimens. It is one of the types of microscopes used to study cells and cell parts like mitochondria lysosomes and Golgi bodies.

- 4- **Fluorescent.** Fluorescence microscope uses high-energy, short-wavelength light that excites the electrons of certain molecules present within the sample.
- 5- **Scanning electron.** Scanning Electron Microscope is characterized as a microscope that has lower magnifying power but can provide 3 dimensional viewing of objects.

Bright Field Microscope (The Compound Microscope)

1. Commonly used in bacteriology laboratory.
2. It depends on light.
3. It consider as compound microscope.

Bright Field Microscope parts :

1. **Base:** The bottom support of the microscope.
2. **Arm:** It helps in holding the microscope.
3. **Light source (illuminator):** A light source mounted under the stage.
4. **Body tube:** It hold the projector lenses that direct the light toward the ocular lenses.
5. **Nosepiece:** Hold the objectives (movable disk).
6. **Coarse adjustment knob:** Used to make relatively wide focusing adjustments to the microscope.
7. **Fine adjustment Knob:** Used to make relatively small adjustments to the microscope.
8. **Stage:** The flat plate where the slides are placed for observation.

- 9. **Stage Clips:** Clips on the stage used to hold the slide in place.
- 10. **Condenser:** Focuses the light through the specimen.
- 11. **Iris diaphragm:** Vary the amount of light passing through the stage opening.
- 12. **Condenser adjustment knob:** Used to move the condenser up and down.
- 13. **Objective lenses:** Primary magnification (4 ×, 10 ×, 40 ×, 100 ×).
- 14. **Ocular lenses:** Final magnification 10 × (Eye Pieces).

Histology

Histology meaning the study of the tissue, it's the study of the fundamental tissues of the body. The term **histology** is derived from two Greek words:

Histos = Tissue

Logos = Science

Histology : deals with the study of minute structure of tissue in general.

Micro-anatomy : deals with the fine structure of all the tissue present in particular organ. Cytology: deals with the detailed study of individual cell and its internal components .

Shapes of cell

Cell is the unit of structure and function in animals and plants. It was first named as cell by Robert Hooke in 1665, the cell is a membrane bound unit containing discrete organelles , protoplasm and nucleus , the organelles are organized forms of biological molecules which play an important role in the function of cell , example Mitochondria for providing energy , endoplasmic reticulum for producing secretions like enzymes and hormones .

Cell membrane :

Each cell is limited by semi-permeable membrane called cell membrane (plasma lemma) in which cell protoplasm is limited, cell membrane is made of double layers of phospholipids and protein molecules.

Animal cell organelles :

- 1- Cell membrane** : the thin layer of protein and fat that surrounds the cell. The cell membrane is semipermeable, allowing some substances to pass into the cell and blocking others and give cell shape .
- 2- Cytoplasm** : the jelly like material outside the cell nucleus in which the organelles are located.
- 3- Nucleus** : spherical body containing many organelles, including the nucleolus. The nucleus controls many of the functions of the cell (by controlling protein synthesis) and contains DNA (in chromosomes). The nucleus is surrounded by the nuclear membrane.
- 4- Nuclear membrane** : the membrane that surrounds the nucleus.
- 5- Nucleolus** : an organelle within the nucleus - it is where ribosomal RNA is produced.
- 6- Mitochondria** : spherical to rod-shaped organelles with a double membrane. The inner membrane is in folded many times. The mitochondrion converts the energy stored in glucose into ATP (adenosine triphosphate) for the cell.
- 7- Endoplasmic reticulum: (ER)** a vast system of interconnected, membranous, in folded and convoluted sacks that are located in the cell's cytoplasm (the ER is continuous with the outer nuclear membrane).

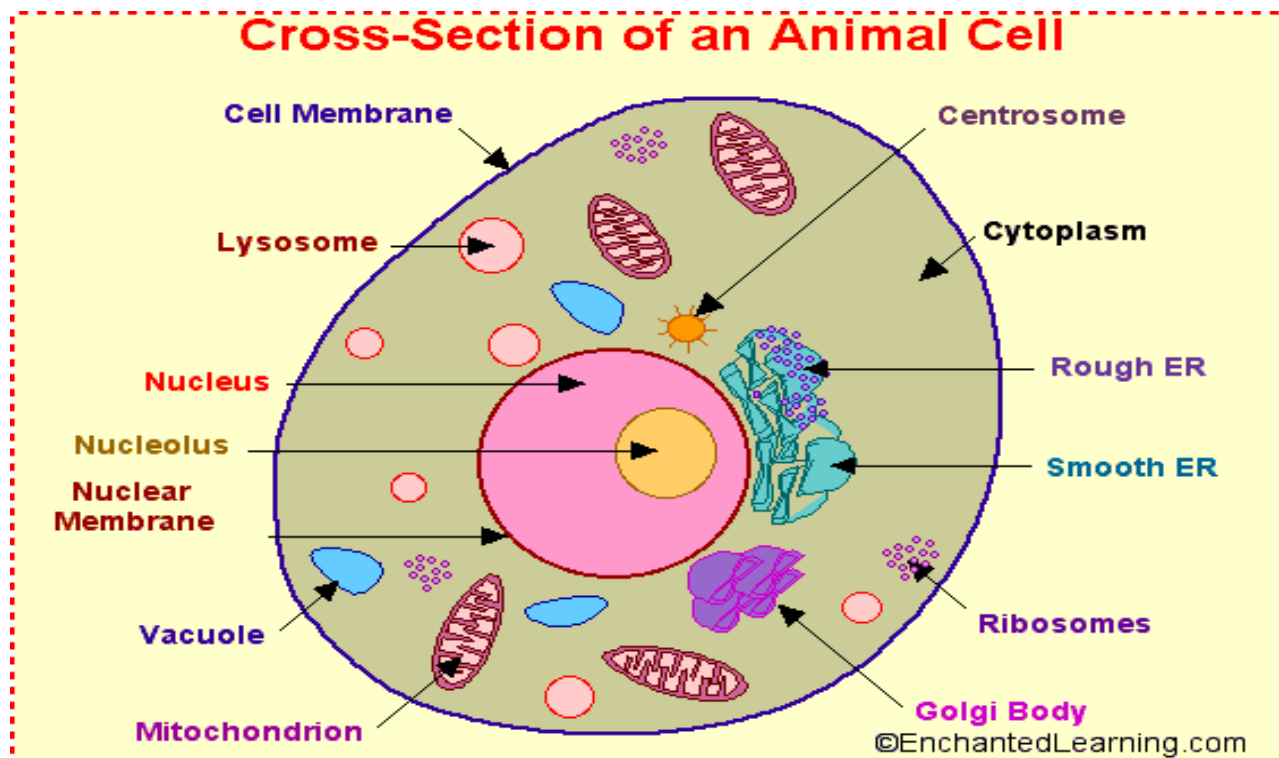
- 8- Endoplasmic reticulum: (ER) a vast system of interconnected, membranous, in folded and convoluted sacks that are located in the cell's cytoplasm (the ER is continuous with the outer nuclear membrane).
- 9- Ribosomes: small organelles composed of RNA-rich cytoplasmic granules that are sites of protein synthesis.
- 10- Golgi apparatus: **Golgi body** - : a flattened, layered, sac-like organelle that looks like a stack of pancakes and is located near the nucleus. It produces the membranes that surround the lysosomes. The Golgi body packages proteins and carbohydrates into membrane-bound vesicles for " export " from the cell.
- 11- **Lysosome**: (also called cell vesicles) round organelles surrounded by a membrane and containing digestive enzymes. This is where the digestion of cell nutrients takes place.
- 12- **Vacuole** - fluid-filled, membrane-surrounded cavities inside a cell. The vacuole fills with food being digested and waste material that is on its way out of the cell.

Function of cell membrane :

- 1. It's giving cell shape .
- 2. Diffusion inside and outside the cell .
- 3. Generate bioelectrical potential.
- 4. They are sites for intracellular granules .
- 5. They are sites for intercellular contacts.

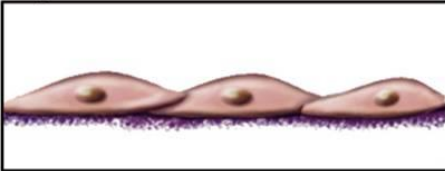
Function of nucleus

1. Protein synthesis.
2. Cell division .
3. Cell motility .



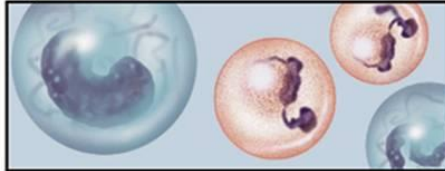
Cell Shapes

Squamous



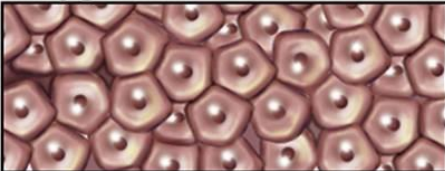
- thin, flat, angular contours

Spheroid



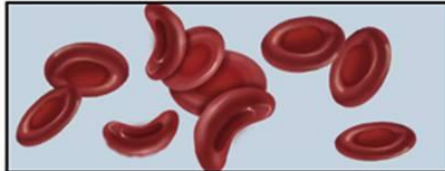
- round to oval

Polygonal



- irregular angular shapes, with more than 4 sides

Discoid



- disc shaped

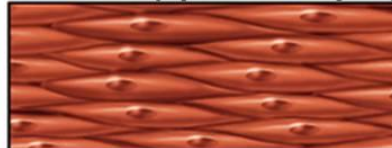
Cell Shapes 2

Cuboidal



- squarish

Fusiform (spindle shaped)



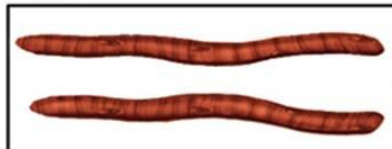
- thick middle with tapered ends

Columnar

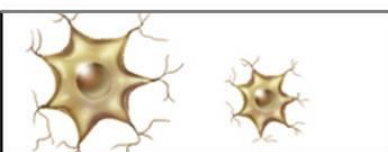


- taller than wide

Fibrous



- long, slender



Stellate

- star-shaped

Tissues

Tissue : Is a group of similar cells specialized in common direction and set a part for performance of a common function .

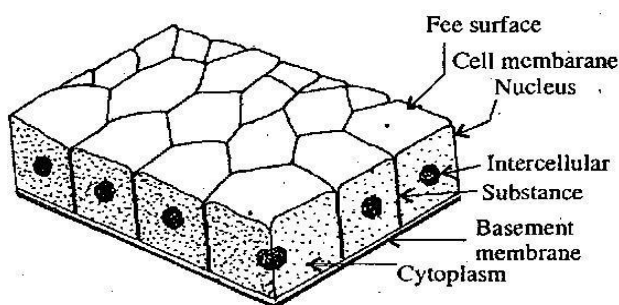
Classification of Tissue Types :

Tissues are classified into four primary tissues according to **structure** and **function** .
There are Four (4) Basic Types of Animal Tissue :

Epithelial Tissue	Connective Tissue	Muscular Tissue	Nervous Tissue
Covers body surfaces and lines body cavities	Binds and Supports body parts	Enables movement of structures within the body and movement of the entire person/animal	Enables responses to stimuli and coordinates bodily functions

Epithelial tissue :

It is a cellular layer which lines the body surface , skin , mucous membranes and glands. Cells may be arranged in a single or multiple layers, the cells rest on abasement membrane which is made of non-cellular amorphous substances mainly mucopolysaccharides.



General Structure of Epithelia

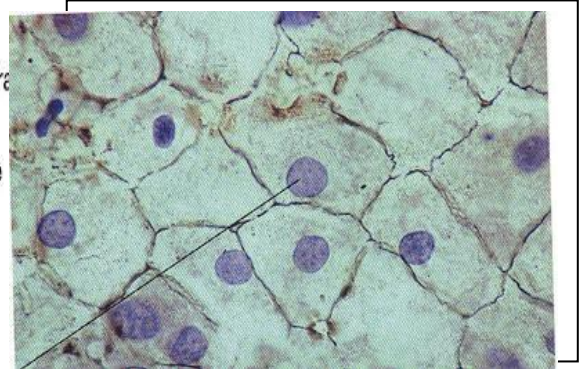
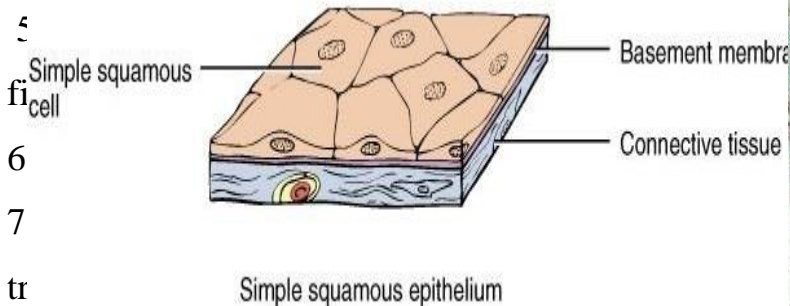
General functions of epithelial tissue :

1- **Selective diffusion.**

2- **Protection .**

3- **Transport :** mucous & particulate material is transported along the epithelial surface.

4- **Secretion :** in glandular epithelium.



8. **Lubrication :** mucous secreted by epithelial cells act as lubricant.

9. Transitional epithelium has two important functions:

- **It's capable of distension .**
- **Provide a waterproof surface impermeable to urine .**

Classification of Epithelial tissue :

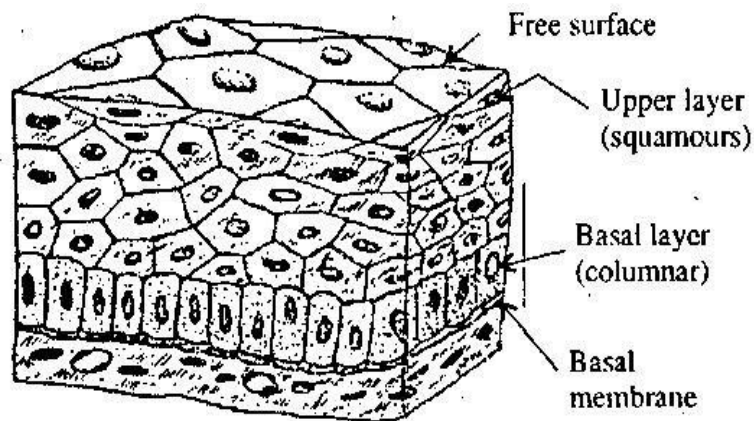
Classification of epithelium is based on the shape of the cells and the arrangement of the cells within the tissue, the arrangement of the cells is stated first, then the shape, and is followed by — **epithelium** || to complete the naming (Ex. Simple Squamous Epithelium).

A - Arrangement of the cells :

1-**Simple epithelium tissue :** Cells are found in a single layer attached to the basement membrane.

2 -Stratified epithelial tissue :

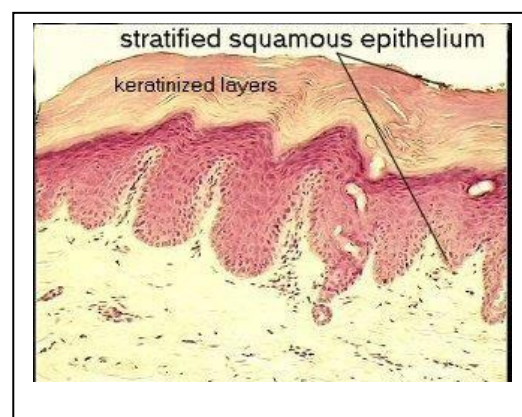
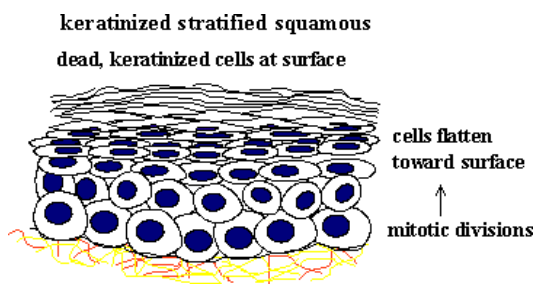
Cells are found in 2 or more layers stacked atop each other. the deepest layer consist of columnar cells arranged on basement membrane, middle layer or layers contain polyhedral cells and superficial are squamous cells (flattened cells). This tissue is specialized for resistance friction.



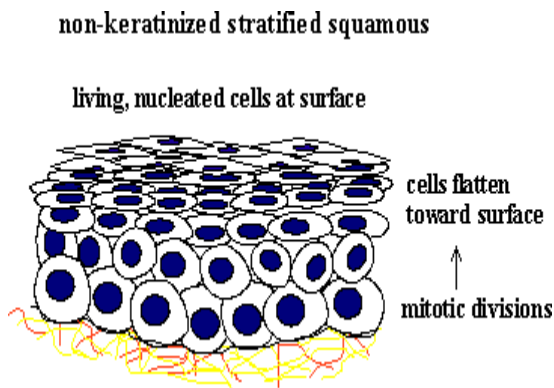
Stratified epithelium

A - There are 2 types of stratified squamous epithelium :

- **Keratinized :** As in epidermis (palm of hand) , where the superficial squamous cells are hardened due to a protein keratin .

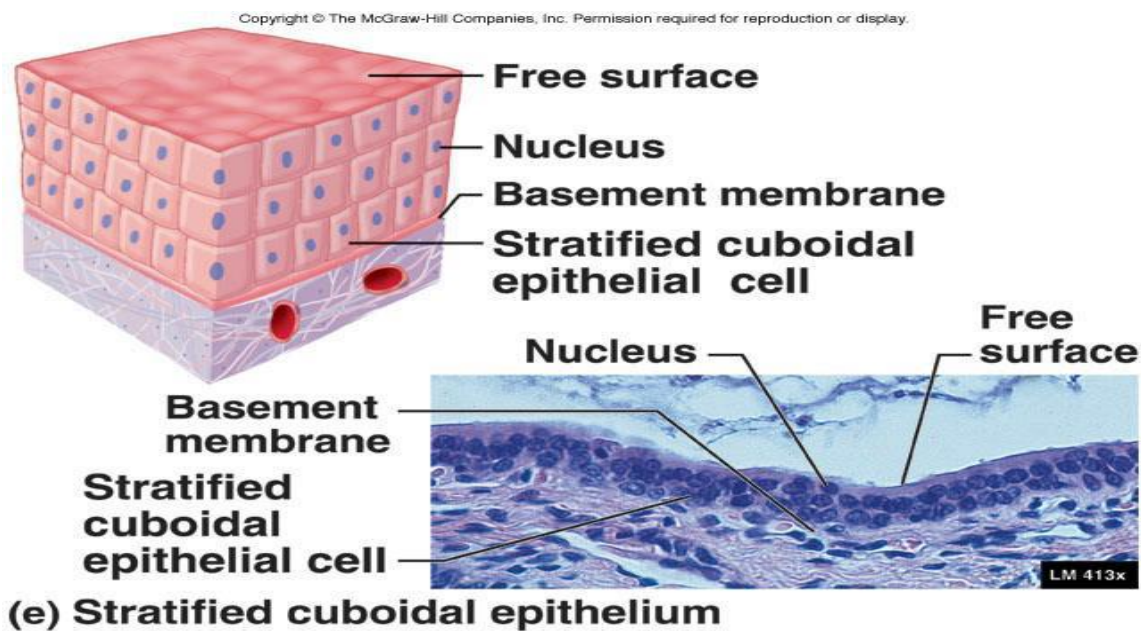


- ▶ **Non-keratinized : Example : cornea, esophagus ,skin frog .**



B - STRATIFIED CUBICAL EPITHELIUM

- Outermost layer of cells are cube like & cells are nucleated & living.
- Middle layer – polygonal shaped cells.
- E.g. – Secretory duct of sweat glands, mammary glands and sebaceous gland.
- Secretory unit of salivary glands, sebaceous gland.

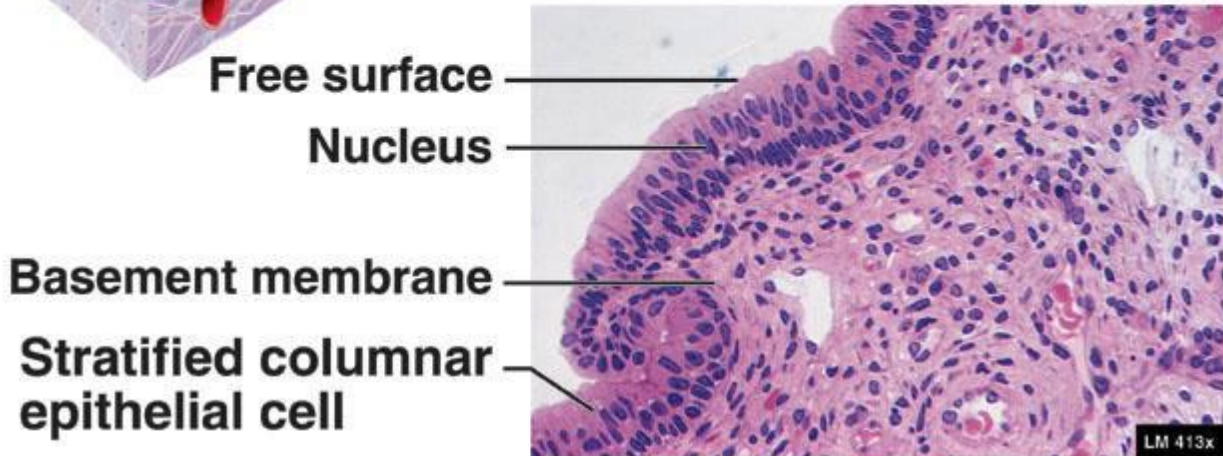
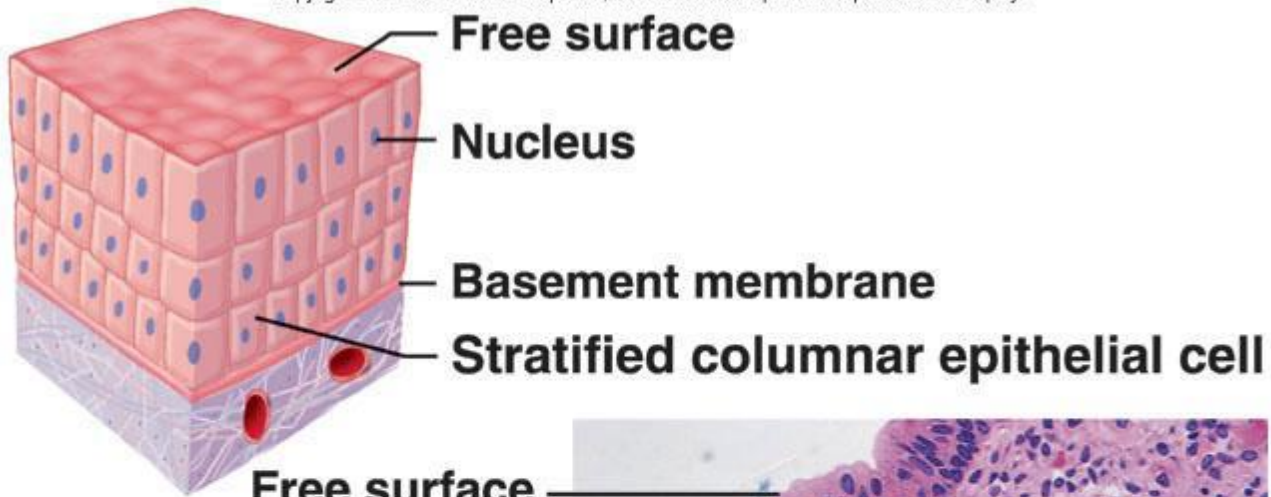


C - STRATIFIED COLUMNAR EPITHELIUM

It consists of columnar cells in both superficial basal layers. Cells are nucleated. Cilia absent on free end.

E.g. – Distal part of male urethra – Epiglottis

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(f) Stratified columnar epithelium

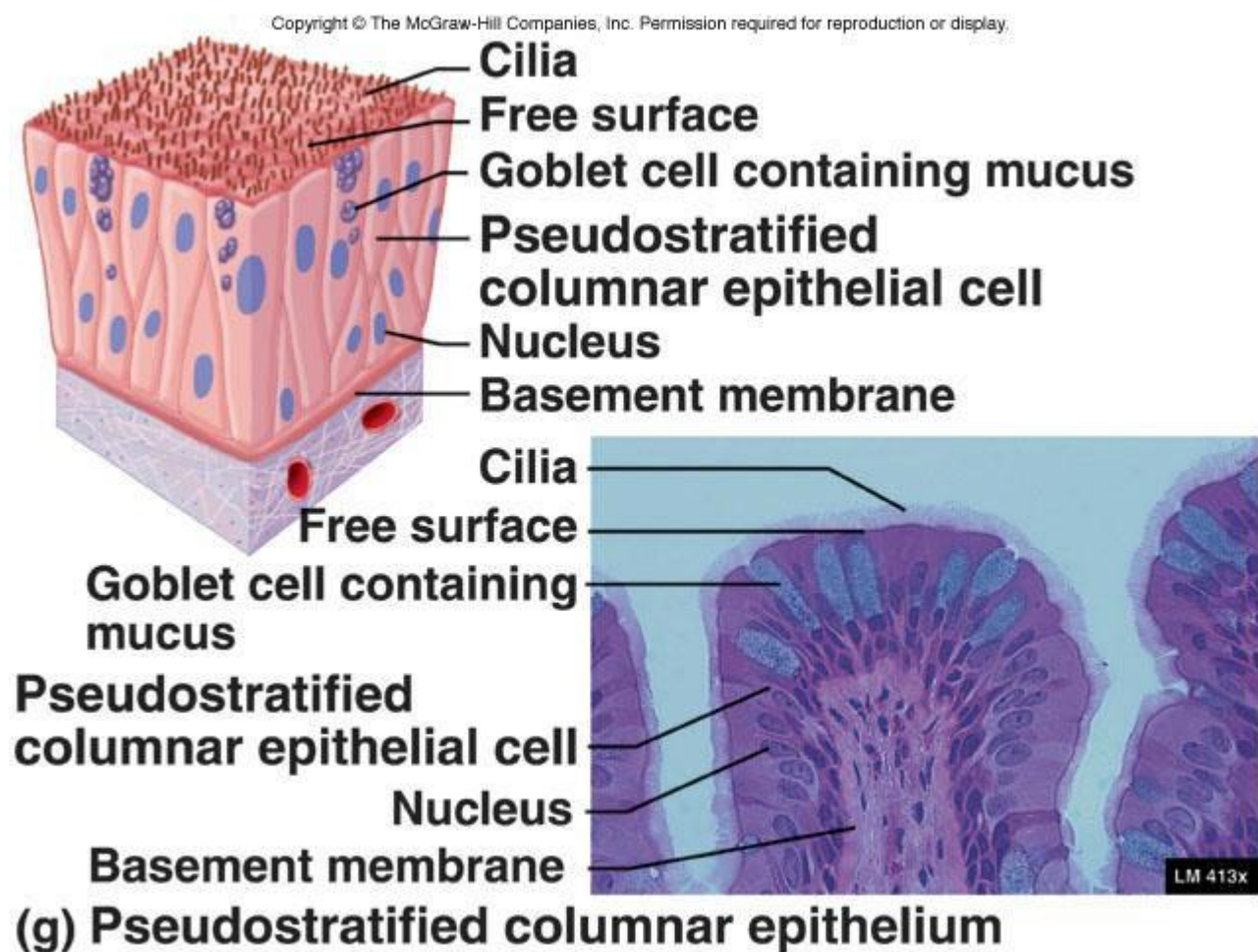


2- Pseudo stratified epithelial tissue :

A single layer of cells that appears to be multiple layers due to variance in height and location of the nuclei in the cells. A single layer of cells set on a basement membrane but the height of the cells varies; all cells don't reach the surface, the nuclei too are present at different levels.

Function: Secretion, particularly of mucus; propulsion of mucus by ciliary action.

Location: Non-ciliated type in male's sperm-carrying ducts and ducts of large glands; Ciliated variety lines the trachea, most of the upper respiratory tract



Transitional epithelial tissue :

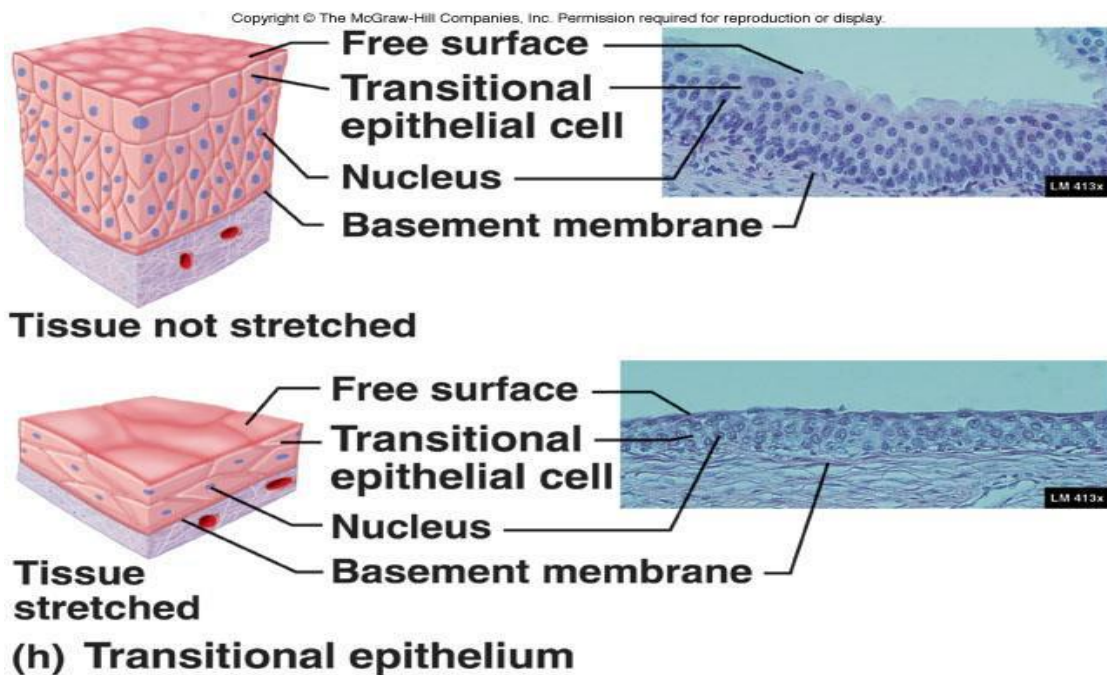
Cells are rounded. It's appearance varies with the state of distension or contraction of the wall , it's characteristic of urinary bladder and part of urethra.

1- In the relaxed condition it has 5 to 6 layers , the basal cells are polyhedral, the middle ones are pear shaped with their conical ends touching the basement membrane cells, the superficial cells are dome shaped (umbrella) with the basal surface touching the rounded end of pear shaped cells of second layer.

2- In distended condition the cells of superficial layer get more flattened & those of middle layers get sandwiched between deeper cells.

Function: stretches readily and permits distension of urinary organ by contained urine.

Location: lines the ureters, urinary bladder, and part of the urethra.

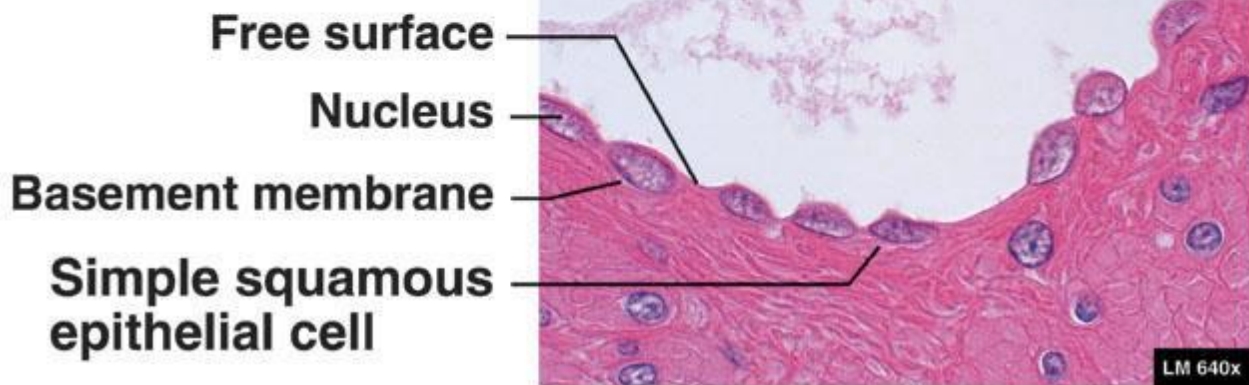
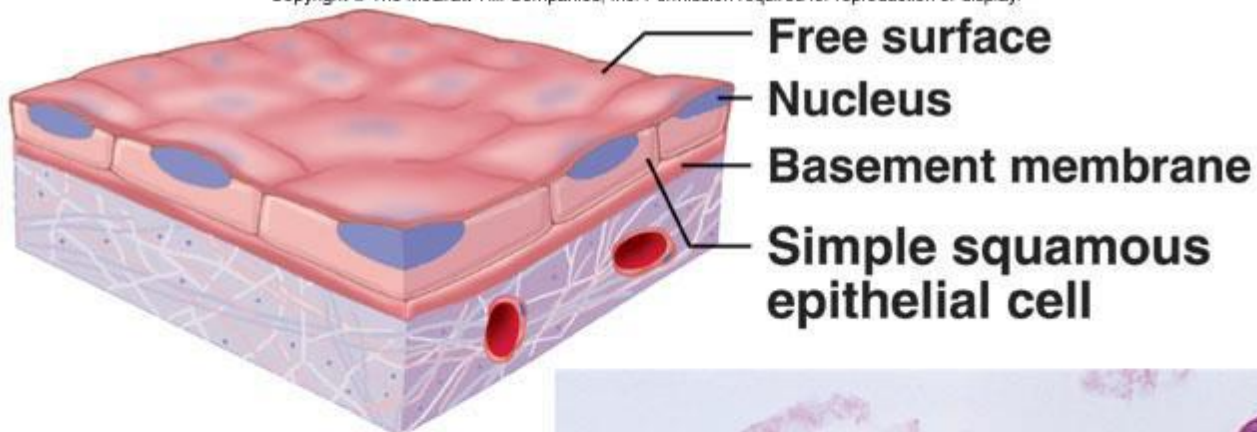


B-Shape of cell .

1-Simple squamous epithelial tissue : flat, thin, scale-like cells.: flat, thin, scale-like-cells.

Location : lining of pleural , lining of heart ,blood vessels and nephron .

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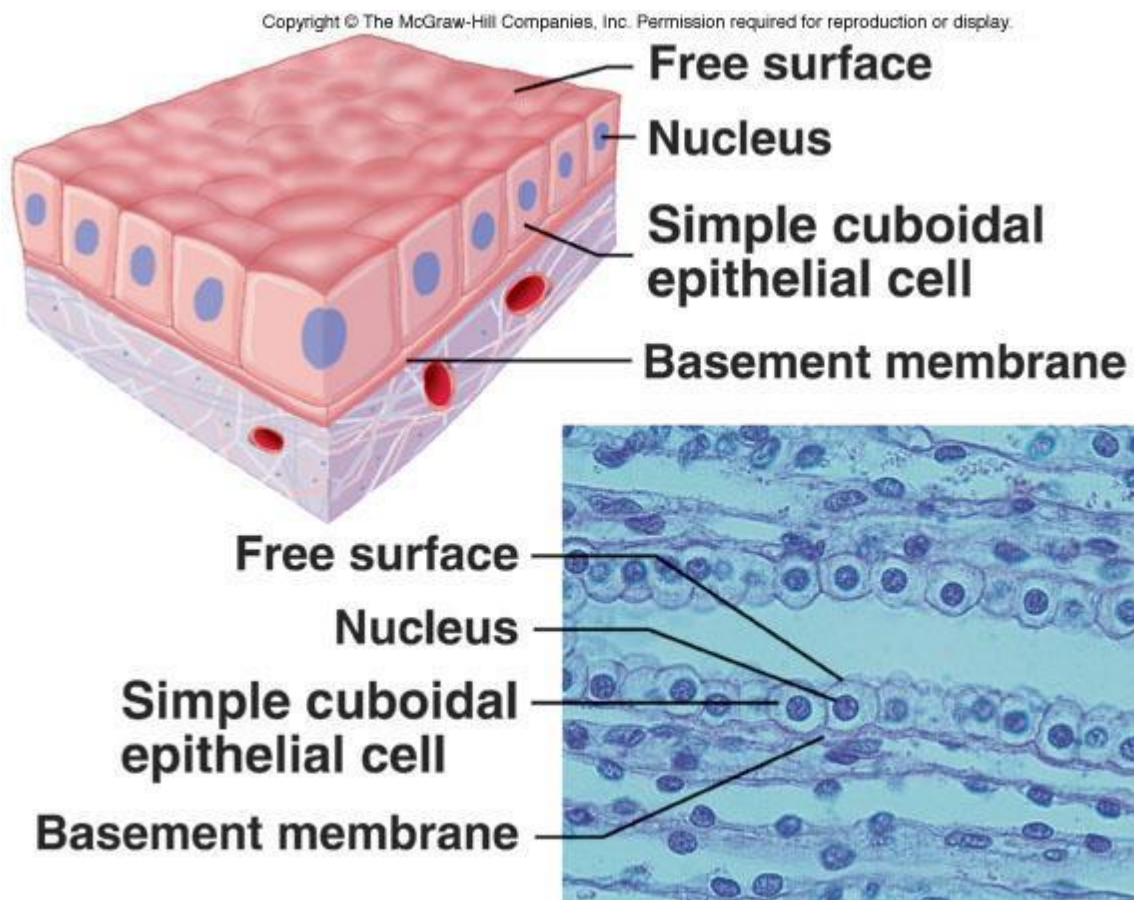
(a) Simple squamous epithelium

2-Simple cuboidal epithelial tissue : cells that have a basic cube shape. Typically the cell's height and width are about equal.

Location: thyroid gland and proximal renal tubule .

Function: secretion and absorption.

Location: Kidney tubules; ducts and secretory portions of small glands, ovary surface



2- (b) Simple cuboidal epithelium

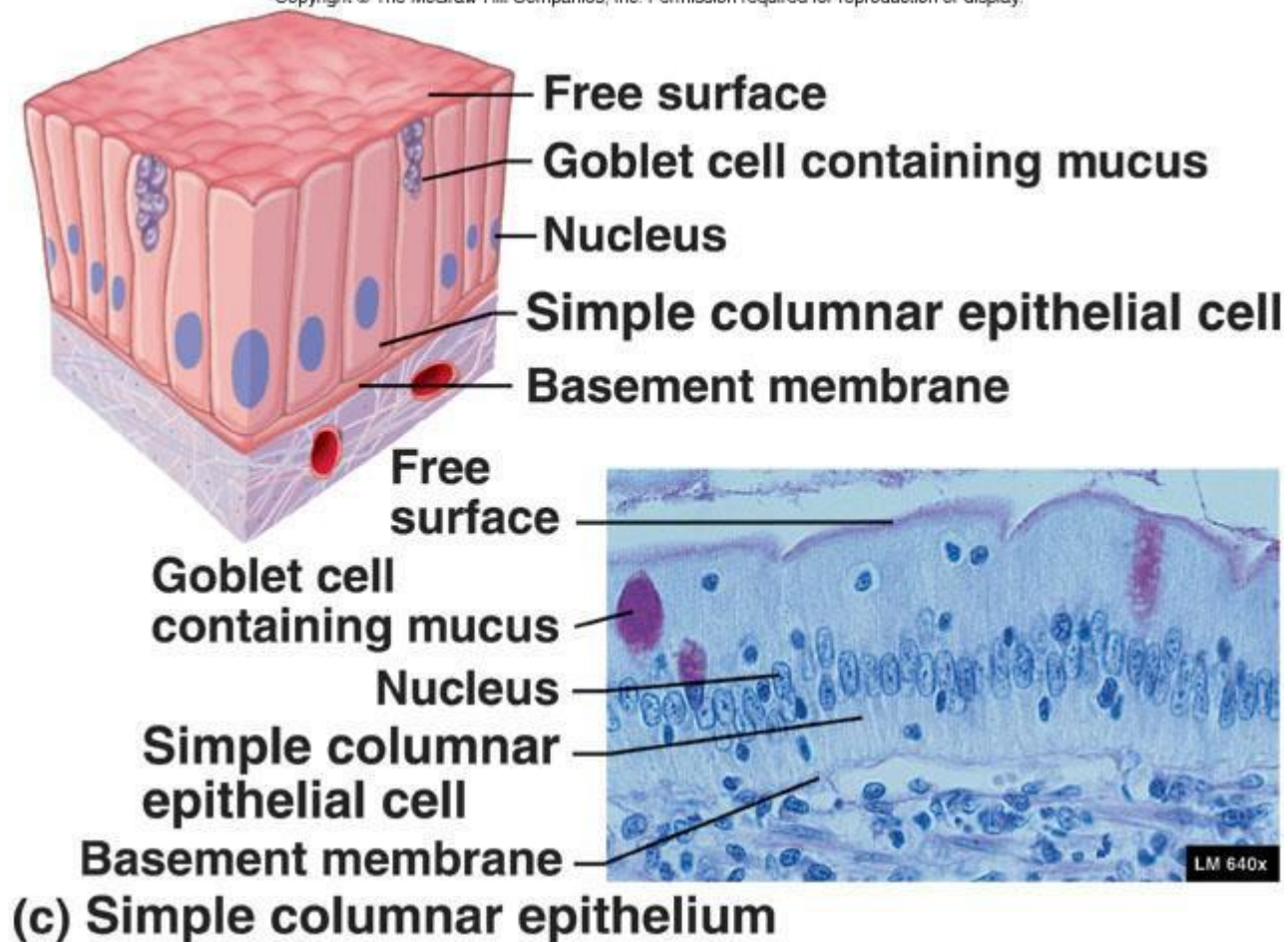
3-Simple columnar epithelial tissue: tall, rectangular or column-shaped cells.

Typically taller than they are wide.

Function: Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliated action.

Location: conciliated type lines most of the digestive tract (stomach to anal canal), gallbladder and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.

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Connective Tissue

Connective tissue (CT) is one of the four types of biological tissue that support, connect, or separate different types of tissues and organs in the body. The other three types are epithelial, muscle, and nervous tissue. Connective tissue is found in between other tissues everywhere in the body, including the nervous system. In the central nervous system, the three outer membranes (the meninges) that envelop the brain and spinal cord are composed of connective tissue.

Classification of Connective tissue :

1- Connective tissue proper :

A-♣ Loose connective tissue :

1-Areolar connective tissue.

2 -Adipose tissue.

3 -Reticular tissue.

4 -Mucoid tissue e.g. – Umbilical cord

B-♣ Dense connective tissue :

1 -Fibrous tissue.

2 -Elastic tissue.

2- Specialized connective tissue :

Skeletal tissue : Bone and Cartilage

A- Cartilage :

1 -Hyaline cartilage

2 -Fibro cartilage.

3-Elastic cartilage

B - Bone :

1 - Compact bone.

2 -Spongy bone.

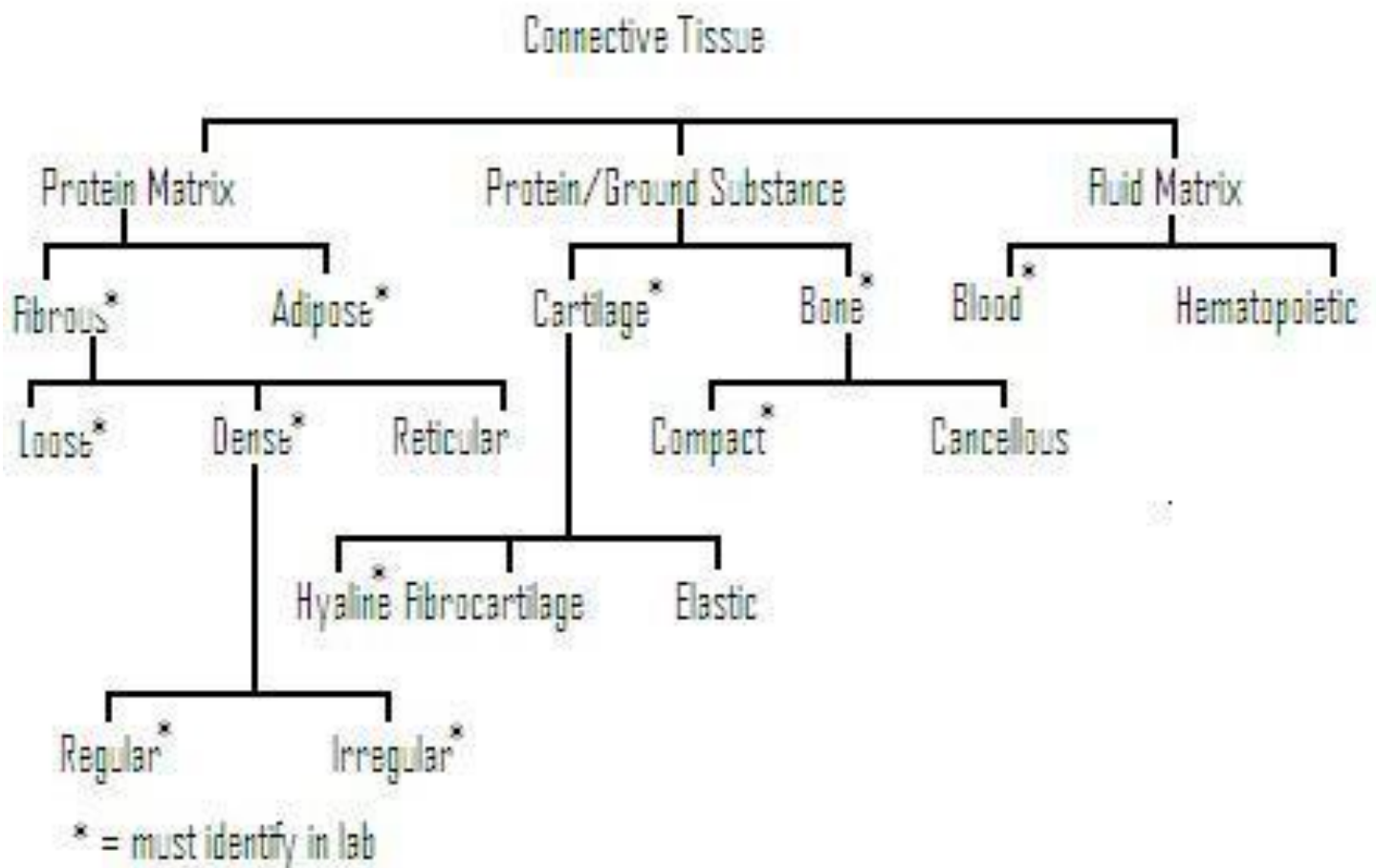
C - Blood .

D - Lymph .

Function of connective tissue :

1. Protect and support other cells by forming capsule.
2. They protect the tissue against foreign invasion.
3. They carry blood to the cells.
4. The ground substance prevents spread harmful substances during inflammation.

Classification of Connective tissue :



Cells of Connective tissue:

1. Mesenchyme cells - embryonic cells which persist in the adult and are capable of differentiation and proliferation during regeneration.

2. Fibroblasts - large, flat, branching cells which appear spindle-shaped in a side view. Fibroblasts have large, oval and faint staining nuclei with one or two obvious nucleoli.

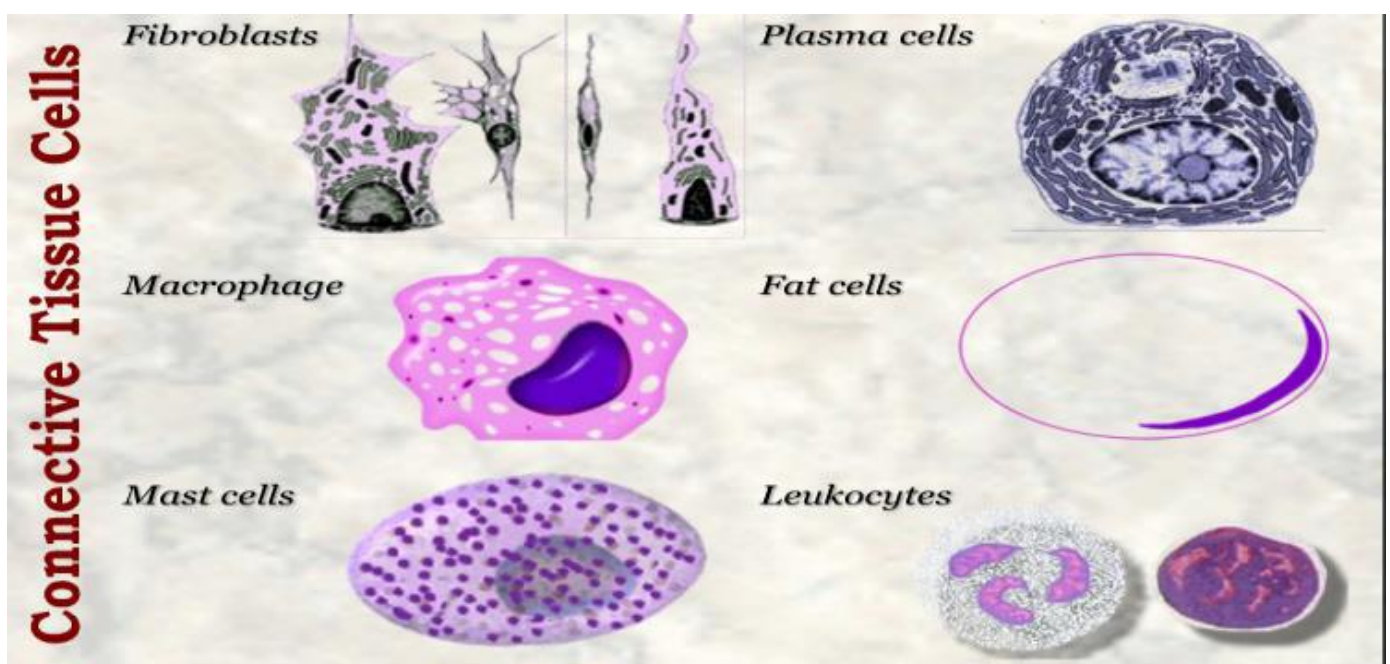
3. Macrophage (histiocyte) /next in abundance to the fibroblasts in loose connective tissue, these cells are initially non-motile. During inflammation, they become very actively amoeboid and phagocytic. The nucleus of this cell type is often indented and dark staining. These cells are an important component of the reticulo endothelial system (RES) located in the spleen, liver, lymph nodes and other organs.

4. Adipose cells / These cells are commonly seen in loose connective tissue (areolar). They are often found arranged around small blood vessels. Initially they resemble fibroblasts but with numerous vacuoles of fat droplets.

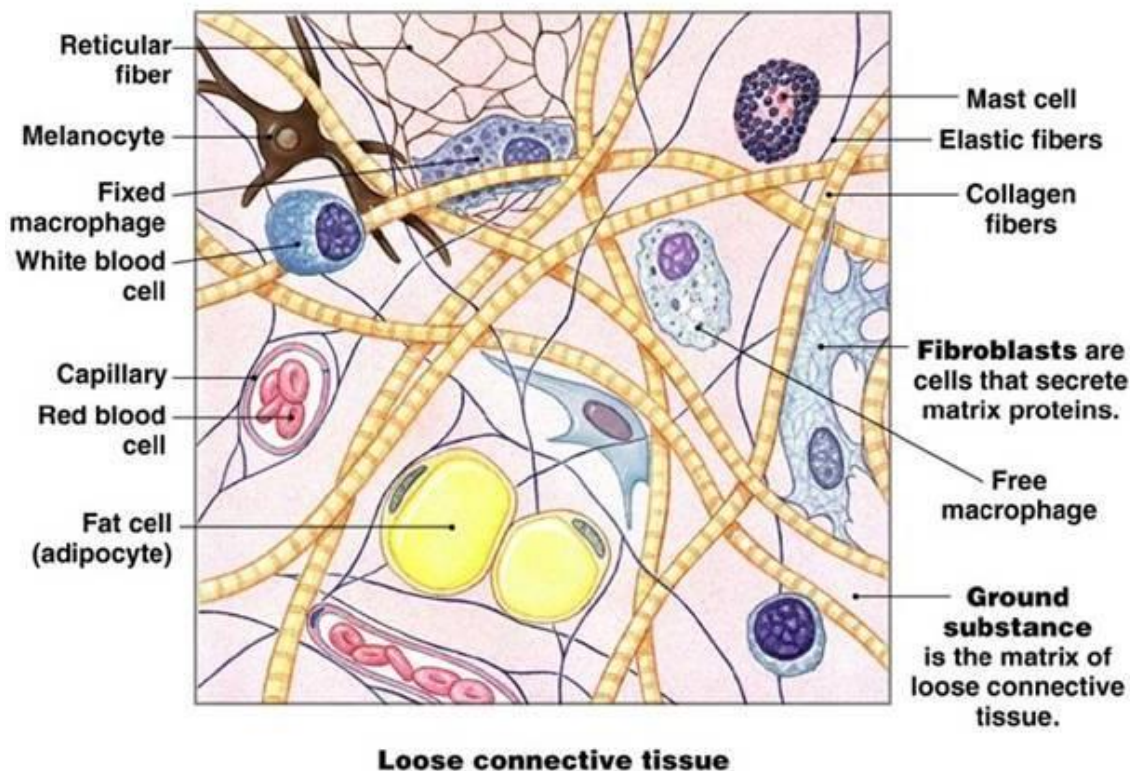
5. Leukocytes - are white blood cells which wander into the connective tissues surrounding blood vessels.

- **Eosinophiles** are very common throughout the respiratory and digestive tracts, as well as in active mammary tissue.
- **Neutrophils** are found at sites of inflammation. Plasma cells, derived from B-lymphocytes, are common in areas of chronic inflammation

6. **Mast cells** - are large cells (20 to 30 μm) filled with deeply basophilic granules which often obscure the nucleus. They are usually adjacent to blood vessels. Like the blood basophils, these cells contain mediators of immediate hypersensitivity such as histamine, heparin and serotonin.



Cell connective tissue



Components of connective tissue:

1. Extracellular Matrix:

Extracellular matrix is a collection of extracellular molecules secreted by cells that provides structural and biochemical support to the surrounding cells. Mainly have two types:

- a. Ground substances (Glycoprotein and Glycosaminoglycan's).
- b. Fibers (Collagen, reticular, and elastic fibers).

2. Cells.

Matrix : Matrix is produced by the cells of the tissue and can be fluid, gel-like, or solid

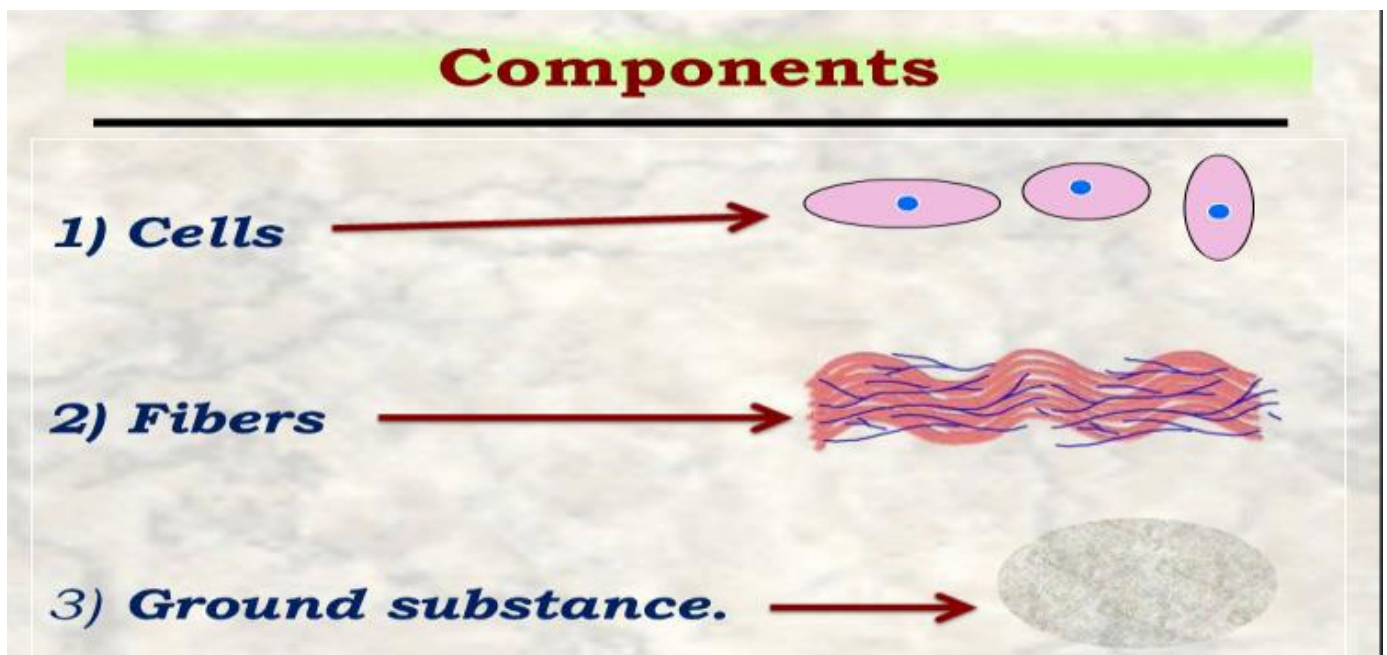
Connective tissues contains a matrix and 3 types of fibers :

1- Collagenous fibers : Collagenous fibers provide **strength**. They are made of collagen and consist of bundles of fibrils.

2- Elastic fibers : Elastic fibers make tissue **-stretchable** and are made of elastin.

3- Reticular fibers : Reticular fibers **join** connective tissues to other tissues.

Reticular fibers consist of one or more types of very thin collagen fibers.



1- Connective Tissue Proper :

♣ Loose connective Tissue:

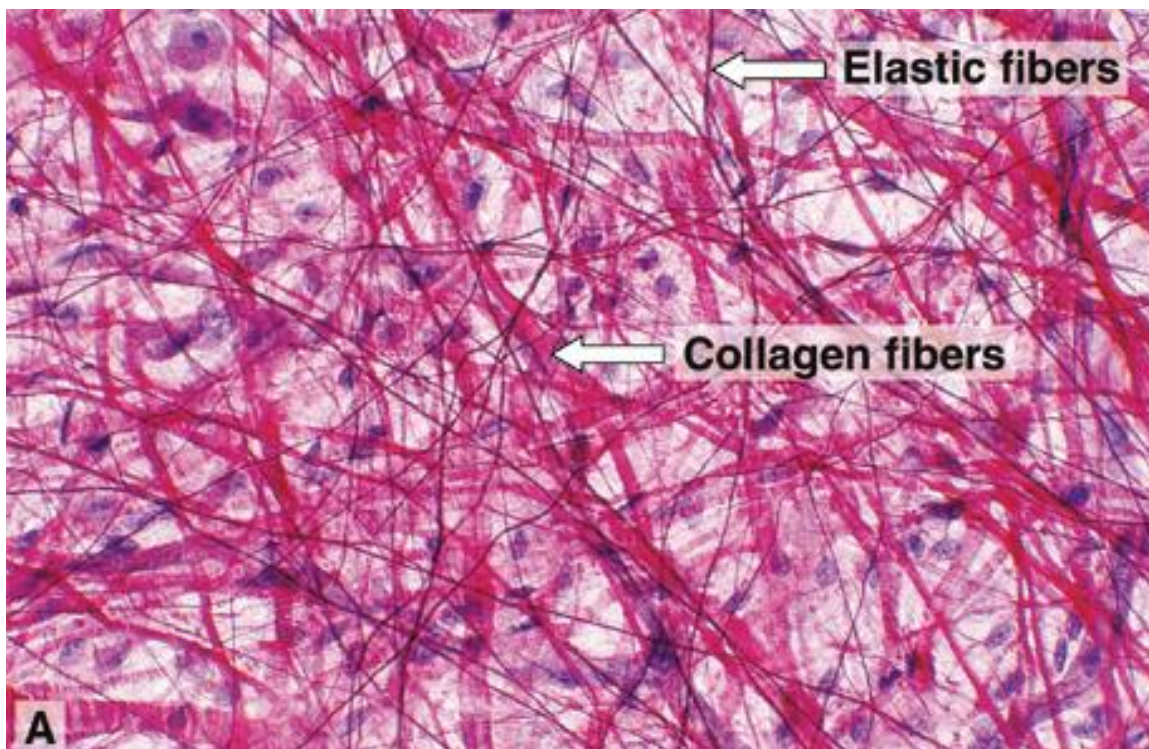
This type of tissue contains many cells, a loose arrangement of fibers, and moderately viscous fluid matrix.

1-Areolar : Loose areolar connective tissue is the most widespread type of connective tissue proper. It underlies almost all of the epithelia in the body.

Functions : Support and binding of other tissues, holding body fluids, defending the body against infection, storing nutrients as fat.

It contain a 2 types of fibers :

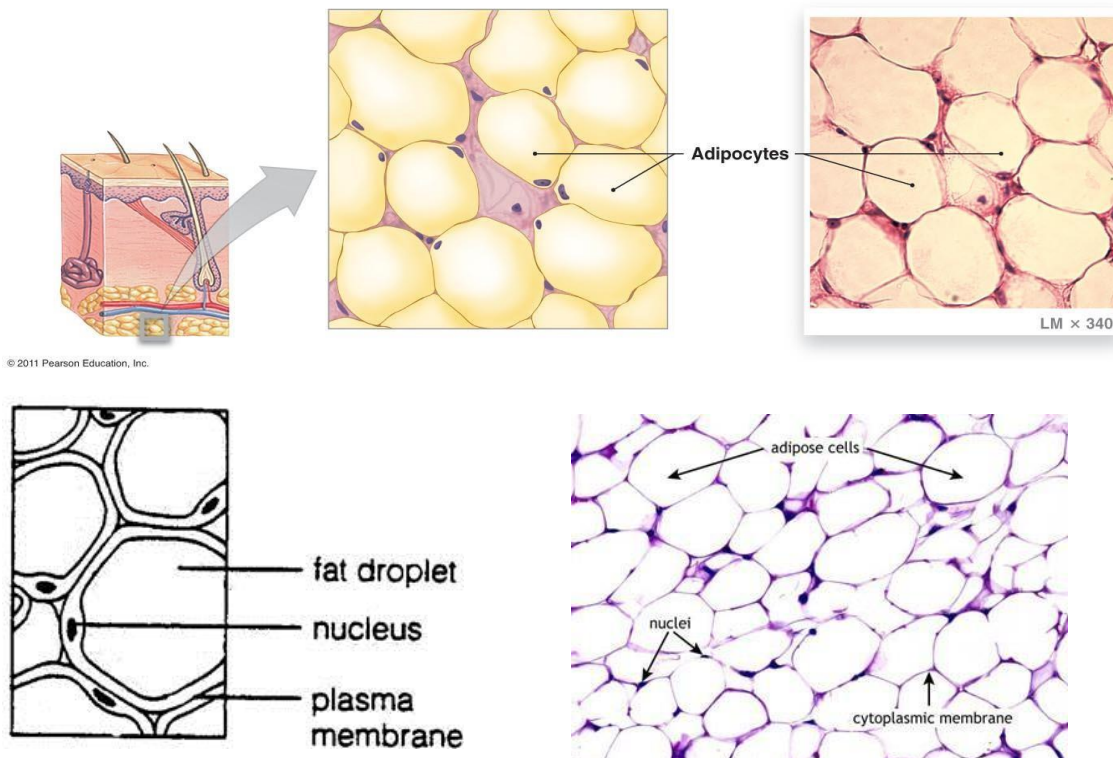
- White or collagenous fibers . - Yellow or elastic fibers .



1-Adipose :

Loose adipose tissue is crowded with fat cells, which account for 90% of its mass. Adipose tissue is richly vascularized. It removes lipids from the bloodstream after meals and later releases them into the blood, as needed.

The structure of adipose tissue deep to the skin



Function : Reserve food fuel, insulates against heat loss, supports and protects organs.

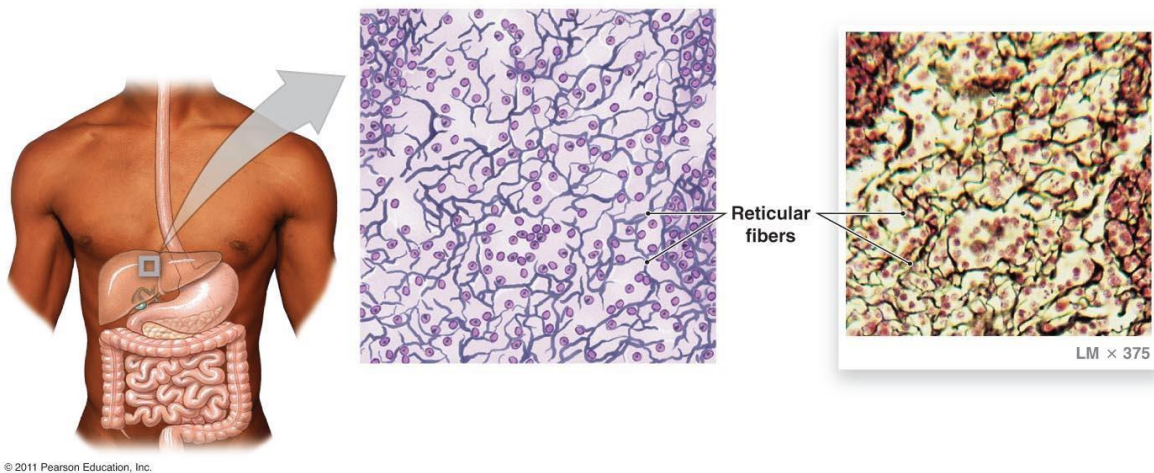
Location : Much of the body's adipose tissue is found in the hypodermis, but it is also abundant in the mesenteries and forms cushioning pads around the kidneys and behind the eyeballs.

2- Reticular :

Loose reticular tissue is similar to areolar tissue but the only fibers in its matrix are reticular fibers. Bone marrow, spleen and lymph nodes consist largely of reticular connective tissue .

Function : Form a soft internal skeleton that supports other cell types like white blood cells, mast cells, macrophages.

The structure of reticular tissue in the liver



Dense Connective Tissue :

In this type of tissue, the collagen fibers are densely packed, and arranged in parallel. This type of tissue is found in ligaments (which link bone to bone at joints) and tendons (connections between bones or cartilage and muscle). These are powerfully resistant to axially loaded tension forces, but allow some stretch.

These three types of fibers are combined in different levels to produced connective tissue with different properties. For example, if a tissue has more elastin it will be **stretchy**. If the tissue has more collagenous fibers it will be **sturdy and strong**.

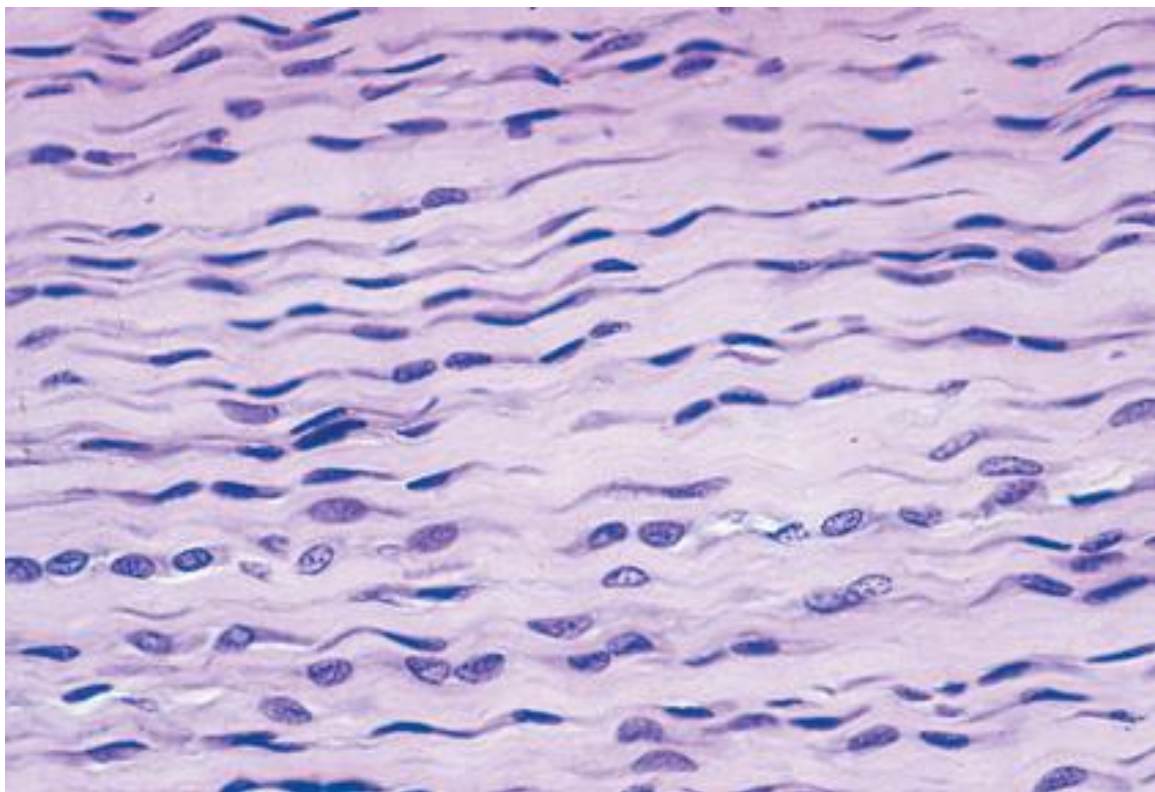
Dense connective tissue : include :

1 - Dense Regular connective tissue :

Appearance: Fibers are –regularl in the sense that they all run parallel to each other or in the same direction.

Location: Tendons, Ligaments, Apo neurosis (similar to tendons)

Function: Their main function is to support other tissues, but mainly in one direction because the fibers all run in one direction.

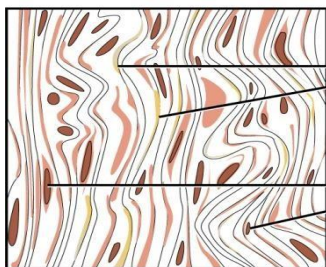
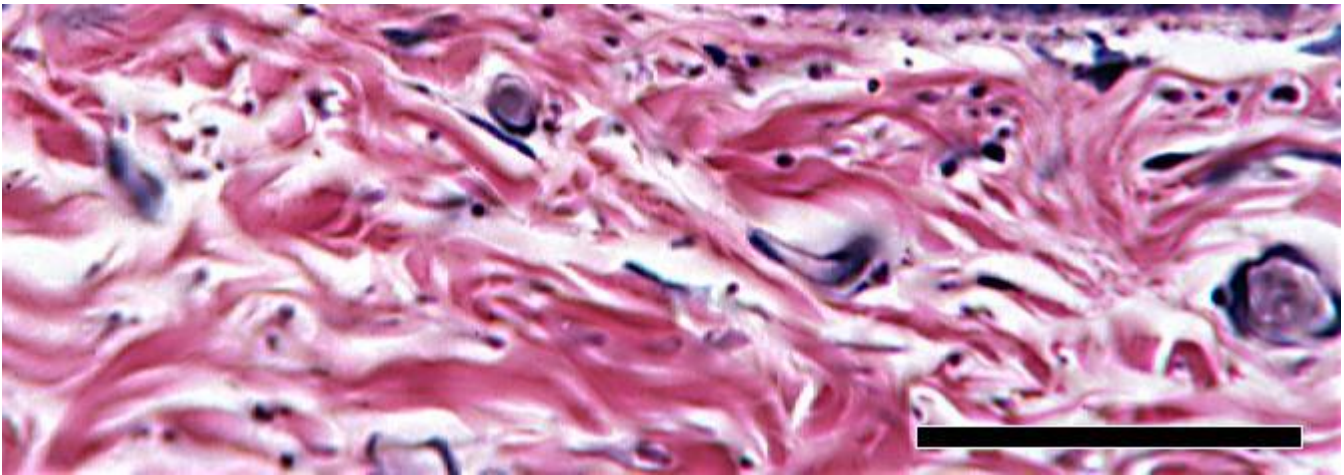


2- Dense Irregular connective tissue :

Appearance : Fibers are -irregular in the sense that they run in multiple directions.

Location : Fibrous capsules of organs and joints, dermis of the skin, sub mucosa of the digestive tract.

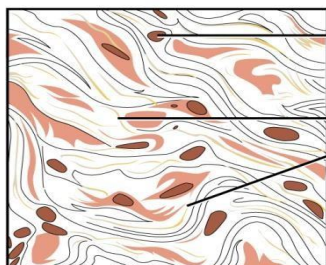
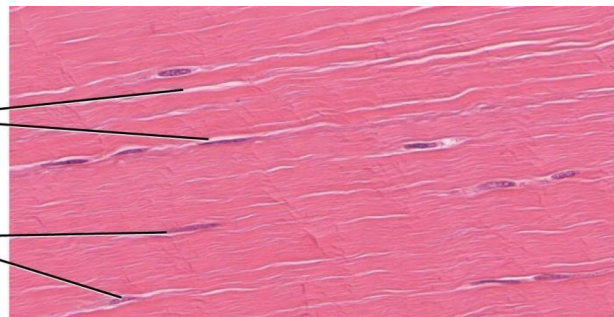
Function: Dense irregular tissue functions to support tissues in multiple directions. This is because the fibers run in multiple directions



(a) Regular dense

Collagen
fibers

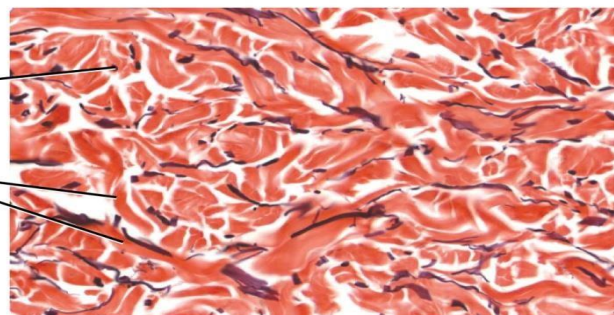
Fibroblast
nuclei



(b) Irregular dense

Fibroblast
nuclei

Collagen
fiber
bundles

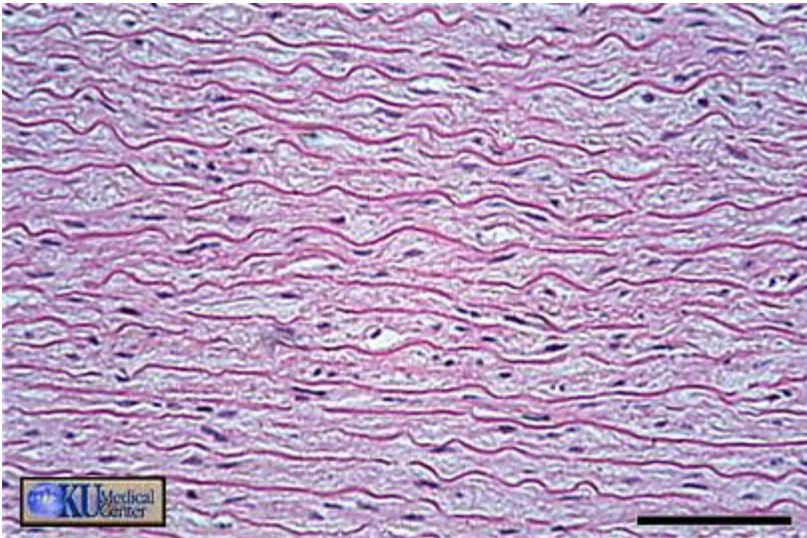


3. Elastic connective tissue :

Has the ability to receive a relatively large amount of blood all at once with a lot of pressure. The aorta for example has to expand and recoil RIGHT AWAY because the next heart beat is on the way. It's just like a dense regular connective tissue but with a high proportion of elastic fibers instead.

Location : **Between vertebrae of the spinal column and in the blood vessel walls.**

Function: Stabilizes of vertebrae and penis cushions shocks, permits expansion and contraction of organs .



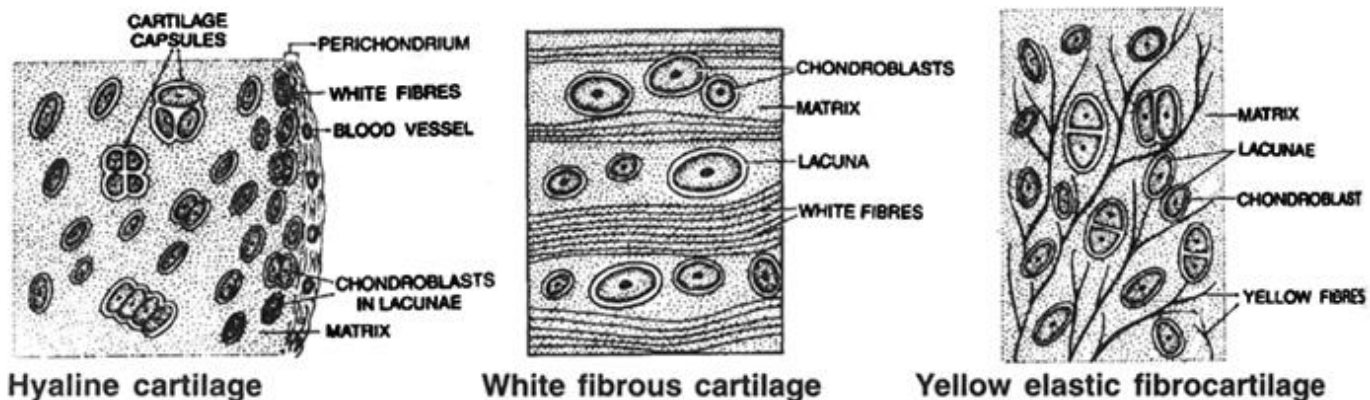
<p>Compare <i>between</i> epithelial and connective tissues</p>
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Epithelial tissues	Connective tissues
<ol style="list-style-type: none"> 1. Origen from three germ layers. 2. It's have free surface. 3. Cover external surface or lining internal cavity 4. Attached to basement membrane. 5. It's have specializations of cell surfaces. 6. The cell attach to each other by cell junctions. 7. The tissue formed from cells and very little of ground substance. 8. A vascularity (loss blood vessels) 	<p>Origen from only mesoderm layer Don't have free surface Major functions connect and support tissues. Loss basement membrane. Loss specializations of cell surfaces. Loss cell junctions. The tissue formed from three components: cells, fibers and much of ground substance). Contain blood and lymph vessels.</p>

• Cartilage :

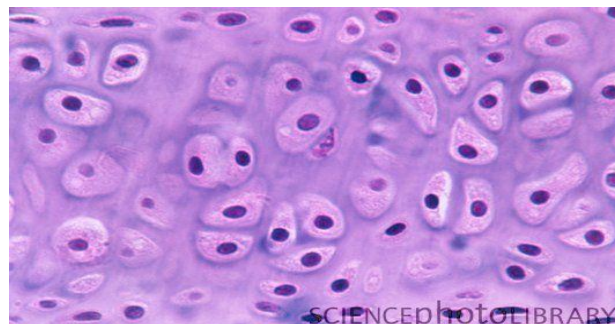
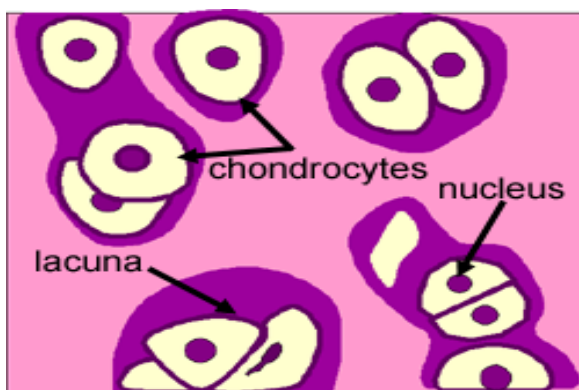
Is a flexible connective tissue , including the joints between bones, the rib cage, the ear, the nose, the bronchial tubes and the intervertebral discs. It is not as hard and rigid as bone, but it is stiffer and less flexible than muscle.

There are three types of cartilage:



1- Hyaline Cartilage :

This type of cartilage has a glassy appearance when fresh. **Hyaline cartilage** has widely dispersed fine **collagen fibers** ,which strengthen it. It has a **perichondrium**, and it is the **weakest** of the three types of cartilage.



Function : Supports and reinforces

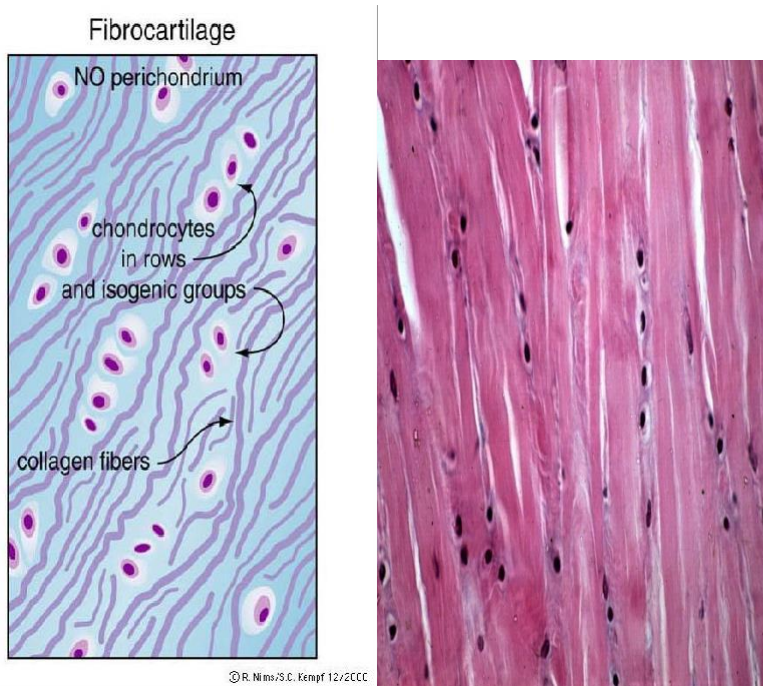
Location : found in the **ribs, nose, larynx, trachea**. Is a precursor of bone.

2 - Fibro cartilage :

Matrix is similar to hyaline cartilage but less firm. Thick collagen fibers predominate. This is the **strongest** kind of cartilage, because it has alternating layers of hyaline cartilage. This type of cartilage *does not* have a **perichondrium** as it is usually a **transitional layer** between hyaline cartilage and tendon or ligament.

Function : Absorbs compressive shock.

Location : Is found in **intervertebral discs, joint capsules, ligaments**.

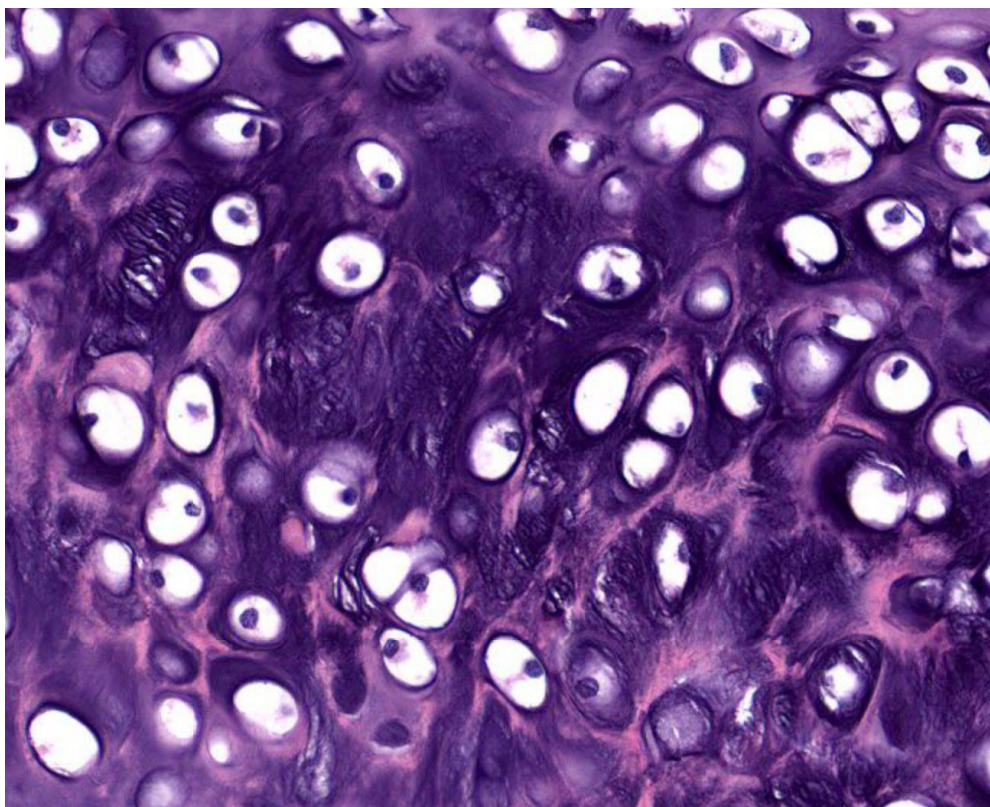


3- Elastic Cartilage :

Similar to hyaline cartilage but more elastic fibers in the matrix. In **elastic** cartilage, the chondrocytes are found in a threadlike network of elastic fibers within the matrix. **Elastic** cartilage provides strength, and elasticity, and maintains the shape of certain structure such as the external ear. It has a **perichondrium**.

Function: Maintains shape of structure while allowing great flexibility.

Location : Is found in the **external ear, epiglottis and larynx**



Elastic cartilage: matrix

- **Bone tissue :**

Bone tissue is a type of connective tissue that contains lots of calcium and phosphorous salts. About **25%** of bone tissue is water, another **25%** is made up of protein fibers like collagen. The other **50%** of bone tissue is a mixture of mineral salts, primarily calcium and phosphorous.

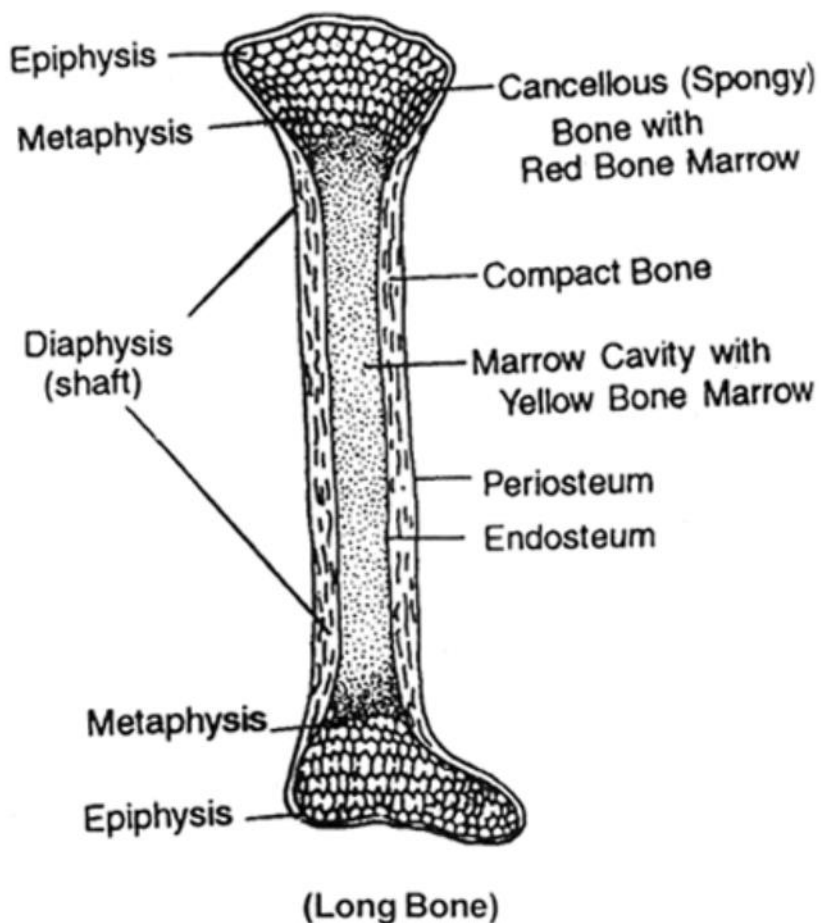
structure of long bone :

Long bone has three region

Epiphysis

Diaphysis

Metaphysis



Bone cells :

1 -Osteoblasts :- These are the bone forming cells (osteogenic). These are cuboidal or trapezoid in shape with the nuclei lining at one or the other. They have many processes. The cytoplasm is rich with RNA.

FUNCTION :

- 1) **synthesis of organic components of bone matrix** (growth, response to fracture, remodeling)
- 2) regulate **mineralization** of bone matrix
- 3) regulate **activity of bone resorption** (osteoclasts)

2 - Osteocytes :- They flattened , ovoid shaped lying in the lacunae and each consists of darkly staining nucleus with small amount of cytoplasm and numerous branching processes. The processes of an osteocytes joined with the other osteocyte (adjacent cells) , there function generator osteoblasts when the bone has been laid down.

3 -Osteoclasts:-

- derived from the fusion of mononuclear hemopoietic cells (mononuclear phagocyte system)
- **involved in resorption of bone matrix**
- found in depressions on the bone surface of bone tissue **-How ship's lacunae**
- **5-50 nuclei, very large cells -40µm, motile cells**
- abundant **mitochondria** -acidophilic cytoplasm
- great number of **lysosomes**

Types of bone tissue :

1- Compact bone :

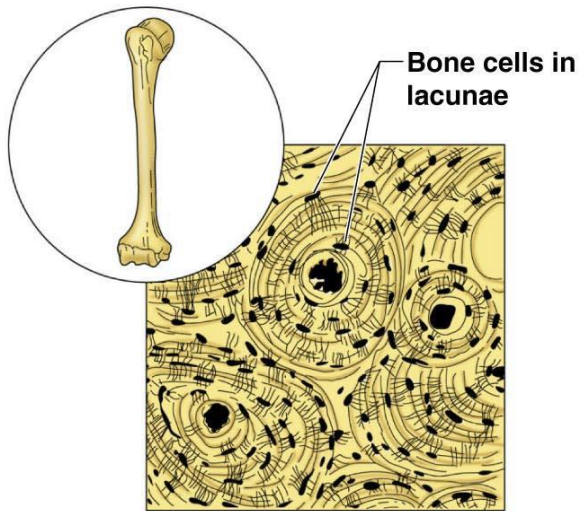
1- Periosteum: covering the long bone, and formed of two layers:-

- Outer fibrous layer of collagen fibers.
- Inner cellular layer of osteogenic cells and osteoblasts.

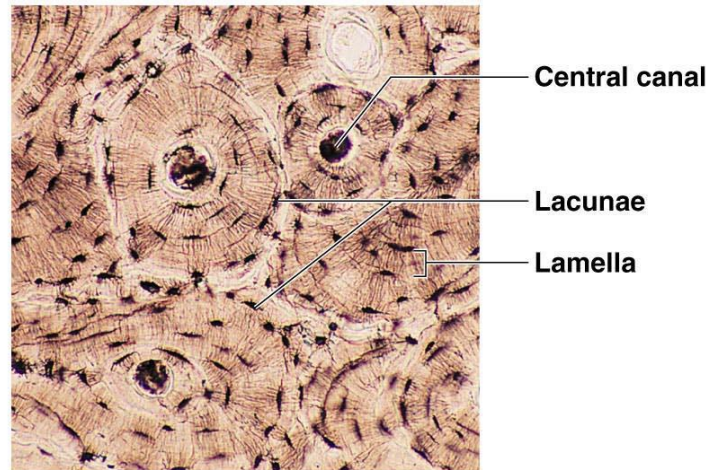
2- Endosteum: a cellular layer lining the bone cavities, and formed of osteogenic cells and osteoblasts.

3- Haversian system (osteon):- Bone lamellae are arranged concentrically around the blood vessels. The bone lamellae are formed of osteocytes inside lacunae and canaliculi embedded in calcified matrix.

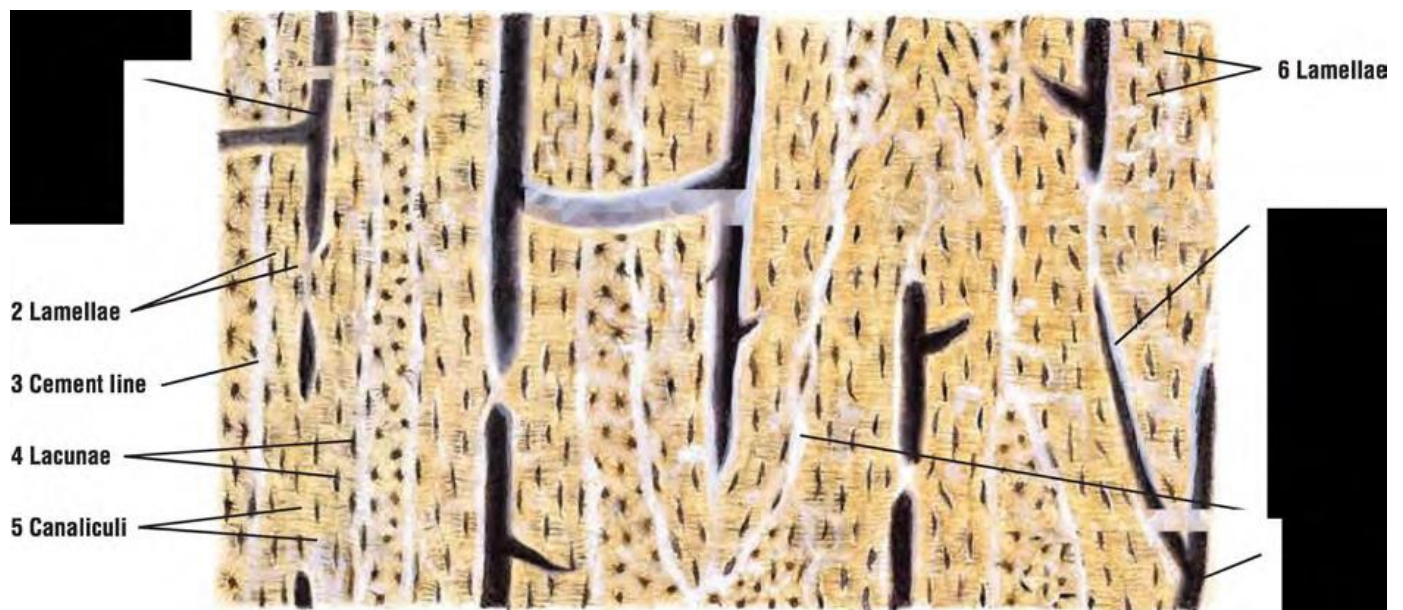
4- Volkmann`s Canals:- They are transverse canals connecting blood vessels in the Haversian canals to each other and to those in the periosteum and in marrow cavities.



(a) Diagram: Bone

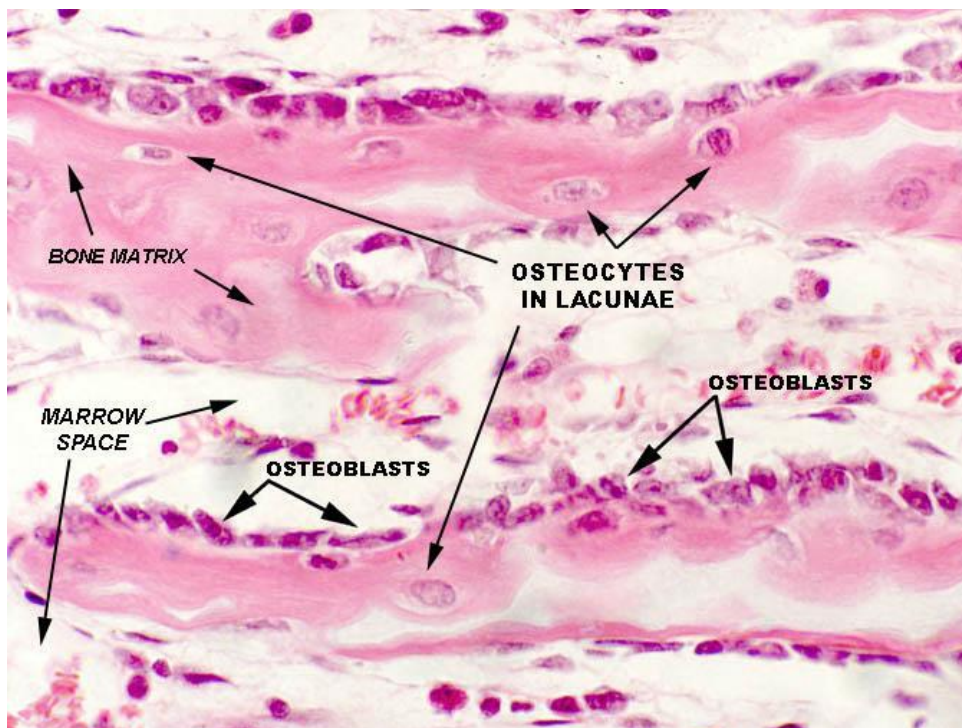


Photomicrograph: Cross-sectional view of ground bone (250x).



2- Spongy or cancellous bone :

- Network of irregular plates (**trabeculae**)
- Bone marrow between trabeculae, **covered by endostium**
- Parallel lamellae, osteocytes between lamellae, Haversian systems only in thick trabecules



Function :

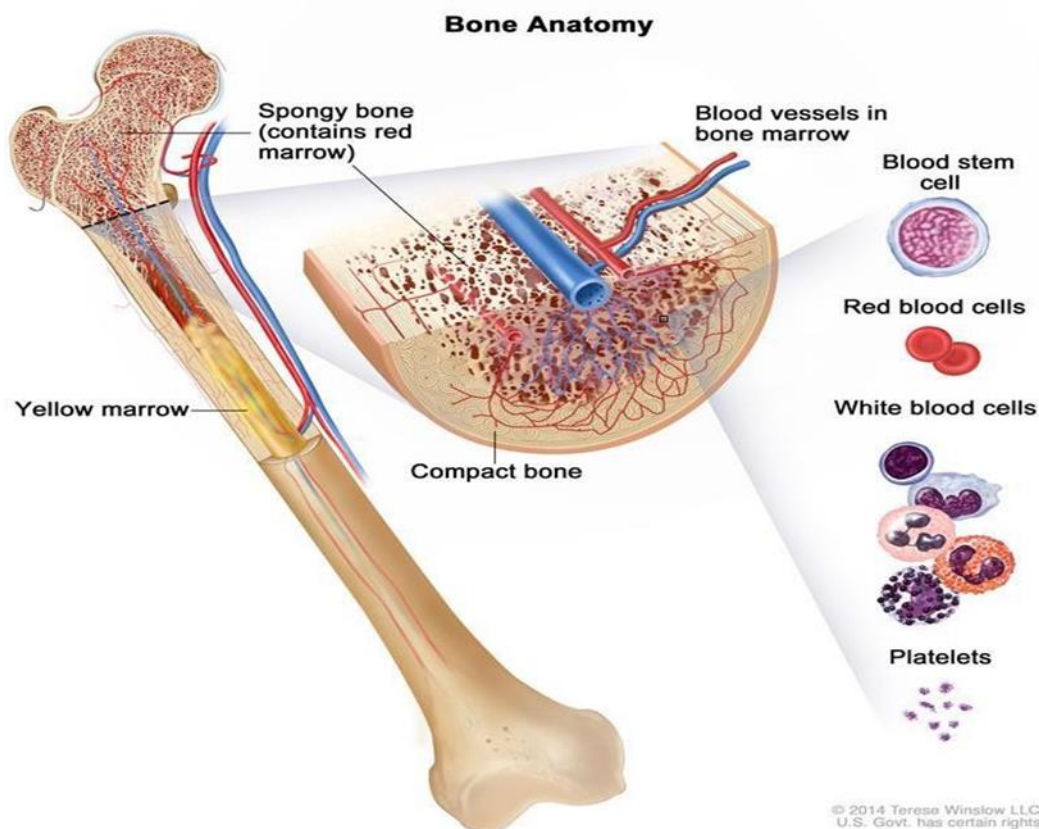
- 1- Support: Bones provide a framework for the attachment of muscles and other tissues.
- 2- Protection: Bones such as the skull and rib cage protect internal organs from injury.
- 3- Movement: Bones enable body movements by acting as levers and points of attachment for muscles.

- 4- Mineral storage: Bones serve as a reservoir for calcium and phosphorus, essential minerals for various cellular activities throughout the body.
- 5- Blood cell production: The production of blood cells, or hematopoiesis, occurs in the red marrow found within the cavities of certain bones.
- Energy storage: Lipids, such as fats, stored in adipose cells of the yellow marrow serve as an energy reservoir

Bone marrow :

It is present in the cavity of compact and spongy bone , consist of reticular connective tissue , fibers ,RBC,WBC ,platelets, fat cells and blood vessels . They are two types of bone marrow :

1. Red bone marrow.
2. Yellow bone marrow.



3- Blood :

• Blood/ is the most atypical connective tissue. It does not bind things together or give mechanical support. It is classified as connective tissue because it develops from mesenchyme and consists of blood cells surrounded by a non-living matrix. Blood tissues are found inside the blood vessels. (arteries, arterioles, capillaries, venules and veins). Be able to identify and describe the major function(s) of the following:

- Erythrocytes (RBCs)
- Granulocytes (neutrophils, eosinophils, basophils)
- A granulocytes (lymphocytes, monocytes)
- Platelets
- Know the approximate percentage of each type of leukocyte present in normal blood.
- Be able to describe the differences between plasma and serum.
- Introduction
- 1- Erythrocytes (Red Cells)
- 2- Platelets
- 3-Leukocytes (Whit Cells)
- a-Granulocytes
- b-A granulocyte

Composed of:

- 1- Cells
- 2- Plasma : contents :
- 3- Water: 92%
- 4- Proteins: 7%
- a- Albumin: 58%
- b- Immunoglobulin's: 37%
- c-Fibrinogen: 4%
- d- Other proteins: 1%
- e- Other stuff: 1% (electrolytes, nutrients, respiratory gases, waste products)
- f- Plasma clots, serum does not clot
- g- Serum = plasma minus clotting factors (it's what's left after plasma clots)

1- Erythrocytes (Red Cells)

- 1- Nicely designed biconcave disk shape
- 2- Roughly 7 μm wide and 2 μm thick

- 3- Cytoskeleton: spectrin, ankyrin, actin
- 4- No nucleus
- 5- Cytoplasm: water (65%); organelles (1%); hemoglobin (34%)

- 2- Platelets
 - 1- Life span: 8-10 days
 - 2- Derived from megakaryocytes in bone marrow
 - 3- Normal number: $150-450 \times 10^9/L$
 - 4- About $2 \mu m$ in diameter
 - 5- No nucleus
 - 6- Function: help blood to clot

- 3- Leukocytes (Whit Cells)
- a- Granulocytes
 - 1- Neutrophils : 45-75% of differential count (between $2-8 \times 10^9/L$)
 - About $15 \mu m$ in diameter
 - Multi-lobed nucleus...

 - 2- Eosinophil : 1-4% of differential count (about $0.5 \times 10^9/L$)
 - About $15 \mu m$ in diameter
 - Large, gorgeous, orange-red (eosinophilic) granules in cytoplasm
 - Greek eos = first blush of dawn
 - Bi-lobed nucleus

 - 3- Basophils : Less than 1% of differential count (less than $0.3 \times 10^9/L$)
 - About $10 \mu m$ in diameter
 - Tons of large, deep blue (basophilic) granules in cytoplasm
 - Irregularly-shaped nucleus (hard to see under all those granules)
 - Functions: fight infection, mediate allergic responses

- b- A granulocytes
 - 1- Lymphocytes : 20-50% of differential count (between $1-4 \times 10^9/L$)
 - Most lymphocytes are small ($6-12 \mu m$) but some are larger (up to $20 \mu m$)

- Nucleus: dark staining; “clumpy and smudgy”
- 2- Monocytes : 1-8% of differential count (between $0.1-0.8 \times 10^9/L$)
- 12-20 μm in diameter
- Nucleus: indented, oval, kidney, or horseshoe-shaped. “Raked” chromatin.

Blood function :

- 1- Supply O₂ to different tissues .
- 2- Supply of nutrients to body tissues .
- 3- Remove of waste product such as CO₂ and urea .
- 4 – Immunological function .
- 5 – Coagulation .
- 6 – Regulation of body temperature .
- 7- Regulation of body PH (normal PH of human blood is 7.3 – 7.4)

4- Lymph :

Lymph is another type of fluid connective tissue. This clear fluid originates from blood plasma that exits vessels at capillary beds. A component of the lymphatic system, lymph contains immune system cells that protect the body against pathogen.

Muscular tissue

Muscle/ is an organ specializing in the transformation of chemical energy into movement.

Functions of muscle tissue:

- 1-Body movement (Locomotion)
- 2-Heartbeat.
- 3-Maintenance of posture.
- 4- Production of body heat (Thermogenesis)
5. Stabilizing joints.
6. Respiration (Diaphragm and intercostal contractions)
7. Communication (Verbal and Facial)
8. Constriction of organs and vessels
 - Peristalsis of intestinal tract
 - Vasoconstriction of blood vessels and other structures (pupils).

Characteristics:

- 1- Excitability:** Capacity of muscle to respond to a stimulus
- 2- Contractility:** Ability of a muscle to shorten and generate pulling force
- 3- Extensibility:** Muscle can be stretched back to its original length
- 4-Elasticity:** Ability of muscle to recoil to original resting length after stretched.

There are 3 Types of muscle tissue :

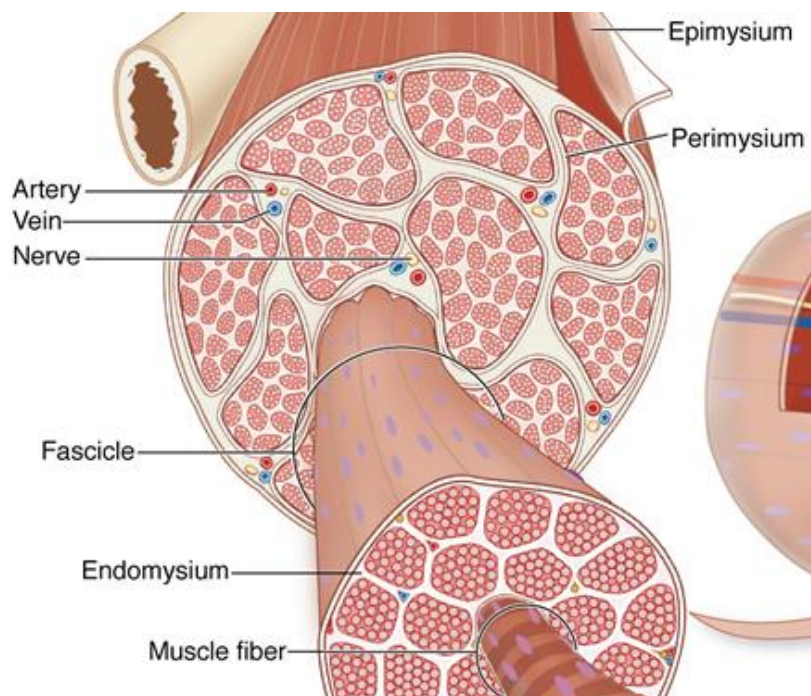
A- **Skeletal muscle**

- These muscles are responsible for movement of skeleton (locomotion), facial expressions, posture, respiratory movements and other types of body movement.
- Under voluntary (conscious) control; controlled by somatic motor neurons
- Appears striated under the microscope
- Skeletal muscle contains three layers of connective tissue:

Epimysium—this layer surround the entire muscle.

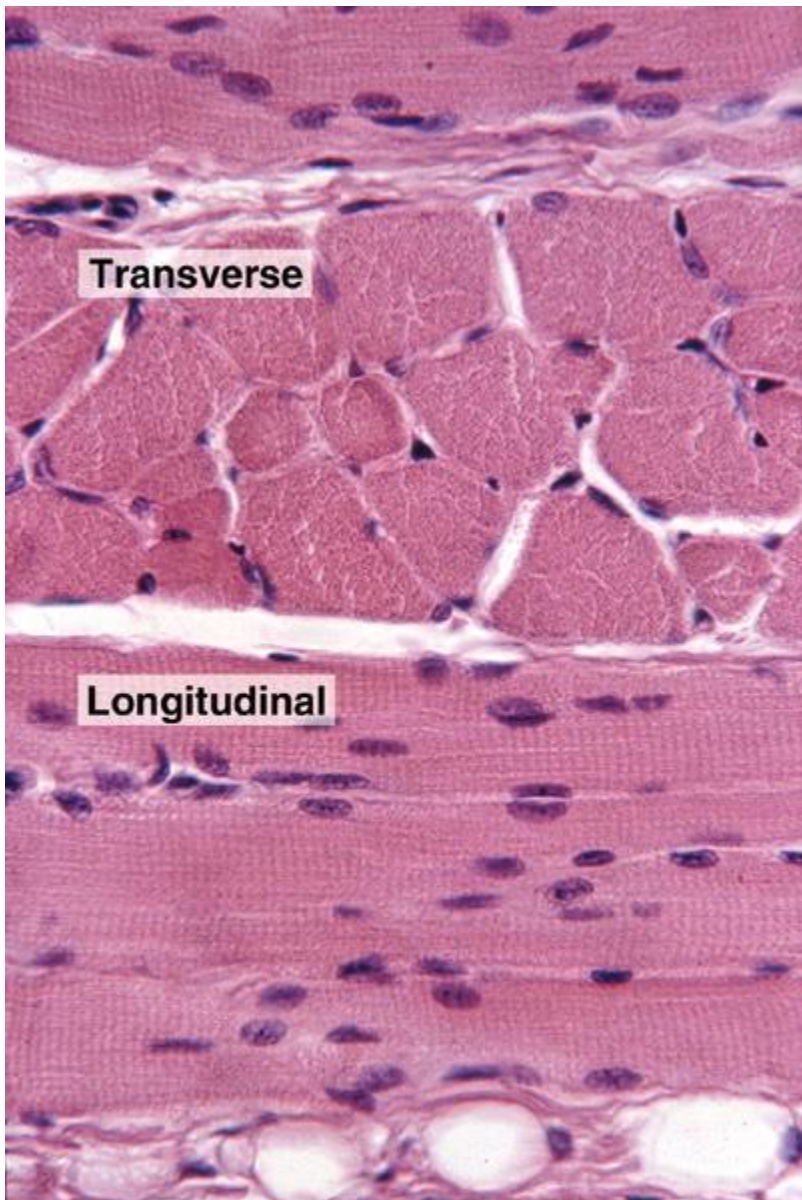
Perimysium—this layer is continuous with the epimysium and it surrounds bundles of muscle fibers.

Endomysium—this layer is continuous with the perimysium and it surrounds individual muscle fibers. It contains capillaries and nerve fibers that supply the



muscle fiber.

The cells of skeletal muscle are referred to as **muscle fibers**. The fibers are long, tapering cells that contain many nuclei (i.e., **multinucleated**). The cell membrane is called the **sarcolemma** and the cytoplasm is called the **sarcoplasm**.

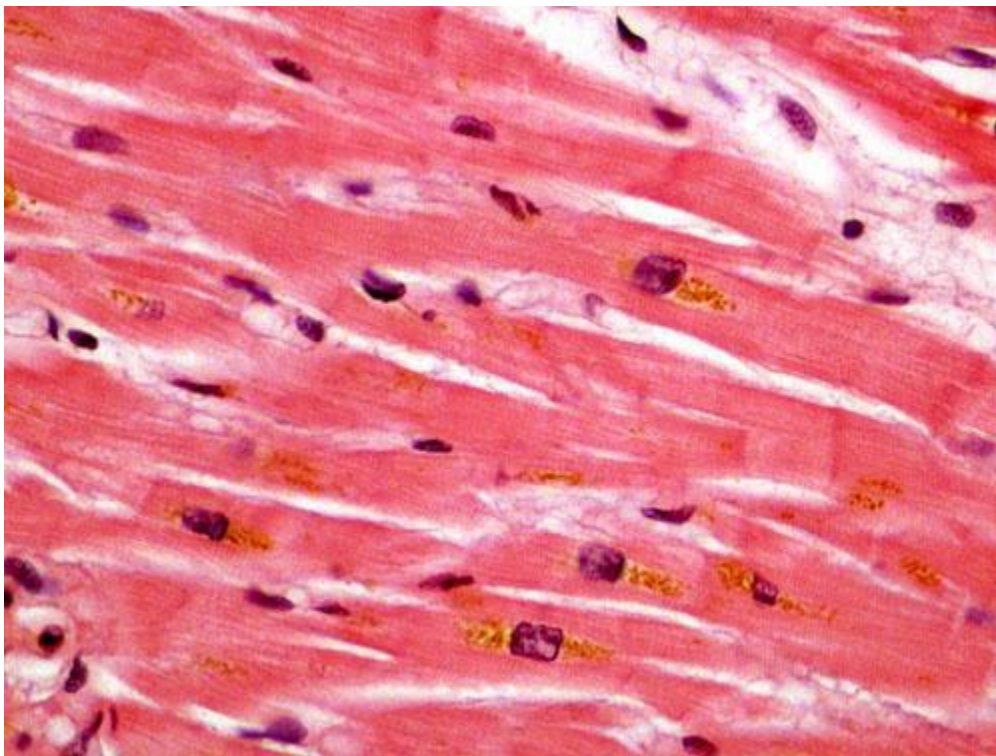


Transverse and longitudinal sections of skeletal muscle showing muscle fibers and the nuclei

B - Cardiac muscle :

Cardiac muscle is found only in the **heart**. Similar to skeletal muscle, cardiac muscle has a single, centrally-located nucleus.

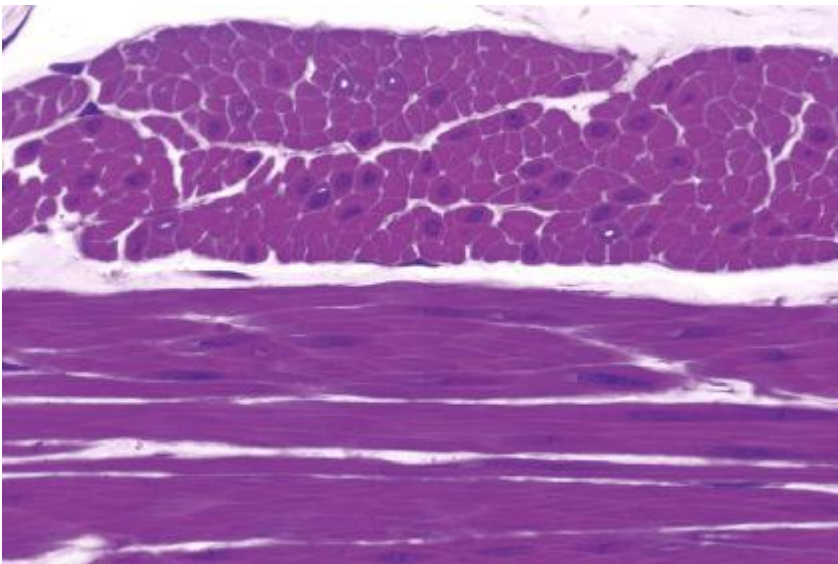
- This muscle is responsible for movement of heart (and blood).
- Under involuntary (unconscious) control involuntarily by endocrine and autonomic nervous systems.
- Also appears striated under the microscope.



c - Smooth muscle

Smooth muscle cells have a single, centrally-located nucleus and are spindle shaped. The walls of blood vessels, the tubes of the digestive system, and the tubes of the reproductive systems are composed primarily of smooth muscle.

- This muscle is responsible for movement of hollow organs such as digestive tract, uterus, bladder, blood vessels, skin, eye, glands.
- Also under involuntary (unconscious) control involuntarily by endocrine and autonomic nervous systems.
- Does not appear striated under the microscope.



Nervous tissue :

Nervous tissue is one of four major classes of vertebrate tissue. It is the specialized tissue that makes up **the central nervous system** and **the peripheral nervous system**. Nervous tissue is the main component of the nervous system: the [brain](#), [spinal cord](#), and nerves.

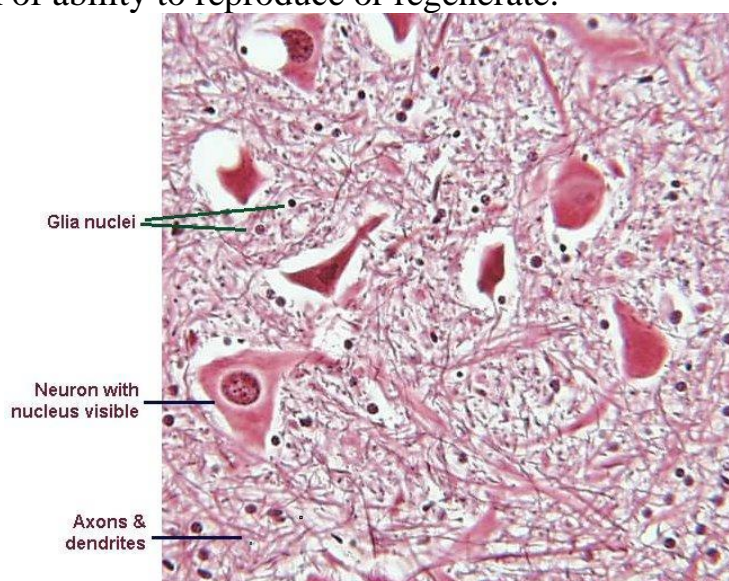
Nerve tissue :

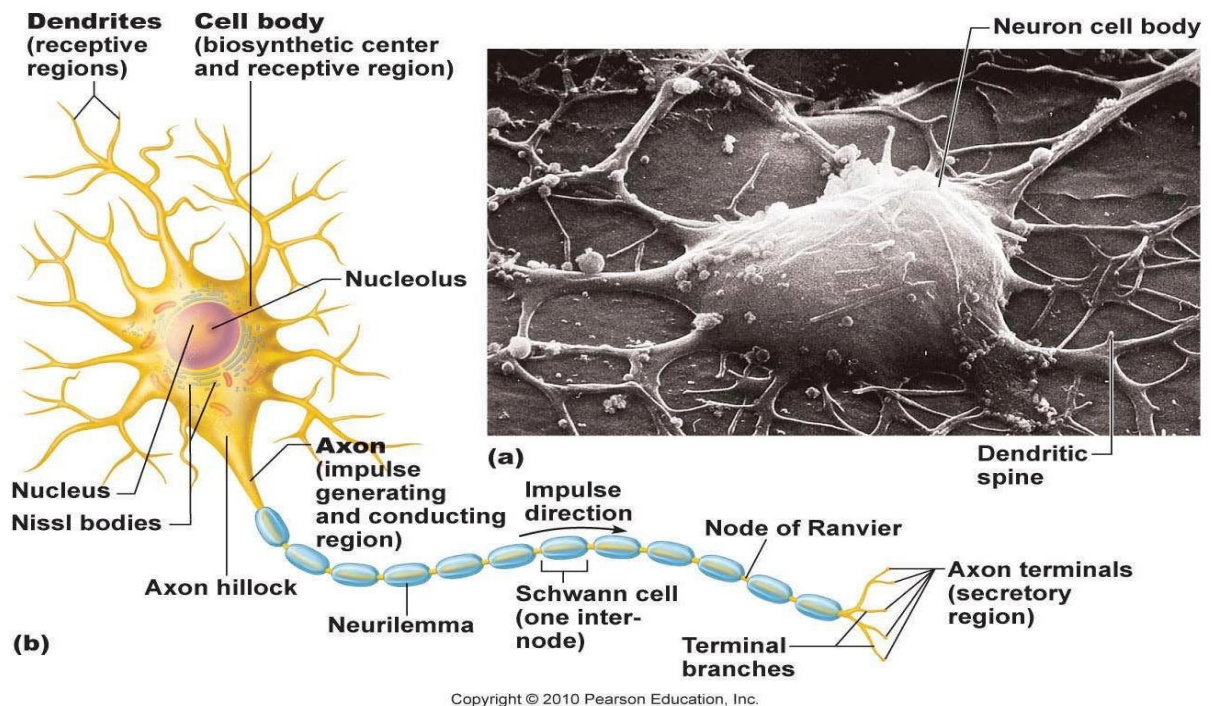
Nerve tissue is composed of 2 main types of cells :

A-Neurons - nerve cells that are specialized to detect and react to stimuli, by generating and conducting nerve impulses.

B-Neuroglia cells - accessory cells for filling spaces and supporting neurons.

All neurons have a cell body called **soma** which contains a nucleus, organelles, and a modified endoplasmic reticulum called **Nissl body**. Although there is **DNA** in the neuron, somehow DNA replication and mitosis do not occur, resulting in the neurons lack of ability to reproduce or regenerate.





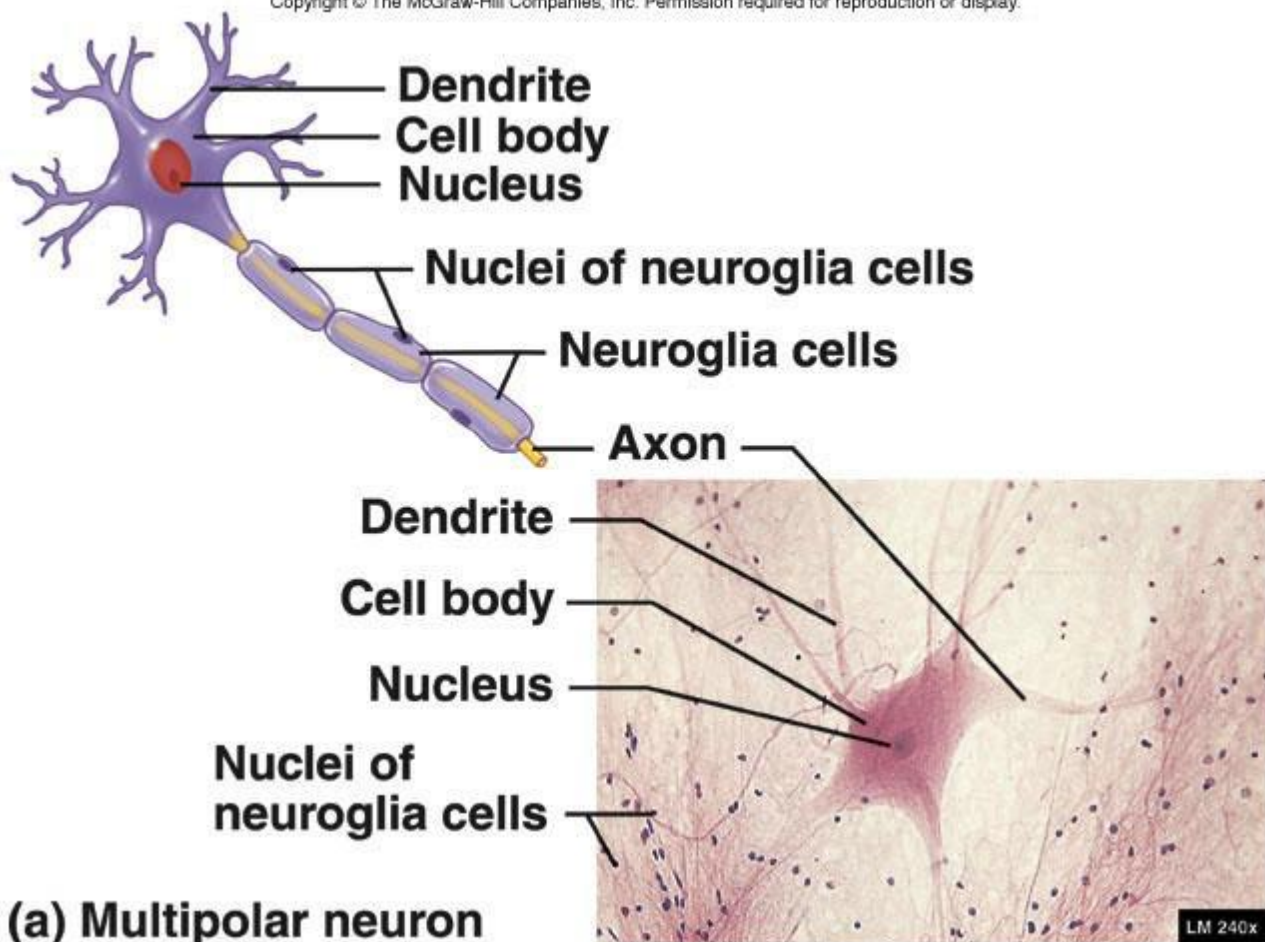
Extensions of the soma form nerve such as **dendrites** which conduct nerve impulses toward the soma, and **axon** which conducts nerve impulses away from the soma (to another neuron, or to an effect or organ).

- The number of dendrites ranges from 1(in unipolar and bipolar neurons) to thousands (in multipolar neurons).
- All neurons only contain 1 axon.
- Longer axons are enclosed by a lipoprotein substance called **myelin sheath** produced by a type of neuroglia cell called **Schwann cells**.

Structure of nervous cell :

- This myelin sheath insulates the axon against depolarization, and forces action potential to occur in the gaps (**node of Ranvier**) in between the myelin sheath
 - Axons enclosed by myelin sheath are called myelinated axons which make up the
 - **white matter** in the nervous system; while axons that have no myelin sheath are called unmyelinated axons which make up the **gray matter** in the nervous system.

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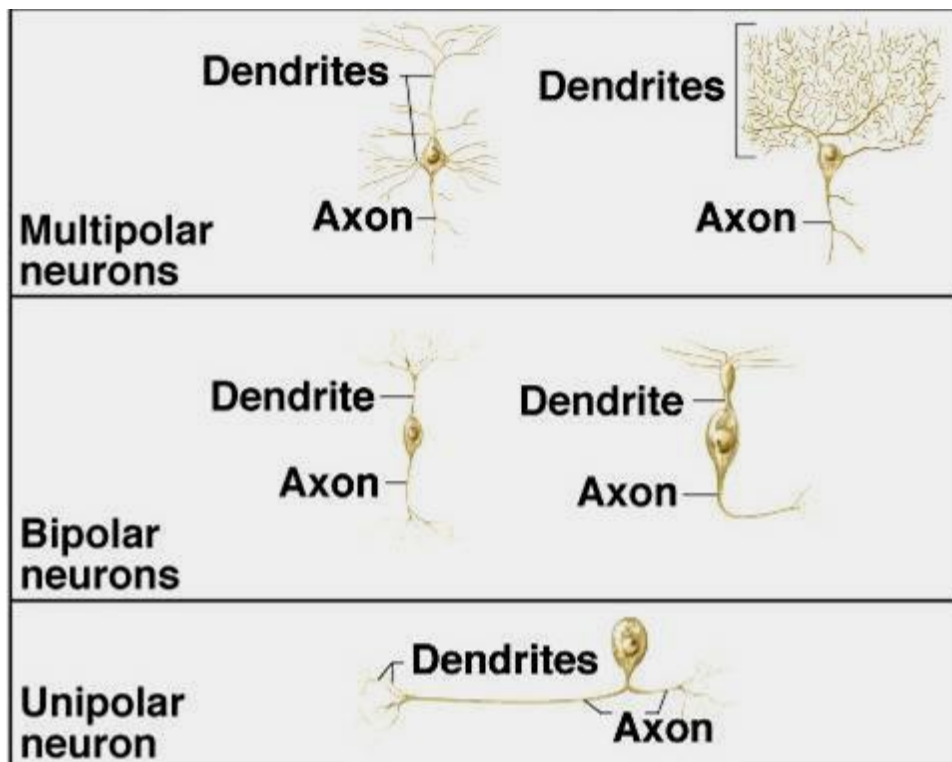
Classification of neurons :

A- Classification based on structure :

a) **Unipolar neuron** - a single nerve fiber is extended from the soma, and it divides into a dendrite and an axon (sensory neurons that conduct reflexes or detect various stimuli).

b-**Bipolar neuron** - a dendrite and an axon extend from the soma independently (sensory neurons involved in special senses such as vision, olfaction, and hearing).

c) **Multipolar neuron** - one axon and many dendrites extend from the soma (interneurons located inside the brain and spinal cord).



B- classification based on function

1• Sensory Neurons (afferent neurons)

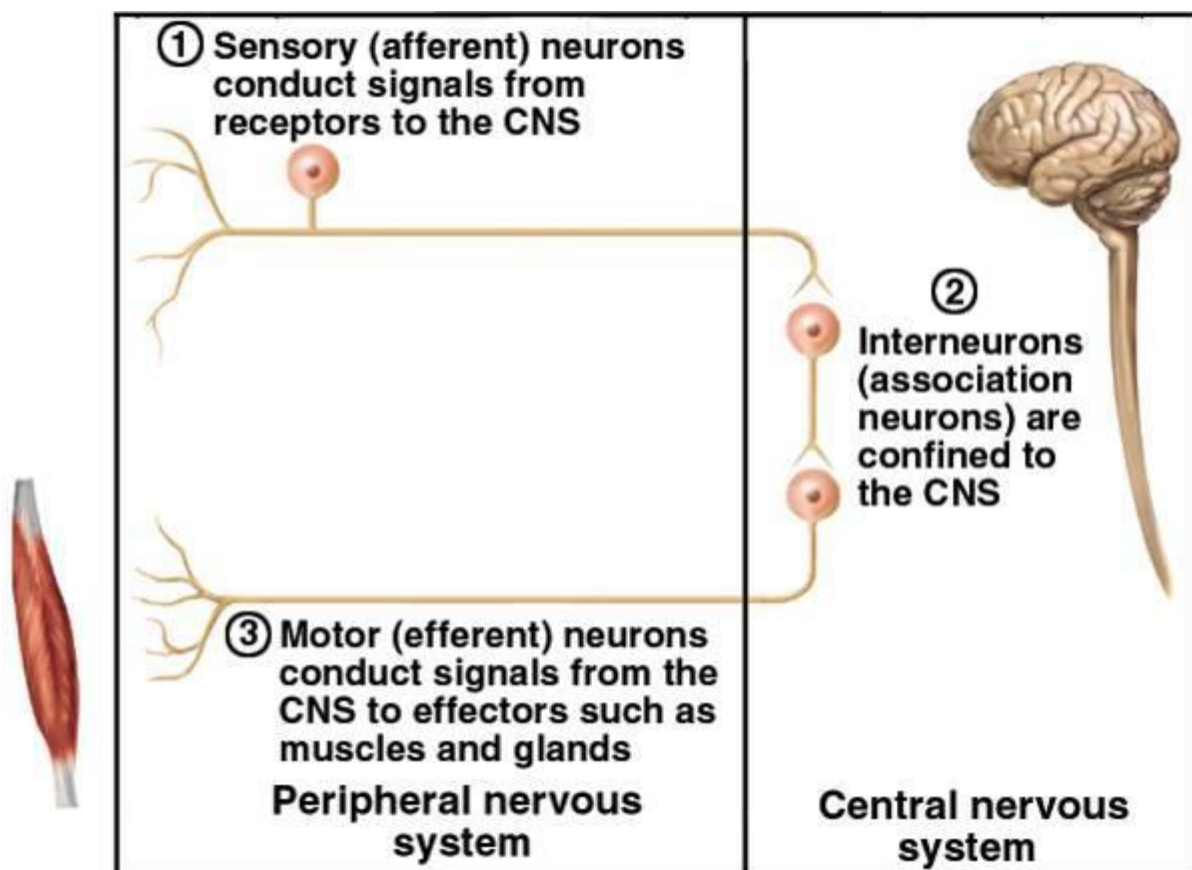
- receptors that detect changes in the external environment and within the body (temperature, pressure, vibrations, light, chemicals)
- this information is transmitted into brain or spinal cord

2 • Interneurons (association neurons)

- positioned between sensory neurons and motor neurons in the CNS
- 90% of human neurons are interneurons
- interneurons process, store and retrieve information

3• Motor Neurons (efferent neurons)

- send signals out to muscles and glands



Classification of Neuroglia :

Neuroglia: are the supporting cells of the nervous system.

1. Astrocytes: star shaped cells found between neurons and blood vessels.

Function: structural support, transport of substance between blood vessels and neurons.

2. Microglial cells: small ovoid cells.

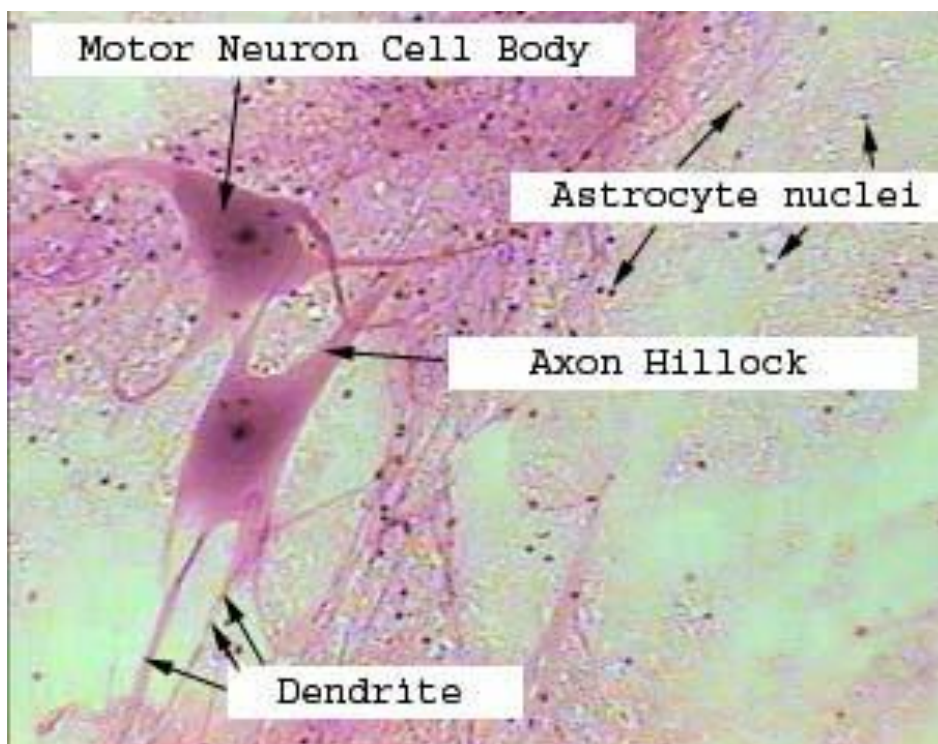
Function: structural support and phagocytosis (immune protection).

3. Ependymal cells: cuboidal or columnar shaped cells.

Function: form a porous layer through which substances diffuse between the interstitial fluid and the cerebrospinal fluid.

4. Oligodendrocytes: resemble astrocytes but have less processes and arranged in rows along nerve fibers.

Function: produce myelin sheet within the brain spinal cord.



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