محاضرات الانسجة النظري

قسم تقنيات المختبرات الطبية

المرحلة الاولى

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المحاضرة الاولى

What is a cell?

Cells are the basic building blocks of all living things. The human body is composed of trillions of cells. They provide structure for the body, take in nutrients from food, convert those nutrients into energy, and carry out specialized functions. Cells also contain the body's hereditary material and can make copies of themselves.

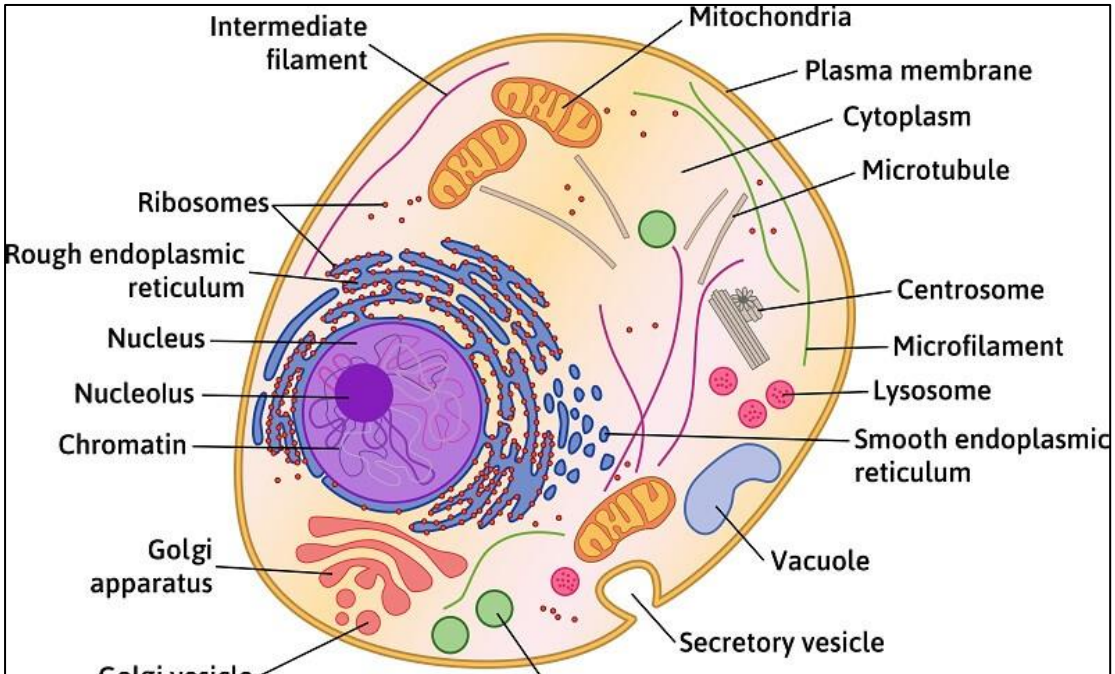
The cell was discovered by Robert Hook in 1655. There are 2

type of cell (Eukaryotes) which contain Nucleus and (prokaryotes), which do not and

usually single cell organism, while the Eukaryotes cell either single celled or part of

multicellular organism.

Cells have many parts, each with a different function. Some of these parts, called organelles, are specialized structures that perform certain tasks within the cell. Human cells contain the following major parts, listed in alphabetical order:



1- Cell membrane

The cell membrane or plasma membrane surrounded the cytoplasm of a cell, in animal, the plasma membrane in the outer boundary of the cell, this membrane serves to separate and protect a cell from its surrounding environmental and is made mostly from ((Double layer of phospholipids)), which are amphiphilic (part hydrophobic and hydrophilic)

The member is aside to be (semi- permeable) in that its can either let substance .molecular or ion) pass through freely or not pass through at all)

Cell surface membrane also contains (Receptor) protein that allow cell to detect signaling molecules such as (Hormone).

2- Cytoplasm

Within cells, the cytoplasm is made up of a jelly-like fluid (called the cytosol) and other structures that surround the nucleus.

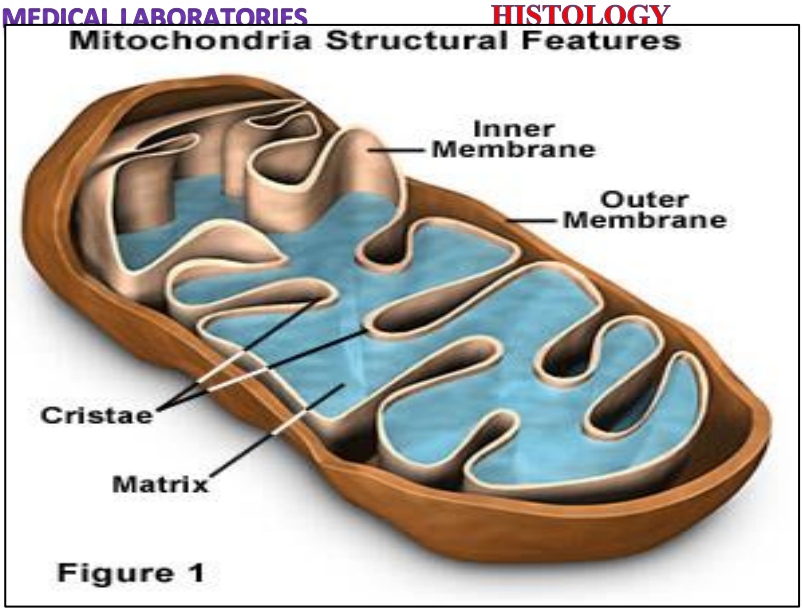
3-Nucleus

the nucleus is the large, membrane-bounded organelle that contains the genetic material in the form of multiple linear DNA molecules organized into structures called chromosomes. In cell biology, the nucleus function is to act as the control center of the cell. This is because it contains the genetic material that codes for the vital functions of the cell.

4- mitochondria:

Mitochondria are membrane-bound cell organelles (mitochondrion, singular) that generate most of the chemical energy needed to power the cell's biochemical reactions. Chemical energy produced by the mitochondria is stored in a small molecule called adenosine triphosphate (ATP). Mitochondria contain their own small chromosomes. Generally,

mitochondria, and therefore mitochondrial DNA, are inherited only from the mother..



5- Endoplasmic Reticular:

The ER is the largest organelle in the cell and is a major site of protein synthesis and transport, protein folding, lipid and steroid synthesis, carbohydrate metabolism and calcium storage.

Its composition has two components: the smooth endoplasmic reticulum (SER) and the rough endoplasmic reticulum (RER). The SER is generally used for the creation/ storage of lipids and steroids, while the RER plays a significant role in the synthesis of various proteins

6- Golgi Apparatus:

A Golgi body, also known as a Golgi apparatus, is a cell organelle that helps process and package proteins and lipid molecules, especially proteins destined to be exported from the cell. Named after its discoverer, Camillo Golgi, the Golgi body appears as a series of stacked membranes..

7.Ribosomes:

A ribosome is a complex molecular machine found inside the living cells that produce proteins from amino acids during a process called protein synthesis or translation. The process of protein synthesis is a primary function, which is performed by all living cells.

Ribosomes are specialized cell organelles and are found in both prokaryotic and eukaryotic cells. Every living cell requires ribosomes for the production of proteins.

8- Cytoskeleton

The cytoskeleton is a network of long fibers that make up the cell's structural framework. The cytoskeleton has several critical functions, including determining cell shape, participating in cell division, and allowing cells to move. It also provides a track-like system that directs the movement of organelles and other substances within cells.

The cellular digestive

1) Endocytosis: It performs the uptake and transfer of solid substances through the cell membrane into the interior

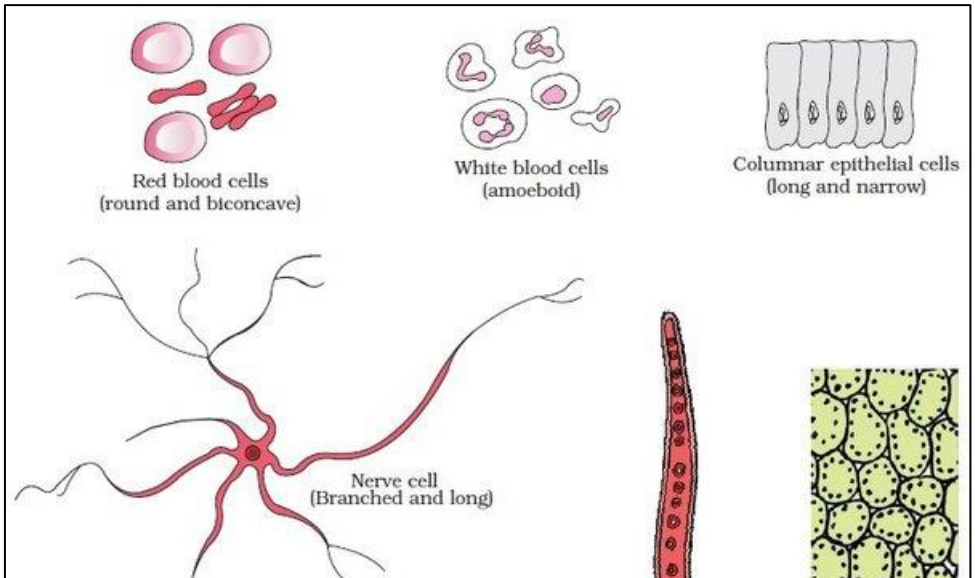
2) Exocytosis: in contrast, the release of material from the cell cytoplasm a cross the cell membrane is called Exocytosis.

3) Pinocytosis: Is the process by which cell ingest small molecules of extracellur fluid or liquid.

4) Phagocytosis: Is refer to the ingestion or intake of large particles by the cell, such as Bacteria or cellular debris.

Cell Shape

Usually, the cells are round, elongated or spherical. There are also some cells which are long and pointed on both the ends. Such cells exhibit spindle shape. In some cases, the cells are very long. Some may be branched like the neuron or the nerve cell. The nerve cell transfers and receives messages.



المحاضرة الثانية والثالثة

The Tissues

A tissue is an ensemble of similar cells from the same origin that together carry out a specific function. Organs are then formed by the functional grouping together of multiple tissues.

Cells: are the building blocks of life – all living organisms are made up of them. the shapes of cells can vary widely. Animal cells in particular come in all kinds of shapes and sizes. Plant cell shapes tend to be quite similar to each other because of their rigid cell wall,Cells have different shapes because they do different things. Each cell type has its own role to play in helping our bodies to work properly, and their shapes help them carry out these roles effectively.

The study of tissue is known as _____ Histology

Histology : is the study of the microscopic anatomy of cells and tissues of plants and animals, its commonly performed by examining cells and tissues under a light microscope or electron microscope .

Histological studies may be conducted using tissue culture. Histology is an essential tool of biology medicine .

Histopathology : the microscopic study of diseased tissue , accurate diagnosis of cancer and other disease usually requires histopathological examination of samples .

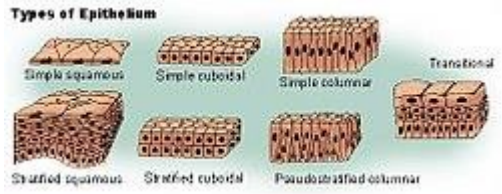
The classical appearance of tissues can be examined in health and disease enabling considerable refinement of medical diagnosis and prognosis .

Types of tissues

there are four basic types of animal tissues: Epithelial tissue. , connective tissue ,muscle tissue & nervous tissue, and All tissue types are subtypes of these four basic tissue

Epithelium

Epithelium



Types of epithlium

Epithelium: is one of the four basic types of animal tissue, along with connective tissue, muscle tissue and nervous tissue.

Epithelial tissues line the cavities and surfaces of blood vessels and organs throughout the body.

There are three principal shapes of epithelial cell: squamous ,columnar, and cuboidal. These can be arranged in a single layer of cells as simple epithelium,

All glands are made up of epithelial cells. Functions of epithelial cells include secretion, selective absorption, protection, transcellular transport, and sensing.

Epithelial tissue, or epithelium, has the following general characteristics:

- Epithelium consists of closely packed, flattened cells that make up the inside or outside lining of body areas. There is little intercellular material.
- The tissue is **avascular,** meaning without blood vessels. Nutrient and waste exchange occurs through neighboring connective tissues by diffusion.
- The upper surface of epithelium is free, or exposed to the outside of the body or to an internal body cavity. The basal surface rests on connective tissue. A thin, extracellular layer called the *basement membrane* forms between the epithelial and connective tissue.

There are two kinds of epithelial tissues:

- Covering and lining epithelium covers the outside surfaces of the body and lines internal organs.
- Glandular epithelium secretes hormones or other products.

Epithelium that covers or lines

Classification

In general, epithelial tissues are classified by the number of their layers and by the shape and function of the cells.

The three principal shapes associated with epithelial cells are—squamous, cuboidal and columnar.

- **Squamous epithelium** has cells that are wider than their height (flat and scale-like).
- **Cuboidal epithelium** has cells whose height and width are approximately the same (cube shaped).
- **Columnar epithelium** has cells taller than they are wide (column-shaped).

By layer, epithelium is classed as either simple epithelium, only one cell thick (unilayered) or stratified epithelium as stratified squamous epithelium, stratified cuboidal epithelium, and stratified columnar epithelium that are two or more cells thick (multi-layered), and both types of layering can be made up of any of the cell shapes.

Simple epithelium

Simple epithelium is a single layer of cells with every cell in direct contact with the basement membrane that separates it from the underlying connective tissue. In general, it is found where absorption and filtration occur. The thinness of the epithelial barrier facilitates these processes.

In general, simple epithelial tissues are classified by the shape of their cells. The four major classes of simple epithelium are: .

(1) simple squamous; which is found lining areas where passive diffusion of gases occur. e.g. skin, walls of capillaries, linings of the pericardial, pleural, and peritoneal cavities, as well as the linings of the alveoli of the lungs.

(2) simple cuboidal: these cells may have secretory, absorptive, or excretory functions. examples include small collecting ducts of kidney, pancreas, and salivary gland.

(3) simple columnar; cells can be secretory, absorptive, or excretory; Simple columnar epithelium can be ciliated or non-ciliated; ciliated columnar is found in the female reproductive tract and uterus. Non-ciliated epithelium can also possess microvilli.

4) pseudostratified columnar epithelium; when taller simple columnar epithelial cells are viewed in cross section showing several

nuclei appearing at different heights, they can be confused with stratified epithelia. This kind of epithelium is therefore described as pseudostratified columnar epithelium .

Stratified epithelium :

Stratified epithelium differs from simple epithelium in that it is multilayered.

Stratified epithelia (of columnar, cuboidal or squamous type) can have the following specializations:

Keratinized : In this particular case, the most apical layers (exterior) of cells are dead and lose their nucleus and cytoplasm, instead contain a tough, resistant protein called keratin. This specialization makes the epithelium water proof, so is found in the mammalian skin. The lining of the esophagus is an example of a non-keratinized or "moist" stratified epithelium

In this case, the most apical layers of cells are filled with keratin, but they still retain their nuclei.

Transitional epithelia: its found in tissues that stretch and it can appear to be stratified cuboidal when the tissue is not stretched or stratified squamous when the organ is distended and the tissue stretches. It is sometimes called urothelium since it is almost exclusively found in the bladder, ureters and urethra.

Structure:

Cells of epithelial tissue are tightly packed and form a continuous sheet. They have almost no intercellular spaces. All epithelia is usually separated from underlying tissues by an extracellular fibrous basement membrane.

Location

See also: Table of epithelia of human organs

Epithelium lines both the outside (skin) and the inside cavities and lumina of bodies. The outermost layer of human skin is composed of dead stratified squamous, keratinized epithelial cells.

Tissues that line the inside of the mouth, the esophagus and part of the rectum are composed of nonkeratinized stratified squamous epithelium. Other surfaces that separate body cavities from the outside environment are lined by simple squamous, columnar, or pseudo stratified epithelial cells. Other epithelial cells line the insides of the lungs, the gastrointestinal tract, the reproductive and urinary tracts, and make up the exocrine and endocrine glands. The outer surface of the cornea is covered with fast-growing, easily regenerated epithelial cells. A specialised form of epithelium – endothelium forms the inner lining of blood vessels and the heart, and is known as vascular endothelium, and lining lymphatic vessels as lymphatic endothelium. Another type, mesothelium, forms the walls of the pericardium, pleurae, and peritoneum.

Basement membrane

Epithelial tissue rests on a basement membrane, which acts as a scaffolding on which epithelium can grow and regenerate after injuries Epithelial tissue has a nerve supply, but no blood supply and must be nourished by substances diffusing from the blood vessels in the underlying tissue. The basement membrane acts as a selectively permeable membrane that determines which substances will be able to enter the epithelium.

Development

Epithelial tissues are derived from all of the embryological germ layers

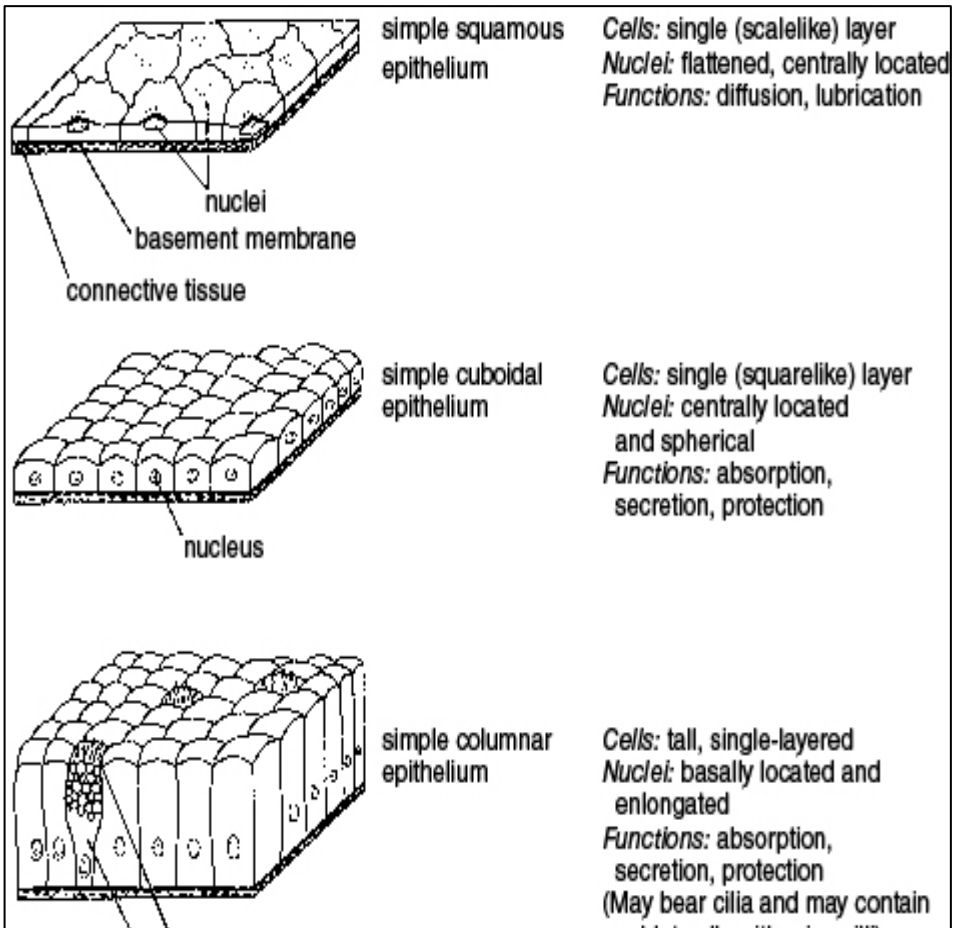
- from ectoderm (e.g., the epidermis);
- from endoderm (e.g., the lining of the gastrointestinal tract);
- from mesoderm (e.g., the inner linings of body cavities).

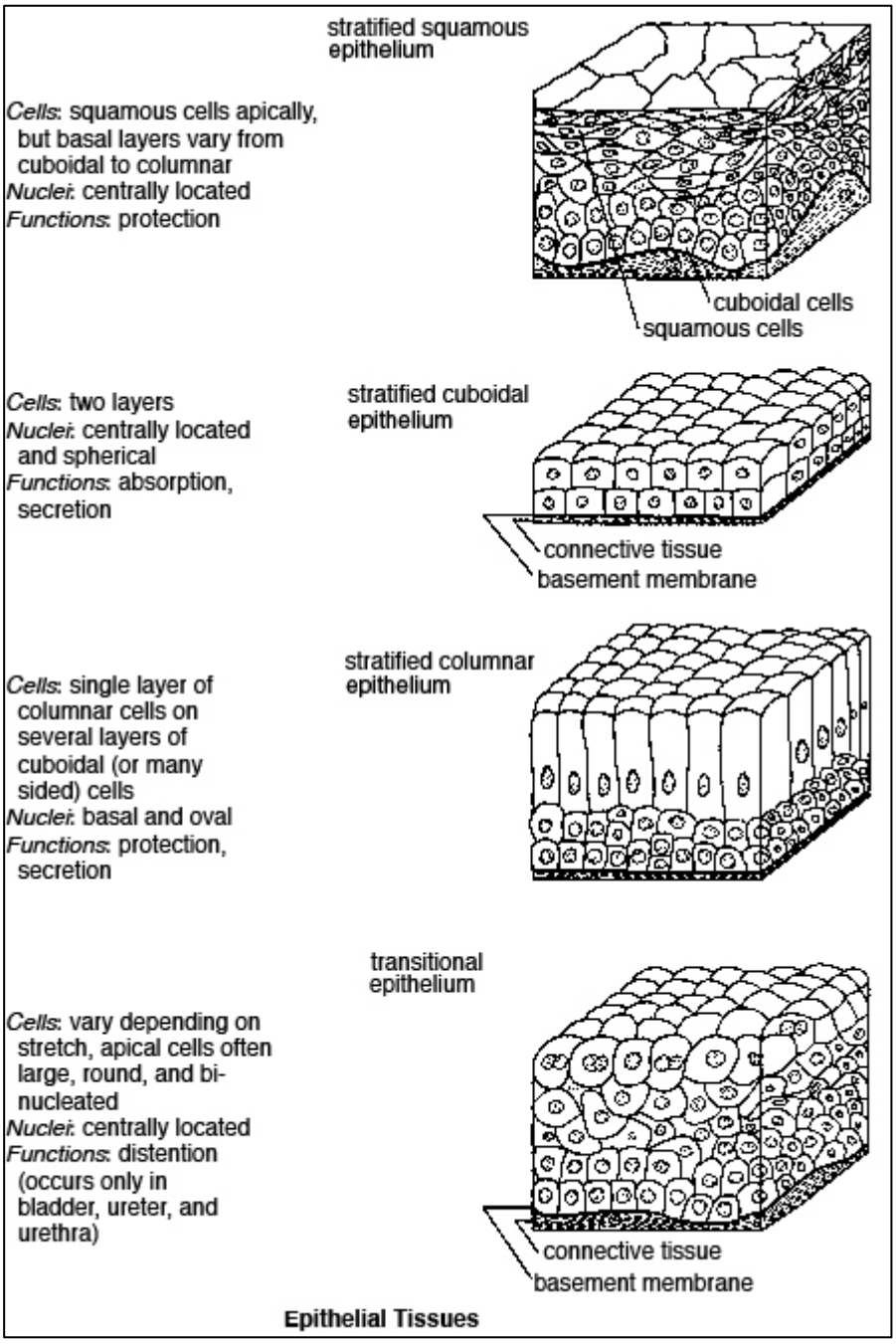
Glandular tissue

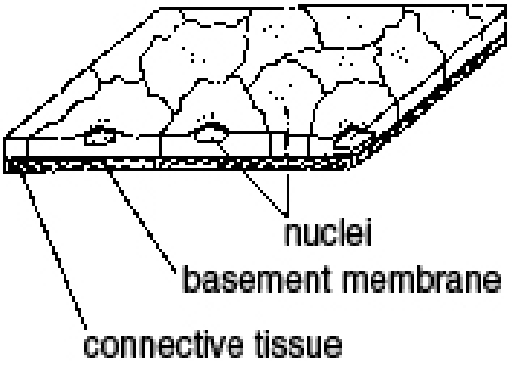
Glandular tissue is the type of epithelium that forms the glands from the in folding of epithelium and subsequent growth in the underlying connective tissue. There are two major classifications of glands: endocrine glands and exocrine glands:

- Endocrine glands secrete their product into the extracellular space where it is rapidly taken up by the blood vascular system.
- Exocrine glands secrete their products into a duct that then delivers the product to the lumen of an organ or onto the free surface of the epithelium.

Figure 1. Types of epithelial tissues.

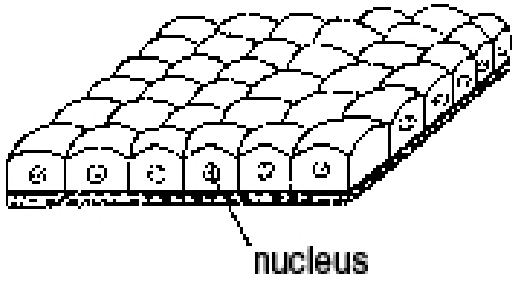



stratified squamous epithelium
Cells: squamous cells apically, but basal layers vary from cuboidal to columnar
Nuclei: centrally located
Functions: protection
cuboidal cells
squamous cells
stratified cuboidal epithelium
Cells: two layers
Nuclei: centrally located and spherical
Functions: absorption, secretion
connective tissue
basement membrane
stratified columnar epithelium
Cells: single layer of columnar cells on several layers of cuboidal (or many sided) cells
Nuclei: basal and oval
Functions: protection, secretion
transitional epithelium
Cells: vary depending on stretch, apical cells often large, round, and bi-nucleated
Nuclei: centrally located
Functions: distention (occurs only in bladder, ureter, and urethra)
connective tissue
basement membrane
Epithelial Tissues



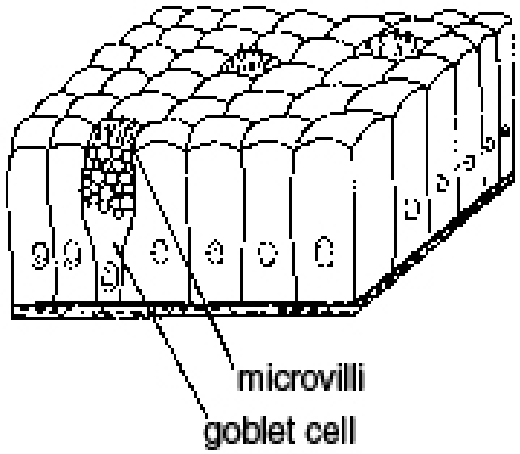
simple squamous epithelium

Cells: single (scalelike) layer
Nuclei: flattened, centrally located
Functions: diffusion, lubrication



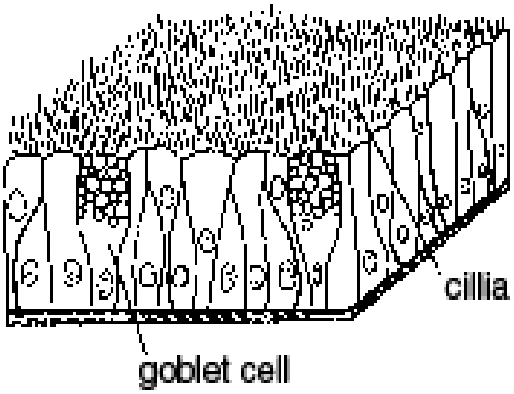
simple cuboidal epithelium

Cells: single (squarelike) layer
Nuclei: centrally located and spherical
Functions: absorption, secretion, protection



simple columnar epithelium

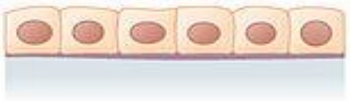
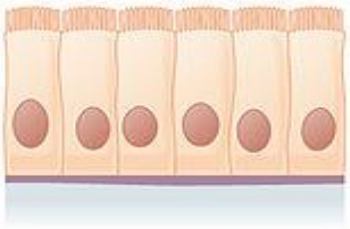
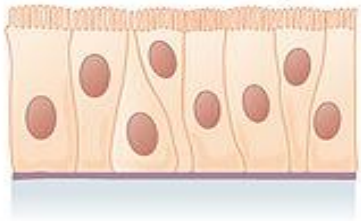
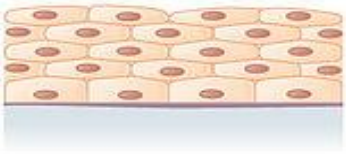
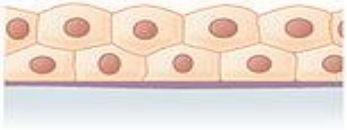
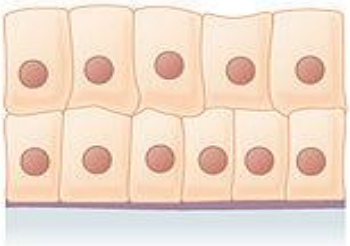
Cells: tall, single-layered
Nuclei: basally located and enlongated
Functions: absorption, secretion, protection
(May bear cilia and may contain goblet cells with microvilli)



pseudostratified epithelium

Cells: differ in height, not all cells reach the apical surface
Nuclei: at various positions
Functions: absorption, secretion, transportation

Epithelial Tissues

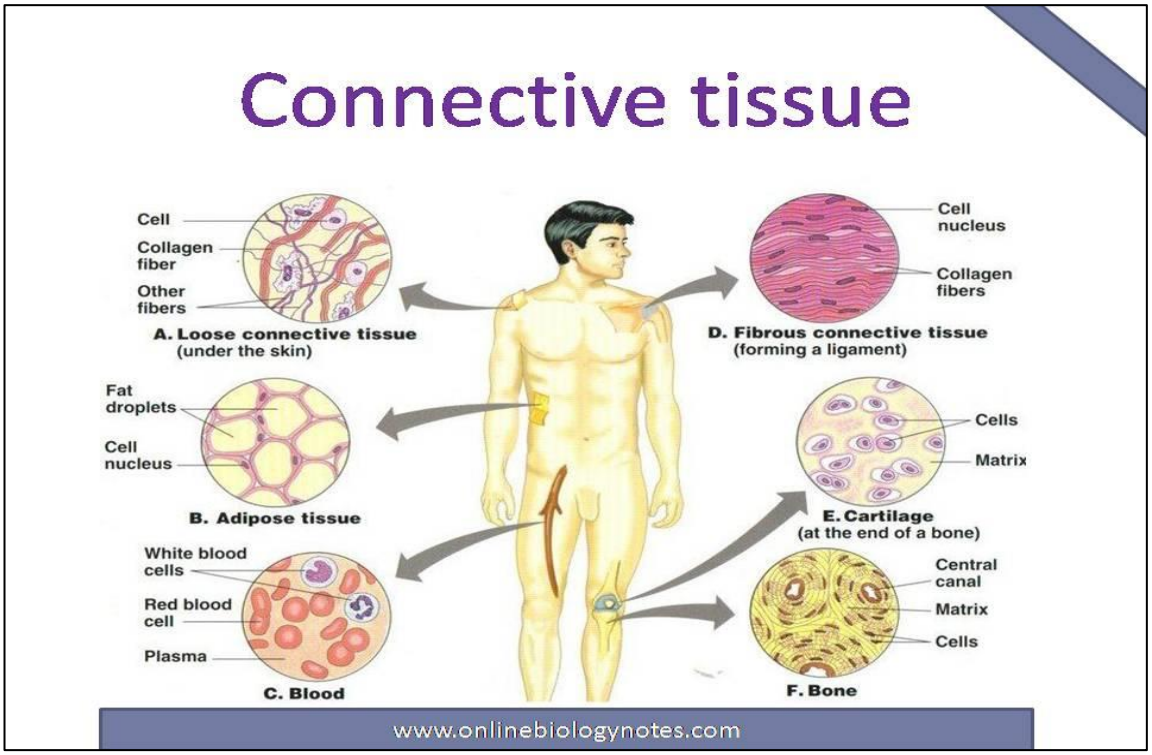
Cells	Location	Function
Simple squamous epithelium 	Air sacs of lungs and the lining of the heart, blood vessels, and lymphatic vessels	Allows materials to pass through by diffusion and filtration, and secretes lubricating substance
Simple cuboidal epithelium 	In ducts and secretory portions of small glands and in kidney tubules	Secretes and absorbs
Simple columnar epithelium 	Ciliated tissues are in bronchi, uterine tubes, and uterus; smooth (nonciliated tissues) are in the digestive tract, bladder	Absorbs; it also secretes mucous and enzymes
Pseudostratified columnar epithelium 	Ciliated tissue lines the trachea and much of the upper respiratory tract	Secretes mucus; ciliated tissue moves mucus
Stratified squamous epithelium 	Lines the esophagus, mouth, and vagina	Protects against abrasion
Stratified cuboidal epithelium 	Sweat glands, salivary glands, and the mammary glands	Protective tissue
Stratified columnar epithelium 	The male urethra and the ducts of some glands	Secretes and protects
Transitional epithelium 	Lines the bladder, uretha, and the ureters	Allows the urinary organs to expand and stretch

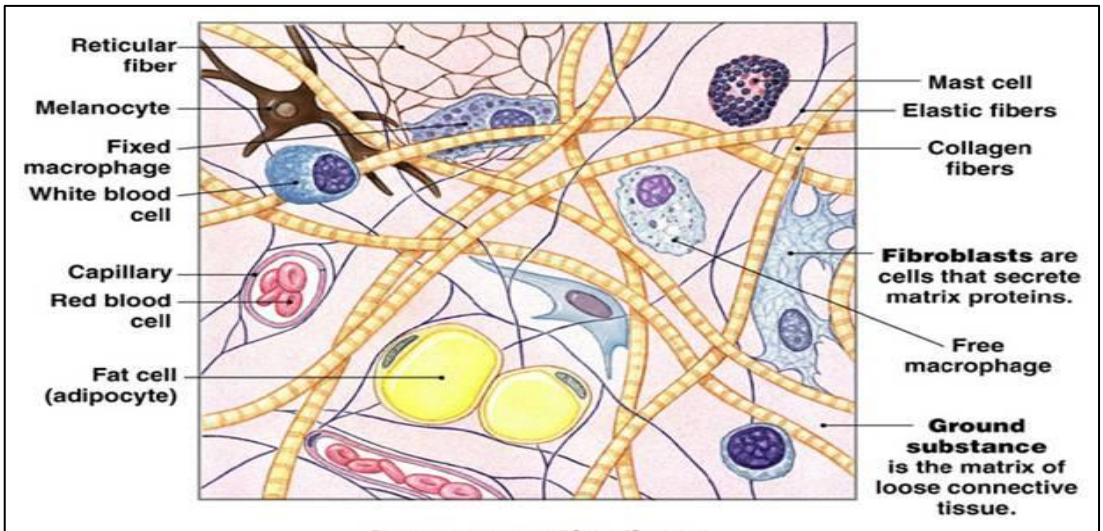
المحاضرة الرابعة والخامسة

Connective Tissue

- ## What is Connective Tissue?

Connective tissue: Connective tissue develop from mesenchyme, an embryonic type of tissue and it consists of cells and extra cellular material called (matrix), the extra cellular matrix consists of connective tissue fluid, ground substance which are embedded the protein fibers (collagen, reticular and elastic).





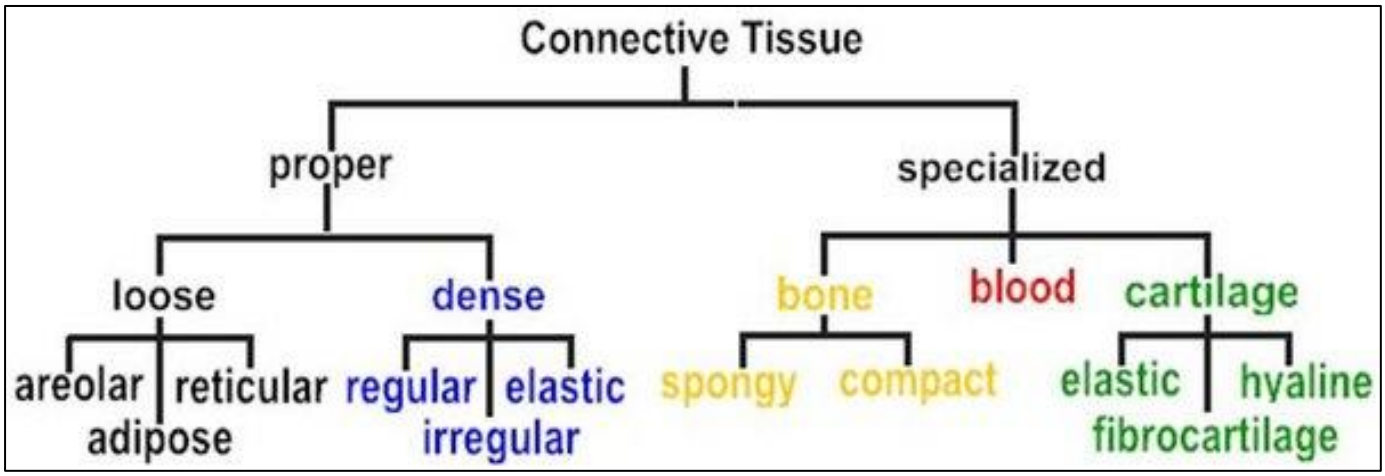
Function of Connective tissue:

The functions of the various types of C.T. are generally depending on the types of cells, fibers, and the characters of the ground substances in the matrix. The functions include:

1. Enclose organs as a capsule and separate organ into layers (Areolar).
2. Connect tissue to one another. (tendons and ligaments)
3. Support and movement (Bones)
4. Storage (Fat)
5. Transport (Blood)
6. Protection (Immune system).

Connective tissue classification:

Connective tissue can be classified as (A) connective tissue **proper** and (B) **specialized** connective tissue. The C.T proper is classified as (1) **Loose** Connective tissue and (2) **Dense** Connective tissue depending on the amount, type, arrangement, and abundance of cells, fiber and ground substance.

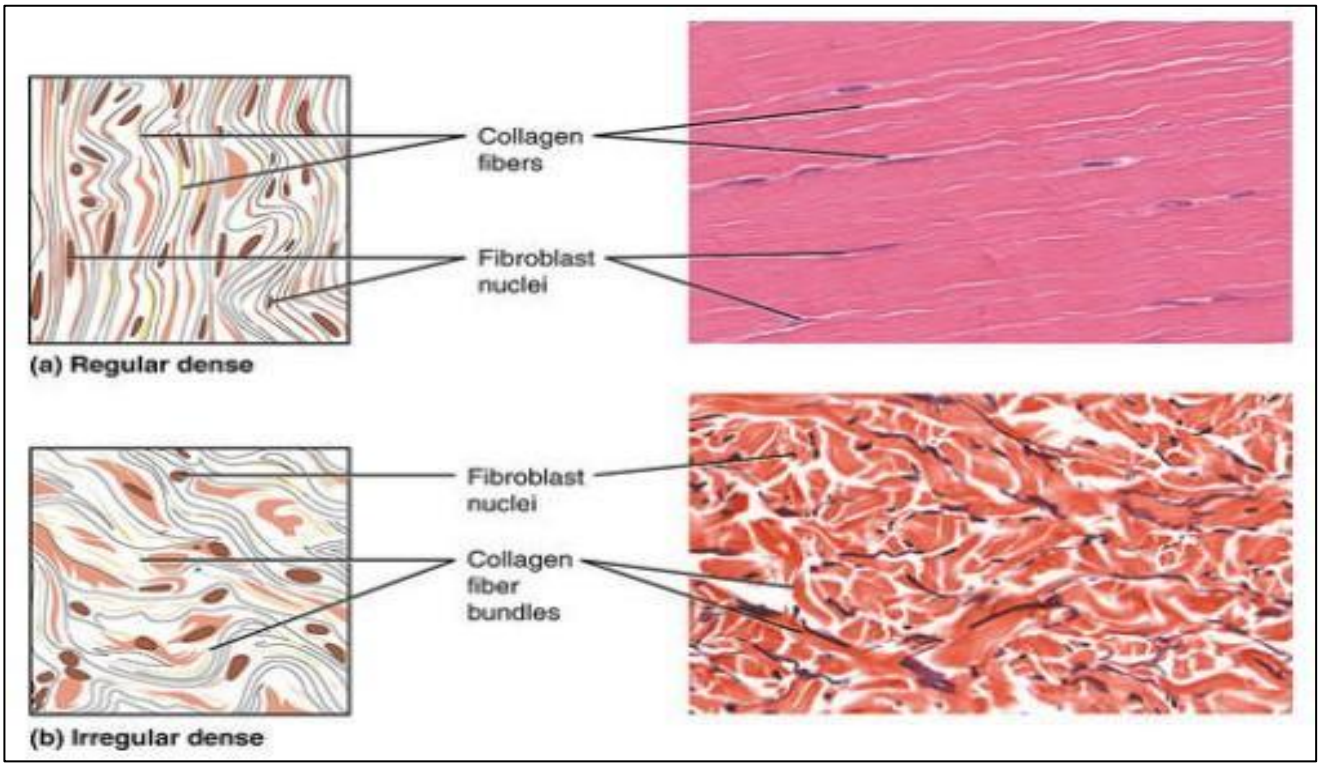


1. Loose Connective tissue: Loose Connective tissue which includes (a) **areolar tissue**, (b) **reticular tissue**, and (c) **adipose tissue**, is more prevalent in the body than dense Connective tissue it is characterized by a loose, irregular arrangement of Connective Tissue Fiber and abundant ground substance. Numerous Connective tissue cells and fiber are found in the matrix (collagen fiber, fibroblasts, adipose cells, mast cells, and macrophages predominate in loose Connective tissue with fibroblasts being the most common cell type).

2. Dense Connective tissue: Dense Connective tissue contains thicker and more densely packed collagen fiber, with fewer cell types and less ground substance. The collagen fiber in:

(a) Dense Irregular Connective Tissue: exhibits a random and irregular orientation. Dense irregular connective tissue is present in the **dermis of the skin**, and in other area that needs strong support.

(b) Dense Regular Connective Tissue: contains densely packed collagen fiber that exhibit regular and parallel arrangement. This type of tissue is found in the **(tendons and ligaments).**



A. Cells of the Connective tissue

1) Fibroblasts: It is active cells in Connective tissue and fixed permanent cells, it is flattened cells with an oval nucleus, and 1 or 2 nucleoli. It is fusiform-shaped fibroblasts synthesize all of the Connective tissue fiber and the extra cellular ground substance.

2) Fibrocyte: It is an Inactive form of fibroblast, smaller spindle- shaped cells without cytoplasmic projection, and the nucleus is similar but smaller than that in the fibroblast.

3) Adipose (fat) cells: It may occur singly or in groups, are seen in Connective tissue these cells store fat,when adipose cells predominate; the Connective tissue is called an adipose tissue. Thelarge adipose cells exhibit narrow rim of cytoplasm and a flattened eccentric nucleus. In histological section, the large fat globules of adipose cells have been dissolved by different chemical leaving a large highly characteristic empty space.

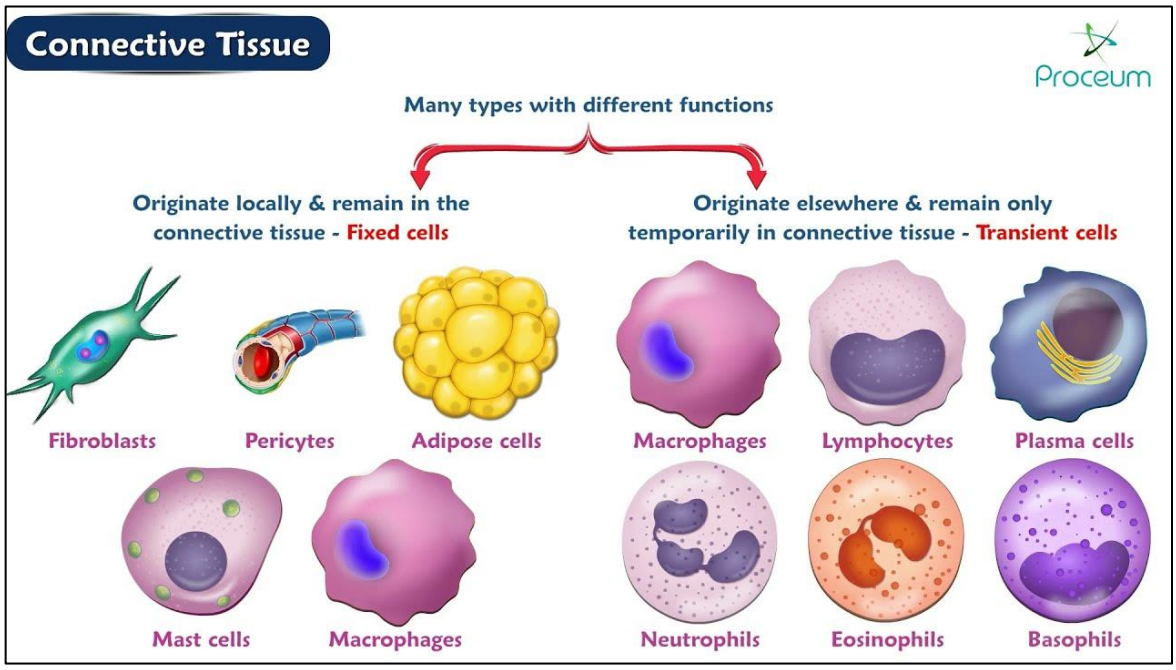
4) Macrophages or histocytes: Are phagocytic cells and are most numerous in loose Connective tissue they are difficult to distinguish from fibroblasts, unless they are performing phagocytic activity and contain ingestion material in their cytoplasm. The cytoplasm of different macrophage is filled with dense- staining particles that were ingested by these cells.

5) Mast cells: Usually closely associated with blood vessels, are widely distributed in the Connective tissue of the skin and in the digestive and respiratory organ, mast cells are spherical cells filled with fine regular dark- staining and basophilic granules. Mast cells synthesize and release (Histamine and heparin). Exposure of mast cell to allergens causes rapid release of histamine and other vasoactive chemicals, histamine is a potent mediator of inflammation, it dilates blood vessels, increases thepermeability to fluid thereby causing edema and induces signs and symptoms of immediate hypersensitive (allergic) reaction. In contrast heparin is a weak anticoagulant.

6) Plasma cells: Arise from the lymphocytes that migrate into the Connective tissue these cells are found in great abundance in loose Connective tissue and lymphatic tissue of the respiratory and digestive tract .it exhibits a smaller eccentrically placed nucleus with condensed coarse chromatin clumps distributed peripherally in a characteristic radial (cart wheel) pattern and one central mass a prominent clear area in the cytoplasm is adjacent to the nucleus.

7) Leukocytes (white blood cells): Neutrophils and eosinophils migrate into the Connective tissue from the blood vessels; their main function is to defend the organism against bacteria invasion or foreign matter. Also, the plasma cells, mast cells, and

macrophages migrate from the blood vessels and take residence in the Connective tissue of different regions of the body.



B. Fibers of connective tissue: There are 3 types of Connective tissue fiber **(collagen, elastic and reticular),** the amount and arrangement of these fiber depend on the function of the tissues or organs in which they are found.

A. Collagen fibers: Collagen fibers are tough, thick, fibrous proteins that do not branch. They are the most abundant fiber and are found in almost all Connective tissue of all organs.

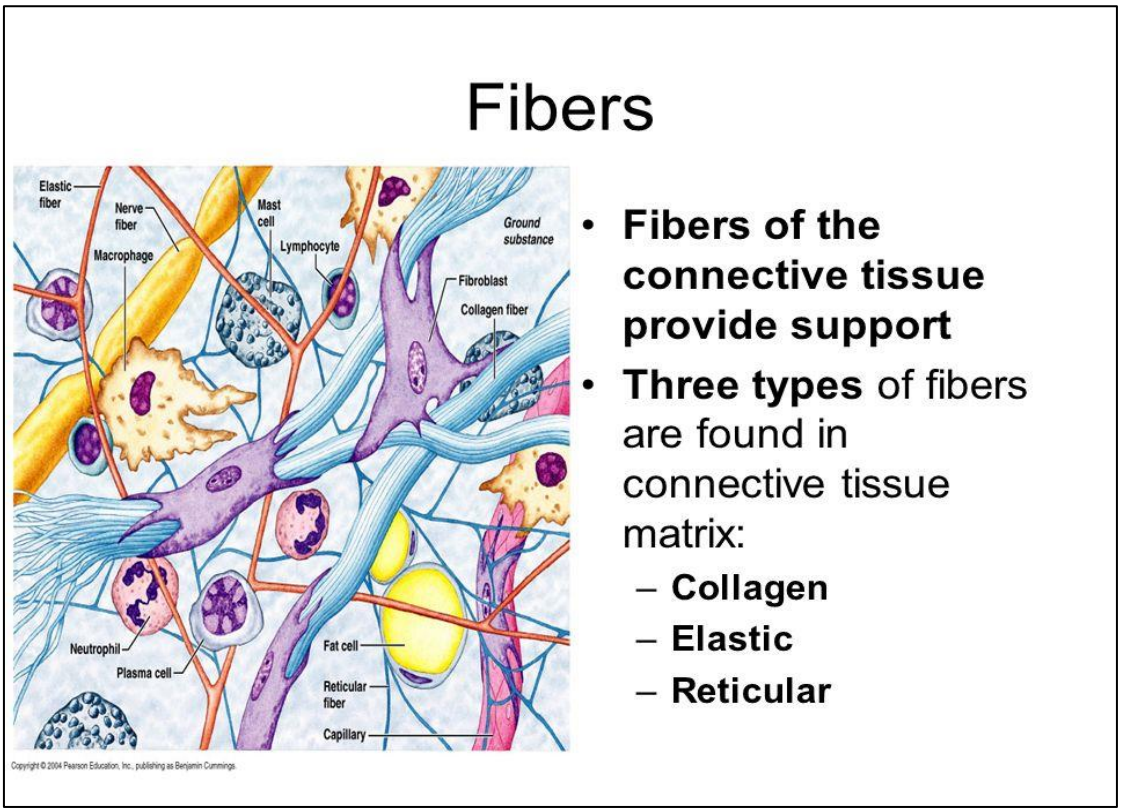
Types of collagen fiber:

- Type 1 collagen fiber: the most abundant type, forms large fibers and fiber bundles and found in the dermis of skin, tendon, ligaments, and bone.
- Type 2 collagen fiber: It is found in adults only in the cartilage.
- Type 3 collagen fiber: is similar to type I, but is more heavily glycosylated and stains with silver. It is the major fiber component of hematopoietic tissues (eg, bone marrow, spleen).

- Type 4 collagen fiber: These are present in the basal lamina of the basement membrane to which the basal regions of the cells attach. It does not form fibers or fibrils.

b) Elastic fibers: Elastic fibers are thin, small, branching fiber that allows stretch. They have less tensile strength than collagen fiber. Elastic fibers are composed of a central **elastin** core and a surrounding network of **fibrillin** microfibrils. Elastic fiber is found in abundance in the lung, bladder, and skin. In the walls of aorta, and pulmonary trunk.

c). Reticular fibers: It consists mainly of **type 3 collagen fiber**, is thin and forms a delicate net like framework in the liver, lymph node, spleen, hemopoietic organs and other location where blood and lymph are filtered.



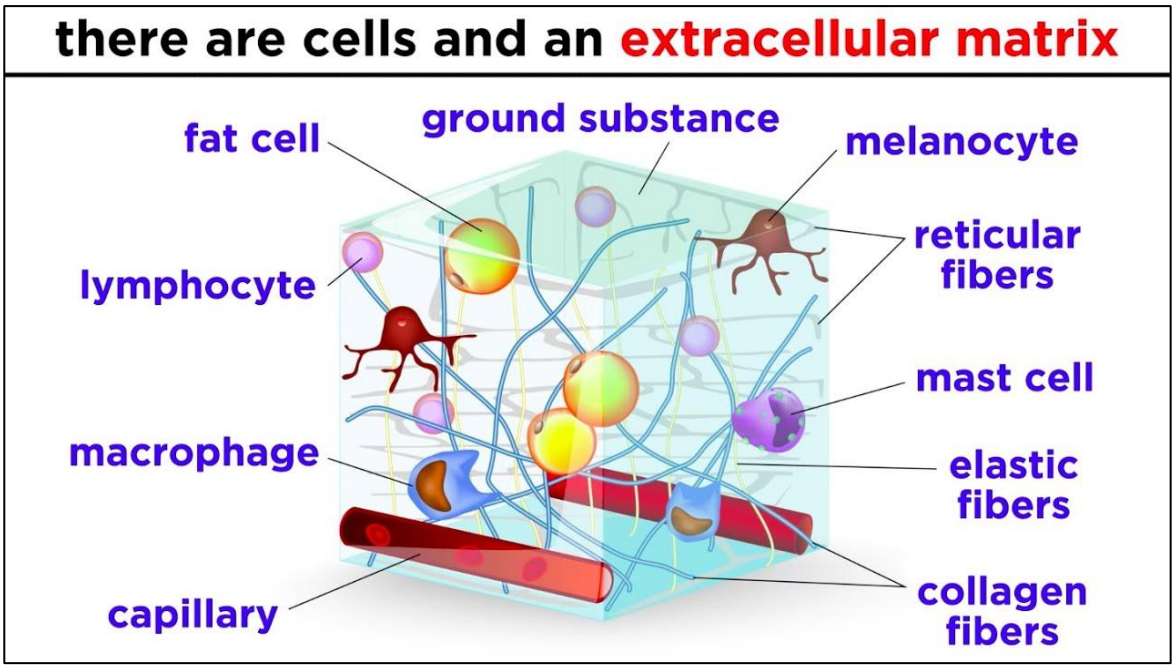
B- Connective Tissue Matrix

- The matrix provides mechanical and structural support and has a role in regulating the metabolic activity.
- The ground substance is a viscous, clear with high water content.
- With the light microscope, it appears amorphous but it lost during tissue fixation and dehydration in routine H&E stain for the paraffin sections.
- The extracellular matrix is a complex structure that surrounds and supports cells within tissue and contains variety of fibers (collagen and elastic).
- The ground substance contains a variety of molecules secreted by C.T. cells such as:

1- Proteoglycans

2- Multi adhesive glycoproteins

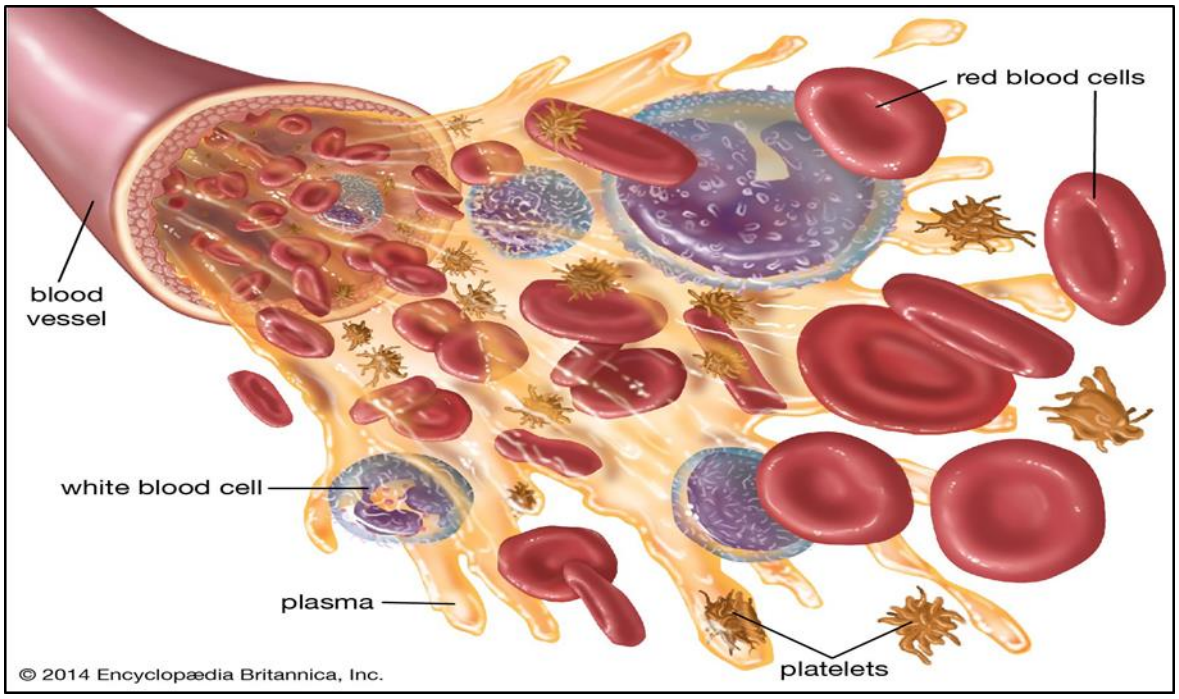
3 - Glycosaminoglycan (GAG).



المحاضرة السادسة

What is Blood?

Blood is a fluid connective tissue that consists of plasma, blood cells and platelets. It circulates throughout our body delivering oxygen and nutrients to various cells and tissues. It makes up 8% of our body weight. An average adult possesses around 5-6 litres of blood.



Types of Blood Cells

We have seen blood consist of cells known as formed elements of blood. These cells have their own functions and roles to play in the body. The blood cells which circulate all around the body are as follows:

Red blood cells (Erythrocytes(RBC):

RBCs are biconcave cells without nucleus in humans; also known as erythrocytes. RBCs contain the iron-rich protein called haemoglobin; give blood its red colour. RBCs are the

most copious blood cells produced in bone marrows. Their main function is to transport oxygen from and to various tissues and organs.

White blood cells (Leucocytes)

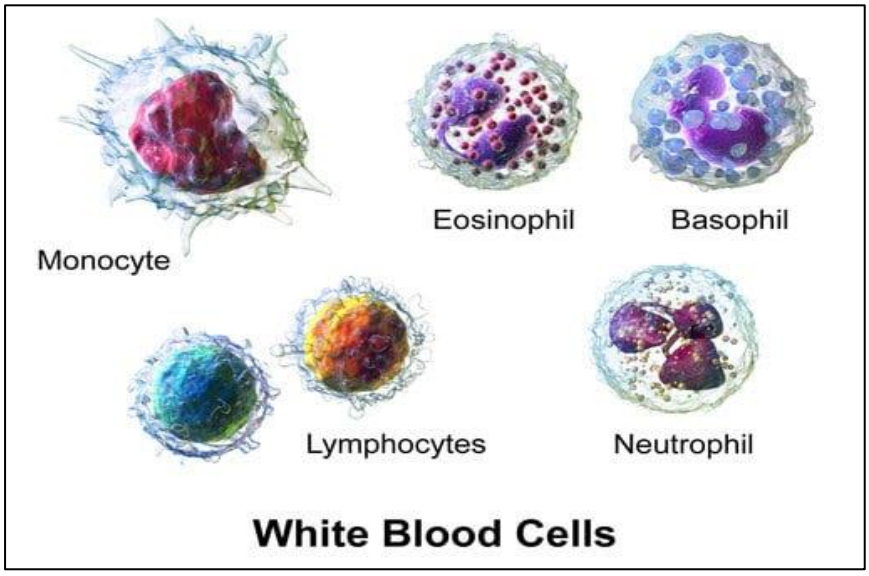
Leucocytes are colorless blood cells. They are colorless because it is devoid of hemoglobin. They are further classified as granulocytes and agranulocytes. WBCs mainly contribute to immunity and defense mechanism.

Types of White Blood Cells

There are five different types of White blood cells and are classified mainly based on the presence and absence of granules.

- Granulocytes
- Agranulocytes

There are **five types of white blood cells** present in the blood



WBC (granulocytes): They are leukocytes, with the presence of granules in their cytoplasm. The granulated cells include:-

1- **Neutrophils** are the most abundant. Neutrophils have small pink granules and its nucleus consists of several lobes connected by narrow chromatin strands. it has a

short life span. They circulate in blood for about 10 hours and then enter the connective tissue, where they survive for another 2 or 3 days.

Function: Neutrophils are active phagocytes, especially for bacterial which they phagocytosis (ingest) and quickly destroy with their lysosomal enzymes.

2- **Eosinophils**

- Eosinophils also have a short life span. Eosinophils are identified in a blood smear by their cytoplasm, which is filled with distinct, large bright pink granules. The nucleus in eosinophils is bilobed. Eosinophils constitute approximately 2 to 4% of the blood leukocytes. **Function:** Eosinophils are also phagocytic cells. Eosinophil increase in number during **parasitic infection** and for controlling mechanisms associated with allergy and asthma.

3- **Basophils**

- They are the least common of the granulocytes,Basophils their large granules stain dark blue. Although the nucleus is not lobulated, it is usually obscured by the density and number of granules. The basophils constitute less than 1% of the blood leukocytes.

Function: Their granules contain histamine and heparin.

WBC (Agranulocytes)

- **Lymphocytes** Agranular leukocytes have few or no cytoplasmic granules and exhibit round shaped nuclei. Lymphocytes constitute approximately 20 to 30% of the blood leukocytes.

- **Monocytes** are the largest agranular leukocytes. The nucleus varies from round or oval to horseshoe-shaped and stains lighter than the lymphocyte nucleus. Monocytes constitute approximately 3 to 8% of the blood leukocytes,They are commonly known as **natural killer cells.**

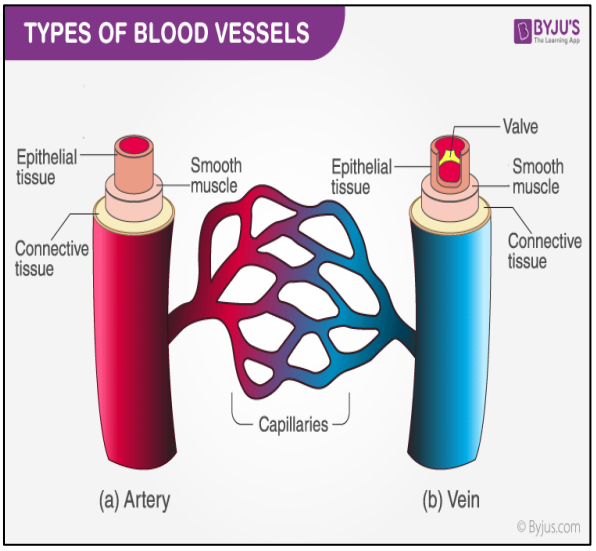
Platelets or thrombocytes : are not blood cells, Instead they are the smallest, nonnucleated formed elements in the blood and appear in the blood of all mammals. Platelets are cytoplasmic fragments or remnants of **megakaryocytes**, the largest cells in the bone marrow. The main function of platelets is to promote blood clotting. When the wall and the endothelium of the blood vessel are damaged, the platelets are activated and form a plug to occlude the site of damage. The platelets in the plug release adhesive glycoproteins that increase the plug size, which is then reinforced by a polymer fibrin

formed from numerous plasma proteins. Fibrin forms a mesh around the plug, trapping other platelets and blood cells to form a blood clot.

Types of Blood Vessels

Three types of blood vessels are:

- Arteries
- Veins
- Capillaries



Arteries

Arteries are strong tubes and muscular in nature. These blood vessels carry oxygen-rich blood from the heart to all the tissues of the body. Aorta is one of the main arteries that arise from the heart and branches further.

Veins

Veins are elastic blood vessels which carry deoxygenated blood from all parts of the body to the heart. An exception is the umbilical and pulmonary veins. The Pulmonary vein carries oxygenated blood to the heart from the lungs and the umbilical vein carries oxygenated blood from the placenta to the fetus.

Capillaries

On reaching tissues, arteries branch further into extremely thin tubes called capillaries. Capillaries bring about the exchange of substances between blood and tissues.

Sinusoids

Sinusoids are a special type of wider capillaries present in bone marrow, liver, lymph nodes, spleen and some endocrine glands. They may be continuous, discontinuous or fenestrated.

Layers of Blood Vessels

Both arteries and veins consist of three layers:

- **Tunica Intima**: It is one of the inner most and thinnest layers of arteries and veins. It comprises endothelial cells. They are in direct contact with the flow of blood.
- **Tunica Media**: It is the middle layer of an artery or vein. Tunica media is made up of smooth muscle cells.
- **Tunica Externa:** It surrounds tunica media. It is made up of collagen and is also supported by the elastic lamina in arteries.

Functions of Blood

Blood is responsible for the following body functions:

1- Fluid Connective Tissue

Blood is a fluid connective tissue composed of 55% plasma and 45% formed elements including WBCs, RBCs, and platelets. Since these living cells are suspended in plasma, blood is known as a fluid connective tissue and not just fluid.

2- Provides oxygen to the cells

Blood absorbs oxygen from the lungs and transports it to different cells of the body. The waste carbon dioxide moves from the blood to the lungs and is exhaled.

3- Transports Hormones and Nutrients

The digested nutrients such as glucose, vitamins, minerals, and proteins are absorbed into the blood through the capillaries in the villi lining the small intestine.

The hormones secreted by the endocrine glands are also transported by the blood to different organs and tissues.

4- Homeostasis

Blood helps to maintain the internal body temperature by absorbing or releasing heat.

5- Blood Clotting at Site of Injury

The platelets help in the clotting of blood at the site of injury. Platelets along with the fibrin form clot at the wound site

6- Transport of waste to the Kidney and Liver

Blood enters the kidney where it is filtered to remove nitrogenous waste out of the blood plasma. The toxins from the blood are also removed by the liver.

7- Protection of the body against pathogens

The White Blood Cells fight against infections.

- **Questions??**
- **Difference Between Blood and Lymph**
- **Blood Groups**

المحاضرة السابعة

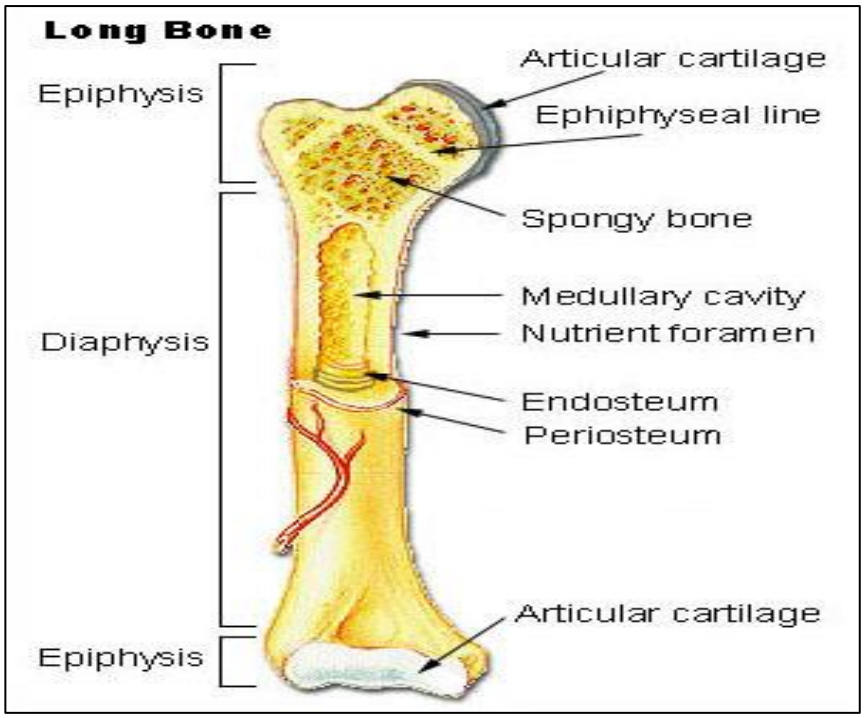
BONE

Bone is a special type of supporting connective tissue, which has a hard, mineralized, extracellular matrix containing osteocytes embedded in the matrix. It is different from cartilage in that bone is calcified and, hence, is harder and stronger than cartilage. In addition, it has many blood vessels penetrating the tissue.

The functions of bone include (1) structural support for the mechanical action of soft tissues, such as the contraction of muscles and the expansion of lungs, (2) protection of soft organs and tissues, as by the skull, (3) provision of a protective site for specialized tissues such as the blood-forming system (bone marrow), and (4) a mineral reservoir, whereby the endocrine system regulates the level of calcium and phosphate in the circulating body fluids.

In general, the external surface of the bone is covered by **periosteum,** a layer of connective tissue containing small blood vessels, **osteogenic cells**, and nerve fibers

conveying pain information. The inner surface of the bone is covered by **endosteum,** a thin connective tissue layer composed of a single layer of osteo-progenitor cells and osteoblasts that lines all internal cavities within bone; this lining represents the boundary between the bone matrix and the marrow cavities. Bone cells include osteogenic cells, osteoblasts, osteocytes, and osteoclasts. These cells contribute to bone growth, remodeling, and repair.



Bone Matrix

Bone is primarily characterized by a hard matrix, which contains calcium, phosphate, other organic and inorganic materials, and type I collagen fibers. Compared to cartilage, bone contains only about 25 % water in the matrix, whereas cartilage matrix contains about 75% water. This combination makes bone hard, firm, and very strong. Bone matrix has organic and inorganic components**. (1) Organic (noncalcified) matrix** is mainly type I collagen with nonmineralized ground substance (chon-droitin sulfate and keratin sulfate). It is found in the freshly produced bone matrix, **osteoid** (also called **prebone**), which is produced by **osteoblasts**. This matrix stains light pink in H&E preparations.

(2) Inorganic (calcified) matrix, mainly in the form of **hydroxyapatite,** contains crystalline mineral salts, mostly of calcium and phosphorus. After osteoid is produced, this fresh matrix undergoes a mineralization process to become the calcified matrix.

Bone Cells

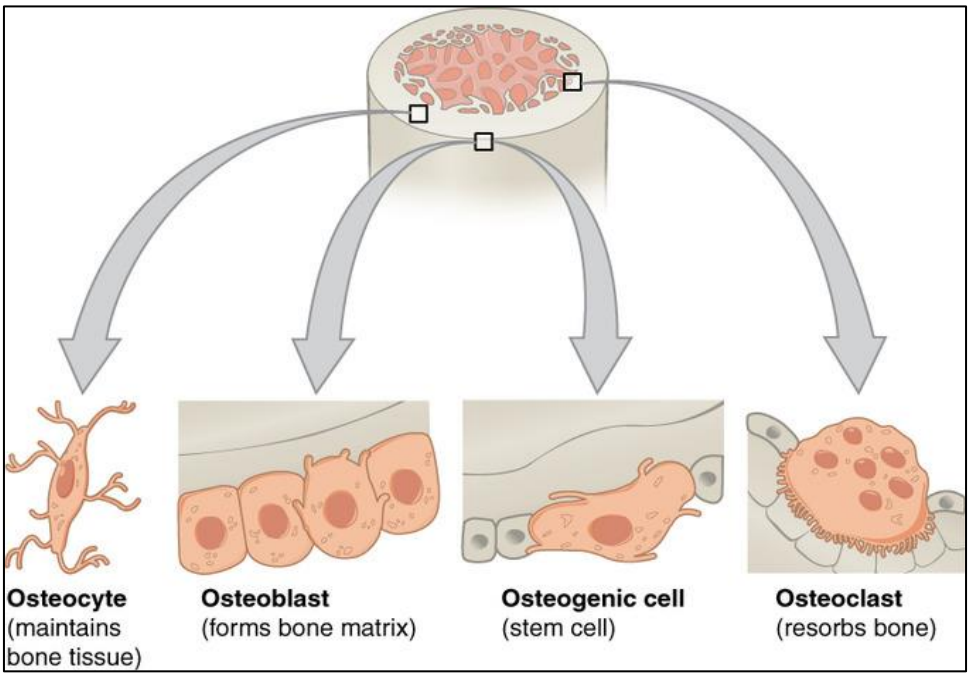
Bone consists of four types of cells: **osteoblasts, osteoclasts, osteocytes, and osteoprogenitor (or osteogenic) cells**. Each cell type has a unique function and is found in different locations in bones.

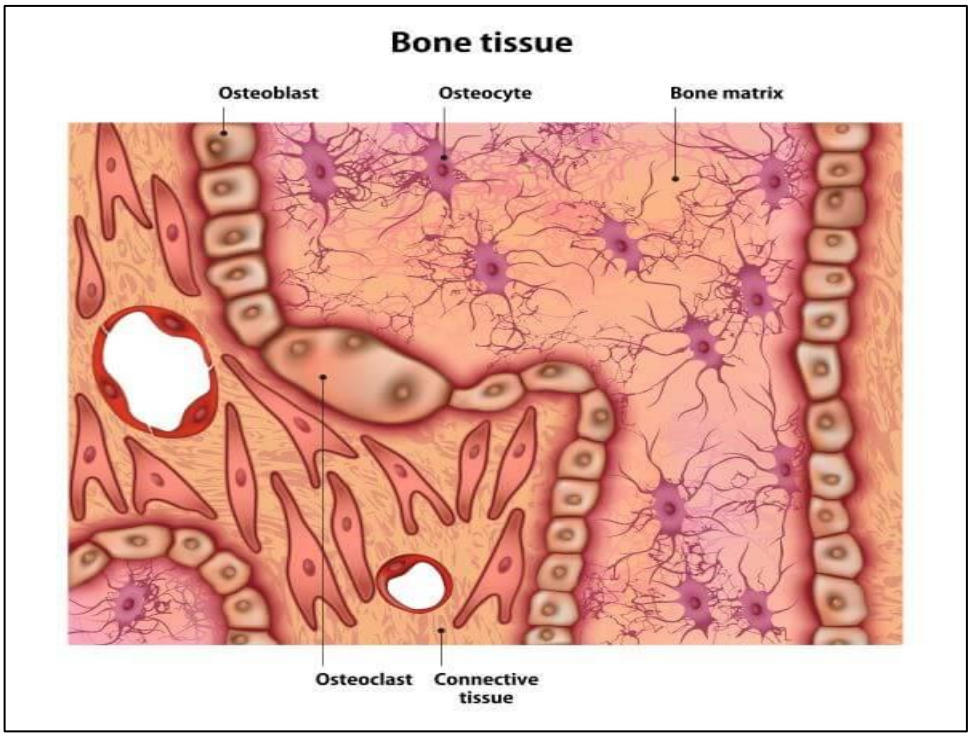
(1) Osteoprogenitor cells are located in the periosteum on the surface of the growing bone and can differentiate into osteoblasts.

(2) Osteoblasts produce the bone matrix. They are cuboidal or low columnar in shape and have a well-developed **Golgi complex** and **RER,** which correlates with their protein-secreting function.The overall process of mineralization relies on the elevation of calcium and phosphate within the matrix and the function of hydroxyapatite crystals. This is brought about by complex functions of the osteoblast.

(3) Osteocytes are small, have Cytoplasmic processes, and are unable to divide. These cells originate from osteoblasts and are embedded in the bone matrix. Osteoblasts deposit the matrix around themselves and end up inside the matrix, where they are called "osteocytes." Each osteocyte has many long, thin processes that extend into small narrow spaces called **canaliculi.** The nucleus and surrounding cytoplasm of each osteocyte occupy a space in the bone matrix called **a lacuna**. Thin processes of the osteocyte course through thin channels (**canaliculi**) that radiate from each lacuna and connect neighboring lacunae.

(4) Osteoclasts are large, multinucleated cells, which derive from monocytes, absorb the bone matrix, and play an essential role in bone remodeling.





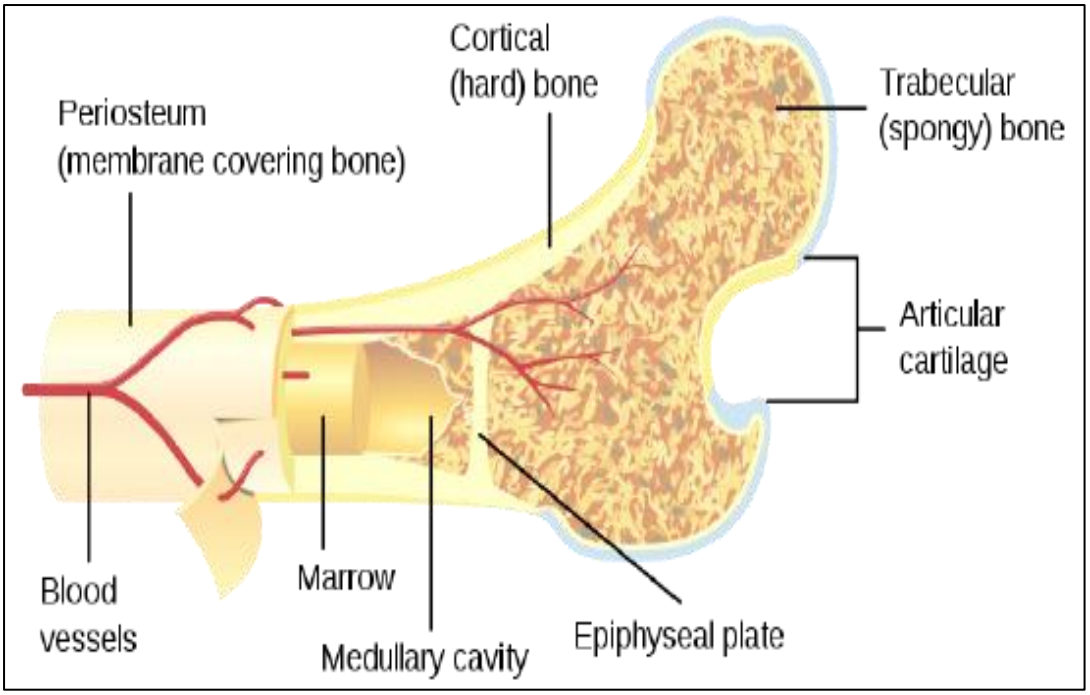
Types of Bone

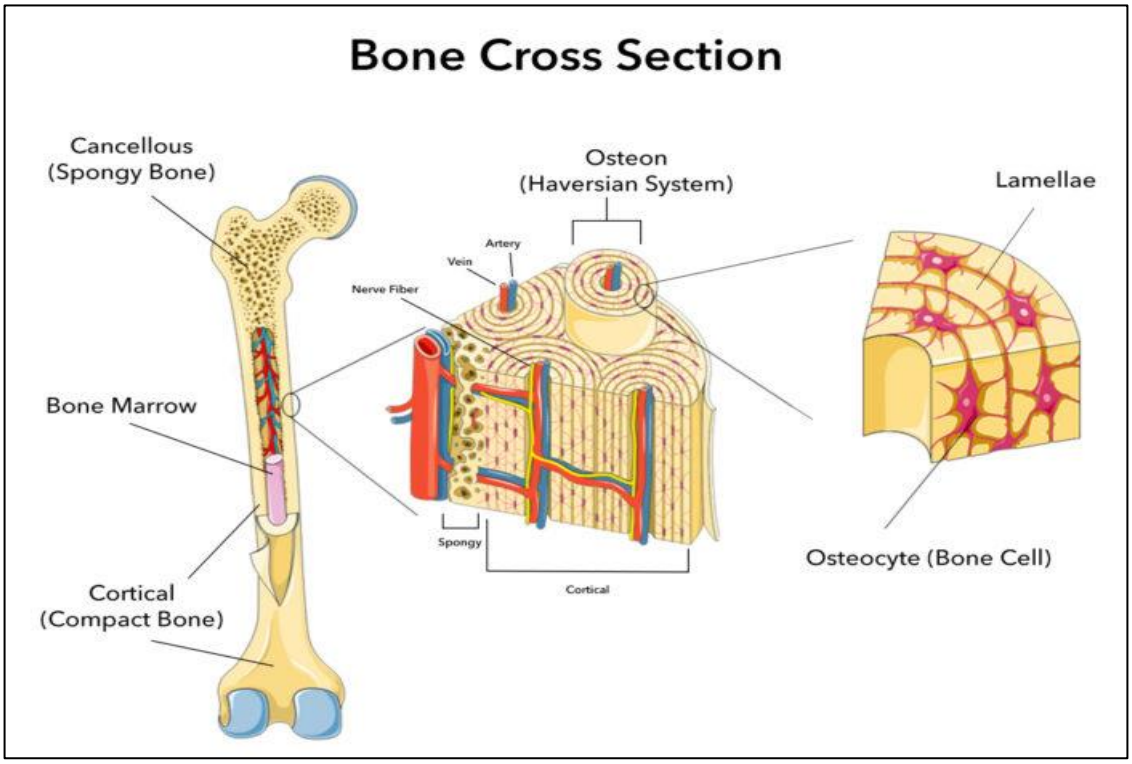
There are several ways to classify bone tissues. Microscopically, bone can be classified as **primary bone (immature bone)** and **secondary bone (mature, or lamellar bone).** Bones can also be classified by their shapes as follows: **long bones, short bones, flat bones, and irregular bones.**

Mature bone can be classified as **(1) compact bone** and **(2) cancellous bone** based on gross appearance and density of the bone.

Compact bone, also called cortical bone, has a much higher density and a wellorganized osteon system. It does not have **trabeculae** and usually forms the external aspect (outside portion) of the bone. **The Haversian canal** is a central space through which blood vessels pass;**The Volkmann canal** is the space that sits perpendicularly to the Haversian canals and forms the connection between two Haversian canals.

Cancellous bone, also called spongy bone, has a much lower density and contains bony **trabeculae** or **spicules** with intervening **bone marrow**. It can be found between the inner and the outer tables of the skull, at the ends of long bones, and in the inner core of other bones.

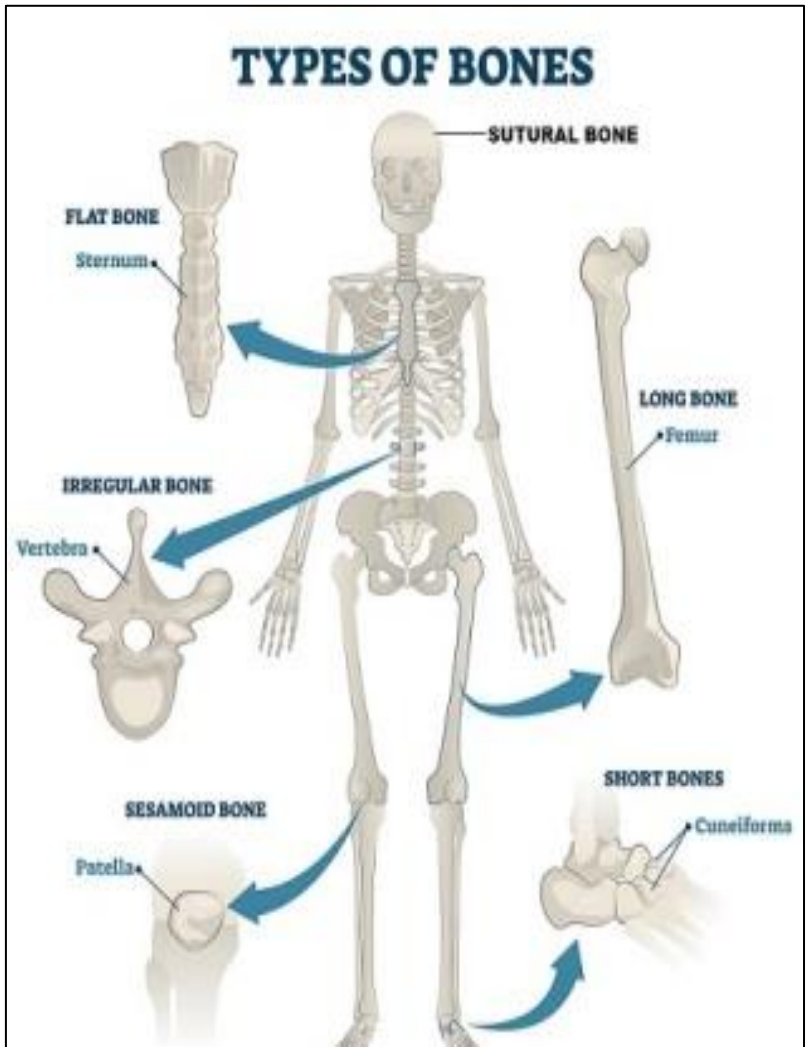

Cortical
(hard) bone
Periosteum
(membrane covering bone)
Trabecular
(spongy) bone
Articular
cartilage
Blood
vessels
Marrow
Medullary cavity
Epiphyseal plate


Bone Cross Section
Cancellous
(Spongy Bone)
Osteon
(Haversian System)
Lamellae
Artery
Vein
Nerve Fiber
Bone Marrow
Spongy
Cortical
Cortical
(Compact Bone)
Osteocyte (Bone Cell)

Bone types

There are four different types of bone in the human body:

- **Long bone** – has a long, thin shape. Examples include the bones of the arms and legs (excluding the wrists, ankles and kneecaps). With the help of muscles, long bones work as levers to permit movement.
- **Short bone** – has a squat, cubed shape. Examples include the bones that make up the wrists and the ankles.
- **Flat bone** – has a flattened, broad surface. Examples include ribs, shoulder blades, breast bone and skull bones.
- **Irregular bone** – has a shape that does not conform to the above three types. Examples include the bones of the spine (vertebrae).



Bone conditions

Some conditions of bone include:

- **Fractures** – broken bones of various types.
- **Osteoporosis** – is a disease that results in a decrease in bone mass and mineral density..
- **Osteomyelitis** – infection of bone tissue is a rare but serious condition.
- **Acromegaly** – overgrowth of bones in the face, hands and feet.
- **Rickets_** is a childhood bone condition, It results in soft, weak bones, typically due to a vitamin D deficiency.

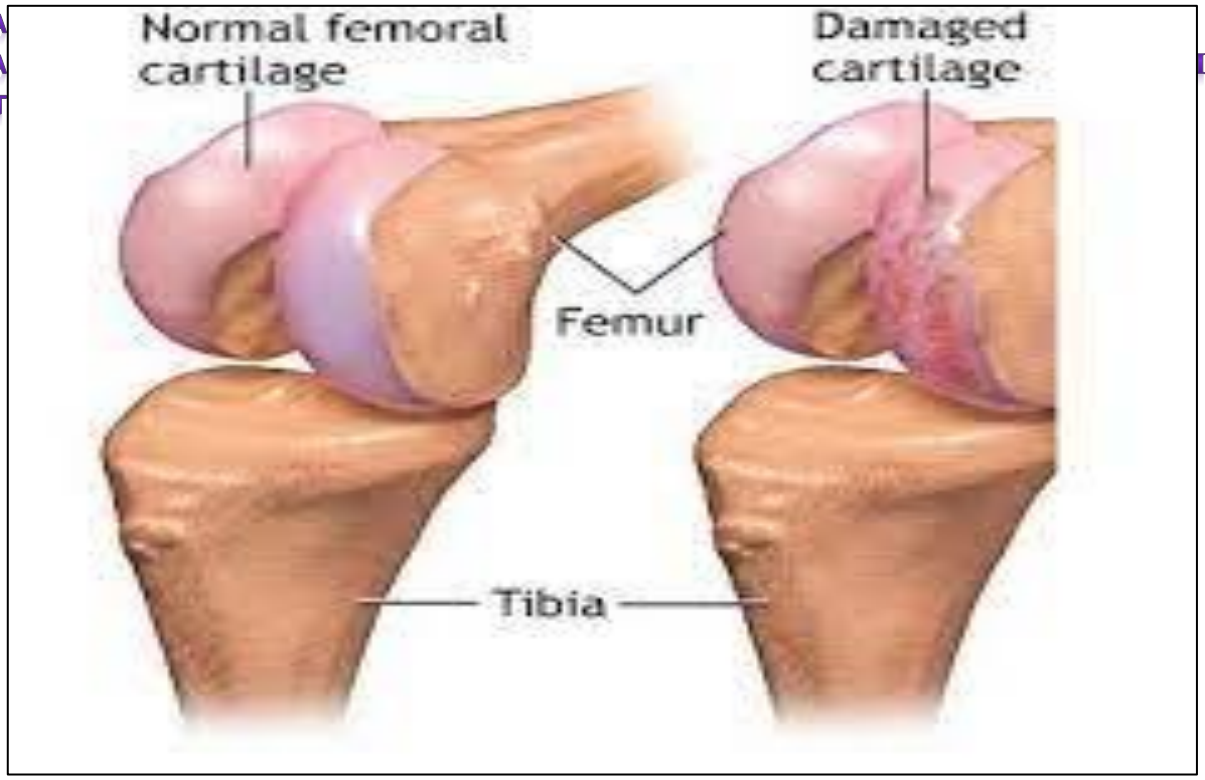
المحاضرة الثامنة

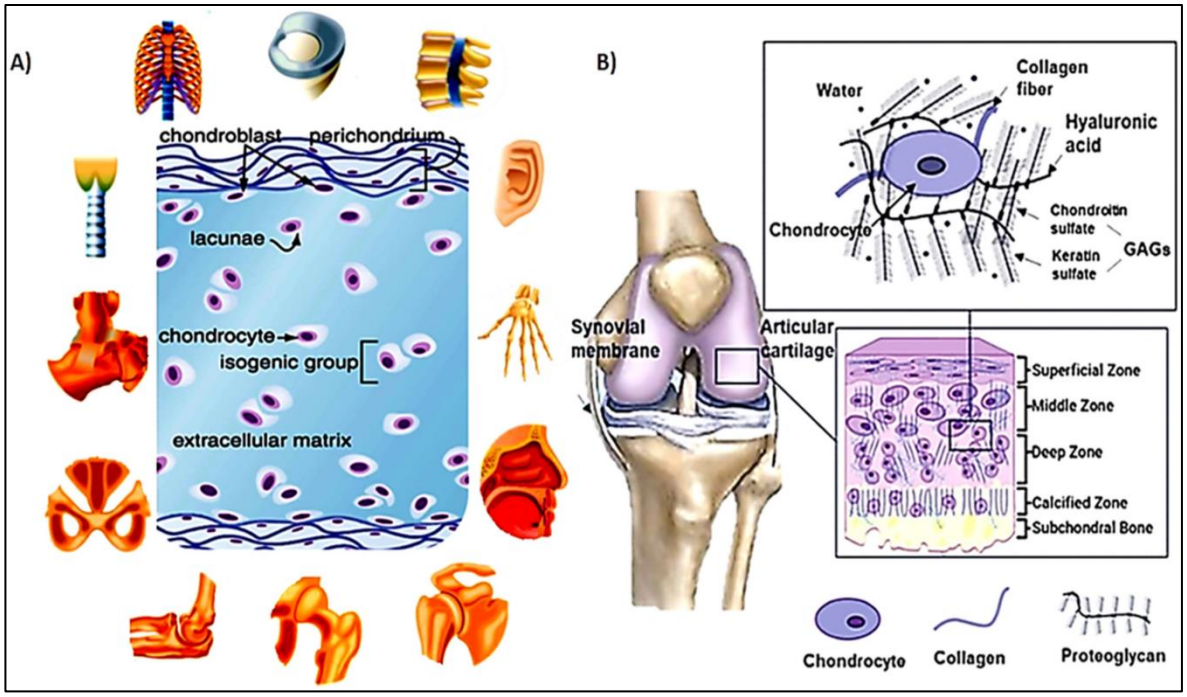
What is cartilage?

Cartilage is a strong, flexible connective tissue that protects your joints and bones. It acts as a shock absorber throughout your body.

Cartilage at the end of your bones reduces friction and prevents them from rubbing together when you use your joints. It's also the main tissue in some parts of your body and gives them their structure and shape.

Cartilage consists of cells called **chondrocytes** (Gr. chondros, cartilage + kytos, cell) embedded in the ECM. Chondrocytes synthesize and maintain all ECM components and are located in matrix cavities called **lacunae**. All types of cartilage lack vascular supplies (**Avascular tissue**) and chondrocytes receive nutrients by diffusion from capillaries in surrounding connective tissue (the perichondrium). Cartilage also lacks nerves. The cartilage form the fetal skeleton. Also it is essential for the development and growth of long bones.





Composition: Like all connective tissues, cartilage is composed of cells, fibers, and ground substance. The extracellular matrix predominates and determines cartilage's mechanical properties. Type II collagen is a characteristic cartilage matrix component.

Perichondrium: Which is essential for the growth and maintenance of cartilage is a capsule like sheath of dense connective tissue that surrounds cartilage. It harbors the vascular supply for avascular cartilage and connects cartilage with the surrounding tissues. Perichondrium composed of two layers:

1. **Fibrous – stratum fibrosum** - external part, contains fibers collagen I, fewnumber of cells – fibroblasts.
2. **Cellular – stratum chondrogenicum** abundant cells – fibroblasts and chondroblast .

A) Cartilage cells

1. **Stem cells (chondrogenic cells):**
   - Most cartilage is enveloped by a layer of dense connective tissue, the perichondrium, which contains the vascular supply and fibroblast .
   - like stem cells from which additional chondrocytes may arise.
   - They are derived from mesenchymal cells.
   - They are spindle shaped cells with ovoid nucleus, small Golgi, few mitochondria, and rER.
2. **Chondroblasts:**
   - They are derived from mesenchymal cells within the center of chondrofication, or from chondrogenic cells.
   - They are ovoid, basophilic cells, rich with rER, well developed Golgi, numerous mitochondria, and more secretory vesicles.
   - The cells synthesize the fibers and the matrix.
3. **Chondrocytes:**
   - They are chondroblasts that are surrounded by matrix (within lacuna).
   - They are ovoid near the periphery, and more rounded deeper in the cartilage.
   - The cells have eccentric large nuclei, with prominent nucleoli, and the usual cell organelles.
   - The cells synthesize and secrete the fibers and ground substance.
4. **Chondroclasts:** belong to mononuclear phagocyte system involved in destruction of the cartilage.

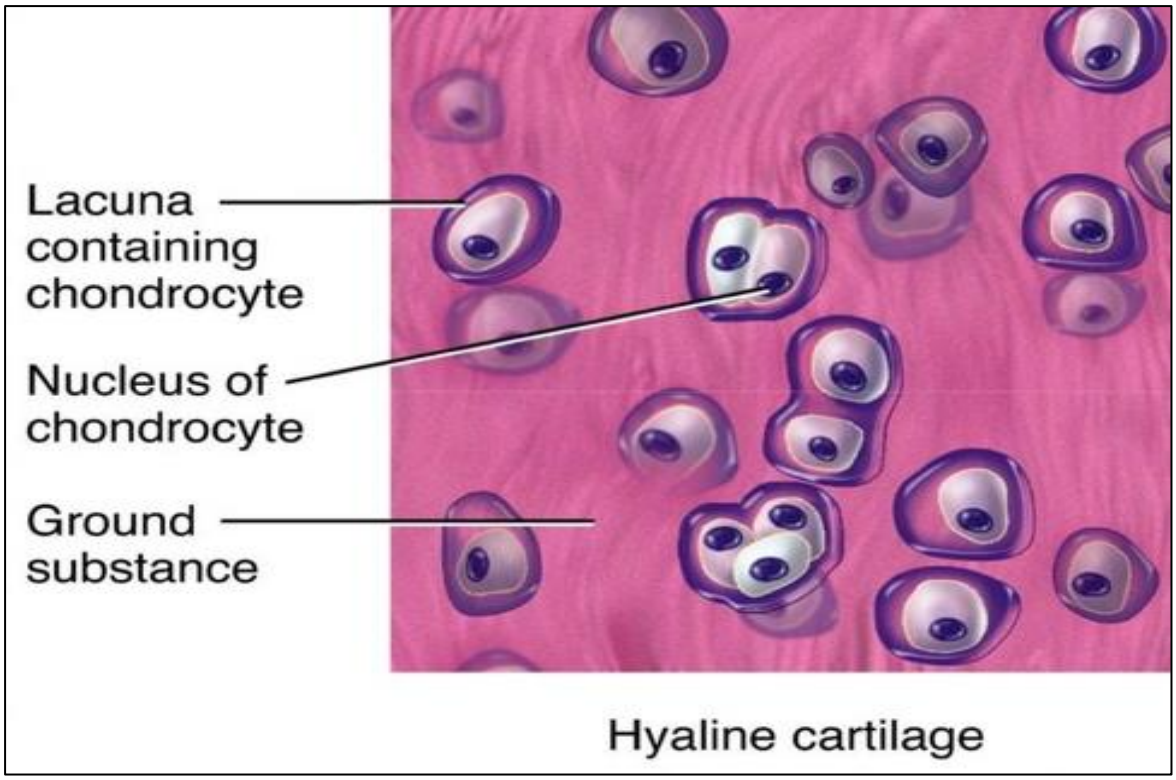
B) amorphous ground substance (matrix)

1. glycosaminoglycans – hyaluronic acid .
2. proteoglycans – form proteoglycan aggregates that interact with collagen and bind the water .

3. structural glycoproteins – chondronectin .

C) fibrils

1. collagen I – form fibers, in fibrocartilage .
2. collagen II – fibrils with diameter 20nm .
3. elastic fibers – in elastic cartilage .



Types of Cartilage :

There are three types of cartilage, differ in their appearance and mechanical properties, due to differences in the composition of their extracellular matrix, and the type of fibers. Generally, no distinction is made among the cells present in the different cartilage types.

- Hyaline Cartilage: contains type II collagen fibrils.
- Elastic cartilage: contains type II collagen fibers and abundant elastic fibers.
- Fibrocartilage: contains dense, coarse type I collagen fibers.

1. **Hyaline Cartilage**

- It is a bluish gray, semi-translucent, and flexible structure.

- It is the commonest type, present in the nose, larynx, trachea, bronchi, articulated surfaces of joints, on the ventral ends of ribs (costal cartilage).
- It is covered with dense fibrous connective tissue called perichondrium.
- Matrix, is formed by the chondrocytes, rich in proteoglycans and glycosaminoglycans, and contain type II collagen (fibers are not formed, fibrils with diameter 20nm).
- Cartilage cells: Chondrocytes and Chondroblasts .
- The matrix is subdivided into two types:
  1- **Territorial**, a peri cellular capsule (around lacunae) ; and
  2- **Interterritorial,** in-between lacunae.

2- Elastic Cartilage

- It is located in the ear pinna, external and internal auditory tube, and epiglottis .
- It is similar to hyaline cartilage, as it is formed of perichondrium, matrix, chondrocytes, and chondroblasts. But, the matrix contains more elastic fibers as well as type II collagen fibers.

3-Fibro-cartilage

- Unlike elastic or hyaline cartilage, it does not possess perichondrium, and the matrix is rich in bundles of type I collagen fibers .
- Fibro-cartilage is localized in the inter-vertebral disks, tendons at insertion to bone, symphysis pubic .
- Fibrocartilage showing rows of chondrocytes separated by collagen fibers.
- Fibro-cartilage is frequently seen in the site of insertion of tendons to the epiphyseal hyaline cartilage.

Intervertebral Disks: The intervertebral disks act as cushions between the vertebrae, allowing limited movement of the vertebral column. They are bound to the vertebrae by ligaments. Each disk has 2 parts:

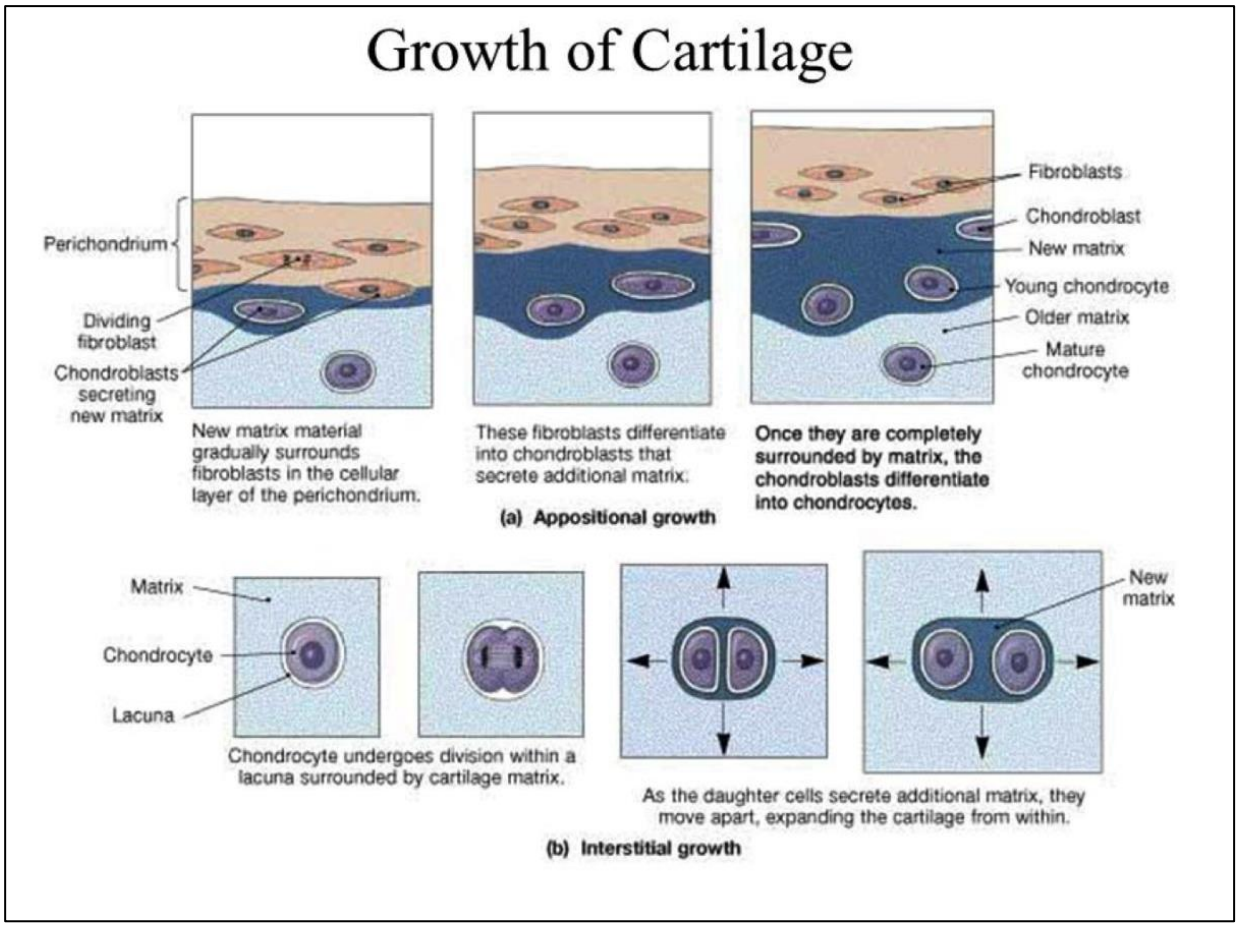
1. Annulus Fibrosus (the outer ring):- is composed mainly of fibrocartilage and is covered on its outer surface by the dense connective tissue of associated ligaments.

2. Nucleus Pulposus:- it forms the center of the disk and it is composed of mucous connective tissue (Mesenchyme), with a few fibers and rounded cells embedded in jelly, hyaluronic acid-rich, ground substance. The nucleus pulposus is smaller in adults than in children, because it is partially replaced by fibrocartilage.

Cartilage growth: All cartilage forms from embryonic mesenchyme stem cells in the process of chondrogenesis. And repair or replacement of injured cartilage is very slow and ineffective, due in part to the tissue's avascularity and low metabolic rate. Cartilage grows by 2 different processes which involve mitosis and the deposition of additional matrix.

1. Appositional growth: resulting from the differentiation of chondroblast of the perichondrium, proliferate and become chondrocytes; once they have surrounded themselves with extracellular matrix, they are incorporated into the existing cartilage.

2. Interstitial growth: Proliferation by mitotic division and hypertrophy of existing chondrocyte.



المحاضرة التاسعة

Digestive System

The food you eat takes an incredible journey through your body, from top (your mouth) to bottom (your anus). Along the way the beneficial parts of your food are absorbed, giving you energy and nutrients. Here's a step-by-step account of the digestive system's workings.

What is the digestive system?

Your digestive system is made up of the gastrointestinal (GI) tract and your liver, pancreas and gallbladder. The GI tract is a series of hollow organs that are connected to each other from your mouth to your anus. The organs that make up your GI tract, in the order that they are connected, include your mouth, esophagus, stomach, small intestine, large intestine and anus.

What organs make up the digestive system?

The main organs that make up the digestive system (in order of their function) are the mouth, esophagus, stomach, small intestine, large intestine, rectum and anus. Helping them along the way are the pancreas, gall bladder and liver.

The **digestive tract** is a long muscular tube lined with epithelium specialized for digestion and absorption of food and water.

The digestive tract (**alimentary tract**), starts in the **oral cavity**, the oral covered by a surface squamous stratified epithelium, and continues through the pharynx, to the esophagus, stomach, duodenum, small intestine, large intestine, rectum, and terminates in the anal canal. Food moves along the digestive tract by **peristalsis**, the rhythmic contractions of the smooth muscle within the walls of the tube. Food moves in one direction (except in unusual circumstances such as vomiting), and multiple circular muscles called **sphincters**, located at critical junctions, prevent the food in transit from going backward. The **mucosal (epithelial layer)** secretions aid in digestion, and later provide the mechanisms for the absorption of nutrients**.**

In addition to the digestive tract, the **digestive system** includes several **(accessory glands)** that secrete various enzymes and fluids to assist with digestion and transport. The major accessory glands of the digestive system include:

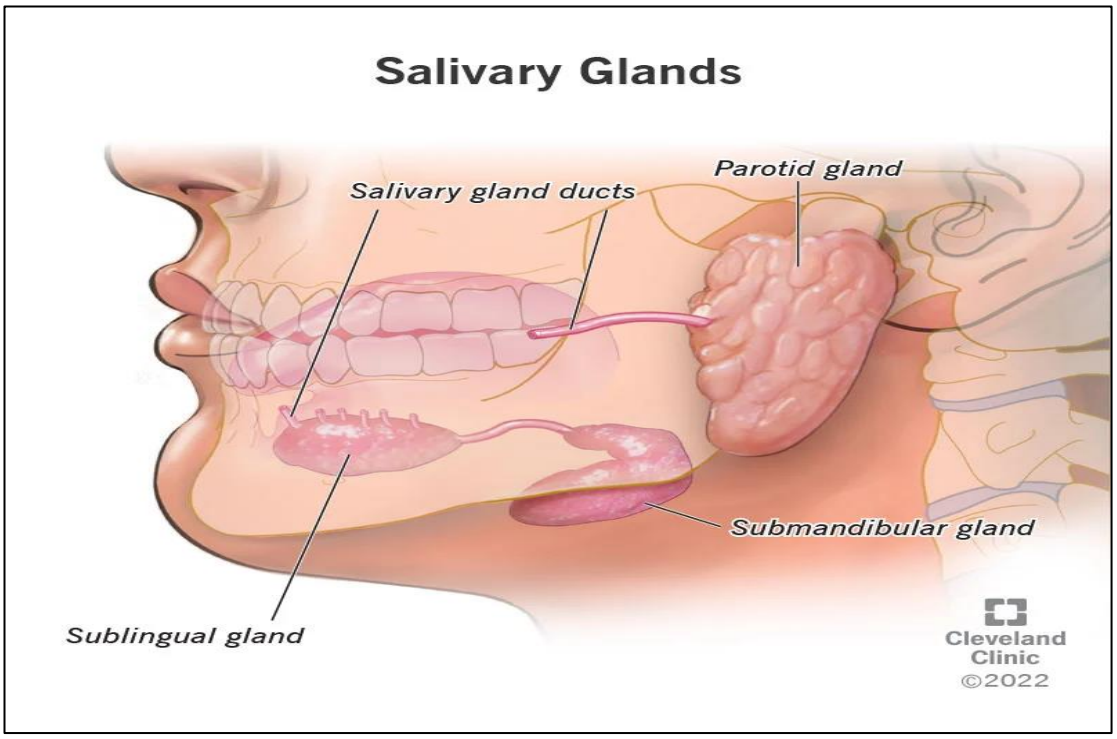
A) Three pairs of salivary gland:

1- Sublingual glands:

These are below either side of your tongue, under the floor of your mouth.

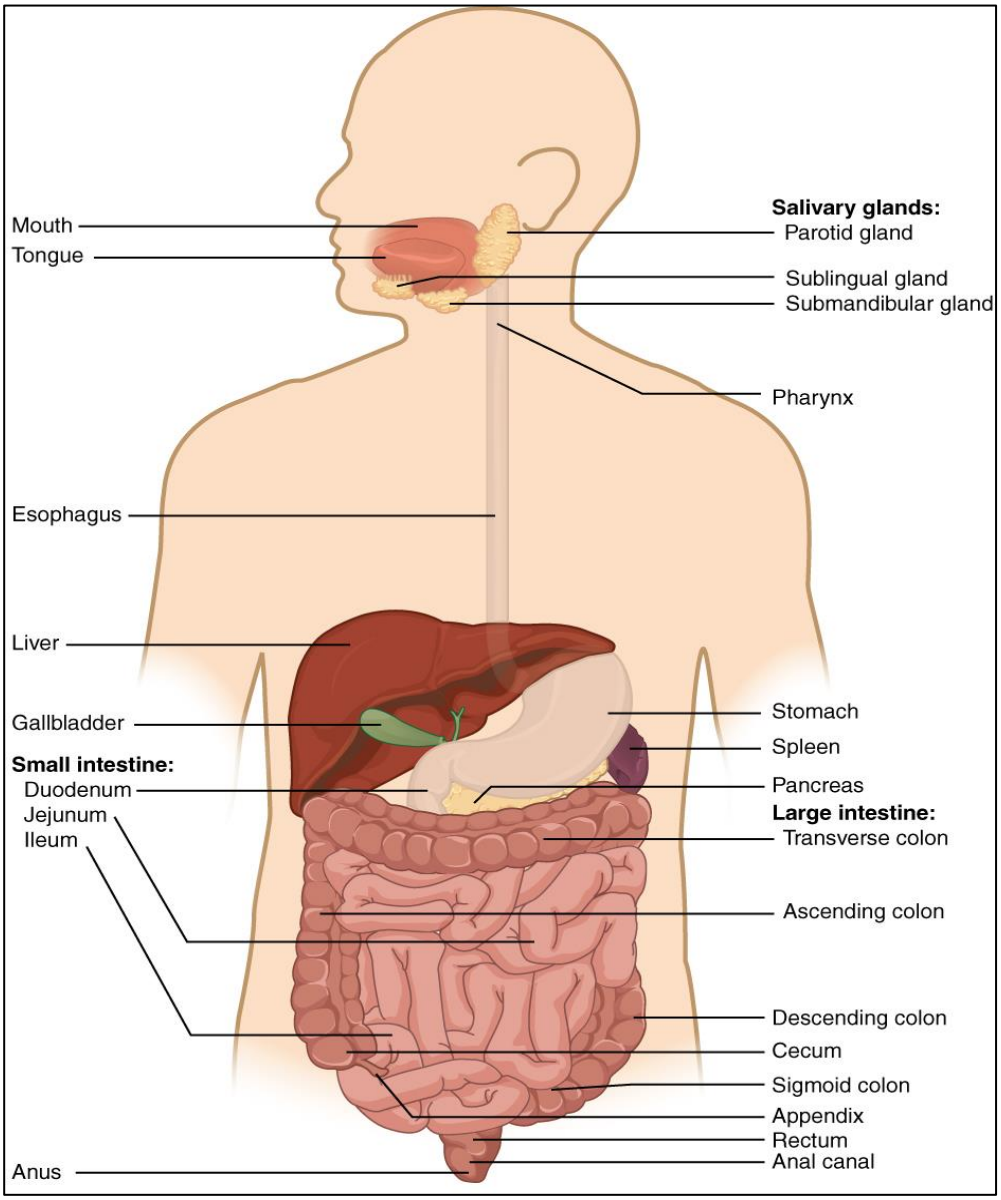
2- Submandibular glands: Located below your jaw, your submandibular salivary glands consist of two parts: the superficial lobe and the deep lobe. Like your sublingual glands, the saliva produced in your submandibular glands enter your mouth from under your tongue.

3- Parotid glands: Your parotid glands are just in front of your ears. Similar to your submandibular glands, your parotid glands have two parts: superficial and deep. The saliva produced by your parotid glands enters your mouth from small ducts near your upper molars.



B) The pancreas.

C)The liver with the gallbladder.



FOUR LAYERS OF DIGESTIVE TRACT WALLS

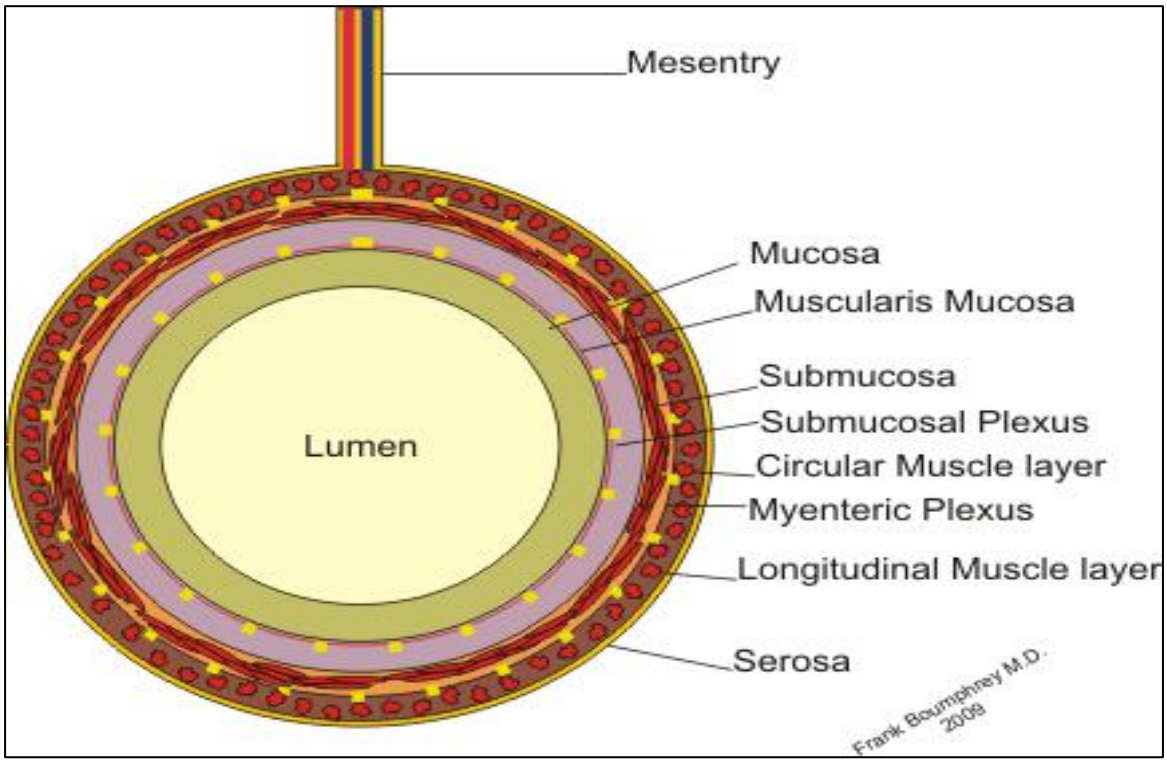
Walls of the digestive tract have four concentric layers. Going from the inside out, these are:

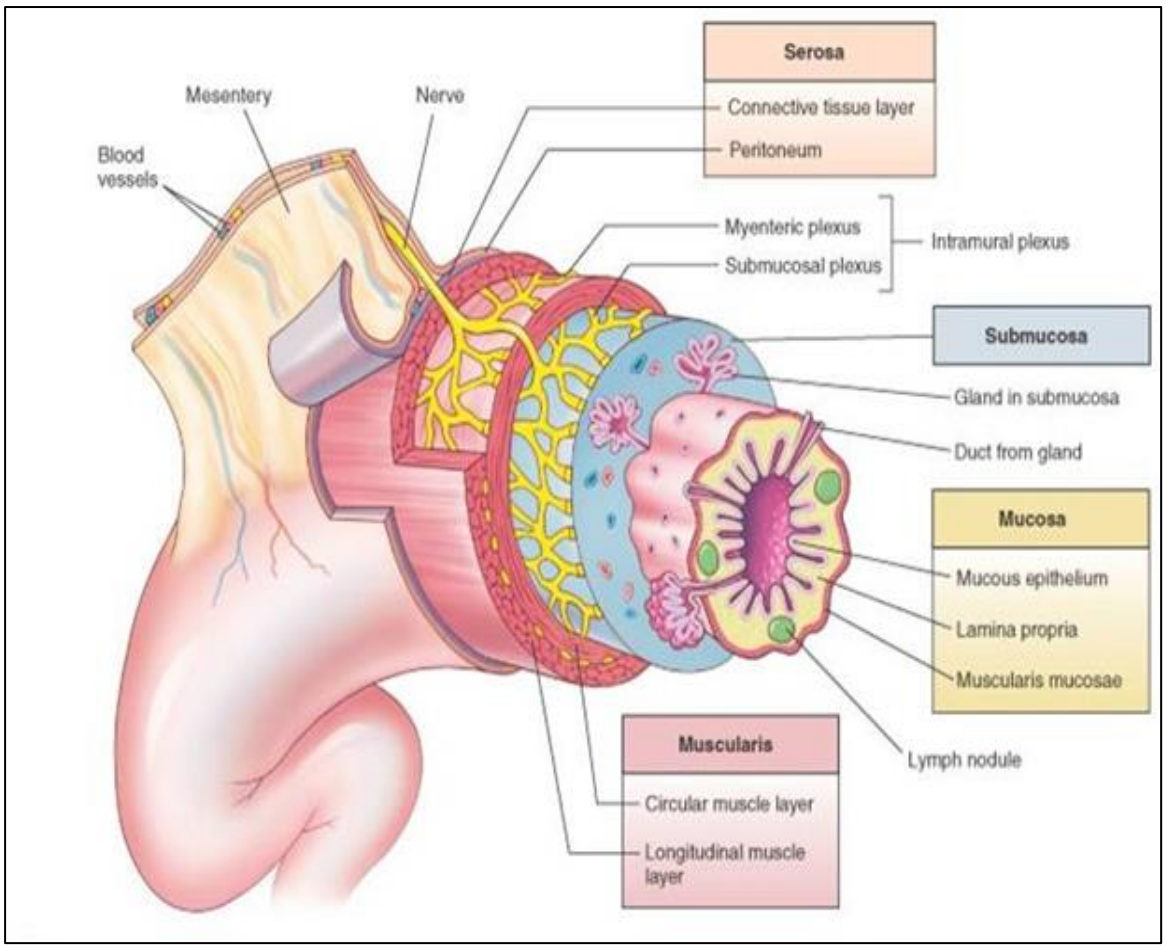
1-**Mucosa**

2- **Submucosa**

3-**muscularis externa**

4-**adventitia or serosa**


Mesentry
Mucosa
Muscularis Mucosa
Submucosa
Submucosal Plexus
Lumen
Circular Muscle layer
Myenteric Plexus
Longitudinal Muscle layer
Serosa
Frank Boumphrey M.D.
2009


Serosa
Connective tissue layer
Peritoneum
Mesentery
Nerve
Blood vessels
Myenteric plexus
Submucosal plexus
Intramural plexus
Submucosa
Gland in submucosa
Duct from gland
Mucosa
Mucous epithelium
Lamina propria
Muscularis mucosae
Lymph nodule
Muscularis
Circular muscle layer
Longitudinal muscle layer

MUCOSA

The mucosa is the innermost layer. It is made of:

1-**Epithelium**

2- **lamina propria**

3 **-muscularis mucosae** (this is separate from the thicker layer of smooth muscle within the muscularis layer).

1 -Epithelium covers the inner surface of the digestive tract. It starts as **stratified squamous epithelium** in the esophagus and changes to **simple columnar epithelium** in the stomach. In the intestines, it stays columnar but acquires microvilli to increase the surface area for absorption. The segmental characteristics of the epithelium will be described in later sections. As with every other epithelium, it lies on the basement membrane.

2 -The **lamina propria**, a thin layer of loose connective tissue, lies directly below the mucosal epithelium.

3- The **muscularis mucosae** is a relatively thin layer of smooth muscle located between the mucosa and the submucosa.

SUBMUCOSA

The submucosa is composed of a layer of **dense, irregular connective tissue.** It contains large blood vessels, lymphatics and the neurons of the **submucosal plexus of Meissner**.

MUSCULARIS EXTERNA

The muscularis, sometimes called **muscularis externa** to differentiate from the muscularis mucosae, consists of two clearly visible layers of smooth muscle (three in the stomach only):

A) an **inner circular layer**

B) an **outer longitudinal layer**

Another nerve plexus, **a myenteric plexus of Auerbach,** lies between the circular and longitudinal layers of smooth muscle. This muscular layer contracts to produce peristalsis.

ADVENTITIA

The **adventitia** is the outermost layer and is a thin layer of loose connective tissue. In places, a thin layer of simple squamous epithelium called **mesothelium** covers adventitia on the external surface. When covered by mesothelium, the adventitia is called the **serosa.**

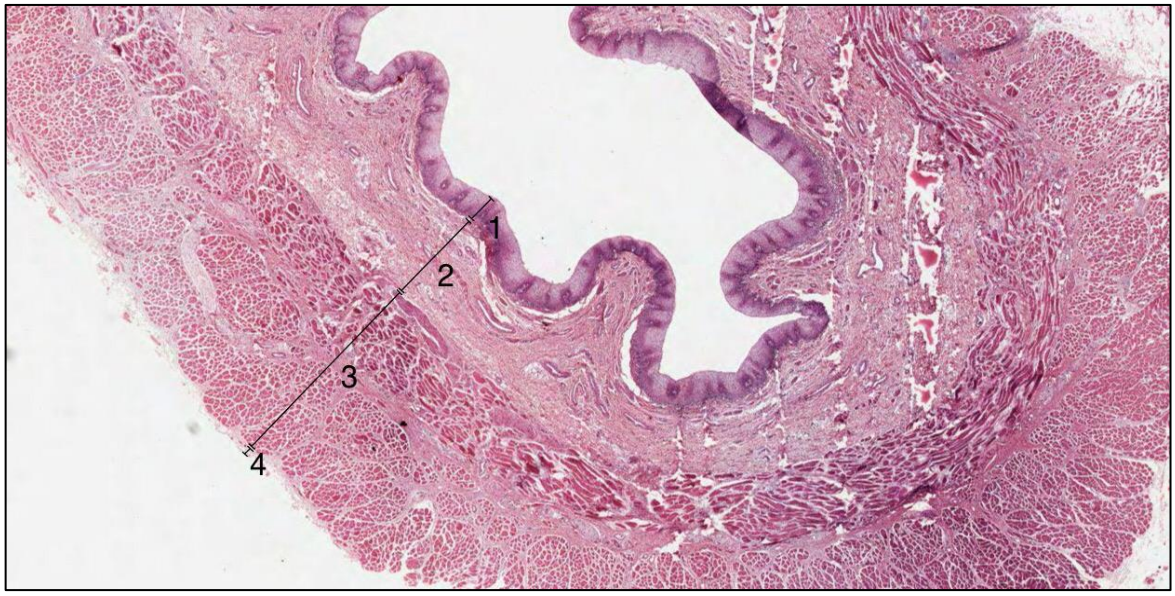


Figure: Layers of the digestive tract walls: The image is of the esophagus

ESOPHAGUS

The **esophagus** is a long, soft tube that connects the pharynx to the stomach. Its only function is the transport of food.

The mucosal surface of the esophagus is lined by a thick layer of stratified squamous epithelium, adapted for fast transport and withstanding abrasive forces of moving food pieces. The muscularis is well developed as the esophagus' peristalsis has to push food toward the stomach. In the upper segment of the esophagus, the muscularis layer contains mostly skeletal muscle that transitions to a mixture of skeletal and smooth in the middle, and finally only smooth muscle in the lower part.

STOMACH

The **stomach** is a muscular sack for the storage and digestion of food. The stomach can be divided into three regions:

1- **Fundus**
2- **Body**
3- **Pylorus**

Each stomach region contains slightly different mucosa that reflects their different function.

At the junction with the esophagus, the stratified squamous epithelium of the esophagus abruptly changes to the simple columnar epithelium of the stomach. Simple columnar epithelium is recognizable by the shape and position of the nuclei. They are elongated and arranged in a neat, single row along the basement membrane.

Figure Simple columnar epithelium of the stomach at very high magnification

Figure: Gastric glands and gastric pits of gastric mucosa

SMALL INTESTINE

The **small intestine** is a long tube that extends from the stomach to the junction with the large intestine (colon.) The major functions of the small intestine are digestion, secretion, and absorption. The small intestine is divided into three segments:

a) **Duodenum**

b) **Jejunum**

d) **Ileum**.

The mucosa of the small intestine has some adaptations to the functions it serves. It is heavily creased into the structures that increase the surface area where the nutrients are digested and absorbed. These adaptations include **intestinal folds** called the **plicae circulares, villi, and microvilli.**

The **plicae circulares** are folds of mucosa and submucosa that extend into the intestinal lumen. They encircle the entire intestine and are visible without a microscope, so they will not be discussed here.

Villi are microscopic fingerlike projections of the mucosa covered in simple columnar epithelium. **Microvilli** are tiny cytoplasmic extensions on the external surface of epithelial cells. They are barely recognizable under a light microscope as a striated layer on top of the epithelial cells and are called **brush** (striated) **border**.

All three segments of the small intestine are covered by **simple columnar epithelium**. Most of the cells are absorptive cells; interspersed among them is a small number of mucus-producing **goblet cells** that appear as tear shaped dots of a lighter color.

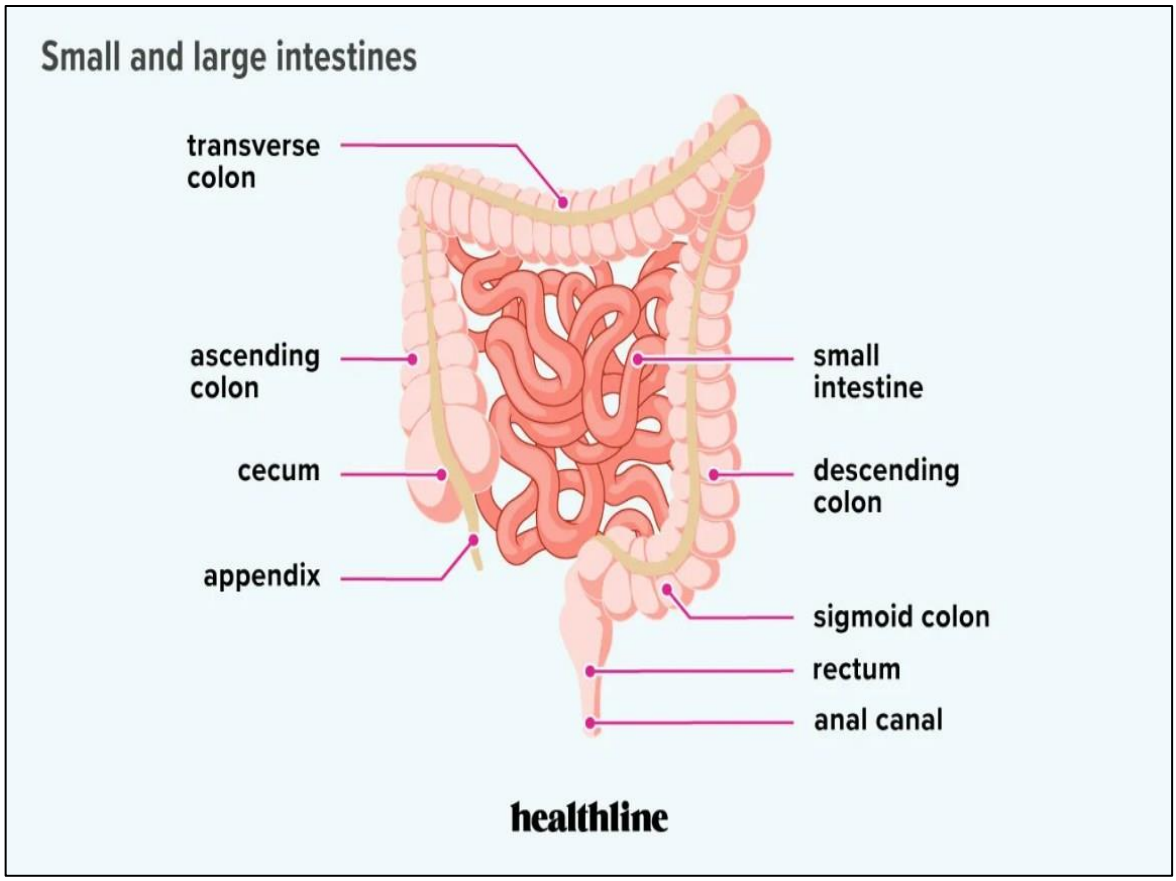
LARGE INTESTINE

The **large intestine** (a.k.a colon) connects the end of the ileum to the anal canal. In the large intestine, the intestinal content that arrived there from the small intestine is dehydrated and compacted into feces. The large intestine starts as a pouch called **cecum** and continues as the ascending, transverse, descending and sigmoid colon, followed by the rectum and anus.

The large intestine has the same four layers as other parts of the digestive tract. It is lined by simple columnar epithelium. The characteristic features of the large intestine are the lack of villi and the presence of the intestinal crypts (glands).Lamina propria of the large intestine mucosa contains multiple **nodules of lymphatic tissue** that appear as darker stained spots.

Anal canal

The Epithelium is protective **(nonkeratinized stratified squamous)** with transition to epidermis (keratinized). Lamina propria is unspecialized with transition to dermis. Muscularis mucosae ends at recto-anal junction.

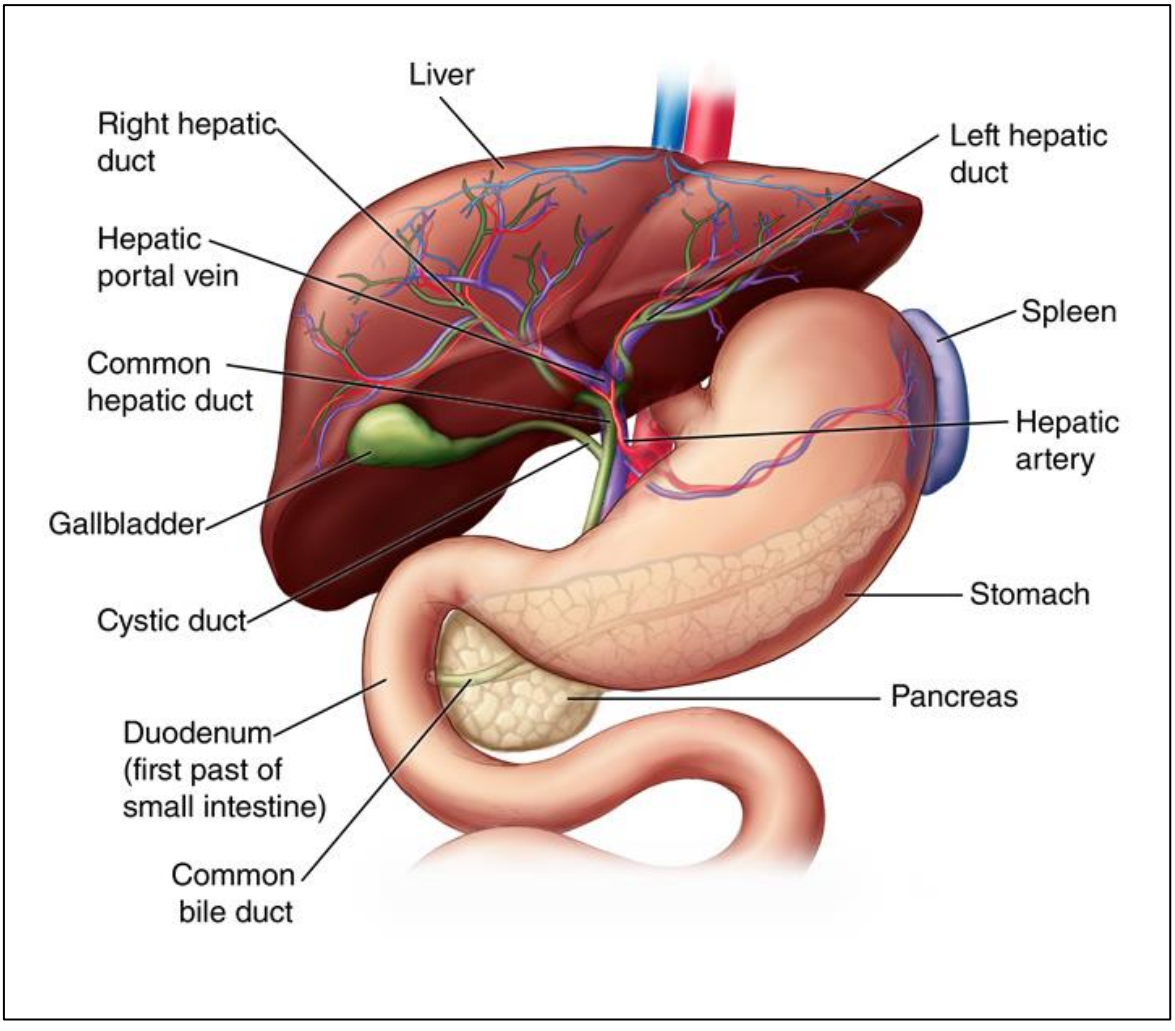


المحاضرة العاشرة

Digestive system: II

Liver

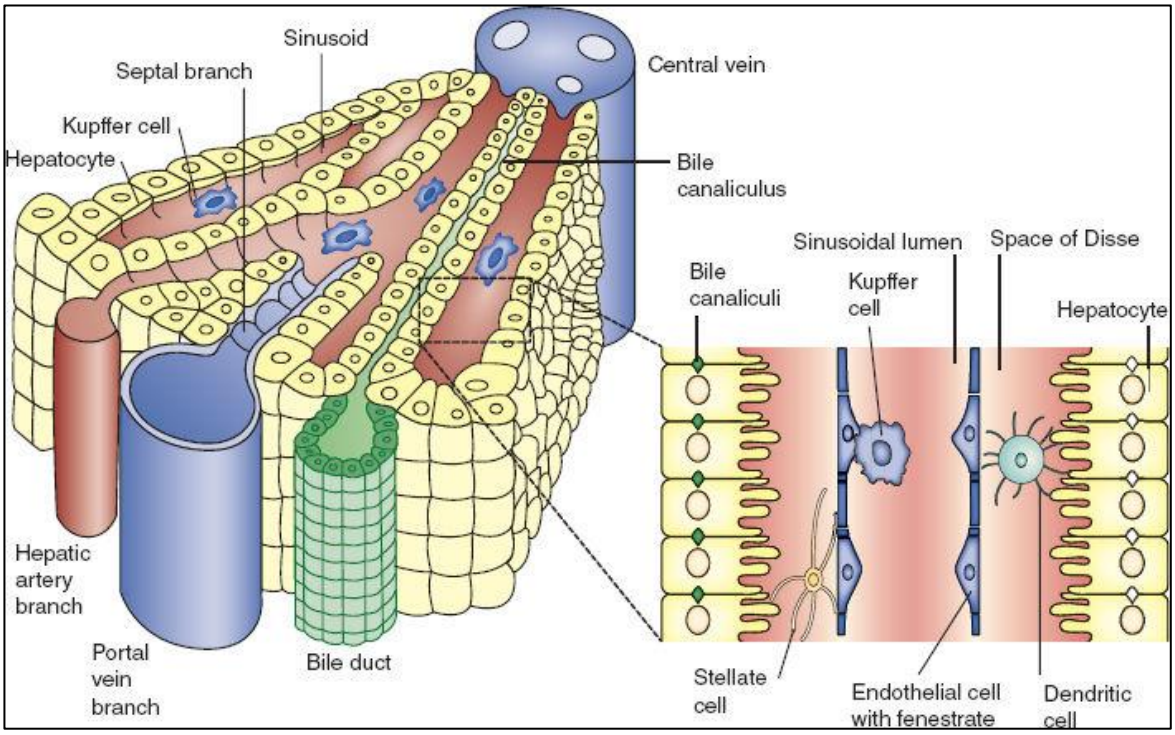
The liver is the largest organ of the body, constituting 2-5% of the adult body weight. It receives blood supply from two major blood vessels. The hepatic artery supplies oxygenated blood, whereas the portal vein, which provides 80% of the total blood supply, supplies nutrient-rich deoxygenated blood. The liver thus acts as a guard between the digestive tract and the rest of the body, transforming, detoxifying, and accumulating metabolites. The liver also produces different types of plasma proteins, such as albumin, which are delivered into the blood, as well as metabolites that are constituents of the bile



Structure

Triads are consisting of 3 structures are located between the lobules:

1. A branch of the hepatic artery that brings oxygenated blood to the liver
2. A branch of the hepatic portal vein that transports nutrients from the intestines.
3. A bile duct that takes bile away from the liver.



Blood arriving through branches of the portal vein and the hepatic artery pass through the sinusoids, towards the central vein. The liver sinusoids are lined with a discontinuous layer of fenestrated endothelial cells. Between the endothelial cells and the hepatocytes, is a discontinuous basal lamina and a subendothelial space named the space of Disse, through which exchange between the blood and the hepatocytes take place.

There are 4 basic cell types that reside in the liver:

1. the hepatocyte
2. the stellate fat storing cell
3. the Kupffer cell

4. the liver endothelial cell

What does the liver do?

The liver has hundreds of jobs. Some of the most vital are:

- Production of bile, which helps carry away waste and break down fats in the small intestine during digestion
- Production of certain proteins for blood plasma
- Production of cholesterol and special proteins to help carry fats through the body
- Conversion of excess glucose into glycogen for storage (glycogen can later be converted back to glucose for energy) and to balance and make glucose as needed
- Regulation of blood levels of amino acids, which form the building blocks of proteins
- Processing of hemoglobin for use of its iron content (the liver stores iron)
- Conversion of poisonous ammonia to urea (urea is an end product of protein metabolism and is excreted in the urine)
- Clearing the blood of drugs and other poisonous substances
- Regulating blood clotting
- Resisting infections by making immune factors and removing bacteria from the bloodstream
- Clearance of bilirubin, also from red blood cells. If there is an accumulation of bilirubin, the skin and eyes turn yellow.

The Pancreas

The pancreas is an organ in the back of your abdomen (belly). It is part of your digestive system.

The pancreas is an organ and a gland. Glands are organs that produce and release substances in the body.

The pancreas performs two main functions:

- **Exocrine function:** Produces substances **(enzymes)** that help with digestion.
- **Endocrine function:** Sends out **hormones** that control the amount of sugar in your bloodstream.

What does your pancreas do?

An exocrine gland runs the length of your pancreas. It produces enzymes that help to break down food (digestion). Your pancreas releases the following enzymes:

.1_ Lipase: Works with bile (a fluid produced by the liver) to break down fats

- Amylase: Breaks down carbohydrates for energy

3_ Protease: Breaks down proteins.

How does the pancreas affect blood sugar?

The endocrine glands in your pancreas release hormones that control blood sugar (glucose). These hormones are:

- **Insulin:** Reduces high blood sugar levels.
- **Glucagon:** Increases low blood sugar levels.

Your body needs balanced blood sugar to help with your kidneys, liver and brain. Your heart and circulatory system and nervous system also need balanced levels of insulin and glucagon to function.

The Gallbladder

It is a pear-shaped, muscular sac attached to the surface of the liver (as a fig). About 1,000 ml of bile are produced by the liver each day, and any excess is stored in the gallbladder. Water is reabsorbed by the gallbladder so that bile becomes a thick, mucus-like material. When needed, bile leaves the gallbladder and proceeds to the duodenum via the bile duct.