

## lec: 1 cell structure & Types

### Histology (microscopic anatomy) :

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

The science concerned with the minute structure of cells, tissues and organs in relation to their function.

### Cells

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

#### 1. Cell membrane :

- limiting membrane of eukaryotic cells - selective barrier that regulates the passage of material into and out of the cell.

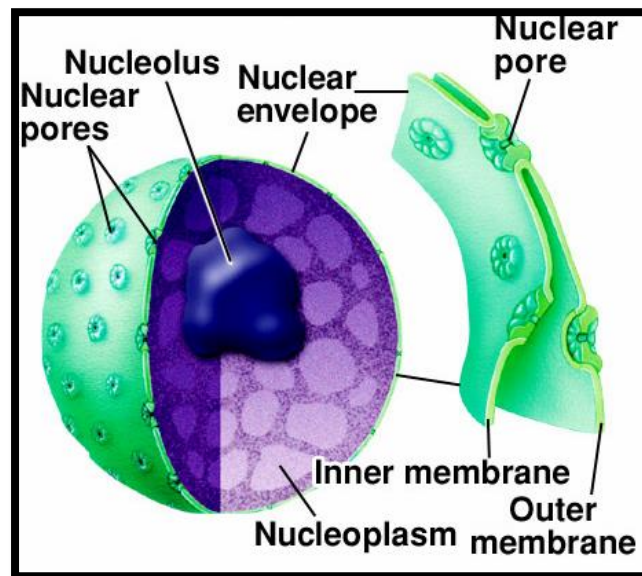
- recognition and regulatory functions

- plays an important role in the way the cell interacts with its environment

**Molecular structure:** Lipids, proteins, saccharides, ions.

## 2. Nucleus :

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



## 3. Nucleolus:

Is the structure within the nucleus and help in synthesis of ribosomes.

Surround by nuclear membrane .

**Nuclear envelope :** thin line

- composed of 2 membranes, between is perinuclear space (cisterna)
- to the inner membrane are attached the fibrous laminae composed of polypeptides called lamins ( $\varnothing$  80-300 nm)

2 membranes fuse together and form nuclear pores covered by diaphragm

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

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

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

**5. Mitochondria :** spherical or oval organelles in diameter  $0,5 \times 10 \mu\text{m}$  visualized by iron hematoxylin , **Function:** transforming of chemical energy into energy easily accessible to the cell (ATP), production and storage of energy.

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

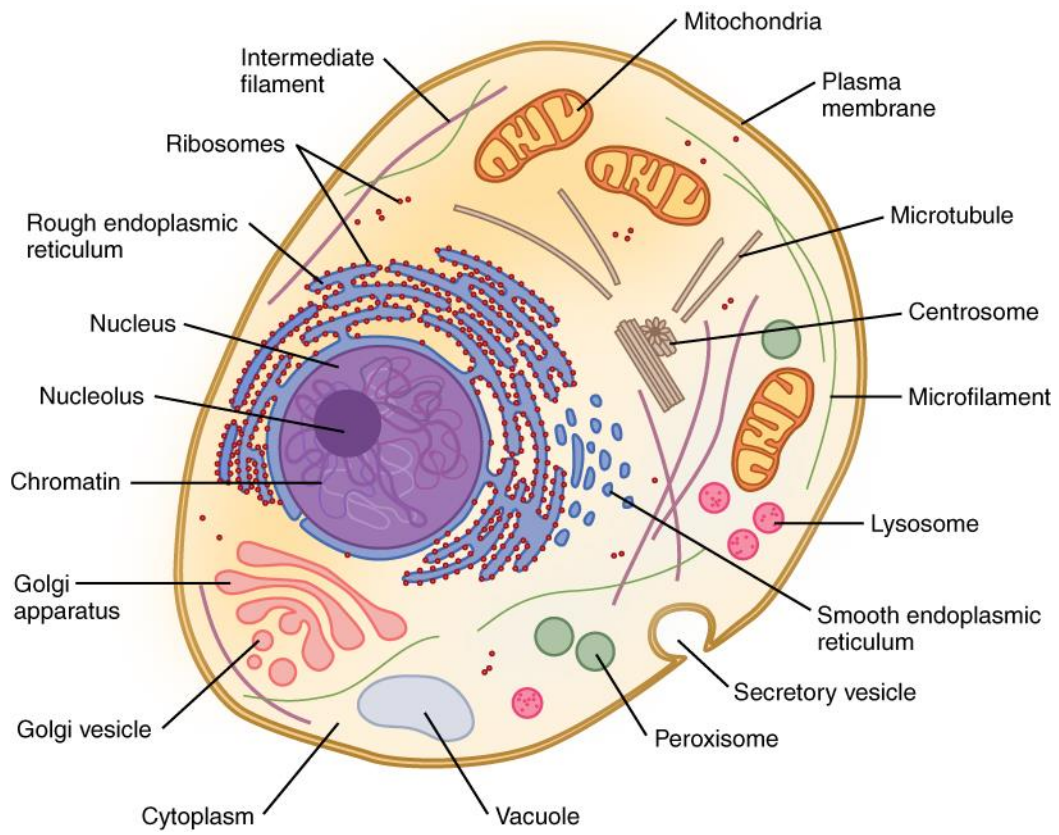
- Flattened vesicles in stacks which receive protein from ER
- Form secretory vesicles to transport proteins to different parts of the cell (vacuole, lysosome, etc) or for secretion.
- *cis* face - "receiving" side of Golgi apparatus
- *trans* face - "shipping" side of Golgi apparatus

**7. Lysosomes:** (contain digestive enzymes)

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

Rough ER - has ribosomes and is involved in secreted protein synthesis

Smooth ER - lacks ribosomes and is involved in membrane lipid synthesis.



**cell components**

### **Tissues :**

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

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

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

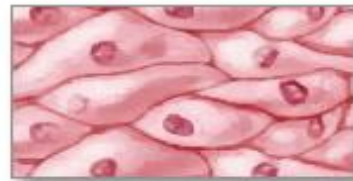
**Epithelial:** Epithelial tissue comprises epithelial cells arranged together in sheets. These sheets serve as protective layers, forming coverings like the skin, and the lining of the small intestine.

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

#### Four types of tissue



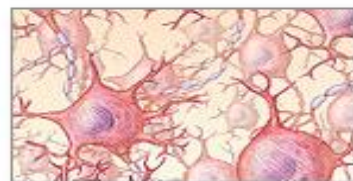
Connective tissue



Epithelial tissue



Muscle tissue



Nervous tissue

## lec: 2 Epithelium (epithelial tissues)

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

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

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

- Epithelial tissue also helps to protect against microorganisms. The skin is the body's first line of defense against bacteria, viruses, and other microbes.
- Epithelial tissue functions to absorb, secrete, and excrete substances. In the intestines, this tissue absorbs nutrients during digestion. Epithelial tissue in glands secrete hormones, enzymes, and other substances. Epithelial tissue in the kidneys excrete wastes, and in the sweat glands excrete perspiration.

- Epithelial tissue also has a sensory function as it contains sensory nerves in areas such as the skin, tongue, nose, and ears.
- Ciliated epithelial tissue can be found in areas such as the female reproductive tract and the respiratory tract. Cilia are hair-like protrusions that help propel substances, such as dust particles or female gametes, in the proper direction.

### Classifying Epithelial Tissue:

Based on:

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

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

2- **Glandular epithelium**: surrounds glands within the body.

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

**a- Simple epithelial tissues**: consist of a single layer of cell.

**b- Stratified epithelial tissues** : consist of multilayer of cells only the bottom layer touches the basement .

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

2- **Simple squamous epithelium** : consist of a single layer of flattened cells with disc shape central nuclei , is found lining sacs of lung and



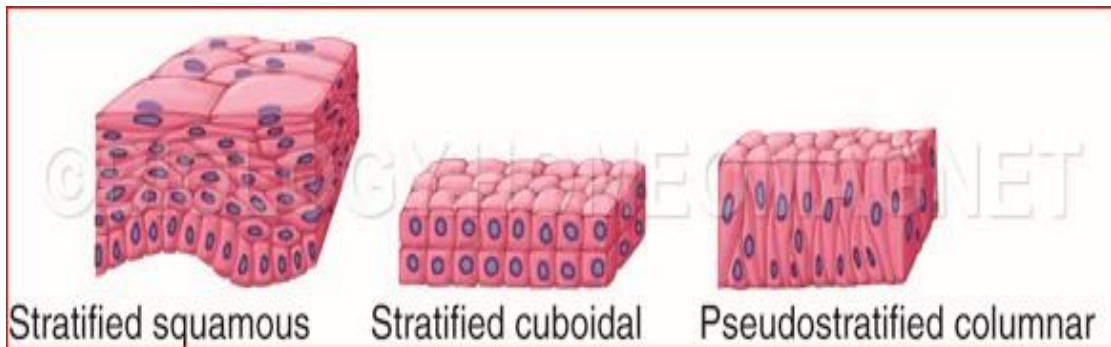
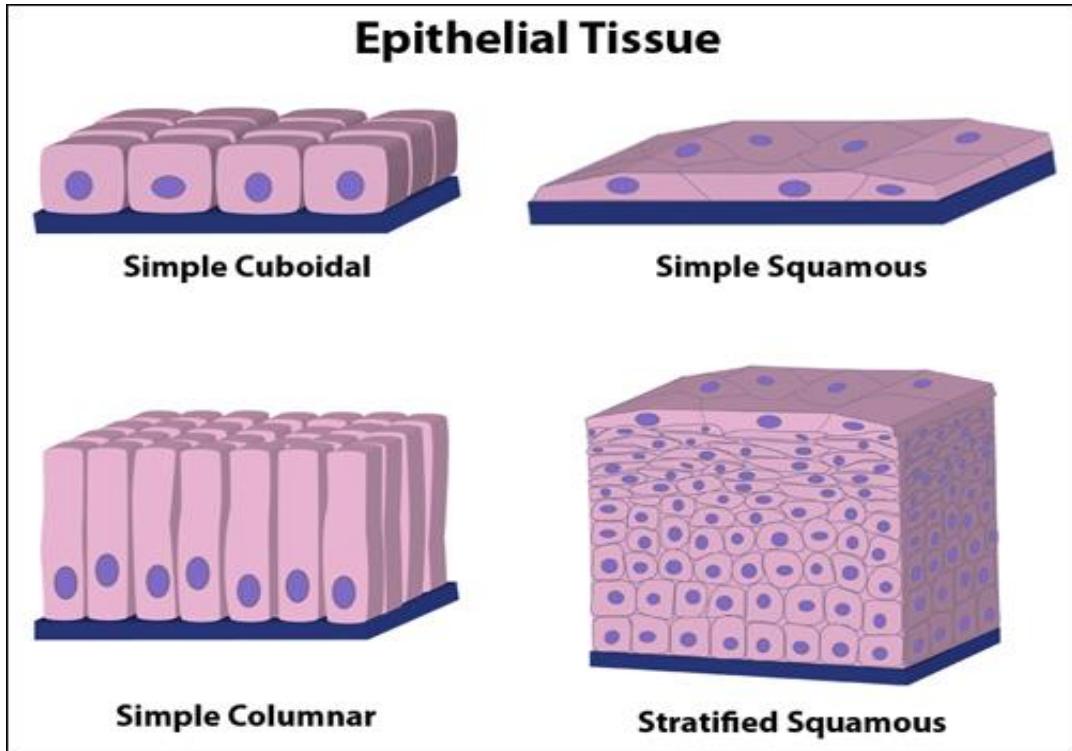
wall of blood vessels , its shape and arrangement permit the exchanges of substance in these locations.

- 3- **Simple cuboidal epithelium** : consist of single layer of cube like cell with large spherical nuclei , this type is found in glands as salivary gland , or in kidney tubule , its function secretion and absorption .
  - 4- **Simple columnar epithelium** : consist of single layer of tall cells with round to oval nuclei located near the bottom of each cell , this type of epithelium is found digestive tract as stomach.
  - 5- **Pseudostratified ciliated columnar epithelium**: one layer of cells , but appears stratified because cells are off different heights . all cells are in contact with the basement membrane .
- 6- **Stratified epithelial tissues** :

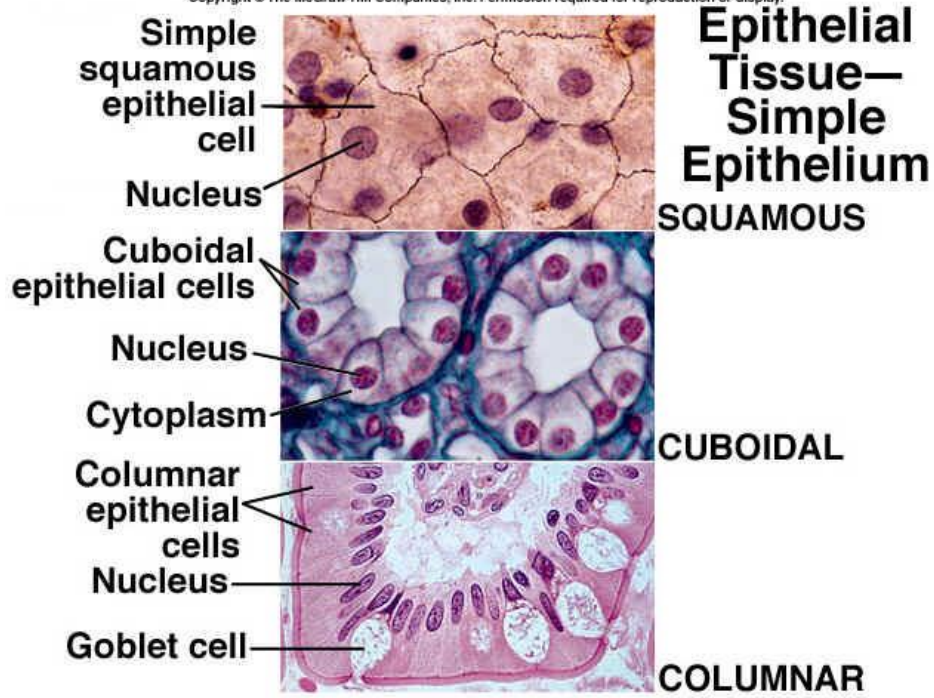
- 1- **Stratified squamous** : has multiple layers of cells, the basal cells are cuboidal or columnar are metabolically active , the surface layer are flattened (**squamous**) there are two type **a. nonkeratinized** (e.g. lining of esophagus) **b. keratinized** (e.g. skin) .
- 2- **Stratified cuboidal** : usually has two or three layers of cuboidal cells. This type of epithelium is largely confined to the lining of large ducts (sweat gland).
- 3- **Stratified columnar**: has several cell layers, the outermost of which contains **columnar** cell . this type of epithelium is relatively rare , found in male urethra .
- 4- **Transitional epithelium** : is similar to Stratified squamous epithelium , except that the outermost cell layer consist of large



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



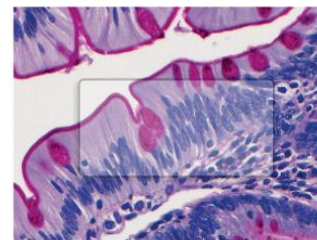
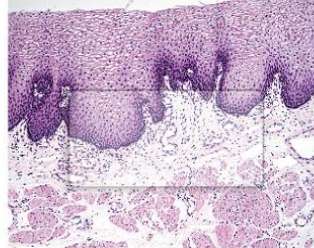
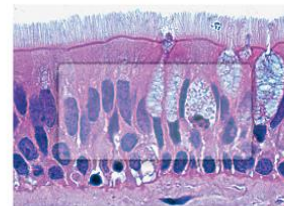
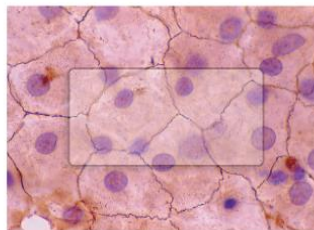
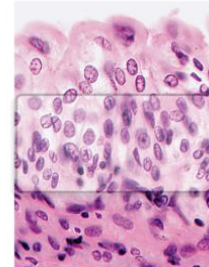
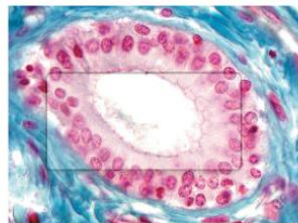
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Correctly label the epithelial tissue images by dragging the tissue name to its corresponding image.

- transitional
- simple squamous
- pseudostratified columnar
- simple columnar
- stratified cuboidal
- stratified squamous

Reset



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

**a- Exocrine gland** : are gland with ducts that secrete their product onto the outer surface (sweat gland ) or into body cavities (pancreas).

**b- Endocrine gland:** are gland without duct secrete hormones internally so they are transported by bloodstream( thyroid gland) .

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

1- **Unicellular glands** : consisting of only one glandular epithelium cell e.g. goblet cell of digestive system.

2- **Multicellular glands** : multiple cell make up one gland ; e.g salivary glands

**Glands are divided according to type of secretion:**

**1- Serous glands:**

a- Secrete watery solution of enzyme

b- Have small lumen

c- Have round nucleus located in the basal of the cell

d- Have well stained cytoplasm

e- The secretory units composed of pyramidal cells with unclear border

f- e.g parotid gland

**2- mucous glands :**

- a- produce mucous secretion
- b- have large lumen
- c- have pressed flattened nucleus in the basal limit of the cell
- d- have poorly stained cytoplasm
- e- the secretory units composed of pyramidal cells with clear border
- f- palatine gland

**3- mixed or seromucous glands :** a gland in which some secretory cells are serous and some mucous (salivary glands)

Connective tissue (CT) is a one of the four main classes of tissues. Although it is the most abundant and widely distributed of the primary tissues, the amount of connective tissue in a particular organ varies. Like to the timber framing of a house, the connective tissue provides structure and support throughout the body.

### **Structure of Connective Tissue**

Connective tissue has three main components:

1. Ground substance
2. Fibers
3. Cells

Together the ground substance and fibers make up the extracellular matrix. The composition of these three elements vary tremendously from one organ to the other. This offers great diversity in the types of connective tissue.

### **Ground Substance**

**1. Ground substance** – is a gel containing:

- water, salts and
- 3 kinds of molecules containing carbohydrates:
  - glycosaminoglycan or GAG,
  - proteoglycans and
  - glycoproteins

**Features of ground substance:**

- Permeability
- Barrier to the penetration of bacteria

**2.Connective Tissue Fibers**

Connective tissue contains three types of fibers: collagen, elastic and reticular.

**1. Collagenous Fibers**

Collagenous fibers consist of types I, II, or III collagen and are present in all types of connective tissue. Collagenous connective tissue is divided into two types, based upon the ratio of collagen fibers to ground substance:

- Loose (areolar connective tissue) is the most abundant form of collagenous connective tissue. It occurs in small, elongated bundles separated by regions that contain ground substance.
- Dense connective tissue is enriched in collagen fibers with little ground substance. If the closely packed bundles of fibers are located in one direction, it is called regular; if oriented in multiple directions, it is referred to as irregular. An example of regular dense connective

- tissue is that of tendons; an example of irregular dense connective tissue is that of the dermis.

**Collagen I : is found the dermis of skin**

**Collagen I I : is found in hyaline cartilage**

**Collagen I I I : found in liver and bone marrow**

## **2.Reticular Fibers**

Reticular fibers are composed of type III collagen. Unlike the thick and coarse collagenous fibers, reticular fibers form a thin reticular network. Such networks are widespread among different tissues and form supporting frameworks in the liver, lymphoid organs, capillary endothelia, and muscle fibers.

## **3.Elastic Fibers**

Elastic fibers contain the protein elastin, which co-polymerizes with the protein fibrillin. These fibers are often organized into lamellar sheets, as in the walls of arteries. Dense, regular, elastic tissue characterizes ligaments. Elastic fibers are stretchable because they are normally disorganized – stretching these fibers makes them take on an organized structure.



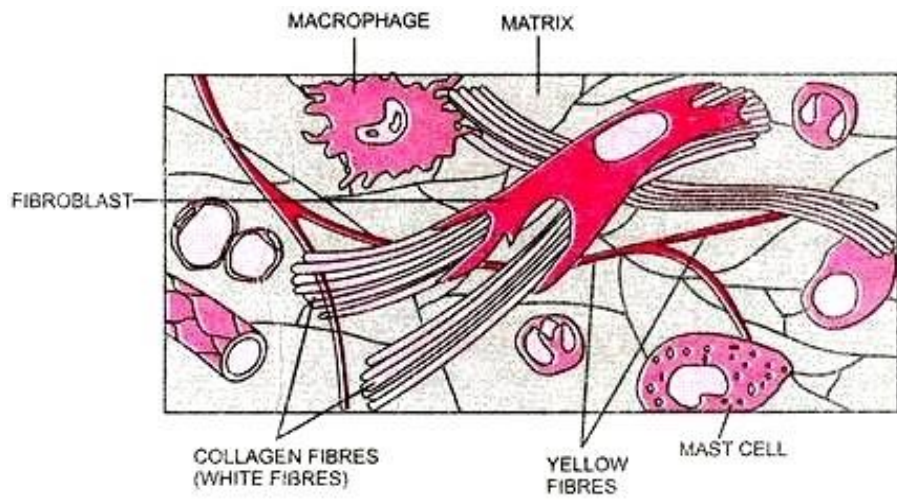
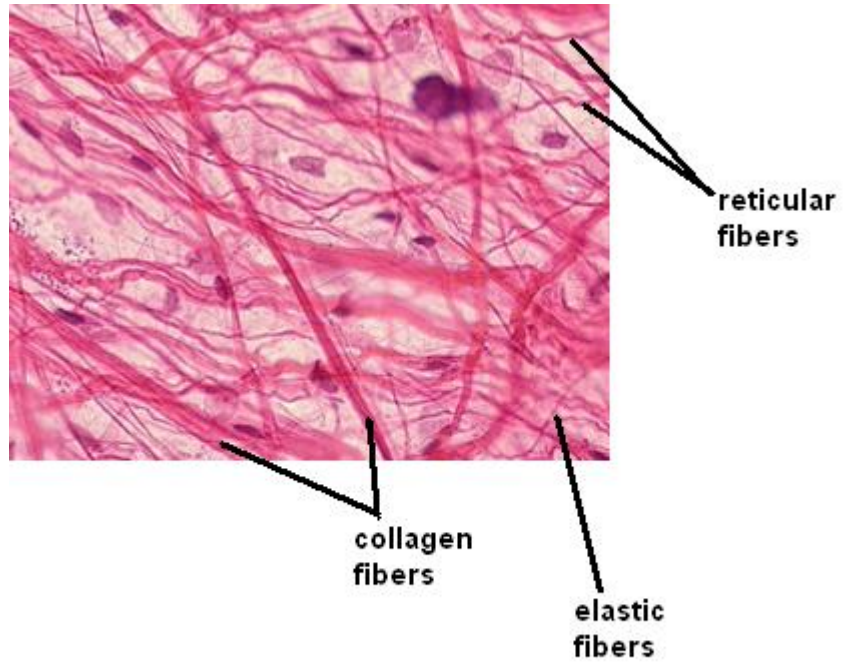
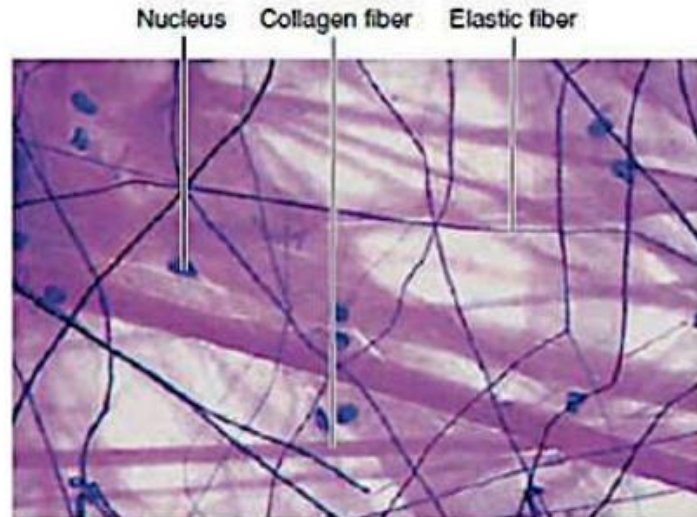


Fig. 7.15. Areolar tissue

# FIBRES

- COLLAGEN
- ELASTIC
- RETICULAR



Fibers of Fibrous Connective Tissue		
Collagenous	Reticular	Elastic
-tough, flexible, resist stretching  Tendons, ligaments, deep layer of the skin	-thin collagen coated with glycoprotein	-thinner -made of <u>elastin</u> ↓ stretch and recoil

### 3.Cells Of Connective Tissue

Although connective tissue has fewer cells than most tissues, the cells found in connective tissue are still important. Fibroblasts and adipocytes do not leave connective tissue.

**a- Fibroblast**

Fibroblasts are widely distributed within connective tissue and synthesize the components of the extracellular matrix. They are also capable of differentiating into other types of connective tissue cells.

**b- Adipocyte**

Adipocytes (or fat cells) are specialized for the synthesis and storage of lipids. They may occur singly but are more often found as clusters within loose connective tissue.

**c- Mast Cell**

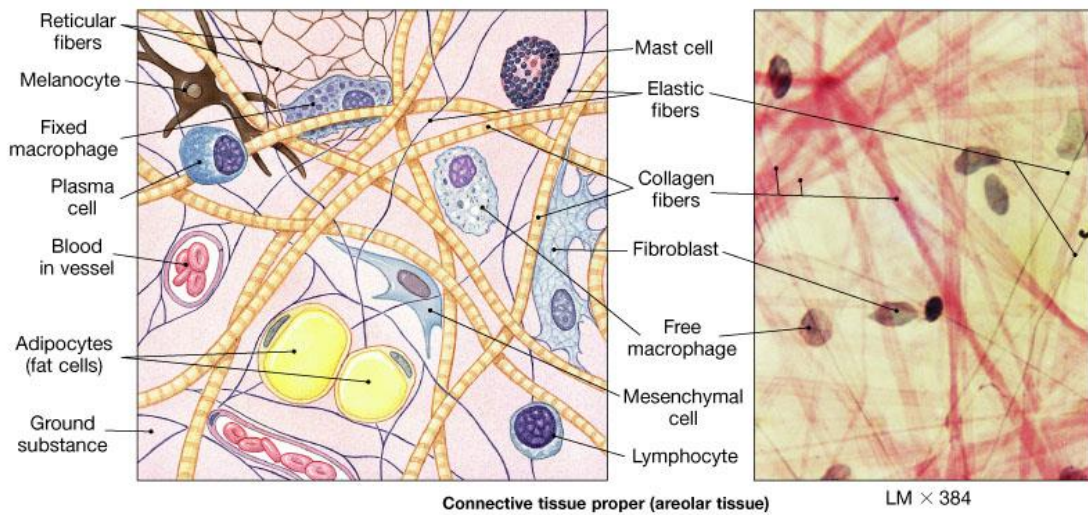
Mast cells are widely distributed in connective tissue. They release molecules that dilate blood vessels and recruit more immune cells to the site of an infection.

**d-Plasma Cell**

Plasma cells produce large quantities antibodies against specific antigens.

**e-Macrophage**

Monocytes differentiate into macrophages within tissues. Macrophages are avidly phagocytic cells that engulf and digest microbes, cellular debris and foreign substances.



**The Cells and Fibers of L.I.C.T.**

**Types of Connective Tissue**

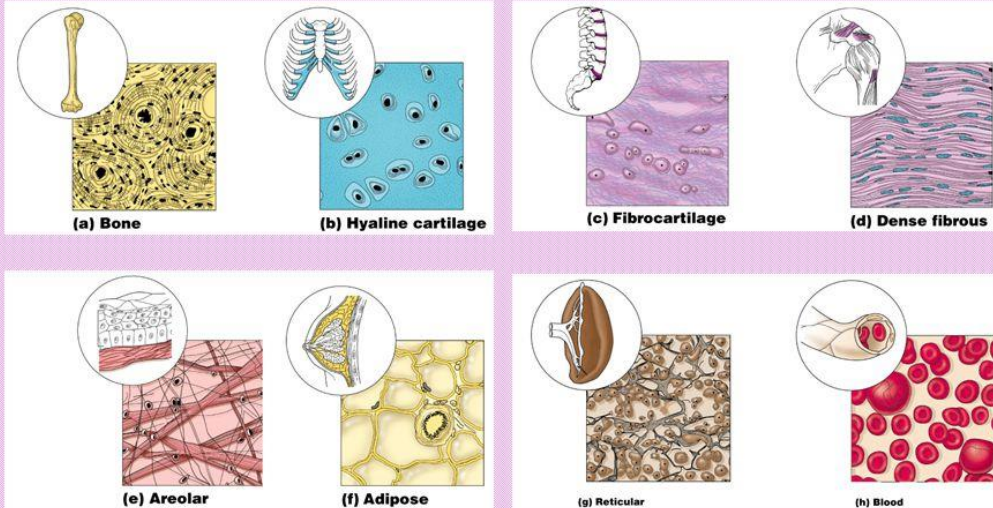
- 1- Proper connective tissue
- 2- Specialized Connective Tissue

**Proper connective tissue :**

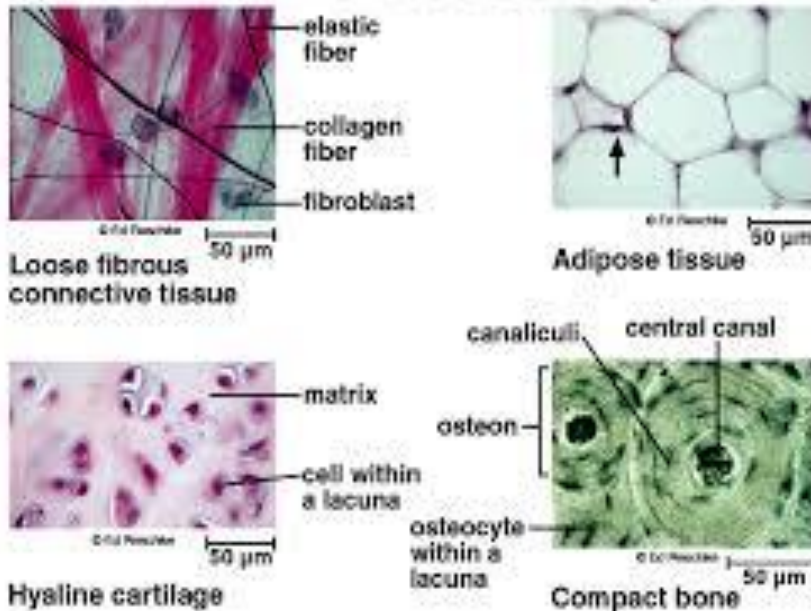
- Classified:
- as loose or dense
  - regular or irregular



# Connective Tissue



## Connective tissue examples



**Loose connective tissue :** The loose connective tissue contains cells, fibers, and ground substance in roughly equal parts. Among the cells, the fibroblasts are the predominant cells; other types of connective tissue cells are also present, along with nerves and blood vessels. Collagen fibers predominate, but elastic and reticular fibers are also present. The loose connective tissue has moderate amount of ground substance. The combination of these components gives a delicate consistency to the loose connective tissue making it flexible and not very resistant to stress.

### **Loose Connective Tissue Location**

1. Lamina propria (areolar tissue)
2. Blood vessels (Areolar tissue)
3. Found in the ducts of glands (Areolar tissue)
4. Bone marrow (Reticular tissue)
5. Spleen (Reticular tissue)
6. Lymph nodes (Reticular tissue)
7. Umbilical cord (Mucoïd tissue)
8. Embryo (Mesenchyme - embryonic tissue).

### **1.Areolar Connective Tissue**

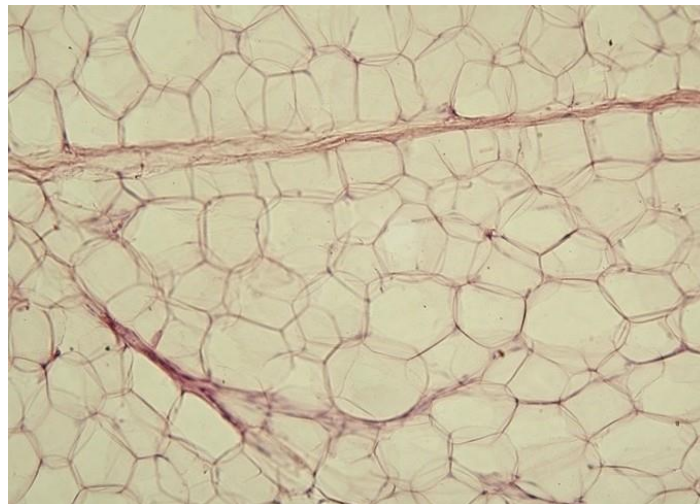
These tissues are widely distributed and serve as a universal packing material between other tissues. The functions of areolar connective tissue include the support and binding of other tissues. It also helps in defending against infection.

Is a loosely arranged connective tissue that is widely distributed in the body such as in gastrointestinal tract, blood vessels and ducts of glands. The areolar tissue contains collagen fibers, reticular fibers and

a few elastic fibers embedded in a thin and almost fluid-like ground substance.

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

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



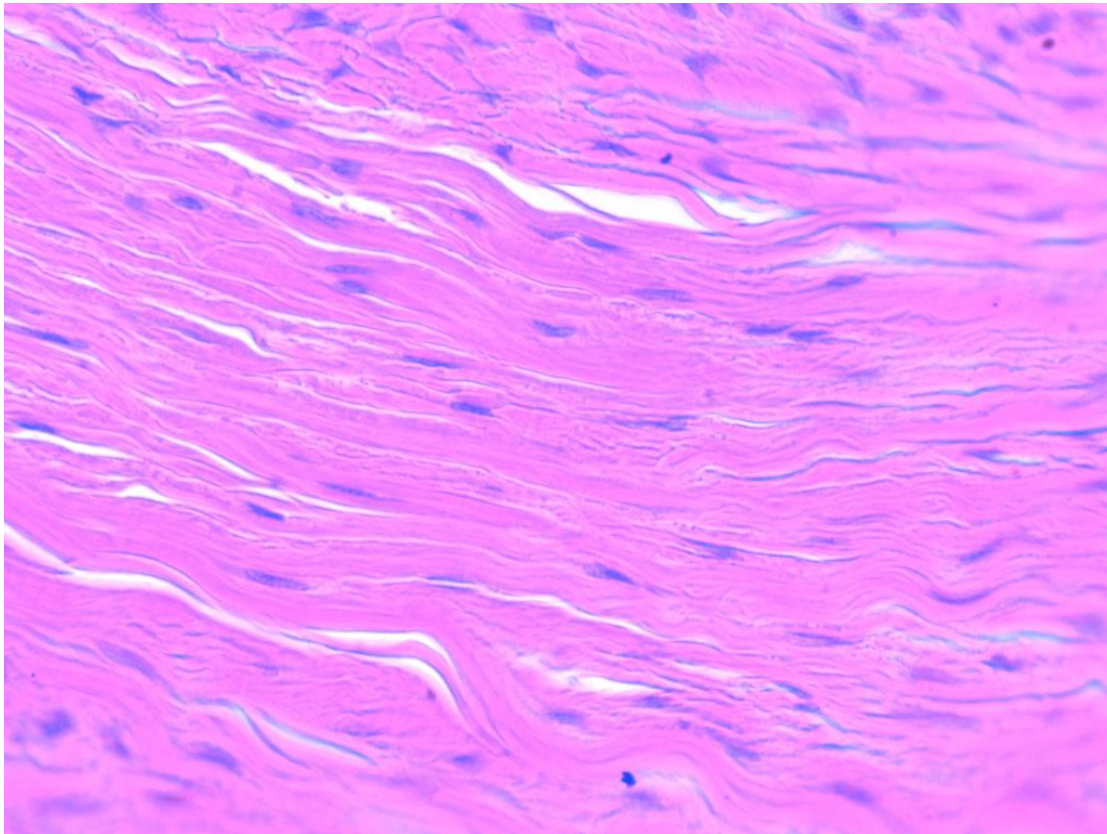
**Adipose tissue:** Yellow adipose tissue in paraffin section with lipids washed out.

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



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

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



**Dense connective tissue ( regular)**

—  
—  
—  
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## — Lec 4: Specialized Connective Tissue:

### Cartilage

is a form of fibrous connective tissue that is composed of closely packed collagenous fibers in a rubbery gelatinous substance called **chondrin**. The skeletons of sharks and human embryos are composed of cartilage. Cartilage also provides flexible support for certain structures in adult humans including the nose, trachea, and ears.

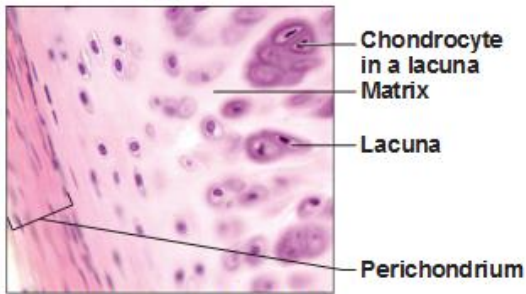
There are three different types of cartilage, each with different characteristics.

**1. Hyaline cartilage;** is the most common type and is found in areas such as the trachea, ribs, and nose. Hyaline cartilage is flexible, elastic, and surrounded by a dense membrane called perichondrium.

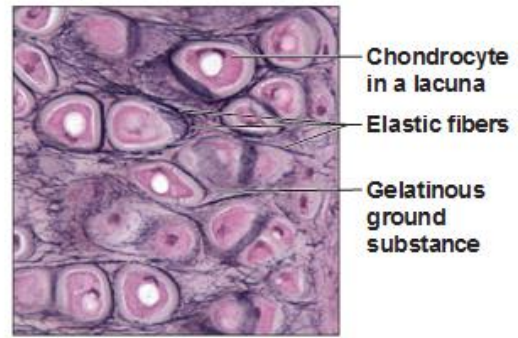
**2. Fibrocartilage :** is the strongest type of cartilage and composed of hyaline and dense collagen fibers. It is inflexible, tough, and located in areas such as between vertebrae, in some joints, and in heart valves. Fibrocartilage does not have perichondrium.

**3.Elastic cartilage :** contains elastic fibers and is the most flexible type of cartilage. It is found in locations such as the ear and larynx (voice box).

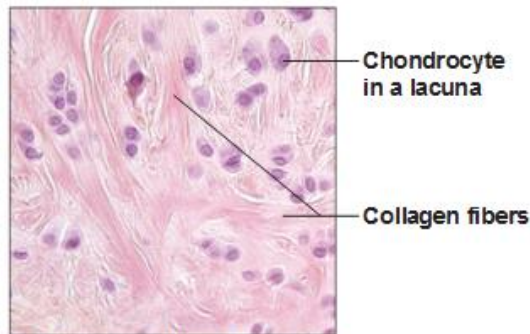
## Cartilages in the Adult Body



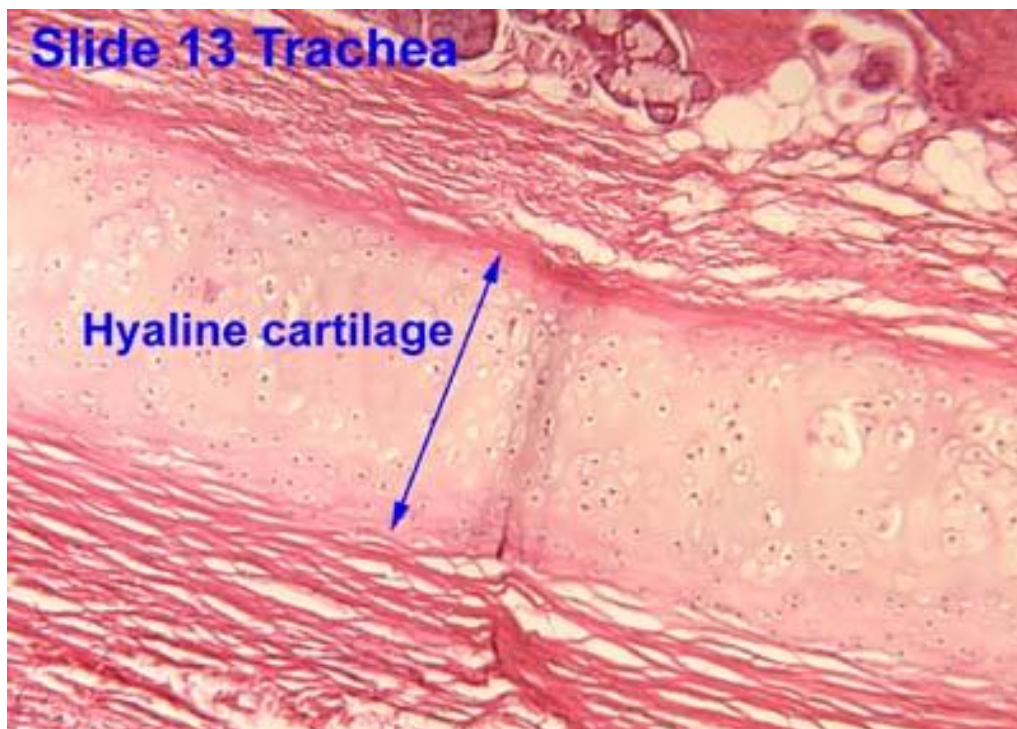
(a) Hyaline cartilage (180×)



(b) Elastic cartilage (470×)



(c) Fibrocartilage (285×)



**Bone :**

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

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

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

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

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

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

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

**Lamellae** : are concentric rings of a strong matrix



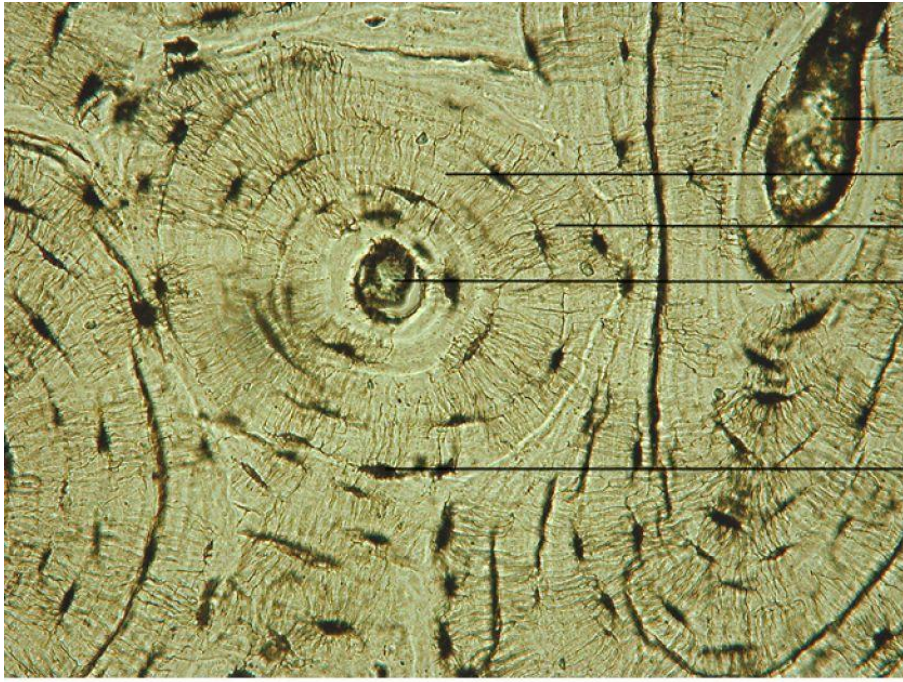
**Lacuna** : are the small space between the lamella in which the osteocytes

**Canaliculi**: a minute channels that linked the lacuna together which provide routes for pass the nutrients and waste product for osteocytes.

The bulbous ends of each long bone, known as the **epiphyses** (or singularly as an *epiphysis*), are made up of spongy, or **cancellous**, bone tissue covered by a thin layer of compact bone. The **diaphysis**, or shaft, contains the **medullary cavity** and blood cell–producing **marrow**. A membrane called the **periosteum** covers the outer bone to provide nutrients and oxygen, remove waste, and connect with ligaments and tendons.



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



Perforating canal

Lamella

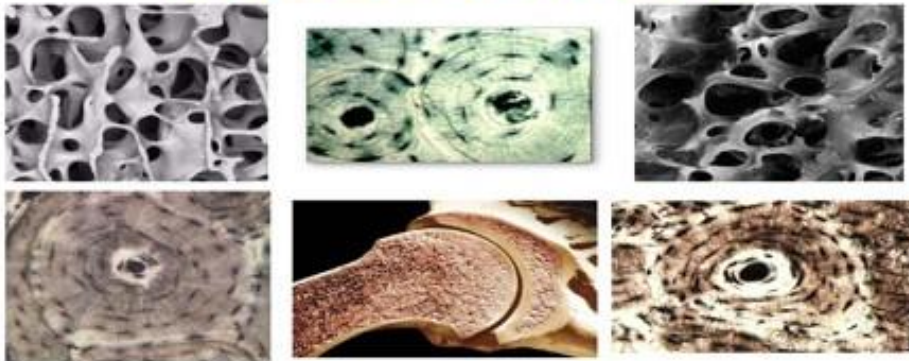
Canaliculi

Haversian canal

Lacuna

Compact Bone (100x)

## Bone Tissue



## Ossification of Bone

**Ossification:** is the process of the synthesis of bone from cartilage. There are two types of ossification- intramembranous and endochondral ossification. Bone may be synthesized by intramembranous ossification, endochondral ossification or a combination of the two.

### 1- Intramembranous ossification:

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

### 2-Endochondral Ossification

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

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

**-Zone of proliferation :** Chondrocytes are stacked in prominent rows and the cartilage matrix becomes more basophilic in this



zone. Mitotic figures are present and the axis of the mitotic figure usually is perpendicular to that of the row of chondrocytes.

**-Zone of hypertrophy :** Chondrocytes and their lacunae increase in size .

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

**-Zone of ossification :** Osteoblasts deposit bone matrix on the exposed plates of calcified cartilage.

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

