

General Histology

SECOND STAGE
DENTISTRY DEPARTMENT



Dr. Mareb H. Ahmed, Histology, 19-9-2023

HISTOLOGY

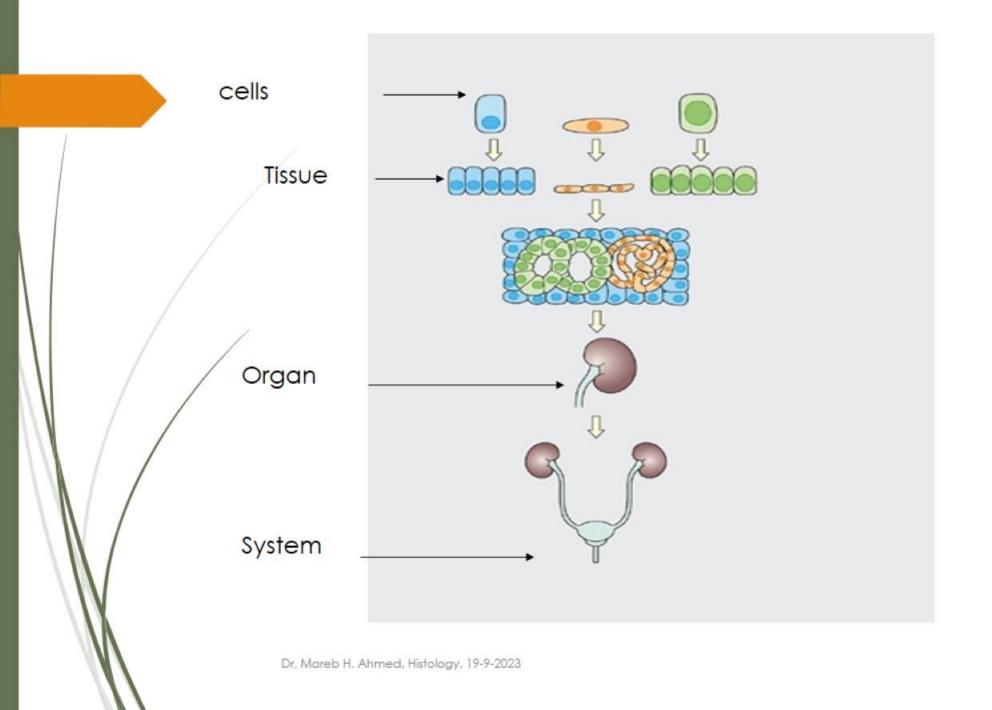
Study microscopic structure of cells, tissues and organs.

all tissues consist of two basic components:

cells that are related in structure and function and a surrounding material called extracellular matrix (ECM)

ORGANIZATION OF THE HUMAN BODY

- The cell is the smallest structural and functional unit of all living organisms.
- The tissue is a collection of cells that perform a similar function.
- The organ is a group of tissues that cooperate to perform a special function.
- The system is an organization of different organs.





HOW TO STUDY HISTOLOGY?

- To study Histology we must understand:
- 1-Microscopes.
- 2-Microtechnique (Tissue preparation).

L/M E/M

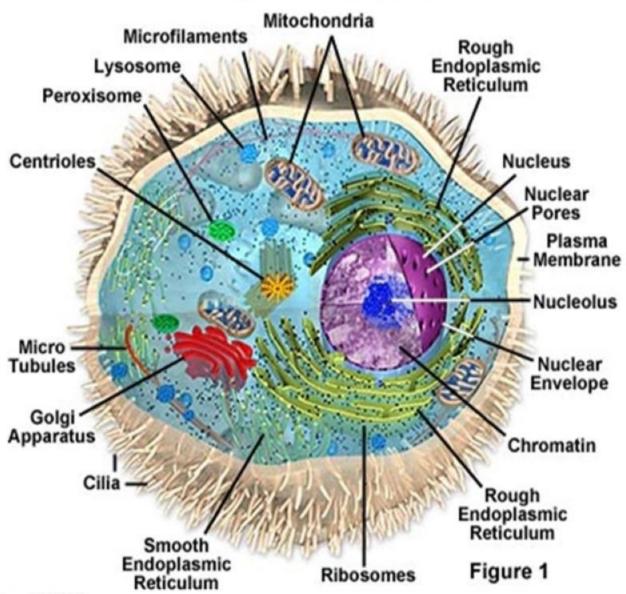
MACHINE: - Magnification	Up to 1000 (eye piece power X objective power)	up to 400,000
- Beam used	Light beam from lamp or sun	Electron beam arise from heated tungsten filament.
- Tube	Contain air	Vaccum
- Lenses.	Glasses	Electromagnetic fields.
- Viewing	Direct by eye	Indirectly (fluorescent screen).
Technique:		
V ixation	Formalin 10%	
Embedding	Paraffin	
Cutting	By metal knife	66.2
Thickness	Up to 10 microns	
Staining	Depends on colour	
Spreading	on glass slide	

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Anatomy of the Animal Cell

The cell

- Each cell is surrounded by a cell membrane.
- The cell is divided into two components; the cytoplasm and the nucleus.



The Cell Membrane (Plasmalemma)

Structure of the Cell Membrane

Carbohydrate chains

Lipid Bilayer

Transport Protein

Phospholipids

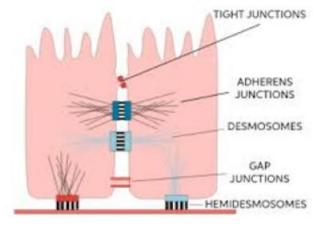
Inside of cell (cytoplasm)

- It is very thin, has a trilaminar appearance.
- It is composed of:
- 1/Lipids (40%): in the form of phospholipids and cholesterol
- 2- Proteins (50%): are present within the lipid bilayer.
- 3- Carbohydrates (10%): It is present on the external surface of the cell membrane and is called cell coat.
- Functions:
- 1- It surrounds the cell from outside and protects it.
- 2- It controls the movement of materials inside and outside the cell

<u>Specializations of cell membrane</u>

	MV	Cilia	Flagella	Stereocilia
Number	Number Brush border		single	many
Length	short	tall	Very long	short
Motile	no	yes	yes	no
Structure	filament	microtubule	microtubule	filament
Site	Site SI		sperm	Ear
Function	Increase SA	Movement	Movement	Absorption

4- Cell junctions



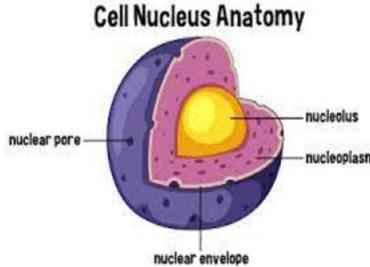
- 4- Cell junctions: they connect adjacent cells together and are of 3 types:
- I- **Tight junction:** the two cell membranes fuse with each other by their outer layers and the intercellular space between them is absent.(e.g. intestinal absorptive cells).
- II Gap junction: there is narrowing of the inter cellular space between the two adjacent cells .(e.g. cardiac muscle).
- III- Desmosome: the inter cellular space between the two adjacent cells is normal. The two cell membranes thickened and show condensation on the cytoplasmic surface called plaque and there are tonofilaments attached to them.

The Nucleus

The nucleus is the largest component of the cell. It is present in all cells except the red blood corpuscles.

Function:

- It carries the hereditary material (DNA), so responsible for heredity.
- It is responsible for cell division.
- It controls all the cellular activities.



The nucleus is formed of 4 components:

1- The nuclear envelope:

- It appears as two membranes. The outer membrane is covered with ribosomes.
- The nuclear envelope has nuclear pores that allow the passage of materials between the nucleus and the cytoplasm.

2- The chromatin:

It consists of strand of DNA attached to basic proteins (histones).

3- The nucleolus:

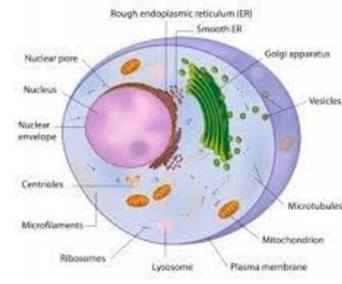
- It is the most prominent structure inside the nucleus. It is formed of RNA and basic proteins.
- Function: The main function of the nucleolus is the formation of ribosomes.

4- The nuclear sap:

It is a semifluid colloidal substance present in between chromatin and nucleolus, provides a medium for transport of materials.

Structure of a Typical Animal Cell

The cytoplasm



It is formed of:

- 1- Cytoplasmic organelles: are permanent structures that have important functions and are important for the life of cell.
- 2- Cytoplasmic inclusions: are products that are stored into the cell and not essential for life.
- 3- Cytoplasmic matrix (cytosol): is a semifluid material in between the organelles and inclusions.

I- Cytoplasmic organelles They are divided into:

A- Membranous organelles: which are surrounded by a membrane that is similar in structure to cell membrane. They include:

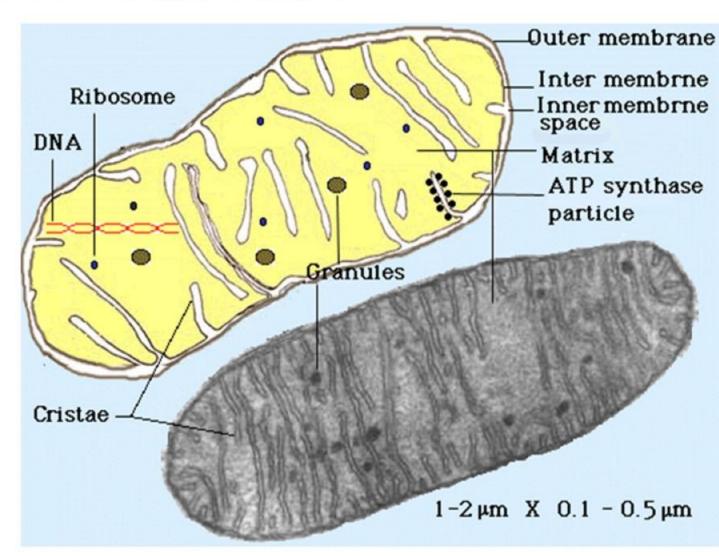
- Mitochondria.
- Rough endoplasmic reticulum (RER).
- Smooth endoplasmic reticulum (SER).
- Golgi apparatus.
- Lysosomes.
- **B- Nonmembranous organelles**: which are not surrounded by a membrane. They include:
 - Free ribosomes.
 - Microtubules.
 - Centrioles
 - Filaments.

A- Membranous organelles

1- Mitochondria

Functions:

- 1- They are the energy house in the cell needed for cellular metabolism (production of ATP).
- 2- They have DNA and RNA, so they can synthesize protein and divide by simple fission.



DIET Carbohydrates Fats Proteins Digested and metabolized products OXYGEN

Brain cell

Nucleus

OMAYO 2004 Mitochondrion

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2- Rough Endoplasmic Reticulum (RER)

- It is a membranous organelle.
- Their surfaces are covered with ribosomes.

Functions:

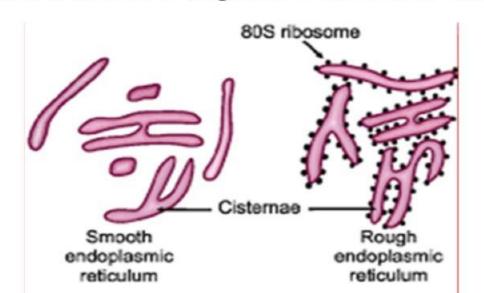
- 1-Synthesis of proteins that will be secreted outside the cell, so it is present in large amount in secretory cells e.g. pancreatic acinar cells, fibroblasts and plasma cells.
- 2- Synthesis of lysosomal enzymes.

3- Smooth Endoplasmic Reticulum (SER)

It is a membranous organelle. Their surfaces have no ribosomes.

Functions:

- 1- Lipid synthesis e.g. cholesterol and steroid hormones
- 2- Glycogen synthesis
- 3- Drug detoxification in liver cells
- 4- Calcium distribution in muscle to regulate contraction and relaxation



Rough endoplasmic reticulum			Smooth endoplasmic reticulum		
1.	It possesses ribosomes attached to its membrane.	1.	It does not have ribosomes on its membrane.		
2.	It participates in the synthesis of enzymes and proteins.	2.	Synthesizes glycogen, lipids and steroids.		
3.	It is internal and connected with the nuclear envelope.	3.	It is peripheral and do not connect to nuclear envelope.		

4- Golgi apparatus

Golgi apparatus consists of:

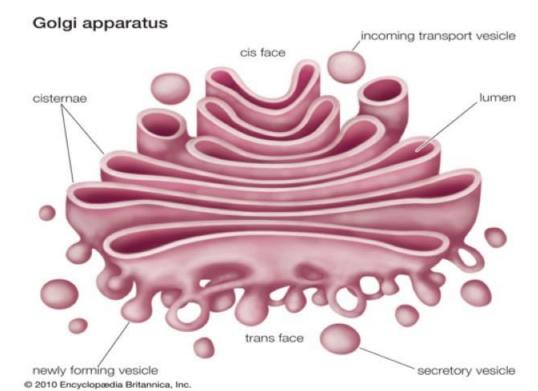
1- Flattened saccules (small sacs):

arranged one above the other forming a stack. Each stack has two surfaces:

- a- A Cis (Immature) face directed towards the nucleus.
- b- Trans (Mature) face directed towards cell membrane
- 2- Small vesicles (transfer vesicles): are associated with the immature face. They originate from RER.
- 3- Large vesicles (secretory vesicles): They arise from the mature face.

Functions

- 1- Condensation of proteins coming from RER through transfer vesicles.
- 2- Chemical modification of secretory products (proteins)
- Package of secretory products into secretory vesicles
- 4- Formation of lysosomes.



5- Lysosomes

 They are rounded small membranous vesicles formed from the Golgi apparatus; contain digestive enzyme.

Functions:

- 1- **Digestion** of Solid material and dead organelles (dead mitochondria)
- 2- Cell metabolism: Lysosomes are important in breakdown of intracellular glycogen e.g. in liver cells.
- 3- Phagocytosis of bacteria and viruses so contribute in defense mechanism

B- Non-membranous organelles 1- Free ribosomes

- They are nonmembranous organelles.
- Each ribosome consists of two subunits; small and large.

Formation:

They are formed in the nucleolus from ribosomal RNA and proteins, then pass to the cytoplasm and may appear in groups to form polyribosomes (polysomes).

Function:

Polysomes synthesize proteins which is extruded outside the cells.
 While free ribosomes synthesize proteins needed by the cell itself.

2- Microtubules

They are non membranous organelles.
 Formed in the cytoplasm from a protein called tubulin.

Functions:

- 1-Formation of the internal skeleton of cells.
- 2-Formation of mitotic spindle during cell division.
- 3-Enter in structure of centrioles, cilia and flagella.

Centrioles

They are small paired structures

Function: They are essential for cell division to form mitotic spindle.

3- Filaments

- There are thread-like structures that may be called fibres, fibrils or filaments.
- Fibre: can be seen by naked eye or low power of L.M.
- Fibril: can be seen by high power of L.M.
- Filament: can be seen only by E.M.

Structure of cytoplasmic filaments:

They appear in most cells and they are of three types:

1-Actin (microfilaments):

They are the smallest in size and consist of protein actin.

- Sites: -a) present mainly in skeletal muscles.
 - b) Present in the core of microvilli.

2-Myosin filaments:

- They are thick filaments and consist of protein myosin.
- -Sites: a)Present also in skeletal muscles.
 - b) present in the core of microvilli (as actin).

3-Intermediate filaments:

- They are intermediate in size
- -Sites- Present in many cells e.g. in epithelial cells (tonofilaments) and in nerve cells (neurofilaments).

Functions:

- 1-Formation of the skeleton of cells.
- 2-Actin and myosin have a role in contraction of muscles.

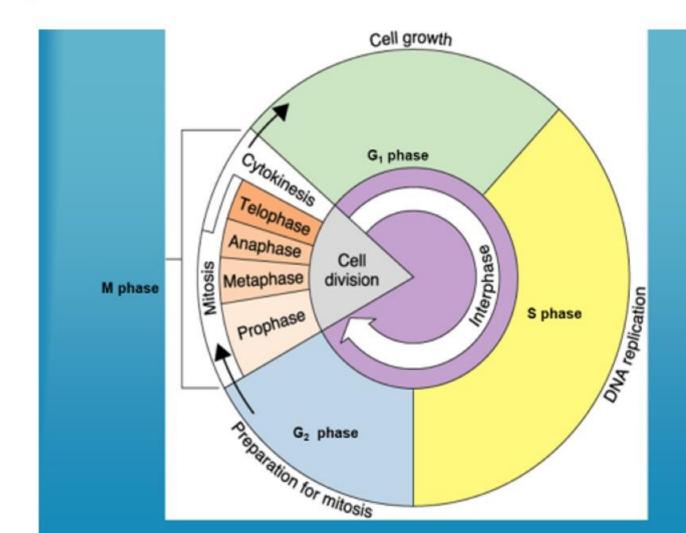
II- Cell inclusions

They are temporary structures that are stored inside the cell and perform no essential function.

Types:

- 1-Stored food:
 - Glycogen in liver cells.
 - Lipids in fat cells.
- 2- Pigments: There are two types:
- a) Endogenous pigments: are produced by the cell itself e.g. haemoglobin in red blood cells and melanin in skin and hair.
- b) Exogenous pigments: enter the cell from outside e.g. carotene (in food), dusts and tattoo.

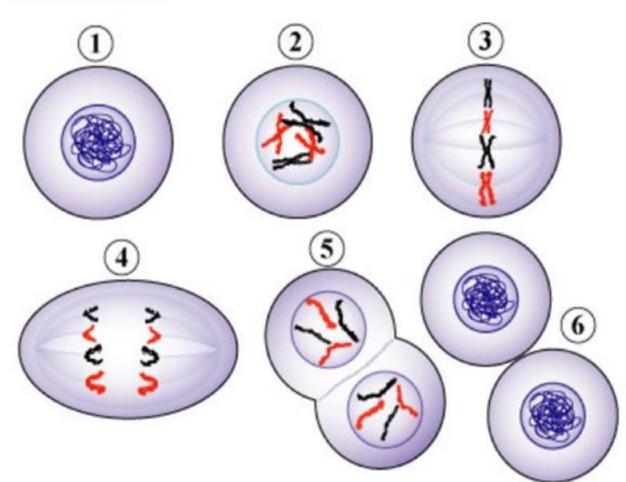
The Cell Cycle: The cell cycle is a regular pattern of growth, DNA replication, and cell division.

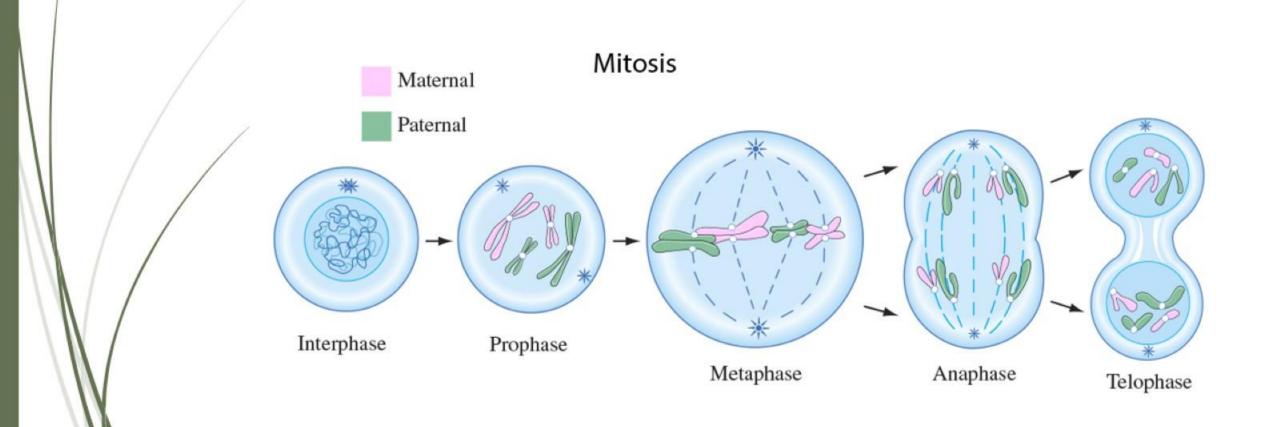


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- Interphase: period of growth and DNA replication between cell divisions
- Three phases:
 - G₁ Phase
 - cell increases in size
 - S Phase
 - Replication of chromosomes
 - Now two strands called sister chromatids joined by a centromere
 - G_2 Phase
 - organelles double
 - new cytoplasm forms
 - All other structures needed for mitosis form

- Cell division: Process that divides cell nucleus to produce two new nuclei each with a complete set of chromosomes
- Four phases (PMAT)
 - Prophase
 - Metaphase
 - Anaphase
 - Telophase







General Histology

SECOND STAGE DENTISTRY DEPARTMENT

Connective Tissue 17-10-2023

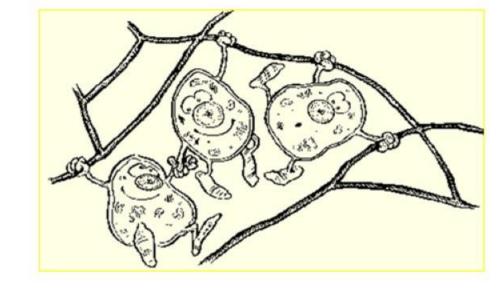
Connective Tissue (C.T.)

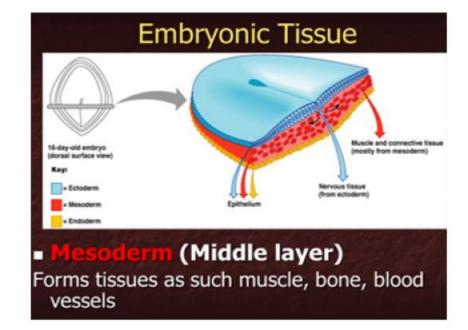
1-Definition

- One of the four basic tissues.
- Connects and binds cells and organs.

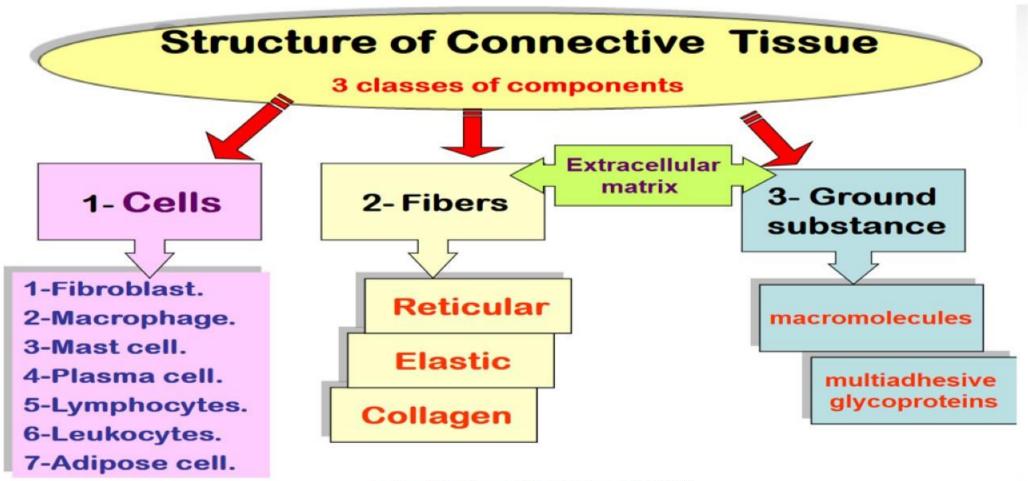
2-Development

- Mesoderm except some C.T. of the head which is derived from ectoderm.
- Mesodermal cells that migrate from their site of origin to developing organs are called mesenchymal cells, they give all types of C.T. cells





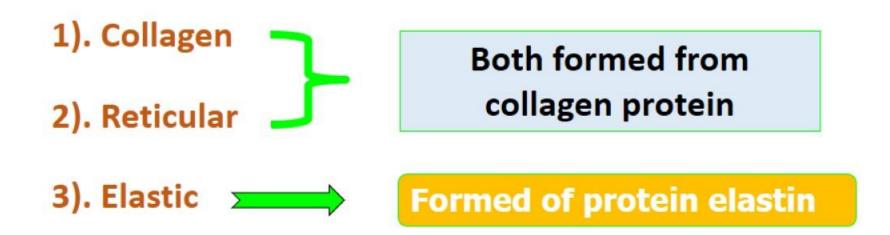
3-Composition



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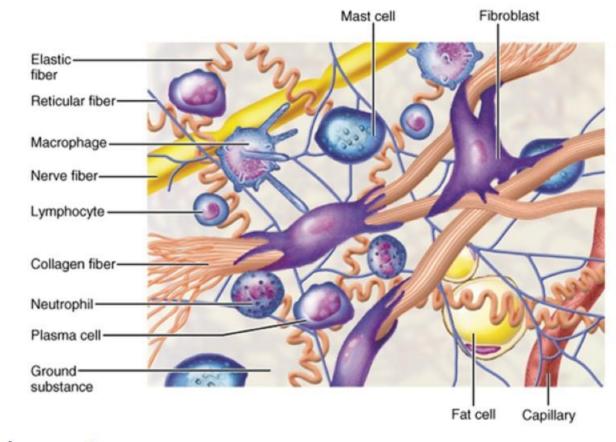
Connective tissue Fibers

- They are slender protein polymers.
- Depending on the structural needs or function.
- TYPES:



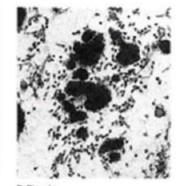
Collagen fibers

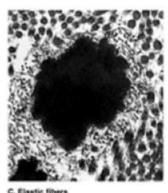
- The most numerous fibers in C.T.
- Closely packed thick fibrils.



- Inelastic giving flexibility and strength to tissue.
- Individual fresh fibers are colorless but aggregated fibers are white.
- Staining: Pink with Eosin and Blue with Mallory.

Elastic fiber system



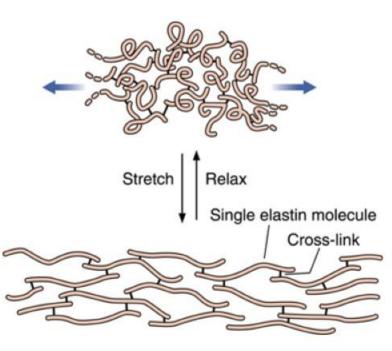


It is composed of 3 types of fibers:

- Oxytalan fibers
- Elaunin fibers
- Elastic fibers

Development:

- · The oxytalan fibers are thin microfibrils.
- Deposition of elastin between oxytalan form elaunin fibers.
- Accumulation of elastin in center of fiber bundles form elastic fibers.
- The bundles are surrounded by sheath of microfibrils.
- Staining: Brown with orcein



Reticular fibers

- Very thin, loosely packed thin fibrils.
- Sites:
- Framework of hematopoietic organs (spleen).
- Network around cells of parenchyma organs (liver, kidney).
- Staining:
- Black with silver salts (argyrophilic).
- Not visible with Hx and E.

3- TISSUE FLUID

Small quantity of fluid contained in ground substance, similar to plasma.

Control of tissue fluid

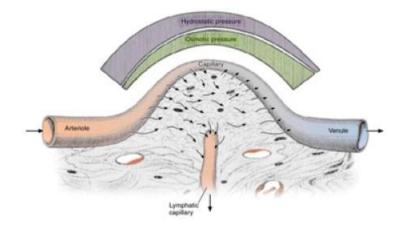
By 2 processes:

- 1-Hydrostatic pressure (HP) by heart → water leaves capillary.
- 2-Osmotic pressure (OP) by plasma proteins → water return to capillary.

Mechanism

From arterial to venous end: HP \downarrow and OP \uparrow \rightarrow water leaves the capillary at arterial end and returns at venous end. Some fluid is drained by lymphatic capillaries

Oedema: fluid accumulation in extracellular space.



II- CONNECTIVE TISSUE CELLS

Fixed cells:

- Develop in C.T.
- UMC, Fibroblasts, Adipose cells.

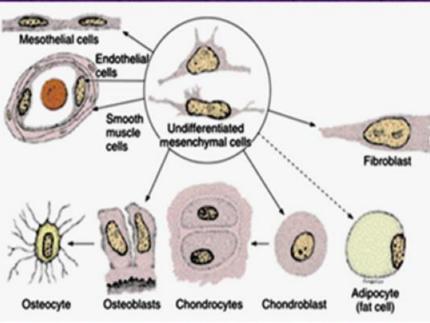
Wondering cells:

- · Develop in bone marrow.
- Mast cells, Plasma cells,
- Macrophage, Leukocytes.

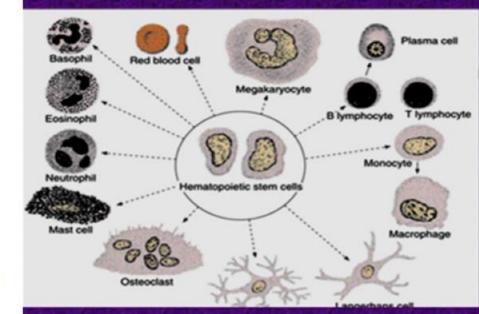
1-Undifferentiated Mesenchymal cells (UMC)

- Shape: processes.
- Nucleus: pale (extended active chromatin).
- Cytoplasm: small amount.
- Viscous ground substance.

Fixed cells



Transient cells



Fixed cells:

Fibroblast

Shape: irregularly branched cells.

Nucleus: Pale (extended active chromatin).

Cytoplasm: Deep basophilia (numerous RER).

· Function: - Synthesis of fibers and matrix.

Fibrocyte

Size: smaller.

Shape: Spindle.

Nucleus: elongated, darker (dense less active chromatin).

Cytoplasm: less basophilia (few RER).

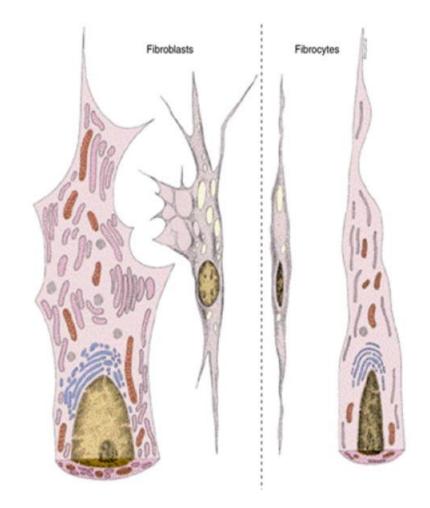
· Function: converts to fibroblast.

Mvofibroblast

Features of fibroblast and smooth muscle cells.

· Contains actin and myosin filaments.

Responsible for wound closure (contraction).



3- Adipose (Adipocytes or Fat) cells

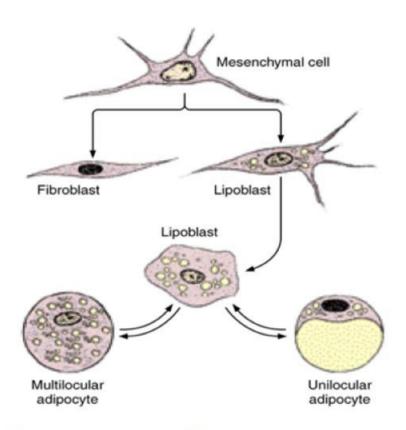
• Origin: U.M.C.

Site: adipose C.T.

Types: Unilocular or Multilocular.

Unilocular fat cells

- Characters: Only one large fat droplet.
- Colour: yellow
- Shape:
- Spherical when single. Polyhedral when packed.
- Stain by HX & E: Signet ring cell (cytoplasm thin ring surrounding one dissolved fat vacuole with eccentric flat nucleus).
- Special stain: suddan III
- Function: Produce energy.



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Colour: yellow

· Shape: Spherical when single. Polyhedral when packed.

 Stain by HX & E: Signet ring cell (cytoplasm thin ring surrounding one dissolved fat vacuole with eccentric flat nucleus).

Special stain: suddan III

Function: Produce energy.

Multilocular fat cells

· Characters: Several fat droplets.

Colour: Brown due to: 2C Capillaries and Cytochromes in mitochondria.

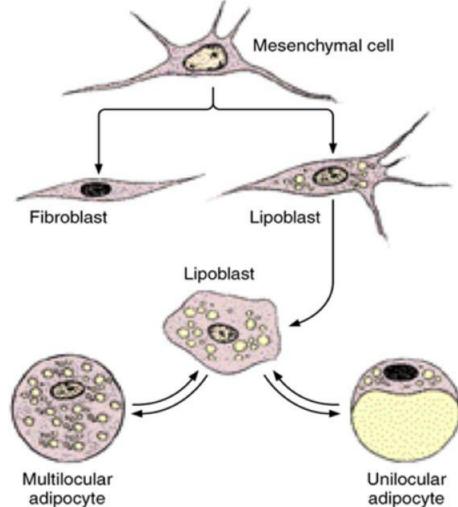
Shape: Polygonal, smaller than unilocular cells.

Stain: osmic acid.

Nucleus: spherical central.

· Cytoplasm: Several fat vacuoles in Hx & E staining.

Functions: Produce heat in human newborn and in hibernating animals



4-Macrophages

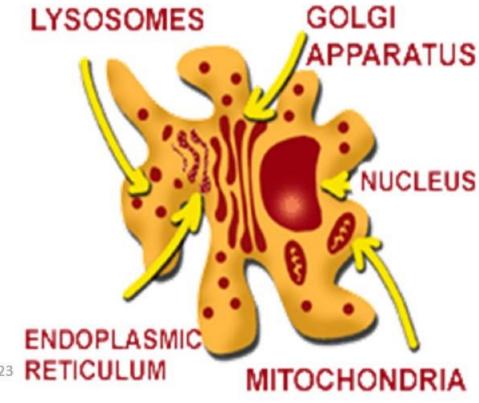
Origin: Monocytes. Member of Mononuclear phagocyte system: all its cells arise from monocyte, possess lysosomes and are phagocytic.

Site:

- · In most organs.
- · Have special names in certain regions, e.g:
- 1-Kupffer cells in liver
- 2-microglial cells in C.N.S
- 3-osteoclasts in bone

Shape

- Irregular surface with protrusions.
- Survive for months in tissue.
- Cytoplasm: Many small vacuoles (Lysosomes).
- Nucleus: kidney shaped.
- Stain: vital dyes (trypan blue or Indian ink), cells engulf granules of stain.
- · Functions: Phagocytosis (Ingestion and digestion of foreign particles).



5- Mast cell

Origin: U.M.C in bone marrow.

Sites: widely distributed but are more in GIT and respiratory T.

Shape: oval.

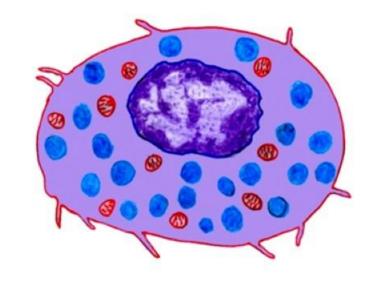
Stain: Metachromatically with toluidine blue.

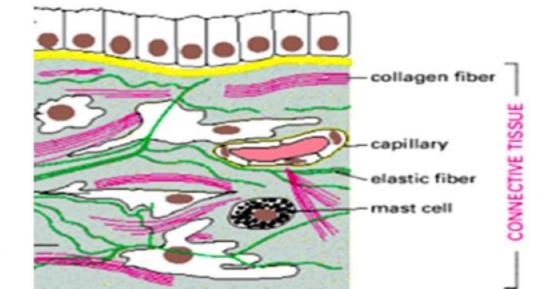
Cytoplasm: filled with basophilic coarse granules.

Nucleus: rounded, central, masked by cytoplasmic granules.

Function: Synthesis and storage of chemical mediators of inflammation.

- a- Heparin (blood anticoagulant).
- b- Histamine (dilate blood capillaries).
- c- ECF-A: eosinophil chemotactic factor of anaphylaxis.
- d- Leukotriens (slow contraction of smooth muscles).





6- Plasma cell

Origin: B-lymphocyte.

• Sites: numerous in sites subjected to penetration by bacteria (e.g. intestine) and areas of chronic inflammation.

Shape: large ovoid cell.

Cytoplasm:

- Basophilic (Rich in RER)
- Unstained area near the nucleus (-ve Golgi image)

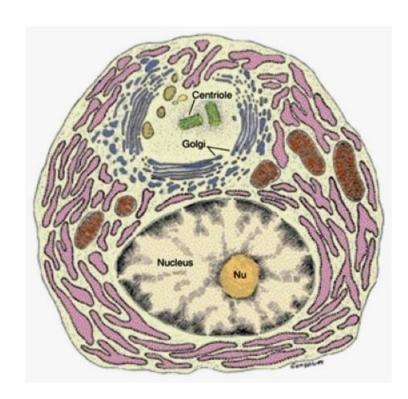
Nucleus:

- Spherical, eccentrically placed.
- Alternating dense and pale chromatin areas (clock-face appearance).
- Function: Synthesis of antibodies

7 - Leukocytes

Granular: neutrophiles, eosinophils, basophiles.

- Nongranular: lymphocytes.
- Migrate from blood to C.T.



Types of connective tissue

Depend on the type of cells, fibers and ground substance

I- Connective tissue proper:

1- Loose.

2- Dense: Regular and Irregular.

II- Specialized C.T.:

Adipose (yellow and Brown)

Reticular - Elastic

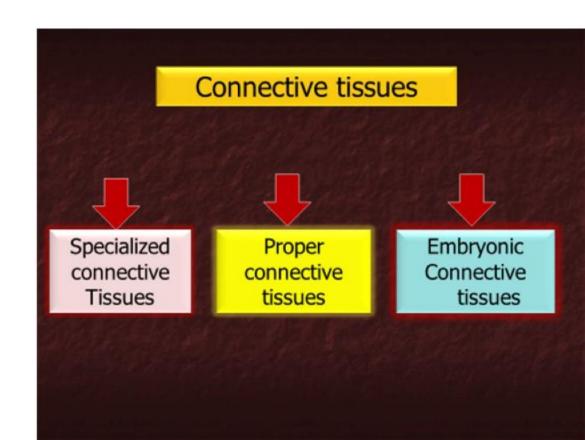
Hemopoietic - Lymphatic.

III- Supporting C.T.

Cartilage - Bone

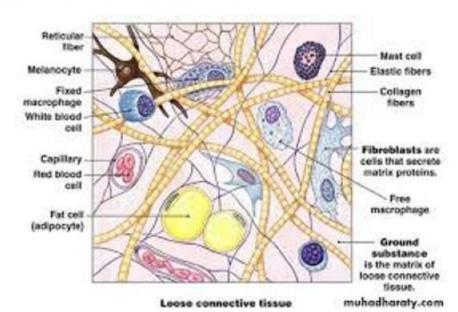
IV- Embryonic C.T.:

Mesenchymal - Mucous.



Connective tissue proper

- 1 Loose C.T. (areolar C.T.)
- Structure: all components of C.T (all cells, fibroblasts and macrophages are the most numerous, all fibers, and large amount of ground substance).
- Characters: vascular, flexible and does not resist stress.
- Sites: Supports epithelial tissue, fills spaces, ensheathes blood vessels.



2- Dense C.T

- Mainly collagen fibers, few fibroblasts and very little ground substance.
- Less flexible and resists stress.

Types:

A) Dense irregular C.T.:

- Collagen bundles are irregularly arranged and run in different directions.
- Resist stress from all directions.

Sites: Skin dermis.

B) Dense regular C.T:

- Collagen bundles are regularly arranged and run in the same direction.
- Resist stress from one direction.

Sites: Tendons, Ligaments.

3-Yellow elastic C.T

- Bundles of thick parallel elastic fibers and thin collagenous fibers with flattened fibroblasts inbetween.
- Great elasticity and yellow colour.

Sites: Ligaments of vertebral column.

4-Reticular C.T

- 1-Reticular cells: fibroblasts with processes and specialized for secretion of reticular fibers.
- 2- Reticular fibers.

Forms the framework of:

- Myeloid tissue (bone marrow)
- Hematopoietic organs.
- Lymphoid organs (lymph node & spleen)

5- Mucoid C.T.

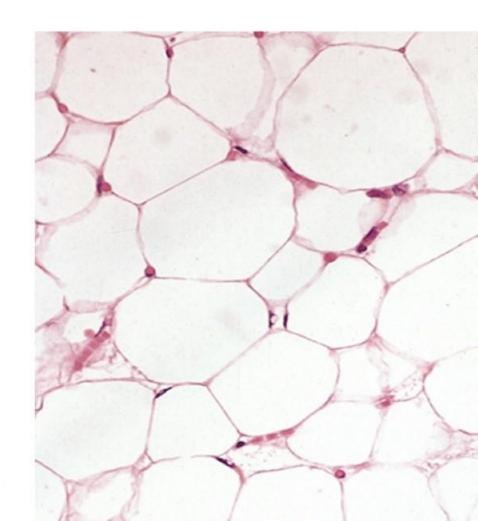
Jelly like matrix.

Sites:

- Umbilical cord (Wharton's jelly).
- Pulp of tooth.
- IVD.

6-Adipose C.T.

- Fat cells predominate.
- Types of adipose C.T.:
- 1- Unilocular (yellow) adipose tissue:
- Unilocular fat cells.
- It is the common type.
- Incomplete lobules.
- Sites: Throughout human body except eyelids.
- Functions
- 1-Store energy.
- 2- Gives the body shape.
- 3- Shock absorber.
- 4- Thermal insulators.
- 5- Fills spaces between tissues and keep organs in position.

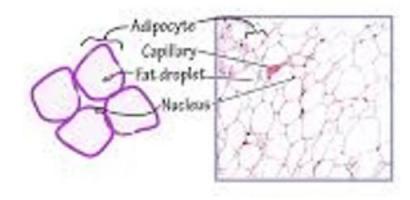


Multilocular adipose tissue (brown fat)

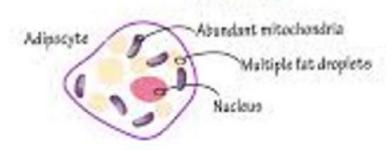
- -Multilocular fat cells.
- Complete lobules.
- Sites:
- In hibernating animals.
- In human embryo and newborn.
- · Functions: Produce heat.

Adipose Tissue

White Fat



Brown Fat



Functions of C.T.

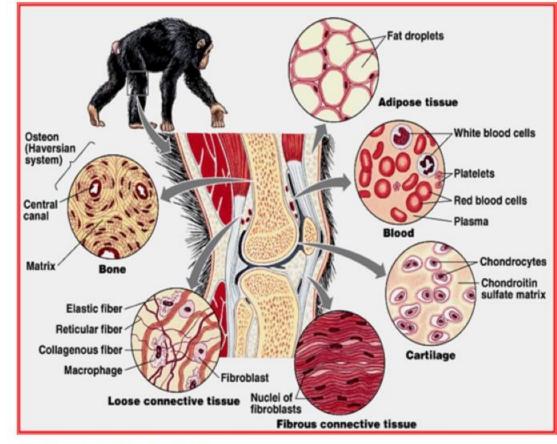
1- Structural Function:

- a- Connective tissue form capsules around organs, and internal architecture.
- b- Dense connective tissue forms tendons and ligaments.
- c- Areolar connective tissue fills spaces between organs.
- d- Bone and cartilage support soft tissues.
- e- Adipose tissue stores fat and gives body shape.

2- Defensive function:

A- By cells:

- Phagocytic cells as macrophage.
- Inflamatory cells as mast cells.
- Immunity cells as plasma cells.
- B- By matrix: physical barrier.



- 3- Nutritive function: Ground substance exchange nutrients and wastes between cells and blood supply.
- 4- Repair Function: by fibroblast

CARTILAGE

Cartilage

 Is a supportive type of connective tissue in which the matrix is firm giving it the characteristic consistency allows the tissue to bear mechanical stresses without permanent distortion.

- Functions:
- supports soft tissues
- shock absorbing and sliding area for joints (smooth surface),
- essential for the development and growth of long bones

General characters:

- Cartilage tissue is derived from mesenchyme.
- The cartilage is avascular. It gets its nutrition by diffusion from blood vessels in the surrounding dense connective tissue (perichondrium) or from the synovial fluid in joint cavities.

Cartilage consists of:

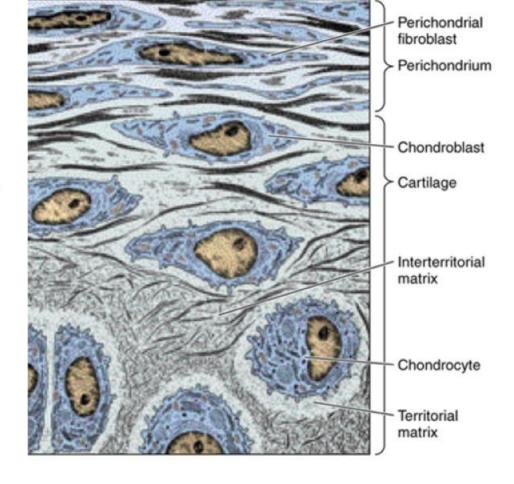
(1) Cells:

- a) Chondroblasts: young chondrocytes present near the surface.
- b) Chondrocytes: secrete the extracellular matrix, within which they are present inside cavities called lacunae.
- (2) Extra cellular matrix: composed of:
- a) Amorphous (ground) substance which is formed of
- i -proteoglycans (chondroitin sulphate & keratan sulphate)
- ii- hyaluronic acid
- iii -and glycoprotein (chondronectin)
- b) Fibers; whose type is different in different types of cartilage.

Hyaline cartilage: possesses a matrix containing type II collagen fibrils

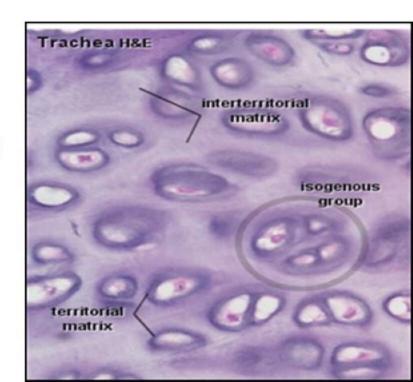
Elastic cartilage: in addition to type II collagen fibrils, there is abundance of elastic fibers.

Fibro-cartilage: the matrix contains a dense network of type I collagen fibers



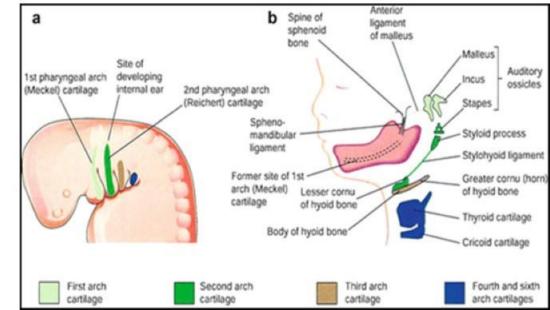
Hyaline Cartilage

- Hyaline cartilage is bluish white and translucent.
- Strong, rubbery, flexible tissue.
- Sites:
- i- Fetal skeleton before it is replaced by bone
- ii- Epiphyseal plate, tracheal rings, nasal septum,
 larynx, costal cartilage & articular surfaces of joints



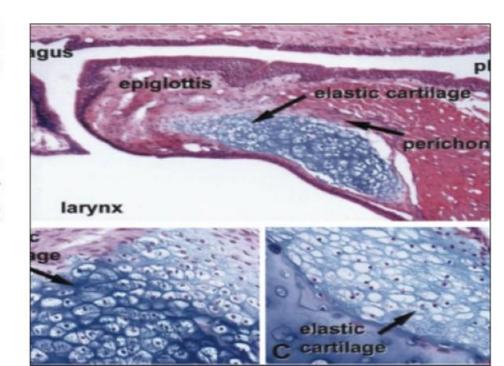
Meckel's Cartilage

- Meckel's cartilage is a solid hyaline cartilage arises from the first pharyngeal arch. Formed at 6th week of fetal development. In humans, the cartilaginous bar of the mandibular arch is formed by Meckel's cartilages (right and left) also known as Meckelian cartilages.
- The dorsal end of each cartilage is connected with the ear-capsule and is ossified to form the malleus; the ventral ends meet each other at the symphysis by mesodermal tissue and are usually undergoing ossification to form that portion of the mandible which contains the incisor teeth.
- The intervening part of the cartilage disappears; the portion immediately adjacent to the malleus is replaced by fibrous membrane, which constitutes the sphenomandibular ligament, while from the CT covering the remainder of the cartilage the greater part of the mandible is ossified.



Elastic Cartilage

- The matrix contains abundant network of elastic fibers in addition to collagen type II fibrils.
- Sites: ear pinna, external auditory canal, eustachian tube, epiglottis and some cartilages of the larynx.
- Elastic cartilage provides strength, and elasticity, and maintains the shape of certain structure such as the external ear.
- The epiglottis is a part of the larynx at the root of the tongue that folds over the glottis to prevent food or liquid from entering the trachea during swallowing. It is formed of elastic cartilage.



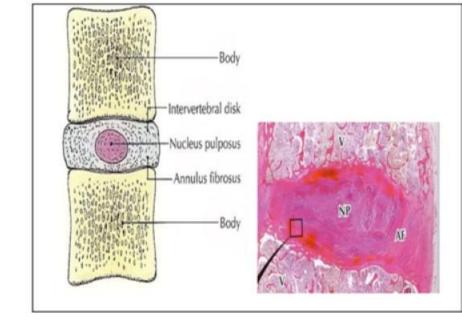
Fibro-Cartilage

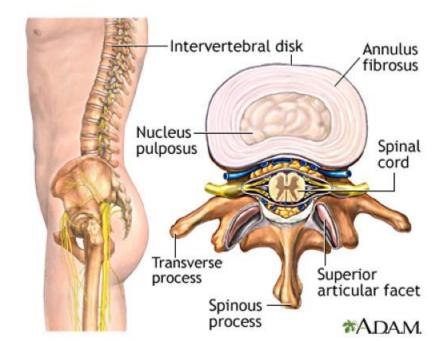
- This is the strongest kind of cartilage
- does not have a perichondrium
- The matrix contains bundles of type I collagen fibers
- Sites: intervertebral disks and symphasis pubis, articular disc of TM joint.

Intervertebral disc (IVD)

- Lubricant cushion.
- Situated between articular surfaces of neighbouring vertebrae, have 2 components: –
- a) Peripheral Annulus fibrosus (AF): fibro-cartilage surrounded by dense CT.
- b) Central Nucleus pulposus (NP):in the center; ground substance + few cells, col. II

Disc: Ruptured AF \rightarrow expulsion of NP \rightarrow flat disc \rightarrow slips from its place between vertebra \rightarrow compress nerves \rightarrow severe pain.





Bone

Bone is a specialized connective tissue with calcified matrix.

Functions:

- Provide support & protection to the vital organs
- Serves as a storage site for the calcium and phosphate.
- · Bone contains bone marrow which acts as a haemopoietic organ.

Structure of the bone:

Bone is formed of:

- A- Solid matrix.
- B- Bone cells
- C- Periosteum
- D- Endosteum

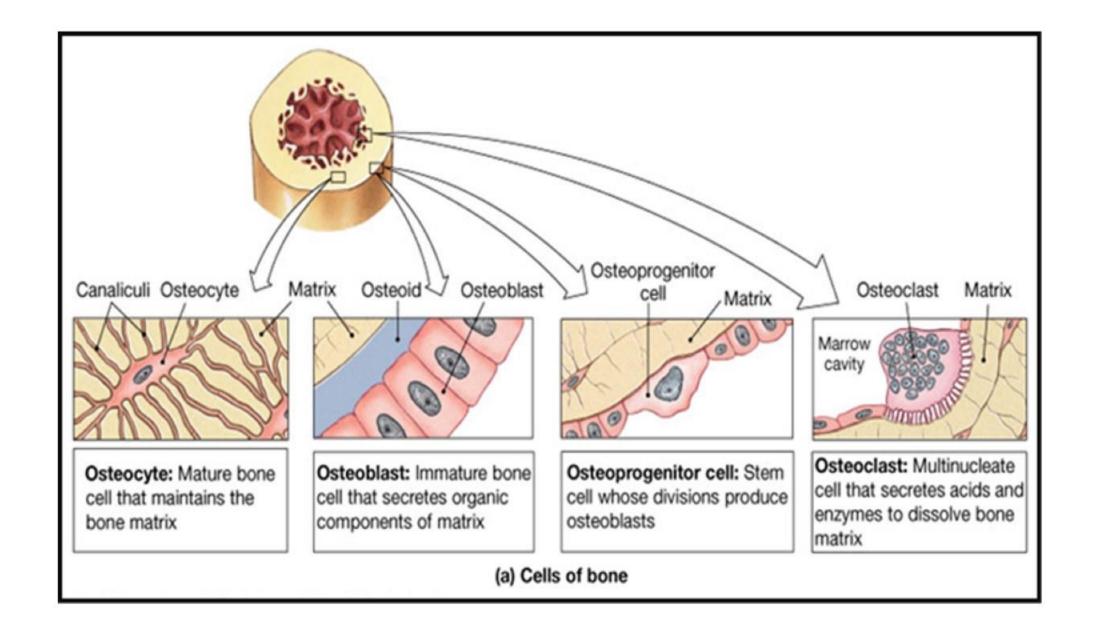
A-Bone Matrix is composed of:

- I) Organic matter (collagen fibers, proteoglycans and glycoproteins)
- II) Inorganic matter, mainly calcium phosphate (45%).
- III) Water(20%).

The calcified matrix is organized into lamellae and within it there are small cavities (lacunae) containing osteocytes.

B-Bone cells

- B-Bone cells are osteogenic cells, osteoblasts, osteocytes and osteoclasts.
- 1-Osteogenic cells: They are the stem cell of the bone. They can divide and differentiate into osteoblasts. They are spindle shaped cell with pale elongated nucleus. They are found in the periosteum and endosteum.
- **2-Osteoblasts:** They are cuboidal cells with pale nuclei and basophilic cytoplasm. They are located on the surface of the bone. Their cytoplasm contains abundant RER, well developed Golgi complex. They are responsible for synthesis of organic components of bone matrix. Osteoblasts change into osteocytes when they are trapped inside lacunae.
- **3-Osteocytes:** Osteocytes are flat cells with less basophilic cytoplasm and darker nucleus. They are present singly in a small cavity called lacuna. They have cytoplasmic processes that pass through canaliculi within the bony matrix to be in contact with the processes of the adjacent cells. They are responsible for maintaining bone matrix and can release calcium ions from bone matrix to the circulating blood when calcium demands increase.
- **4-Osteoclasts:** They are phagocytic cells derived from monocytes. They are large cells having many nuclei and acidophilic foamy cytoplasm. They are present at bony surface depression called Howship's lacuna. They are responsible for resorption and remodeling of bone during bone formation.



Types Of Bone Tissue:

Anatomically there are three types:

- 1)Long bone as femur and tibia.
- 2)Short bone as bones of phalanges.
- Flat bone as bones of skull and sternum.

Histologically bone is classified into:

- 1) **Compact bone** in which the bone lamellae are regularly arranged. It is present in the shafts of long bones.
- 2) **Spongy or Cancellous bone** in which the bone lamellae are irregularly arranged. It is present in the ends of long bones, ribs, vertebrae, in the center of flat bones as skull, scapula, sternum and sacrum

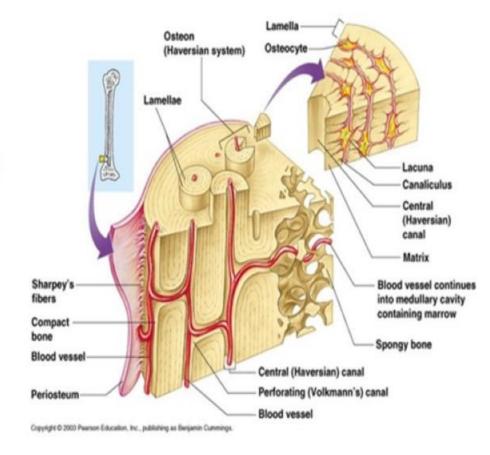
Microscopic structure of decalcified compact bone:

- 1-<u>Periosteum:</u> It is a vascular connective tissue membrane which covers the bone from outside. It is formed of two layers:
- a)Outer fibrous layer and b)Inner cellular layer of osteogenic cells and osteoblasts.
- 2-Endosteum: It lines the inner surface of bone. It is formed of osteogenic cells and osteoblasts.
- 3-Haversian system Or Osteon: Each Haversian system is formed of regularly arranged concentric lamellae of calcified collagenous fibers around vascular canal called Haversian canal. It contains connective tissue, blood vessels and nerves. They are connected with each other and with periosteum by oblique canals known as Volkman's canals.
- 4-External circumferential lamellae: These are the bone lamellae with their osteocytes which run under the periosteum

5-Internal circumferential lamellae: These are the bone lamellae which are inner to the endosteum.

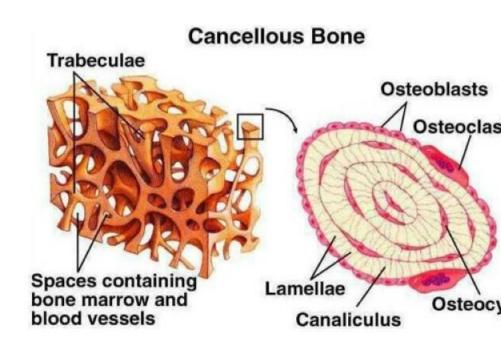
6-Interstitial lamellae: These are irregular bone lamellae which are present in between the Haversian system.

N.B. Perforating fibers of Sharpey are collageneuos bundles that extend from periosteum to the outer circumferential lamellae and interstitial lamellae and fix the periosteum to the underlying bone.



Microscopic Structure Of Spongy Or Cancellous Bone:

- 1- It is formed of irregularly arranged plates of bone trabeculae.
- 2- The bone trabeculae are formed of irregular bone lamellae with scattered osteocytes embedded between these lamellae.
- 3-There is no Haversian system.
- 4-There are multiple bone marrow cavities present between the bone trabeculae.



BONE FORMATION

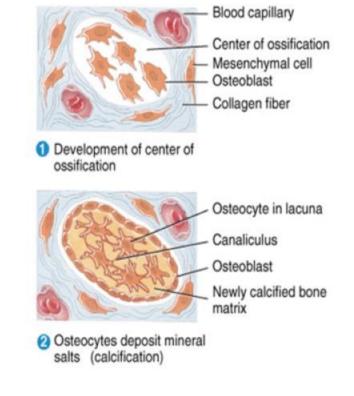
- · All embryonic connective tissue begins as mesenchyme.
- Bone formation is termed osteogenesis or OSSification
- Two types of ossification occur.
 - 1- Intramembranous ossification is the formation of bone directly from or within fibrous connective tissue membranes.
 - 2- Endochondrial ossification is the formation of bone from hyaline cartilage models.

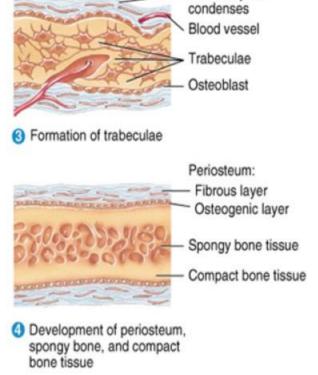
Intramembranous Ossification

It occurs within the mesenchymal tissue

All roofing bones of the Skull

- Frontal bone
- Parietal bones
- Occipital bone
- Temporal bones
- Mandible
- Clavicle



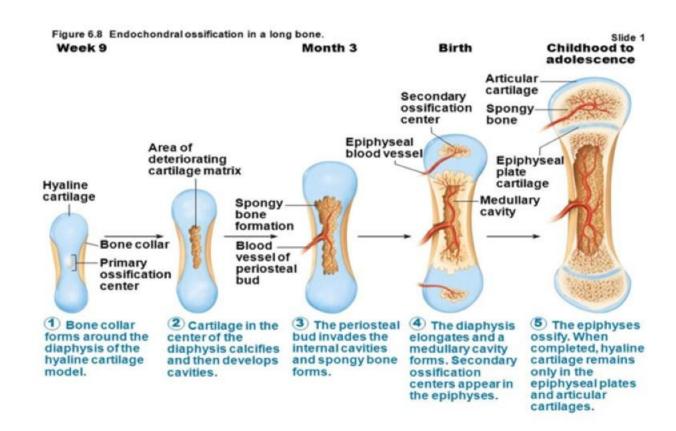


Mesenchyme

O John Wiley & Sons. Inc.

Endochondral Ossification

- Developing bones are deposited as a hyaline cartilage model and then this cartilage is replaced by bone tissue.
- All bones of the body except:
- All roofing bones of the Skull
- Mandible
- Clavicle







General Histology

SECOND STAGE DENTISTRY DEPARTMENT

Connective Tissue 17-10-2023

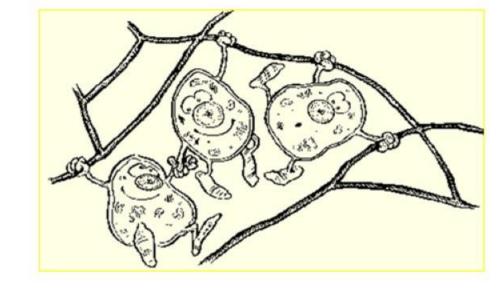
Connective Tissue (C.T.)

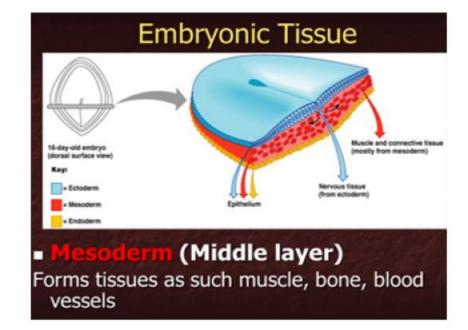
1-Definition

- One of the four basic tissues.
- Connects and binds cells and organs.

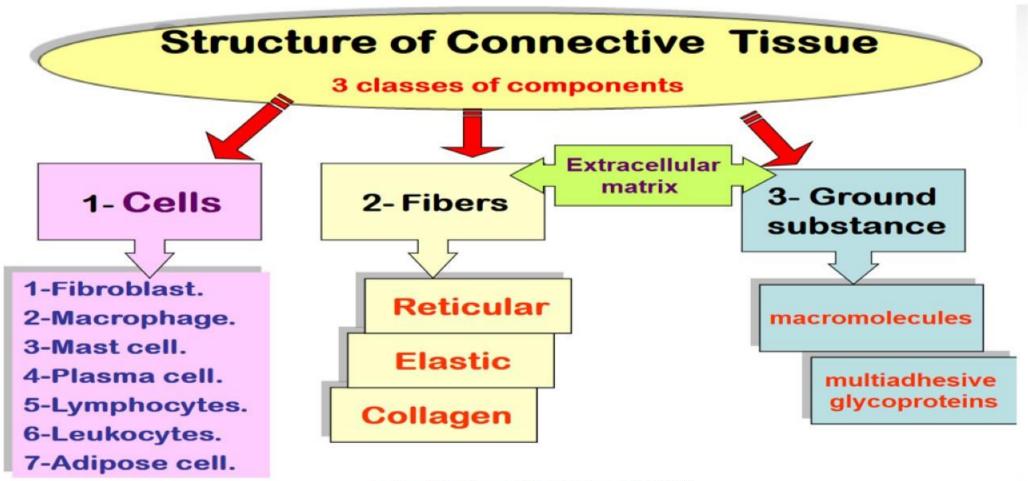
2-Development

- Mesoderm except some C.T. of the head which is derived from ectoderm.
- Mesodermal cells that migrate from their site of origin to developing organs are called mesenchymal cells, they give all types of C.T. cells





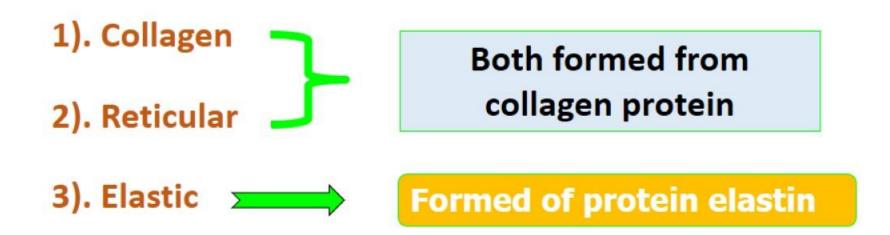
3-Composition



Dr. Mareb H. Ahmed, PhD, Histology, 17-10-2023

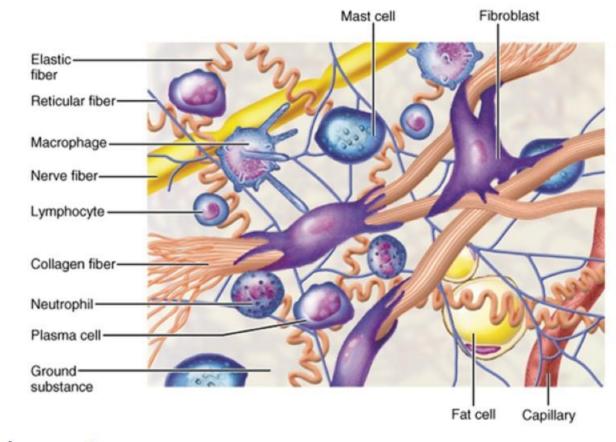
Connective tissue Fibers

- They are slender protein polymers.
- Depending on the structural needs or function.
- TYPES:



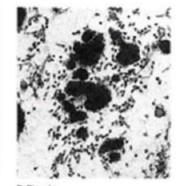
Collagen fibers

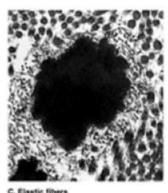
- The most numerous fibers in C.T.
- Closely packed thick fibrils.



- Inelastic giving flexibility and strength to tissue.
- Individual fresh fibers are colorless but aggregated fibers are white.
- Staining: Pink with Eosin and Blue with Mallory.

Elastic fiber system



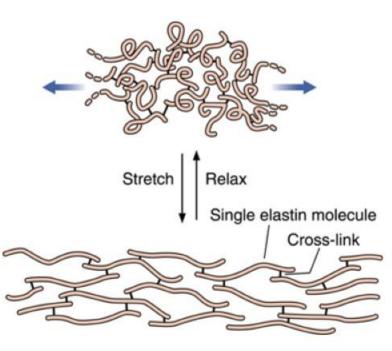


It is composed of 3 types of fibers:

- Oxytalan fibers
- Elaunin fibers
- Elastic fibers

Development:

- · The oxytalan fibers are thin microfibrils.
- Deposition of elastin between oxytalan form elaunin fibers.
- Accumulation of elastin in center of fiber bundles form elastic fibers.
- The bundles are surrounded by sheath of microfibrils.
- Staining: Brown with orcein



Reticular fibers

- Very thin, loosely packed thin fibrils.
- Sites:
- Framework of hematopoietic organs (spleen).
- Network around cells of parenchyma organs (liver, kidney).
- Staining:
- Black with silver salts (argyrophilic).
- Not visible with Hx and E.

3- TISSUE FLUID

Small quantity of fluid contained in ground substance, similar to plasma.

Control of tissue fluid

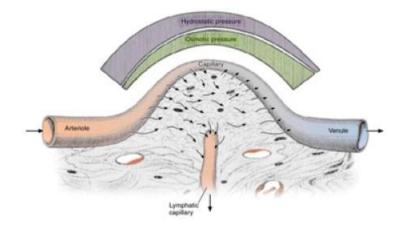
By 2 processes:

- 1-Hydrostatic pressure (HP) by heart → water leaves capillary.
- 2-Osmotic pressure (OP) by plasma proteins → water return to capillary.

Mechanism

From arterial to venous end: HP \downarrow and OP \uparrow \rightarrow water leaves the capillary at arterial end and returns at venous end. Some fluid is drained by lymphatic capillaries

Oedema: fluid accumulation in extracellular space.



II- CONNECTIVE TISSUE CELLS

Fixed cells:

- Develop in C.T.
- UMC, Fibroblasts, Adipose cells.

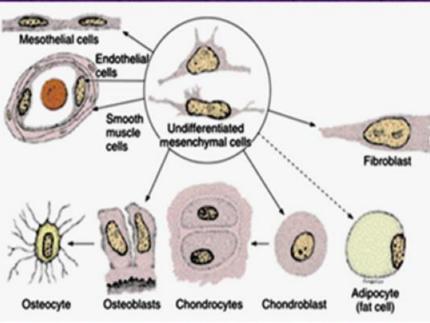
Wondering cells:

- · Develop in bone marrow.
- Mast cells, Plasma cells,
- Macrophage, Leukocytes.

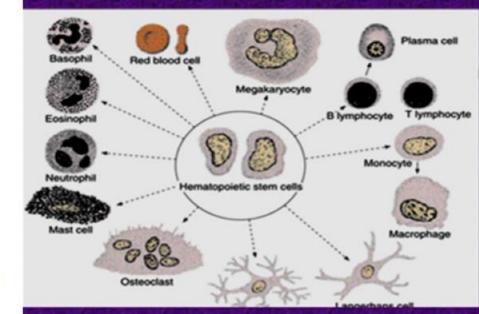
1-Undifferentiated Mesenchymal cells (UMC)

- Shape: processes.
- Nucleus: pale (extended active chromatin).
- Cytoplasm: small amount.
- Viscous ground substance.

Fixed cells



Transient cells



Fixed cells:

Fibroblast

Shape: irregularly branched cells.

Nucleus: Pale (extended active chromatin).

Cytoplasm: Deep basophilia (numerous RER).

· Function: - Synthesis of fibers and matrix.

Fibrocyte

Size: smaller.

Shape: Spindle.

Nucleus: elongated, darker (dense less active chromatin).

Cytoplasm: less basophilia (few RER).

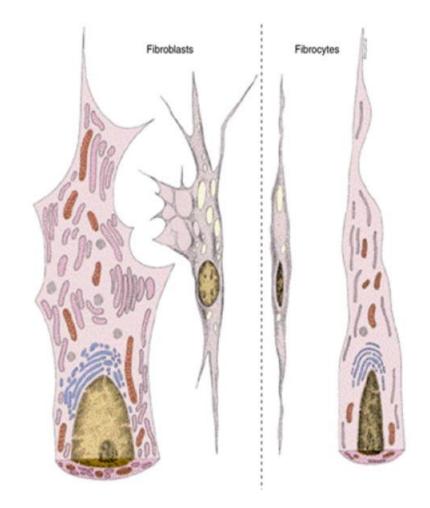
· Function: converts to fibroblast.

Mvofibroblast

Features of fibroblast and smooth muscle cells.

· Contains actin and myosin filaments.

Responsible for wound closure (contraction).



3- Adipose (Adipocytes or Fat) cells

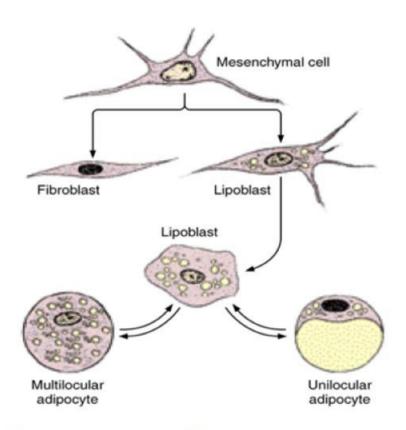
• Origin: U.M.C.

Site: adipose C.T.

Types: Unilocular or Multilocular.

Unilocular fat cells

- Characters: Only one large fat droplet.
- Colour: yellow
- Shape:
- Spherical when single. Polyhedral when packed.
- Stain by HX & E: Signet ring cell (cytoplasm thin ring surrounding one dissolved fat vacuole with eccentric flat nucleus).
- Special stain: suddan III
- Function: Produce energy.



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Special stain: suddan III

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Multilocular fat cells

· Characters: Several fat droplets.

Colour: Brown due to: 2C Capillaries and Cytochromes in mitochondria.

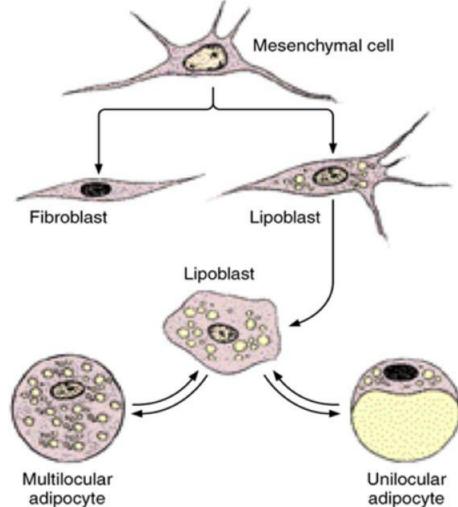
Shape: Polygonal, smaller than unilocular cells.

Stain: osmic acid.

Nucleus: spherical central.

· Cytoplasm: Several fat vacuoles in Hx & E staining.

Functions: Produce heat in human newborn and in hibernating animals



4-Macrophages

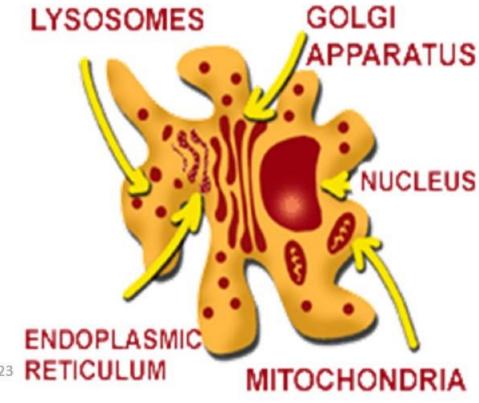
Origin: Monocytes. Member of Mononuclear phagocyte system: all its cells arise from monocyte, possess lysosomes and are phagocytic.

Site:

- · In most organs.
- · Have special names in certain regions, e.g:
- 1-Kupffer cells in liver
- 2-microglial cells in C.N.S
- 3-osteoclasts in bone

Shape

- Irregular surface with protrusions.
- Survive for months in tissue.
- Cytoplasm: Many small vacuoles (Lysosomes).
- Nucleus: kidney shaped.
- Stain: vital dyes (trypan blue or Indian ink), cells engulf granules of stain.
- Functions: Phagocytosis (Ingestion and digestion of foreign particles).



5- Mast cell

Origin: U.M.C in bone marrow.

Sites: widely distributed but are more in GIT and respiratory T.

Shape: oval.

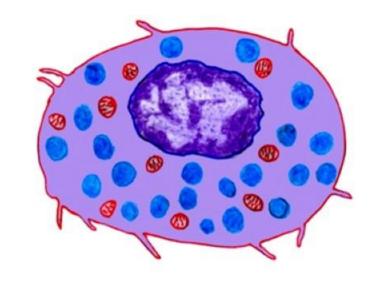
Stain: Metachromatically with toluidine blue.

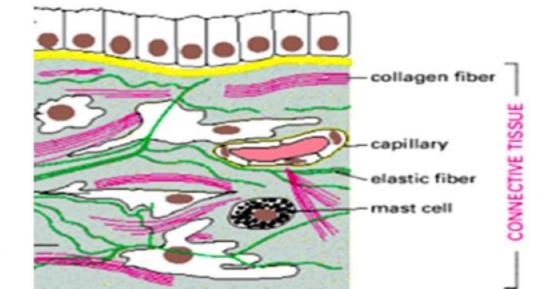
Cytoplasm: filled with basophilic coarse granules.

Nucleus: rounded, central, masked by cytoplasmic granules.

Function: Synthesis and storage of chemical mediators of inflammation.

- a- Heparin (blood anticoagulant).
- b- Histamine (dilate blood capillaries).
- c- ECF-A: eosinophil chemotactic factor of anaphylaxis.
- d- Leukotriens (slow contraction of smooth muscles).





6- Plasma cell

Origin: B-lymphocyte.

Sites: numerous in sites subjected to penetration by bacteria (e.g. intestine) and areas of chronic inflammation.

Shape: large ovoid cell.

Cytoplasm:

- Basophilic (Rich in RER)
- Unstained area near the nucleus (-ve Golgi image)

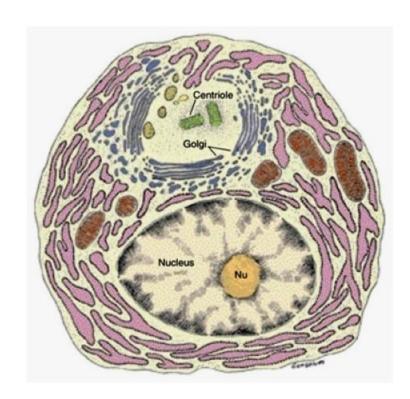
Nucleus:

- Spherical, eccentrically placed.
- Alternating dense and pale chromatin areas (clock-face appearance).
- Function: Synthesis of antibodies

7 - Leukocytes

Granular: neutrophiles, eosinophils, basophiles.

- Nongranular: lymphocytes.
- Migrate from blood to C.T.



Types of connective tissue

Depend on the type of cells, fibers and ground substance

I- Connective tissue proper:

1- Loose.

2- Dense: Regular and Irregular.

II- Specialized C.T.:

Adipose (yellow and Brown)

Reticular - Elastic

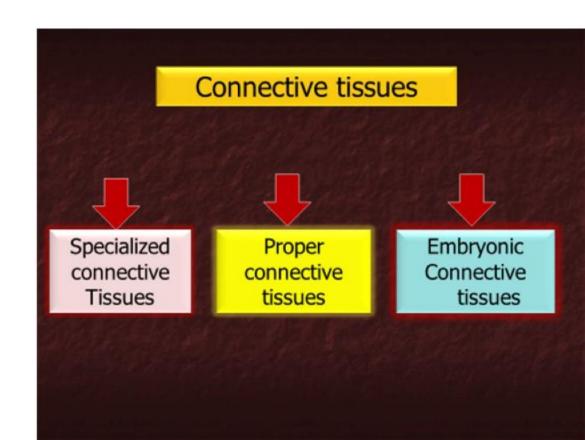
Hemopoietic - Lymphatic.

III- Supporting C.T.

Cartilage - Bone

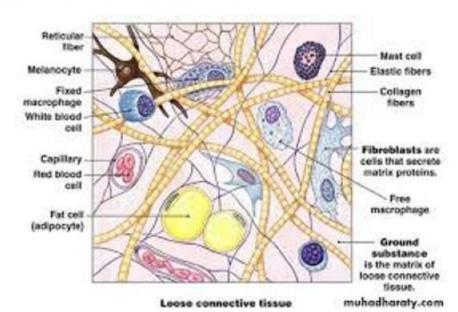
IV- Embryonic C.T.:

Mesenchymal - Mucous.



Connective tissue proper

- 1 Loose C.T. (areolar C.T.)
- Structure: all components of C.T (all cells, fibroblasts and macrophages are the most numerous, all fibers, and large amount of ground substance).
- Characters: vascular, flexible and does not resist stress.
- Sites: Supports epithelial tissue, fills spaces, ensheathes blood vessels.



2- Dense C.T

- Mainly collagen fibers, few fibroblasts and very little ground substance.
- Less flexible and resists stress.

Types:

A) Dense irregular C.T.:

- Collagen bundles are irregularly arranged and run in different directions.
- Resist stress from all directions.

Sites: Skin dermis.

B) Dense regular C.T:

- Collagen bundles are regularly arranged and run in the same direction.
- Resist stress from one direction.

Sites: Tendons, Ligaments.

3-Yellow elastic C.T

- Bundles of thick parallel elastic fibers and thin collagenous fibers with flattened fibroblasts inbetween.
- Great elasticity and yellow colour.

Sites: Ligaments of vertebral column.

4-Reticular C.T

- 1-Reticular cells: fibroblasts with processes and specialized for secretion of reticular fibers.
- 2- Reticular fibers.

Forms the framework of:

- Myeloid tissue (bone marrow)
- Hematopoietic organs.
- Lymphoid organs (lymph node & spleen)

5- Mucoid C.T.

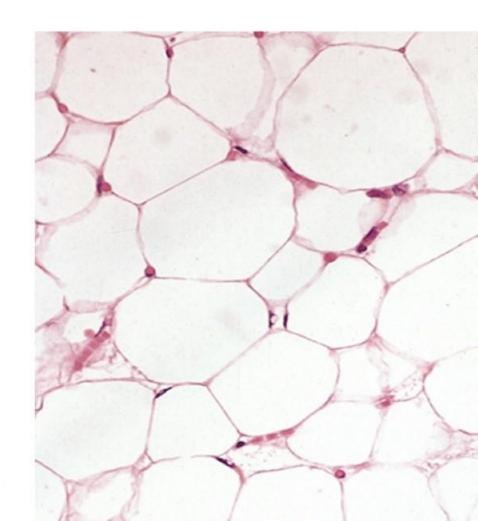
Jelly like matrix.

Sites:

- Umbilical cord (Wharton's jelly).
- Pulp of tooth.
- IVD.

6-Adipose C.T.

- Fat cells predominate.
- Types of adipose C.T.:
- 1- Unilocular (yellow) adipose tissue:
- Unilocular fat cells.
- It is the common type.
- Incomplete lobules.
- Sites: Throughout human body except eyelids.
- Functions
- 1-Store energy.
- 2- Gives the body shape.
- 3- Shock absorber.
- 4- Thermal insulators.
- 5- Fills spaces between tissues and keep organs in position.

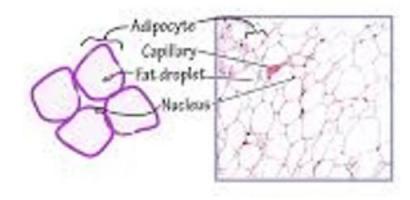


Multilocular adipose tissue (brown fat)

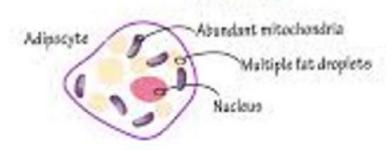
- -Multilocular fat cells.
- Complete lobules.
- Sites:
- In hibernating animals.
- In human embryo and newborn.
- · Functions: Produce heat.

Adipose Tissue

White Fat



Brown Fat



Functions of C.T.

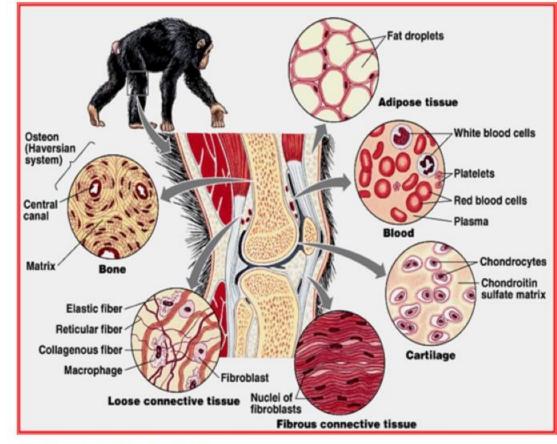
1- Structural Function:

- a- Connective tissue form capsules around organs, and internal architecture.
- b- Dense connective tissue forms tendons and ligaments.
- c- Areolar connective tissue fills spaces between organs.
- d- Bone and cartilage support soft tissues.
- e- Adipose tissue stores fat and gives body shape.

2- Defensive function:

A- By cells:

- Phagocytic cells as macrophage.
- Inflamatory cells as mast cells.
- Immunity cells as plasma cells.
- B- By matrix: physical barrier.



- 3- Nutritive function: Ground substance exchange nutrients and wastes between cells and blood supply.
- 4- Repair Function: by fibroblast

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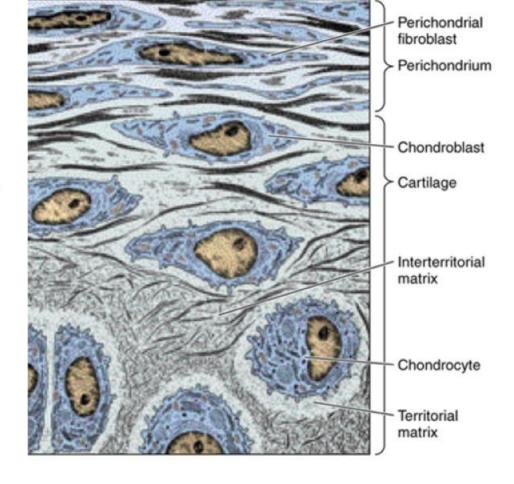
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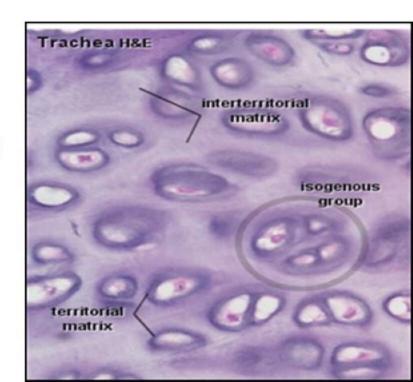
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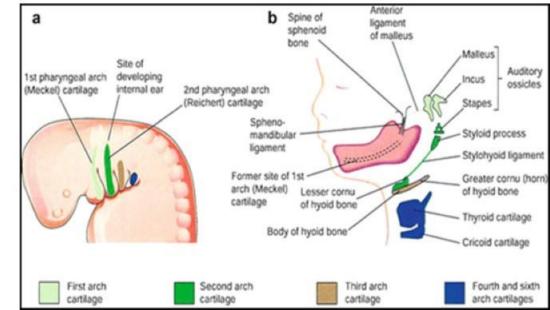
Hyaline Cartilage

- Hyaline cartilage is bluish white and translucent.
- Strong, rubbery, flexible tissue.
- Sites:
- i- Fetal skeleton before it is replaced by bone
- ii- Epiphyseal plate, tracheal rings, nasal septum,
 larynx, costal cartilage & articular surfaces of joints



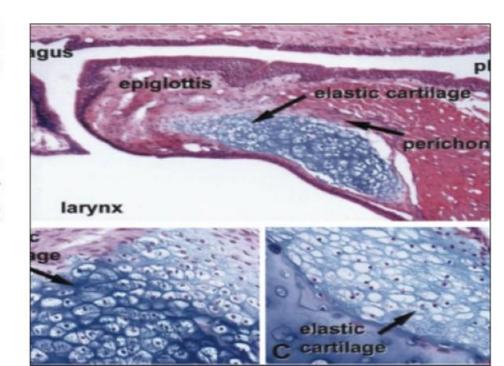
Meckel's Cartilage

- Meckel's cartilage is a solid hyaline cartilage arises from the first pharyngeal arch. Formed at 6th week of fetal development. In humans, the cartilaginous bar of the mandibular arch is formed by Meckel's cartilages (right and left) also known as Meckelian cartilages.
- The dorsal end of each cartilage is connected with the ear-capsule and is ossified to form the malleus; the ventral ends meet each other at the symphysis by mesodermal tissue and are usually undergoing ossification to form that portion of the mandible which contains the incisor teeth.
- The intervening part of the cartilage disappears; the portion immediately adjacent to the malleus is replaced by fibrous membrane, which constitutes the sphenomandibular ligament, while from the CT covering the remainder of the cartilage the greater part of the mandible is ossified.



Elastic Cartilage

- The matrix contains abundant network of elastic fibers in addition to collagen type II fibrils.
- Sites: ear pinna, external auditory canal, eustachian tube, epiglottis and some cartilages of the larynx.
- Elastic cartilage provides strength, and elasticity, and maintains the shape of certain structure such as the external ear.
- The epiglottis is a part of the larynx at the root of the tongue that folds over the glottis to prevent food or liquid from entering the trachea during swallowing. It is formed of elastic cartilage.



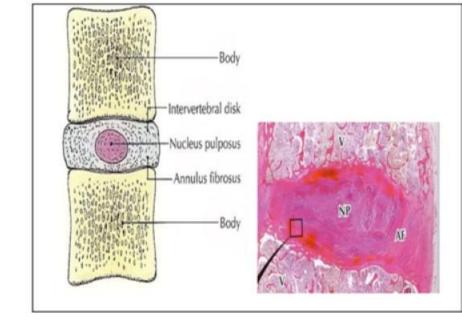
Fibro-Cartilage

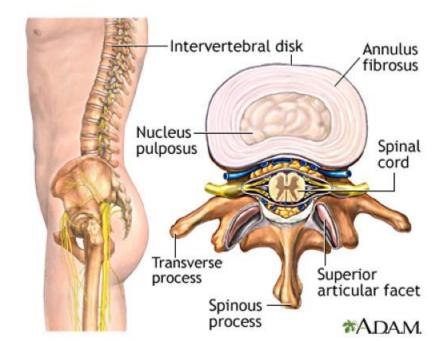
- This is the strongest kind of cartilage
- does not have a perichondrium
- The matrix contains bundles of type I collagen fibers
- Sites: intervertebral disks and symphasis pubis, articular disc of TM joint.

Intervertebral disc (IVD)

- Lubricant cushion.
- Situated between articular surfaces of neighbouring vertebrae, have 2 components: –
- a) Peripheral Annulus fibrosus (AF): fibro-cartilage surrounded by dense CT.
- b) Central Nucleus pulposus (NP):in the center; ground substance + few cells, col. II

Disc: Ruptured AF \rightarrow expulsion of NP \rightarrow flat disc \rightarrow slips from its place between vertebra \rightarrow compress nerves \rightarrow severe pain.





Bone

Bone is a specialized connective tissue with calcified matrix.

Functions:

- Provide support & protection to the vital organs
- Serves as a storage site for the calcium and phosphate.
- · Bone contains bone marrow which acts as a haemopoietic organ.

Structure of the bone:

Bone is formed of:

- A- Solid matrix.
- B- Bone cells
- C- Periosteum
- D- Endosteum

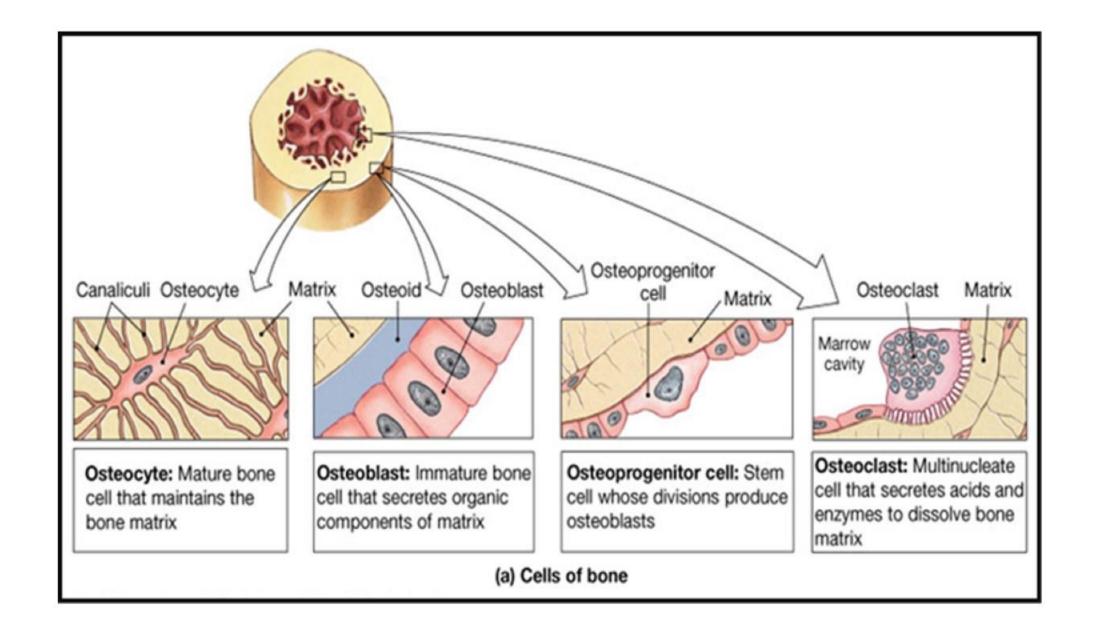
A-Bone Matrix is composed of:

- I) Organic matter (collagen fibers, proteoglycans and glycoproteins)
- II) Inorganic matter, mainly calcium phosphate (45%).
- III) Water(20%).

The calcified matrix is organized into lamellae and within it there are small cavities (lacunae) containing osteocytes.

B-Bone cells

- B-Bone cells are osteogenic cells, osteoblasts, osteocytes and osteoclasts.
- 1-Osteogenic cells: They are the stem cell of the bone. They can divide and differentiate into osteoblasts. They are spindle shaped cell with pale elongated nucleus. They are found in the periosteum and endosteum.
- **2-Osteoblasts:** They are cuboidal cells with pale nuclei and basophilic cytoplasm. They are located on the surface of the bone. Their cytoplasm contains abundant RER, well developed Golgi complex. They are responsible for synthesis of organic components of bone matrix. Osteoblasts change into osteocytes when they are trapped inside lacunae.
- **3-Osteocytes:** Osteocytes are flat cells with less basophilic cytoplasm and darker nucleus. They are present singly in a small cavity called lacuna. They have cytoplasmic processes that pass through canaliculi within the bony matrix to be in contact with the processes of the adjacent cells. They are responsible for maintaining bone matrix and can release calcium ions from bone matrix to the circulating blood when calcium demands increase.
- **4-Osteoclasts:** They are phagocytic cells derived from monocytes. They are large cells having many nuclei and acidophilic foamy cytoplasm. They are present at bony surface depression called Howship's lacuna. They are responsible for resorption and remodeling of bone during bone formation.



Types Of Bone Tissue:

Anatomically there are three types:

- 1)Long bone as femur and tibia.
- 2)Short bone as bones of phalanges.
- Flat bone as bones of skull and sternum.

Histologically bone is classified into:

- 1) **Compact bone** in which the bone lamellae are regularly arranged. It is present in the shafts of long bones.
- 2) **Spongy or Cancellous bone** in which the bone lamellae are irregularly arranged. It is present in the ends of long bones, ribs, vertebrae, in the center of flat bones as skull, scapula, sternum and sacrum

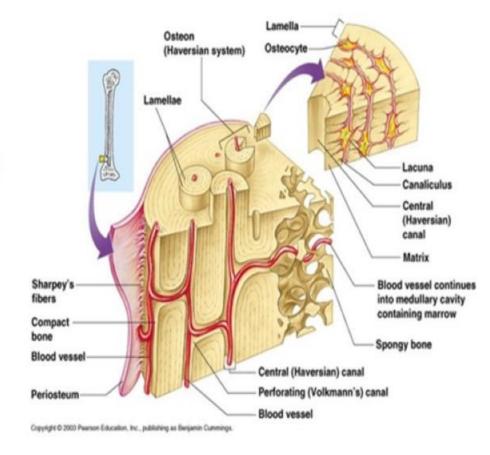
Microscopic structure of decalcified compact bone:

- 1-<u>Periosteum:</u> It is a vascular connective tissue membrane which covers the bone from outside. It is formed of two layers:
- a)Outer fibrous layer and b)Inner cellular layer of osteogenic cells and osteoblasts.
- 2-Endosteum: It lines the inner surface of bone. It is formed of osteogenic cells and osteoblasts.
- 3-Haversian system Or Osteon: Each Haversian system is formed of regularly arranged concentric lamellae of calcified collagenous fibers around vascular canal called Haversian canal. It contains connective tissue, blood vessels and nerves. They are connected with each other and with periosteum by oblique canals known as Volkman's canals.
- 4-External circumferential lamellae: These are the bone lamellae with their osteocytes which run under the periosteum

5-Internal circumferential lamellae: These are the bone lamellae which are inner to the endosteum.

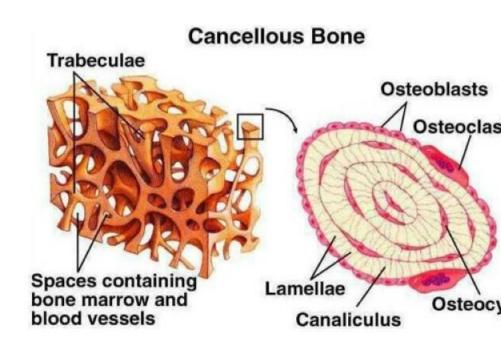
6-Interstitial lamellae: These are irregular bone lamellae which are present in between the Haversian system.

N.B. Perforating fibers of Sharpey are collageneuos bundles that extend from periosteum to the outer circumferential lamellae and interstitial lamellae and fix the periosteum to the underlying bone.



Microscopic Structure Of Spongy Or Cancellous Bone:

- 1- It is formed of irregularly arranged plates of bone trabeculae.
- 2- The bone trabeculae are formed of irregular bone lamellae with scattered osteocytes embedded between these lamellae.
- 3-There is no Haversian system.
- 4-There are multiple bone marrow cavities present between the bone trabeculae.



BONE FORMATION

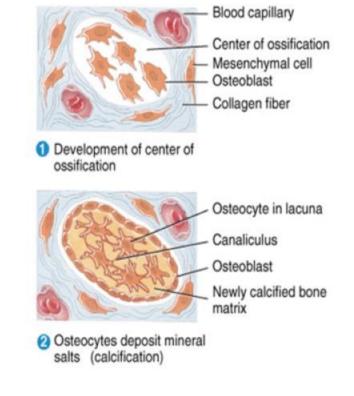
- · All embryonic connective tissue begins as mesenchyme.
- Bone formation is termed osteogenesis or OSSification
- Two types of ossification occur.
 - 1- Intramembranous ossification is the formation of bone directly from or within fibrous connective tissue membranes.
 - 2- Endochondrial ossification is the formation of bone from hyaline cartilage models.

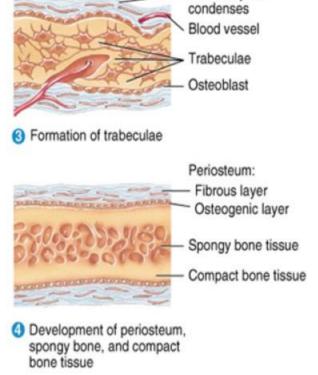
Intramembranous Ossification

It occurs within the mesenchymal tissue

All roofing bones of the Skull

- Frontal bone
- Parietal bones
- Occipital bone
- Temporal bones
- Mandible
- Clavicle



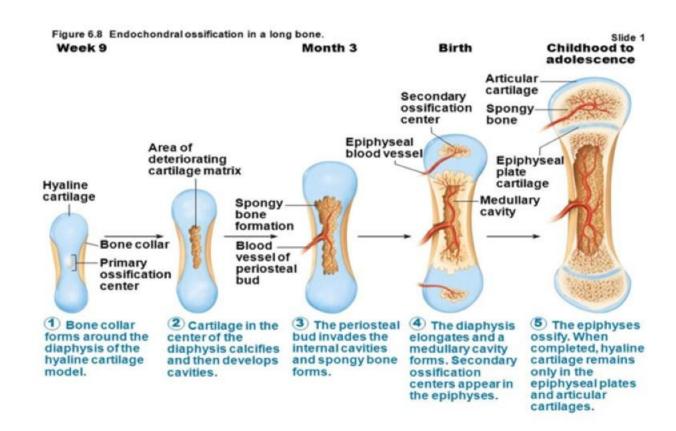


Mesenchyme

O John Wiley & Sons. Inc.

Endochondral Ossification

- Developing bones are deposited as a hyaline cartilage model and then this cartilage is replaced by bone tissue.
- All bones of the body except:
- All roofing bones of the Skull
- Mandible
- Clavicle

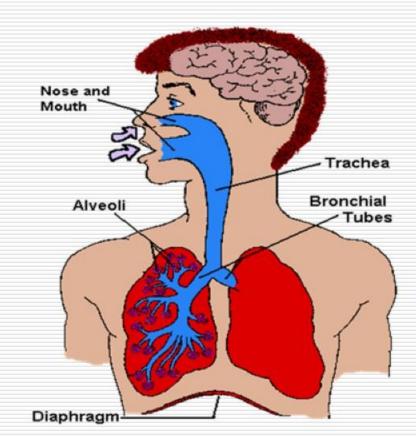






Alnoor University College Dentistry Department Second Year

General Histology Respiratory system

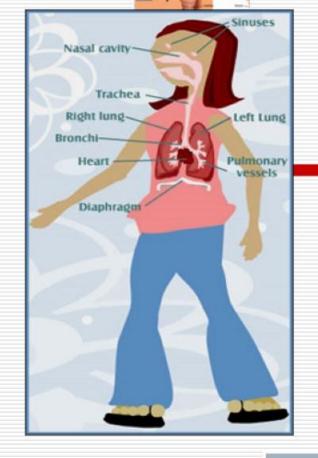


Dr. Mareb H. Ahmed, PhD,

Histology, 23-30/10/2023

The principle function

- The principle function of the respiratory system is exchange of gases (oxygen and carbon dioxide) between air in alveoli of the lung and blood in the capillaries.
- It includes:
- **a-** The <u>lungs</u>: the site for gas exchange.
- b- A system of tubes: links the lungs with the external environment.
- c- A ventilation mechanism which is important for the movement of air through the conducting and respiratory parts of the lungs. It consists of the thoracic cage, intercostals muscles, and diaphragm.



Respiratory system

Conducting part

Respiratory part

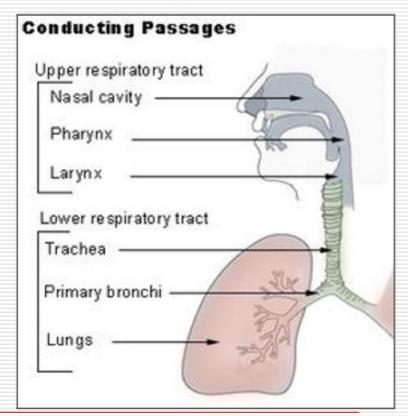
Conducting part

(upper respiratory tract): by which air pass from the atmosphere to

the lung

It consists of

- The nasal cavity
- The pharynx
- The larynx
- The trachea
- Bronchi
- Terminal bronchioles



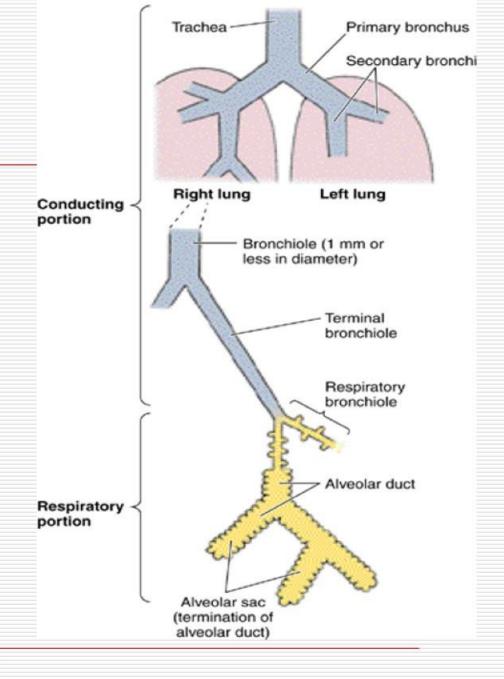
Respiratory part

(lower respiratory system):

where gaseous exchange took place.

It consists of

- Respiratory bronchioles
- Alveolar ducts
- Alveolar sacs
- Alveoli.



I- THE CONDUCTING PORTION

General structural characteristics that suit its function:

- a. Epithelium: mostly pseudostratified columnar ciliated epithelium with abundant goblet cells (respiratory epithelium).
- b. Lamina propria: This is the loose C.T, with rich vascular supply, & seromucous glands.
- c. Supportive layer that keep the airway patent. It may be bone & cartilage (nasal cavity), cartilage (trachea & bronchi) or smooth muscle (bronchioles)
- The conducting portion serves two functions:

The conducting portion serves two functions:

- □ 1- Conducts air to and from the lungs
 - 2- Conditions the inspired air
- ☐ The conducting portion conditions the inspired air before it enters the lung by:
 - Cleaning: the mucous secreted by goblet cells entraps the dust and then moves toward the mouth by the ciliary activity.
 - Moisturing: by the seromucous secretion covering the surface.
 - Warming: by the rich blood vessels in the lamina propria.

Respiratory epithelium:

□- Most of the conducting portion is lined by pseudostratified columnar ciliated epithelium that contains goblet cells. Typical respiratory epithelium consists of 5 cell types as seen in the electron microscope.

1- Ciliated columnar cells

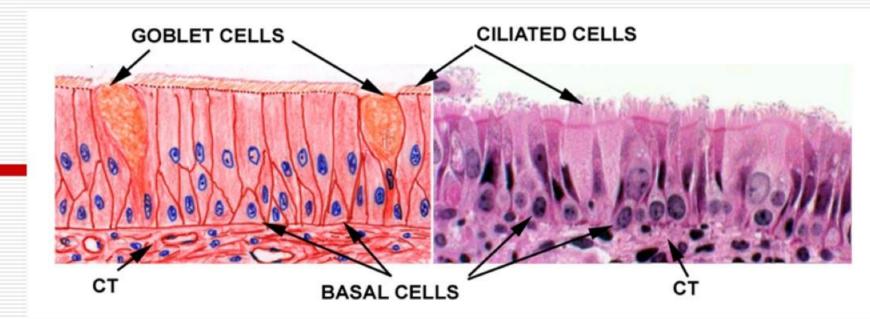
- The most abundant type. Each cell has 200-300 cilia on its apical surface.
- There are numerous mitochondria to supply ATP for ciliary movement.
 - If ciliary movement is impaired, the mucous accumulates in the respiratory portion causing chronic respiratory infections.

☐ 2- Goblet cells:

- The apical portion contains mucinogen granules.
- They have narrow basal part that contains the nucleus and organelles.
- They secrete mucous that covers the epithelial surface, traps particulate matter.

☐ 3- Brush cells:

- Columnar cells that have numerous microvilli on their apical surface.
- They have afferent nerve endings on their basal surfaces and considered to be sensory receptors.

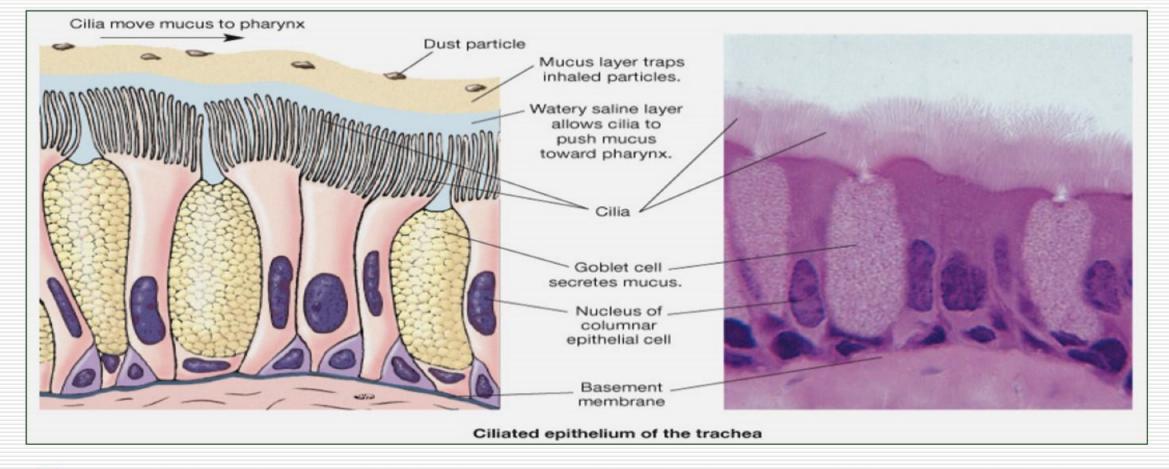


☐ 4- Basal cells:

- Small rounded cells that lie on the basal lamina.
- They are short and considered as stem cells for other cell types.

□ 5- Endocrine cells:

 Similar to basal cells. They belong to DNES (Diffuse Neuro-Endocrine System). They secrete amine and peptide hormones (e.g. serotonin)



A smoker's respiratory epithelium has **more** goblet cells for more rapid clearance of pollutants and **fewer** ciliated cells caused by excessive carbon monoxide (CO) results in a decrease in the movement of mucous layer leading to congestion of the smoker's airways.

Upper Respiratory Tract - NASAL CAVITIES

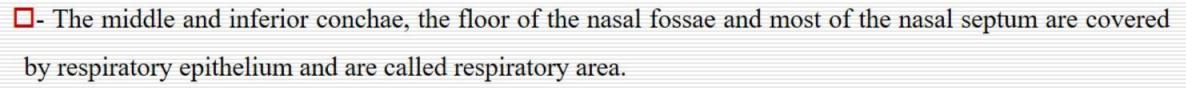
- □- The nose is covered externally by skin with some sebaceous glands.
- The cavity of the nose is divided by nasal septum into right and left nasal cavities.
- Each communicates anteriorly by anterior naris (nostril) and posteriorly with the nasopharynx.
- The wall of each nasal cavity has a rigid wall of hyaline cartilage and bone.
- Each nasal cavity is divided into:

1- Vestibule

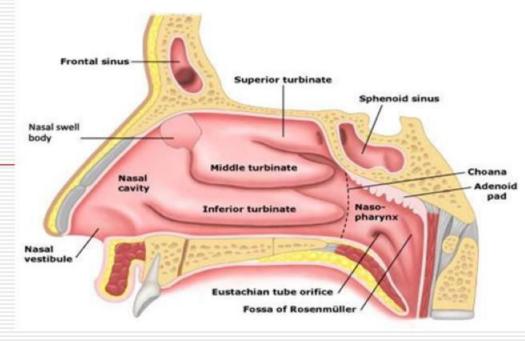
- The most anterior and dilated portion of the nasal cavity.
- □- The nostrils are lined with keratinized stratified squamous epithelium.
- ☐- Deeper it is changed to nonkeratinized epithelium then respiratory epithelium
- It contains sebaceous and sweat glands, and thick short hair (vibrissae) that filter out large particles from the inspired air.

2- Nasal fossae

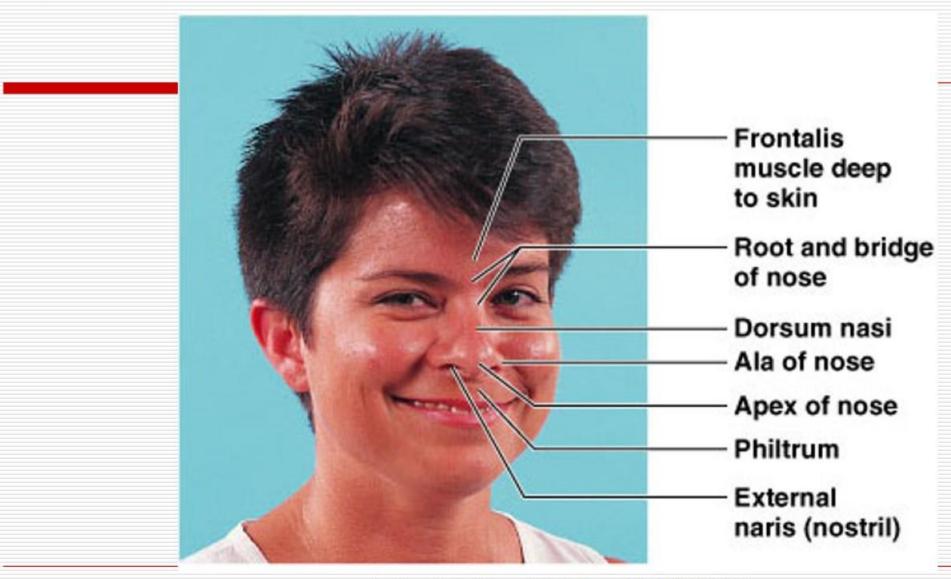
- It is the posterior chamber of the nasal cavity.
- □- Three bony projections known as conchae (inferior, middle and superior) extend from each lateral wall.



- □- The superior conchae, roof of the nasal fossae and upper part of the nasal septum are covered by olfactory epithelium. This part is called olfactory area.
- □- The lamina propria of the conchae contains large venous plexuses known as swell bodies that engorge with blood periodically, and alternately occlude one side of the nasal cavity.

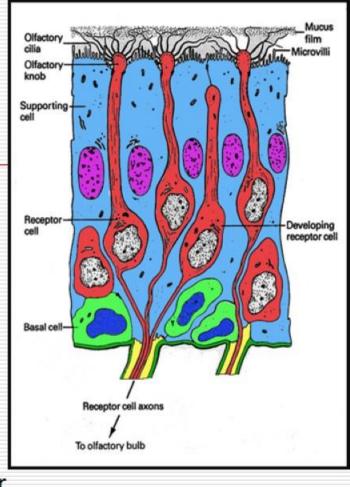


Structure of the Nose

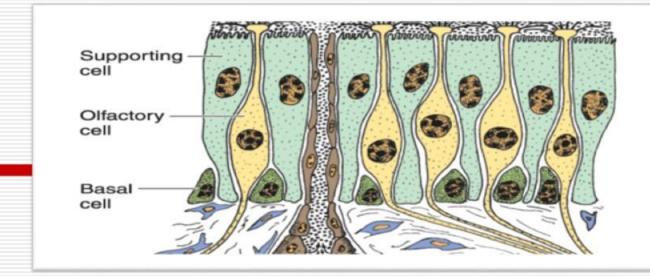


Olfactory epithelium

- The olfactory chemoreceptors are present in the olfactory epithelium covering the olfactory area.
- This is a pseudostratified columnar epithelium composed of 3 types of cells.
- 1- supporting cells:
- They are tall cells with apically located nuclei.
- The cell has microvilli on its apical surface.
- It contains a yellow pigment that gives the epithelium its yellow color.
- 2. Basal cells
- They are short and rounded, located at the basal region
- They may act as undifferentiated stem cells or supporting cells



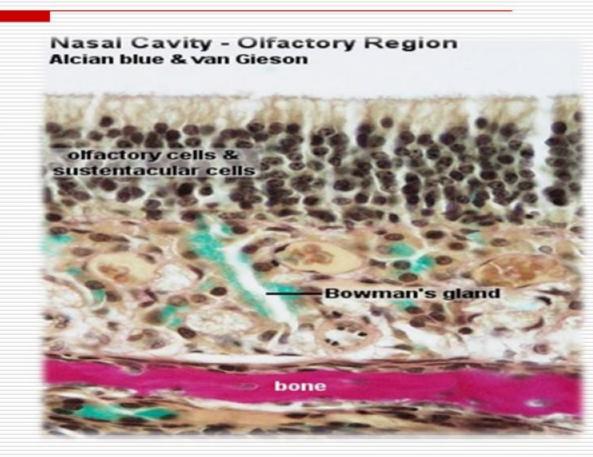
3- Olfactory cells



- They are bipolar nerve cells.
- The apical portion is a modified dendrite that ends in a bulb (the olfactory vesicle).
- This vesicle gives rise to long, immotile cilia (6-8). These cilia act as receptors.
- The afferent axons of these bipolar neurons unite in small bundles (*fila olfactoria*) which pass through the cribriform plate of the ethmoid bone forming olfactory nerve that enters the brain.
- The cilia of olfactory cells and the microvilli of supporting cells are submerged in a fluid layer consisting mainly of serous secretion of glands in the lamina propria called *Bowman's glands*.

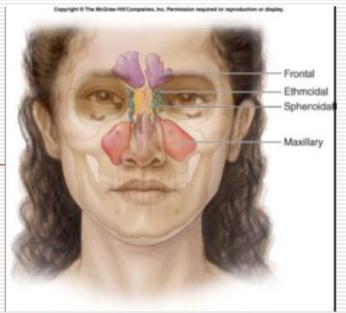
- Bowman's glands:

- Functions of Bowman's glands:
- □ 1- Clear the surface of the olfactory epithelium.
- □2- Serve as a solvent for odoriferous substances.



3- Para nasal sinuses

- They are blind cavities in the frontal, maxillary, ethmoid and sphenoid bones.
- They are lined by thin respiratory epithelium, with few goblet cells.
- The lamina propria is continuous with the underlying periosteum.
- They are connected with the nasal cavity by small openings through which their mucous is drained into the nasal passages.
- Function: Reduce weight of skull and modifies voice.



PHARYNX

Nasopharynx It can be divided into three regions: Oropharynx ☐ Nasopharynx, lined by respiratory epithelium Layngopharynx Oropharynx and laryngeal region lined by

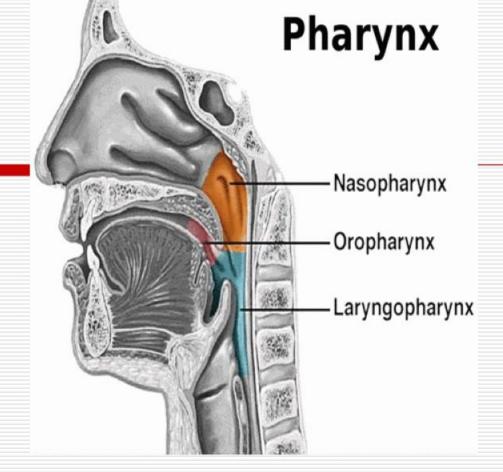
stratified squamous epithelium.

Lymphocytes frequently accumulate beneath the epithelium of the pharynx. Accumulations of lymphoid tissues surrounding the openings of the digestive and respiratory passages form the Tonsils.

Occipital

Cricoid cartilage **Nasal** cavity

Oral cavity

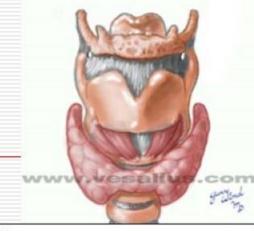


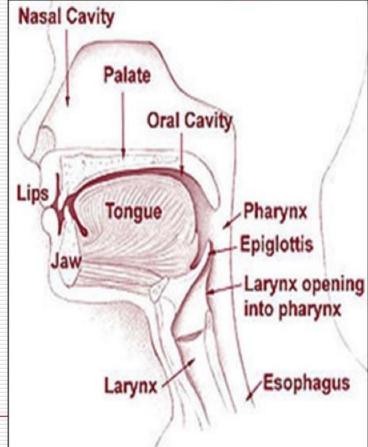
Functions

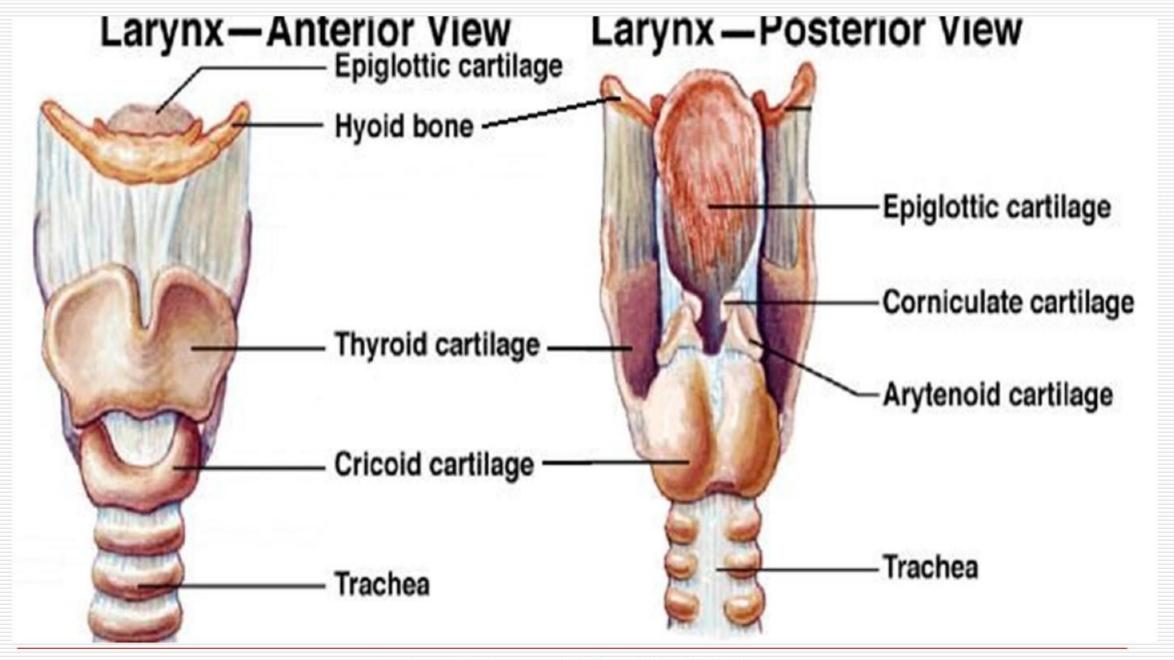
- 1- The pharynx moves food from the mouth to the esophagus.
- 2- It also moves air from the <u>nasal</u> and <u>oral</u> cavities to the <u>larynx</u>.
- 3- It is also used in human speech.

LARYNX

- It is an irregular tube that connects the pharynx to the trachea.
- ☐- Most of the larynx is covered by respiratory epithelium except parts of epiglottis and the true vocal cords.
- □-The lamina propria of the larynx contains seromucous glands and plates of cartilage.
 - Large hyaline cartilages (thyroid, cricoid and most of arytenoids).
 - Smaller elastic cartilages (epiglottis, cuneiform, corniculate and the tips of arytenoids).
- □- These cartilages are bound together by ligaments and the intrinsic muscles of the larynx (striated skeletal muscles).

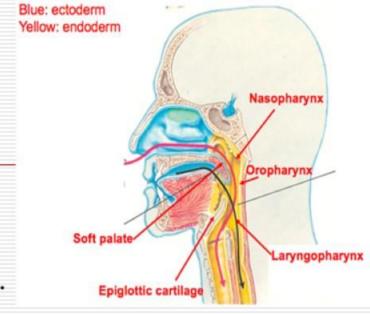






The epiglottis

☐- The larynx includes *the epiglottis* which is a valve like structure preventing food from entering the respiratory passages.

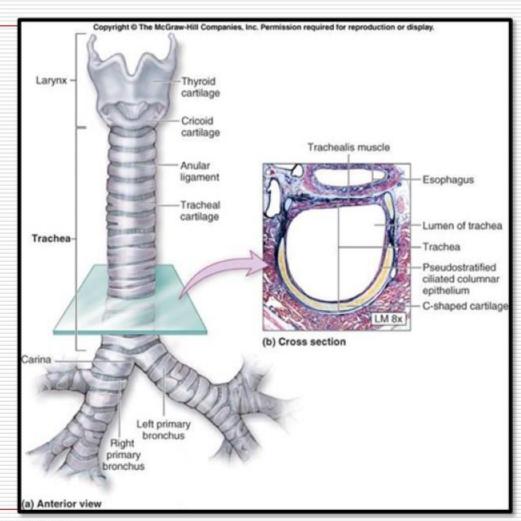


- The epiglottis has two surfaces, lingual (superior) and laryngeal (inferior).
- The lingual surface are covered with non keratinized stratified squamous epithelium.
- The rest of laryngeal surface is covered by respiratory epithelium.
- It is supported by elastic cartilage.

- Below the epiglottis the mucosa forms two pairs of folds that extend into the lumen.
 - The upper pair (False vocal cords) covered by respiratory epithelium.
 - The lower pair (True vocal cords) covered by stratified squamous epithelium. They contain the vocal ligaments. The vocal muscle (skeletal muscle) lies parallel to the ligament and regulates the tension of the fold and its ligament.
- Function: Besides being supplied by cartilages maintaining the airway open, the larynx is the organ of phonation.

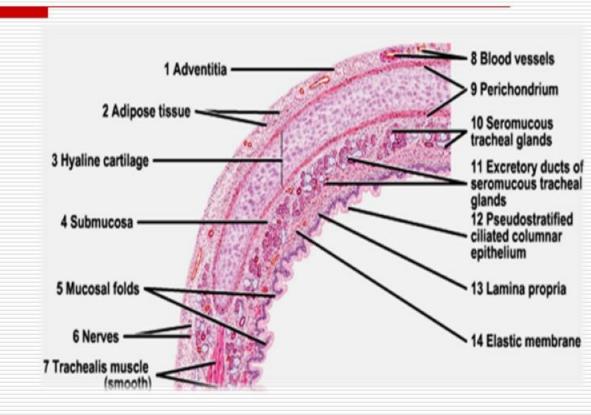
TRACHEA

- The trachea is a rigid tube about 10cm long.
- □- It extends from the base of the larynx to the upper part of the thorax where it bifurcates into right and left primary (main) bronchi.
- □- The wall is supported by 16-20 C-shaped rings of hyaline cartilage.
- The wall of the trachea consists of the following layers layers:



1- Mucosa

- a. Epithelium: respiratory epithelium (pseudostratified columnar ciliated with goblet cells).
- b. Lamina propria: of loose C.T
- c. Elastic membrane: separates the lamina propria from submucosa.

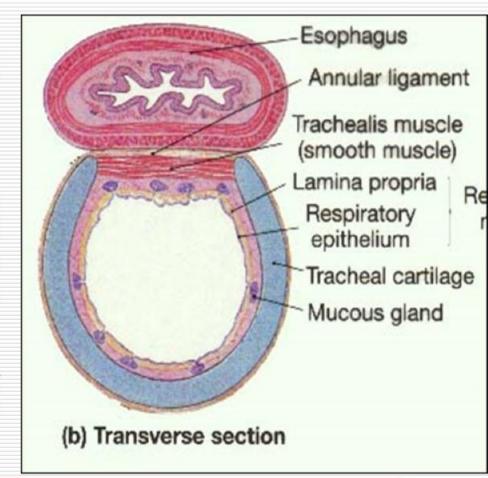


2. Submucosa

■ Loose C.T layer containing numerous seromucous glands & lymph follicles.

3. supportive layer (cartilage and muscle)

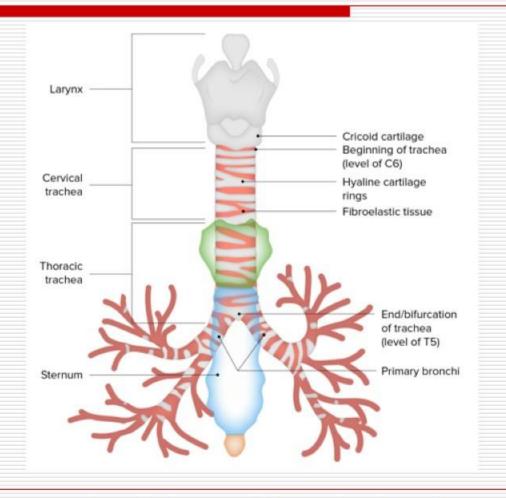
- It is the outer part which contains the C-shaped hyaline cartilage. The gap between the two ends of the C-shaped cartilage is completed by bundles of smooth muscle fibers (trachialis muscle). It is transversely oriented to regulate the lumen.
- Contraction of trachealis muscle in the cough reflex, leads to narrowing of the tracheal lumen which increase velocity of expired air and aids in cleaning the air passages.



4. Adventitia

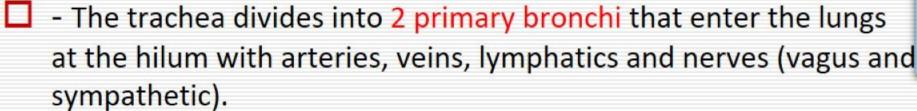
Thin CT layer that surrounds the trachea.

The cartilaginous rings are joined together by fibro elastic connective tissue which permits elongation of trachea during inhalation and enables the trachea to be extended when head titled back



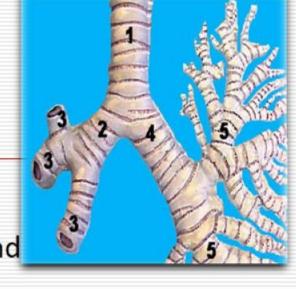
Dr. Mareb H. Ahmed, Histology, 23-30/10/2023

THE BRONCHIAL TREE

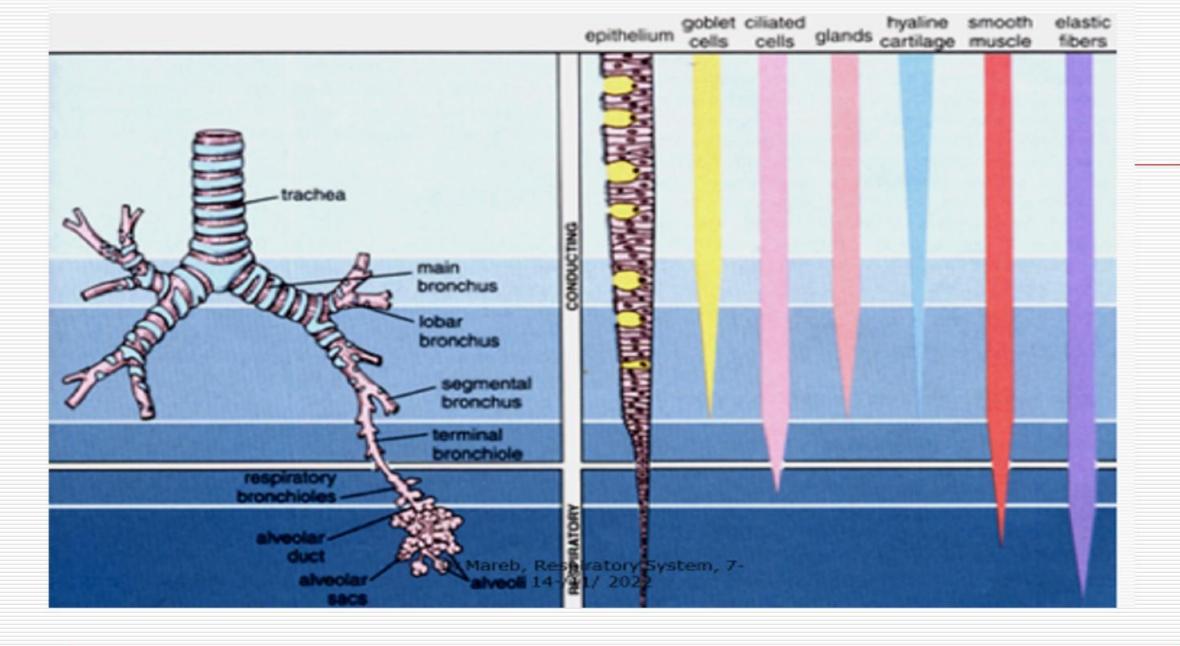


 In the lung, the primary bronchus divides into secondary (lobar) bronchi, each enter a lobe, three in the right lung and two in the left one.

- These lobar bronchi divide, giving rise to smaller bronchi and then bronchioles.
- Each bronchiole enters a pulmonary lobule where it branches to 5-7 terminal bronchioles.

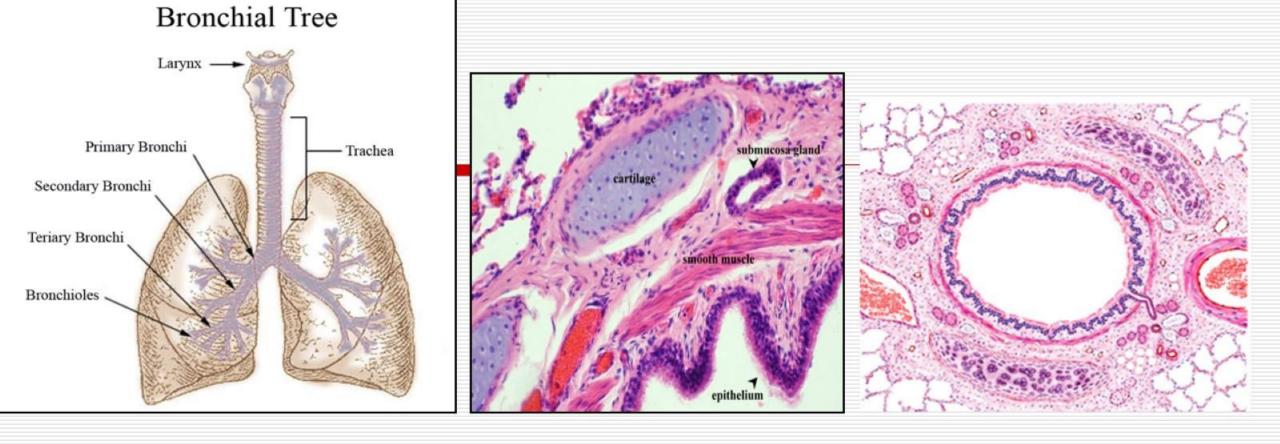


- Cricoid cartilage



BRONCHI

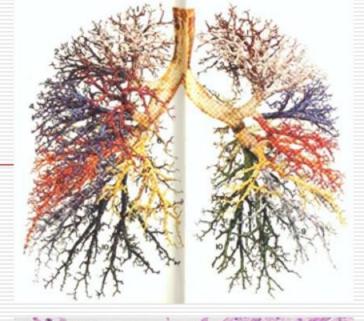
- ☐ The extrapulmonary primary bronchi have the same structure of the trachea.
- The intrapulmonary bronchi have some differences:
- The epithelium is pseudostratified columnar ciliated but with fewer goblet cells.
- A layer of smooth muscle fibers, separates between lamina propria and the underlying layer.
- 3. The C-shaped cartilage is replaced by irregular smaller cartilage plates.



□ Foreign particles are more likely to lodge in the ?????????? primary bronchus.

BRONCHIOLES

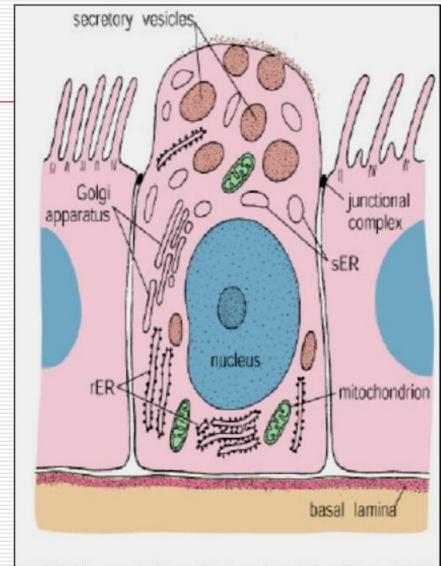
- It is a conducting tube of 5mm diameter or less.
- Their wall consists of:
- □ 1- Mucosa
- Epithelium is simple columnar ciliated
- Goblet cells gradually disappear, and are replaced in terminal bronchioles with Clara cells.





Clara cells

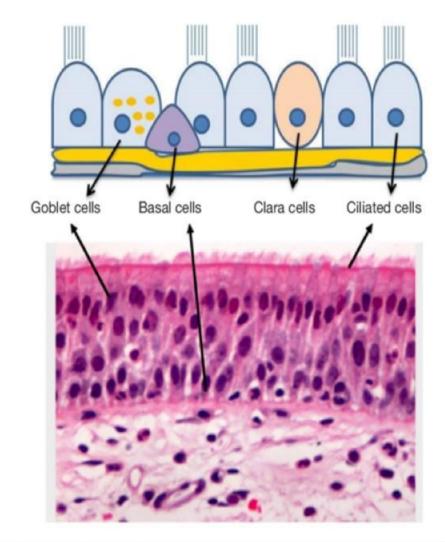
- Clara cells have no cilia and contain secretory granules in their apices. They secrete proteins that protect bronchiolar epithelium against oxidative pollutants and inflammation. They may produce surfactant-like material that reduces the surface tension keeping the bronchioles open.
- Lamina propria: contains many elastic fibers.
- 2- Muscle layer; is well developed and spirally arranged around the lumen.
- 3- Outer C.T layer; has no glands, no cartilage and no lymph follicles.

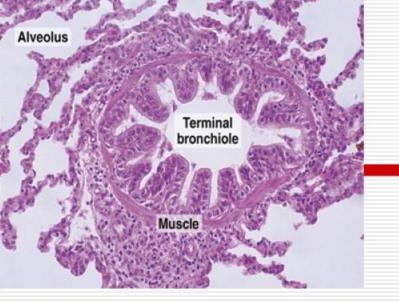


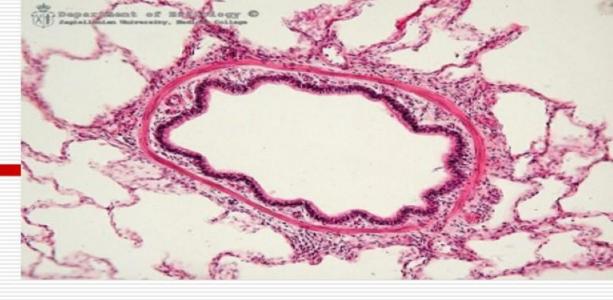
ure 18.12. Diagram of a Clara cell between bronchiolar ciliated epithelial

BRONCHUS BRONCHIOLE Smooth muscle

Cartilage plates



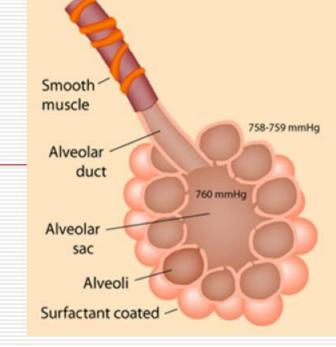


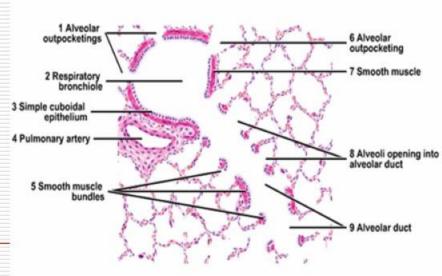


- The smooth muscle layers of bronchioles are controlled by the parasympathetic system.
- Normally the smooth muscle contract at the end of expiration &relax during inspiration.
- In persons suffering from asthma the Smooth muscle coat undergoes prolonged contraction during expiration ,thus they have difficulty in expelling air from lungs.

THE RESPIRATORY PORTION

- Each terminal bronchiole subdivides into two or more respiratory bronchioles, then into alveolar ducts, alveolar sacs and alveoli.
- Gaseous exchange occurs from the respiratory bronchioles to alveoli.

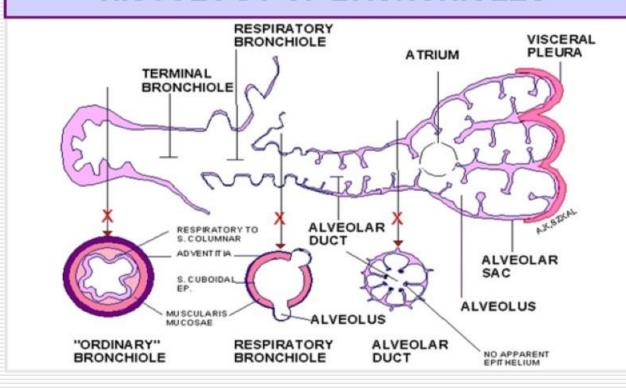




1- Respiratory bronchiole

- The respiratory bronchiole is structurally similar to terminal bronchiole except that its wall is interrupted by numerous alveoli.
- The epithelium is formed of ciliated cuboidal cells and Clara cells.
- Smooth muscle and elastic C.T support the wall of respiratory bronchiole.

HISTOLOGY OF BRONCHIOLES



2- Alveolar ducts and alveolar sacs

- Alveolar duct (thin walled tube) opens into a common chamber (atrium) which communicates with two or more alveolar sacs.
- Alveolar duct, alveolar sacs and alveoli are lined by very thin squamous alveolar cells.

3- Alveoli

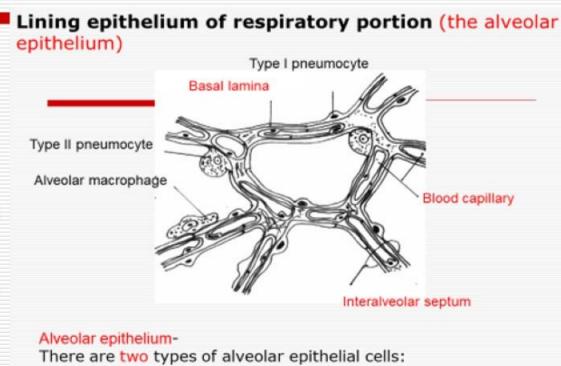
They are sac like evaginations of respiratory bronchioles, alveolar ducts & sacs containing air where gas exchange occurs.

Alveoli

- They are responsible for the spongy structure of the lung.
- The alveoli are lined by 2 types of cells called pneumocytes or alveolar cells.
- Their surface is covered by fluid called surfactant.
- ~ 300 million air sacs (alveoli).
 - Large surface area available for gas exchange exceeds (140 m²).

Lining epithelium of the respiratory portion:

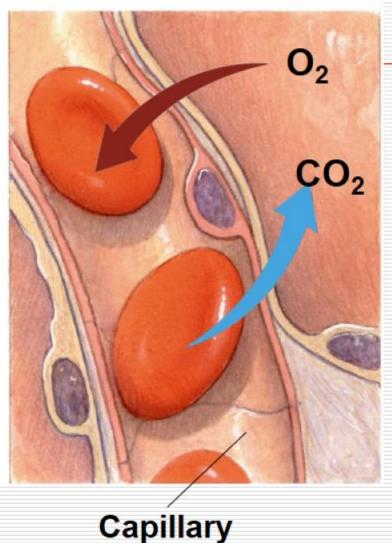
- ☐ There are 2 types of alveolar epithelial cells
- ☐ Type I pneumocyte (simple squamous cell)
 - It lines 97% of the alveolar surface.
 - The cell organelles are grouped around the nucleus.
 - The cytoplasm contains numerous pinocytotic vesicles.
 - It is responsible for gas exchange (O2 and CO2) between the air in the alveoli and blood in the capillaries.



Dr.Mareb, Respiratory System, 7-14-/11/ 2022

Gas Exchange

- Gas exchange takes place in the alveoli.
- Oxygen diffuses into the blood.
- Carbon dioxide in the blood diffuses into the alveolus.



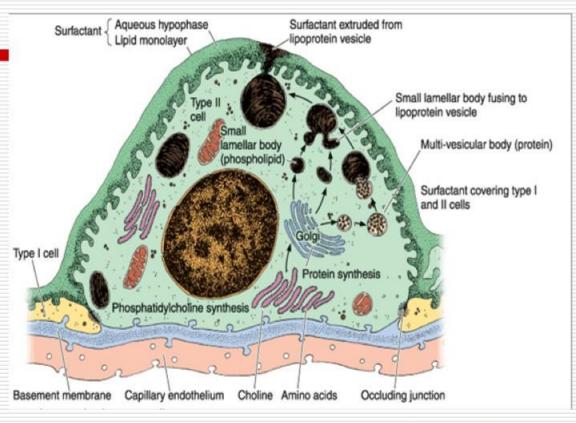
Capmai

Respiratory Bronchiole respiratory bronchiole respiratory bronchiole alveolus alveolar sac alveolar duct serous ciliated secretion clara cell cell alveolus alveolus basement membrane interstitium type I pneumocyte smooth type II pneumocyte free alveolar macrophage

Dr. Mareb H. Ahmed, Histology, 23-30/10/2023

Type II pneumocyte (secretory cell)

- It is found between type I cells.
- It covers only 3% of alveolar surface.
- It is a cuboidal cell with foamy cytoplasm, contains lamellar bodies.



They give rise to a surfactant material that spread over the surface of alveoli lowering the alveolar surface tension and thus preventing them from collapse.

Function of surfactant

- Lowers the alveolar surface tension, thus preventing them from collapse during expiration.
- Facilities inflation of alveoli in inspiration.
- Surfactant has some bactericidal effect, so it prevents bacterial invasion and clean the alveolar surface.

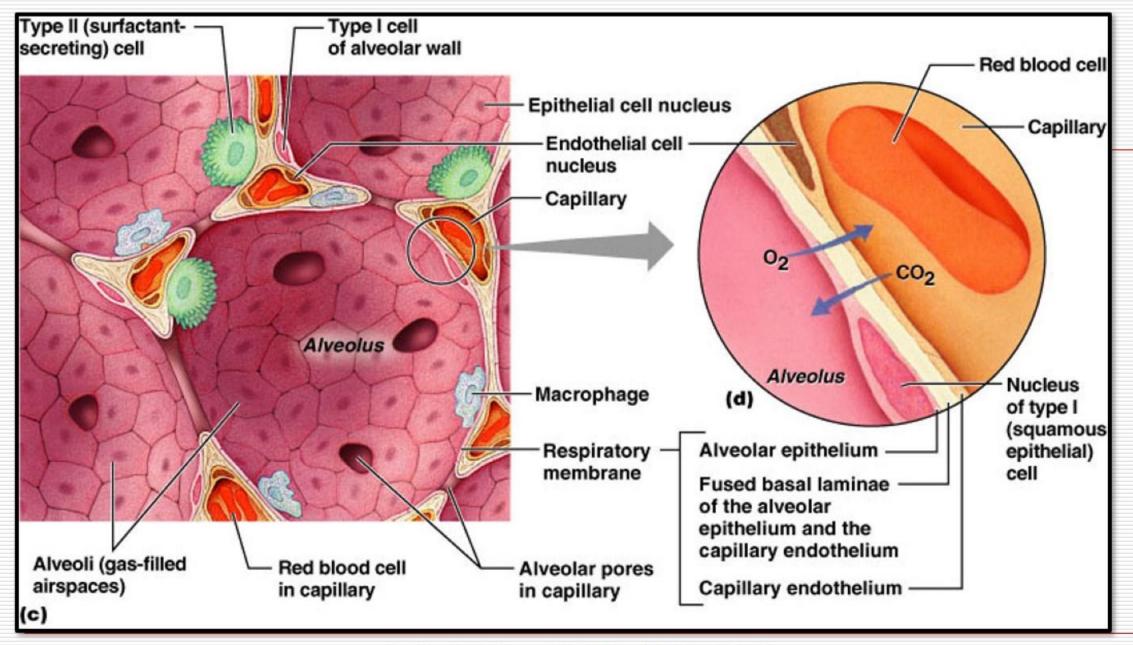
Type II alveolar cells act as stem cells, they divide and form the two types of cells lining the alveoli.

Respiratory distress syndrome Hyaline membrane disease:

- RDS was previously called hyaline membrane disease.
- In fetal development, surfactant appears in the last weeks of pregnancy.
- In infants born prematurely due to insuffient production of surfactant there is respiratory distress due to difficulty in expanding the alveoli.
- Surfactant synthesis can be induced by administration of glucocorticoids

Blood - air barrier

- Air in the alveoli is separated from blood in capillaries by:
- ☐ 1- The surfactant layer on the alveolar surface
- ☐ 2- The cytoplasm of the alveolar cells (type I).
- ☐ 3- The fused basal laminae of type I cell and endothelial cells of the capillary.
- ☐ 4- The cytoplasm of the endothelial cells.



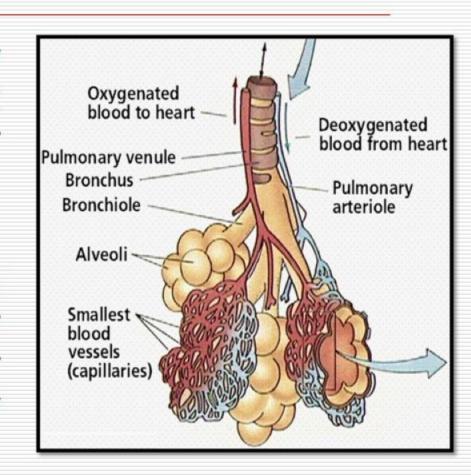
Dr. Mareb H. Ahmed, Histology, 23-30/10/2023

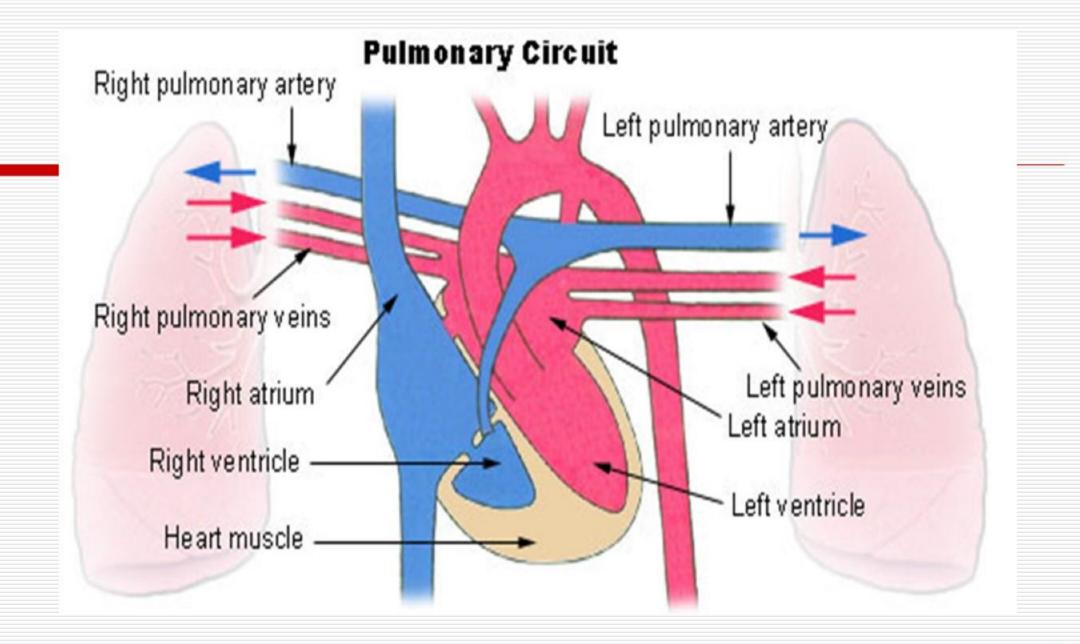
Pulmonary circulation

 The lung has two types of blood supply; **a.** Nutrient (bronchial) vessels: Bronchial arteries from aorta carry oxygenated blood and nutrients, follow the bronchial tree & supply the pleura, interlobular C.T and the wall of the bronchial tree up to the respiratory bronchiole. Bronchial veins carry the blood from lung to azygous vein.

b. Functional (pulmonary) vessels:

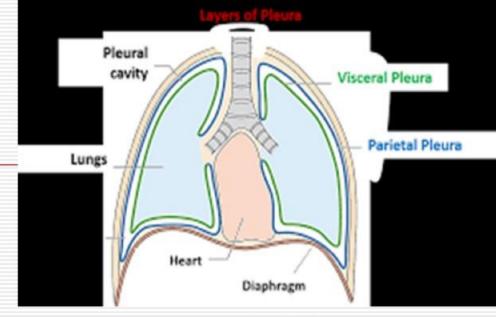
- Pulmonary arteries carry unoxygenated blood from right ventricle to the lung capillaries for oxygenation,
- Follow the branches of intersegmental bronchi as far as the respiratory bronchioles, branches to the alveolar ducts then give rise to capillary networks in the interalveolar septum.





Pleura

It is the serous membrane covering the lung.



- It consists of two layers; parietal and visceral which are continuous in the hilum.
- A cavity is present between the two layers and contains fluid that acts as a lubricating agent allowing smooth sliding of one surface over the other during respiration.
- Both membranes are composed of mesothelial cells resting on a fine connective tissue layer containing collagen and elastic fibers as well as few macrophages and fibroblast.



General Histology SECOND STAGE DENTISTRY DEPARTMENT

Epithelial Tissue 26-9-2023



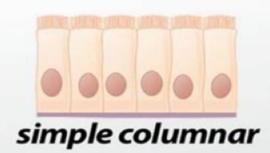


TYPES OF EPITHELIAL TISSUE

epithelial tissues

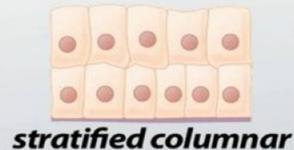
















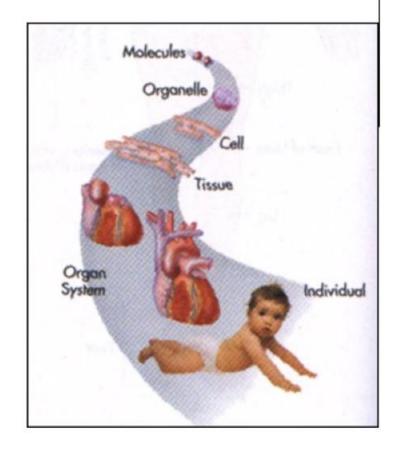






Tissues: groups of cells closely associated that have a similar structure and perform a related function

- Four types of tissue
 - Epithelial = covering
 - Connective = support
 - Muscle = movement
 - Nervous = control
- Most organs contain all 4 types







Epithelial Tissue General characters:

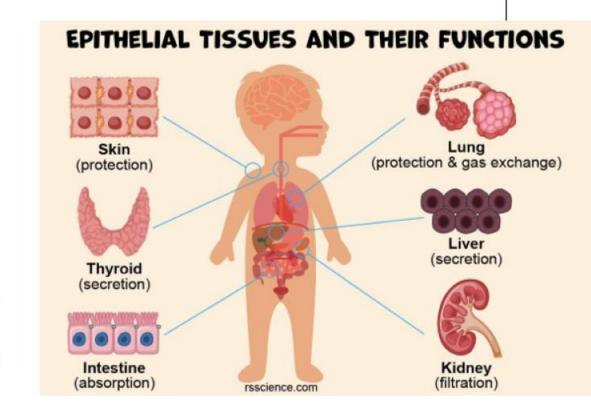
- It is formed of sheets of cells arranged in one or more layers with very little amount of intercellular substance.
- Basal region bound to a basement membrane
- Covers body surfaces like skin, lines hollow organs (Lining of digestive, respiratory and urogenital systems), and forms glands
- Avascular lack blood vessels and gets its nutririon by diffusion from the underlying connective tissue.
- Nerve fibers can pass in between the epithelial cells.
- Epithelial tissue cells are capable of renewal and regeneration by cell division





Functions of epithelial tissue:

- 1- Protection e.g. skin.
- 2- Absorption e.g. small intestine.
- 3- Secretion e.g. glandular epithelium.
- 4- Sensation e.g. neuroepithelium.
- 5- Contraction e.g. myoepithelium.







Types of epithelium

- I- Covering and lining epithelium.
- II- Glandular epithelium.
- III- Special epithelium.
- Germinal epithelium
- Neuroepithelium





I- Covering and Lining Epithelium

 Simple: just one layer or cell shape

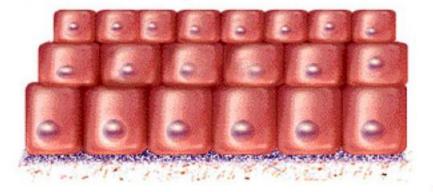
 Stratified: multiple layers and cell shapes





Basement membrane

Stratified epithelium

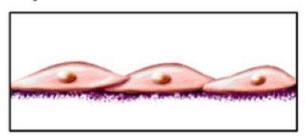




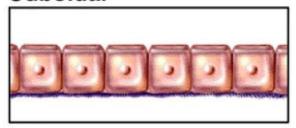


Types of simple epithelium according to the shape of cells:

Squamous



Cuboidal



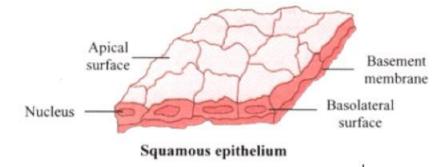
Columnar



Туре	Cell shape	Example
1- Squamous	Square	Endothelium (lines blood vessels), mesothelium (serous lining of celom)
2- Cuboidal	Cubic	Walls of glands
3- Columnar	Columns	Lining of gut tube; sometimes with cilia like lining of uterine tube
4 Pseudo- stratified	Flat cells give rise to columns	With cilia in respiratory tubes to move mucous/particles out of lungs







1-Simple Squamous Epithelium

It is formed of a single layer of flat cells with flat nucleii and rest on the basement membrane.

Sites: It lines the wall of the blood vessels and lymphatic vessels(endothelium), Lining the surface of the body cavities including the pericardial, pleural and peritoneal cavities (mesothelium), heart and alvoeli of the lung, Loop of Henle in the kidney

2-Simple Cubical Epithelium

It is formed of a single layer of cube-like cells with central rounded nuclei.

Sites: It is present in the thyroid follicles and lines the convoluted tubules of the kidney.





3-Simple Columnar Epithelium

It is formed of a single layer of tall columnar cells with basal oval nuclei. It may be:

- a- Simple columnar absorptive epithelium with brush border present in the intestine.
- b- Simple columnar secretory epithelium present in the stomach.
- c- Simple columnar ciliated epithelium present in the uterus, fallopian tube and bronchi of the lung. The surfaces of these cells are provided with cilia.

4-Pseudostratified Columnar Epithelium

It is formed of a single layer of cells. It gives the appearance of being stratified because some cells are tall while others are short not reach the surface. However all the cells are resting on the basement membrane. Can be ciliated and present in the respiratory passage as trachea and the non ciliated type is found in the large ducts of the glands.



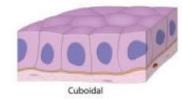


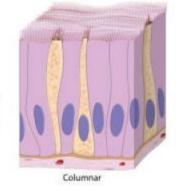
B- Stratified Epithelium

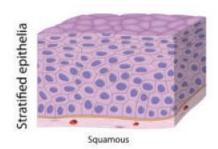
It is formed of many layers of cells in which the basal layer is columnar in shape and the intermediate layers are polyhedral cells. It is classified according to the shape of the most superficial cells into:

- 1- Stratified squamous epithelium.
- 2- Transitional epithelium.
- 3- Stratified columnar epithelium.
 - 4- Stratified cubical epithelium

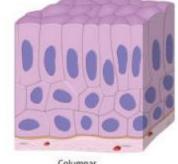








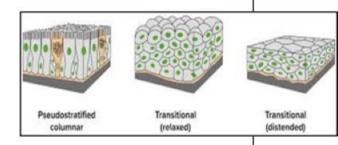






EW.

B- Stratified Epithelium



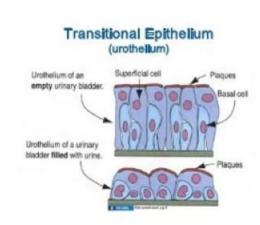
- 1-Stratified Squamous Epithelium
 - The superficial cells are flat squamous in shape. It is formed of two types:
- I) Keratinized: This type is covered with a layer of keratin and found in the skin.
- II) Non Keratinized: It is present in the oral cavity and oesophagus.
- 2- Stratified columnar epithelium

The most superficial cells are columnar in shape.

It is present in the ducts of the glands.







3-Stratified cubical epithelium

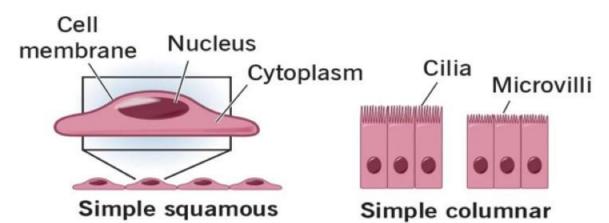
 It is formed of cuboidal cells arranged in 2-3 layers. It is present in ducts of sweat glands.

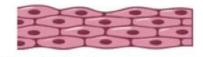
4- Transitional epithelium

- The most superficial cells are cuboidal or dome shaped with one or two nuclei. It is called transitional because the number of layers changed depending on whether the organ is contracted or distended. In contracted state (when the urinary bladder is empty) transitional epithelium has several layers (6-8 layers), When the bladder is full the epithelium has two or three layers.
- Site: it is present in the urinary system(renal pelvis, ureters, bladder)

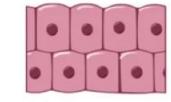


Epithelium

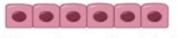




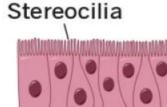
Stratified squamous



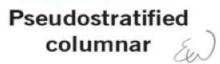
Stratified columnar



Simple cuboidal



Stratified cuboidal



Transitional







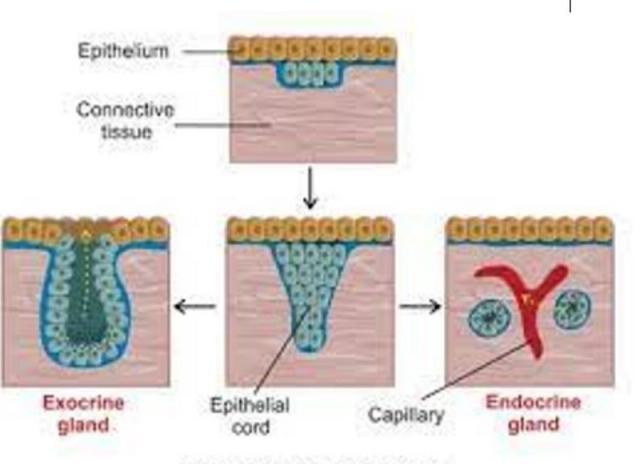
On the basis of number of cell layers the epithelial tissue classified as 2 types Simple epithelium **SQUAMOUS EPITHELIUM** Compound epithelium **CUBOIDAL EPITHELIUM COLUMNAR EPITHELIUM** TISSUE SIMPLE EPITHELIUM **PSEUDOSTRATIFIED EPITHELIUM** EPITHELIAL STRATIFIED SQUAMOUS STRATIFIED EPITHELIUM STRATIFIED CUBOIDAL **COMPOUND EPITHELIUM** TRANSITIONAL EPITHELIUM



Glands

 It is a special type of epithelium which is specialized in secretory function.

 Most glands are formed during development by proliferation of epithelial cells so that they project into the underlying connective tissue.



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Classifications

 1- Glands are classified according to the presence or absence of duct system into:

- a) Exocrine glands which have ducts to carry their secretion outside as salivary glands and sweat glands.
- b) Endocrine glands which have no ducts. They secret hormones directly in the blood as thyroid gland.
- c) Mixed glands: which have exocrine and endocrine functions as pancreas.

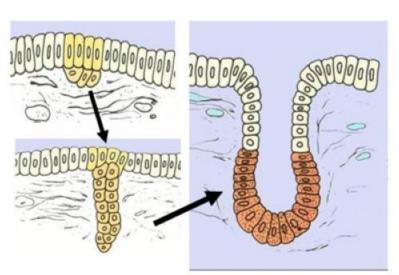


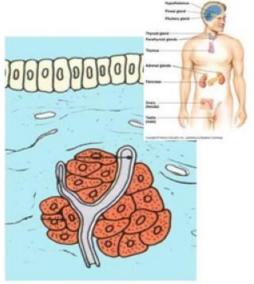


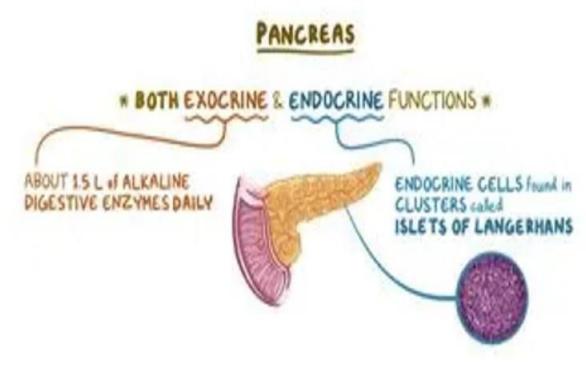
GLANDULAR EPITHELIA

Secrete through ducts onto the surface of the gland

Endocrine glands
Release hormones into surrounding fluid (blood flow)









2-Exocrine glands are classified according to the number of cells into:

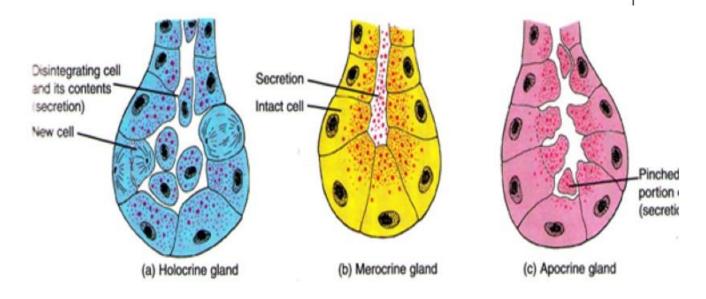
- a) Unicellular gland as goblet cell. Goblet cell is present in the respiratory and intestinal tract.
- b) Multicelluar glands as the salivary glands





3- Exocrine glands are classified according to the mode

of secretion into:



- a) Merocrine glands: product released through exocytosis as in salivary glands.
- b) Apocrine glands: In which the apical parts of the secretory cells of the glands are lost and come out with the secretion as in mammary glands.
- c) Holocrine glands: In which the whole secretory cells are destroyed and come
 out with the secretion as in sebaceous glands.



4- Exocrine glands are classified according to the kind of secretion into:

- a) Serous gland as parotid gland. The secretion is watery fluid.
- b) Mucus glands as goblet cell. The secretion is viscid mucus secretion.
- c) Mixed glands (seromucus) as submandibular glands.
- d) Fatty secretory glands as sebaceous glands.
- e) Watery secretory glands as sweat glands.





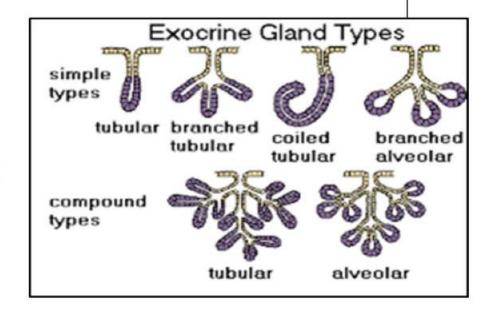
5- Exocrine glands are classified according to the shape of the duct system into:

- i) Simple glands if the ducts are not branched.
 - ii) Branched glands if the ducts gives branches.



6- According to the shape of the secretory part of the glands:

- I) <u>Tubular glands</u> if the secretory portion is tubular:
- a) Simple tubular glands as in intestinal glands.
- b) Simple coiled gland: e.g. sweet gland.
- c) Simple branched tubular glang: e.g. gastric gland.
- d) Compound tubular glands as in the liver.
- II) Alveolar(acinar glands)if the secretory portion is flask shaped:
- a) Simple avoelar glands as in sebaceous glands.
- b) Simple branched avoelar glands as in sebaceous glands
- c) Compound alveolar glands as in mammary glands.
- III) <u>Tubuloalvoelar glands</u> as in the salivary glands:
- a) Simple tubuloalveolar gland (rare type).
- b)Simple branched tubuloalveolar gland (glands of mouth cavity).

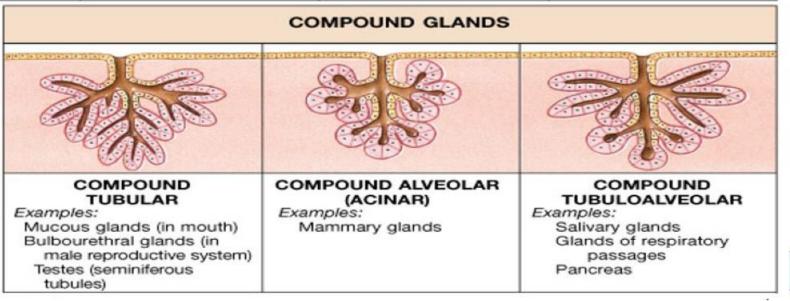






Structural Classification of Exocrine Glands

SIMPLE GLANDS Duct-Gland cells SIMPLE COILED SIMPLE BRANCHED SIMPLE ALVEOLAR SIMPLE BRANCHED SIMPLE TUBULAR (ACINAR) TUBULAR TUBULAR ALVEOLAR Examples: Examples: Examples: Examples: Examples: Gastric glands Not found in adult: a Intestinal glands Merocrine sweat Sebaceous (oil) Mucous glands stage in development (crypts of glands glands Lieberkühn) of esophagus, of simple branched tonque, duodenum glands







III- Special epithelium

- 1- **Neuroepithelium:** The epithelial cells are modified to receive sensory stimuli e.g. taste buds in the tongue, retina in the eye and olfactory mucosa in the nose.
- 2- **Germinal epithelium:** It is a specialized epithelium for reproduction.
 - In the testis and ovary.

Special types of epithelium

1-Neuroepithelium



(Taste buds: dorsal surface of the tongue)

