Blood

Consists of formed elements, erythrocytes, leukocytes, and platelets suspended in plasma

Hemopoiesis

• Blood cells constantly replaced in red marrow because of limited life span, the Common pluripotential stem cell forms pluripotential myeloid and lymphoid stem cells , Myeloid stem cells give rise to erythrocytes, eosinophils, neutrophils, basophils, monocytes, and megakaryocytes

• Lymphoid stem cells give rise to B lymphocytes and T lymphocytes, B and T lymphocytes reside in peripheral lymphoid tissue, lymph nodes, and spleen

Sites of Hemopoiesis

• In embryo, hemopoiesis takes place in yolk sac, liver, spleen, and lymph nodes

• In adult, hemopoiesis is limited to red bone marrow (skull, sternum, ribs, vertebrae, pelvis)

Formed Elements: Major Blood Cell Types

Erythrocytes

• Most numerous cells in blood ,and it is biconcave disc in shape

• Erythrocytes are no nucleated cells that remain in the blood

• Contain hemoglobin with iron molecules in cytoplasm

• Carry oxygen as oxyhemoglobin and carbon dioxide as carbaminohemoglobin

• Biconcave shape increases surface area to carry respiratory gases

• Life span is about 120 days, after which cells are phagocytosed in spleen, liver, and bone marrow

Platelets

• Are fragments of bone marrow megakaryocytes and not blood cells

• Function in blood vessels to promote blood clotting when blood vessel wall is damaged

• In damaged vessels form plug; increase plug size through adhesive glycoproteins and fibrin

• Fibrin traps platelets and blood cells, and forms blood clot

• Cause clot retraction and removal through enzymatic Leukocytes

• Granulocytes contain cytoplasmic granules; they are neutrophils, eosinophil, and basophils

• Agranulocytes are without cytoplasmic granules; they are monocytes and lymphocytes
Granulocytes

Neutrophils

• Cytoplasm appears clear under microscope

• Nucleus contains several lobes connected by thin chromatin strands

• Have a short life span in blood or connective tissue, from hours to days

• Are very active phagocytes that are attracted to foreign material by chemotactic factors

• Destroy phagocytosed (ingested) material with lysosomal enzymes

• Constitute about 60 to 70% of blood leukocytes

Eosinophils

• Cytoplasm filled with large pink or eosinophilic granules

• Nucleus typically bilobed

• Have a short life span, in blood or connective tissue

• Are phagocytic with affinity for antigen–antibody complexes

• Release chemical that neutralizes histamine and other mediators of inflammatory reactions

• Increase during parasitic infestation to destroy helminthic parasites

• Constitute about 2 to 4% of the blood leukocytes

Basophils

• Cytoplasm contains dark blue or brown granules

• Have a short life span

• Nucleus stains pale basophilic, but is normally obscured by dense cytoplasmic granules

• Granules contain histamine and heparin

• Exposure to allergens releases histamine that causes intense inflammatory response in severe allergic reactions

• Constitute less than 1% of blood leukocytes

Agranulocytes

Lymphocytes

• No granules in cytoplasm and vary in size from small to large

• Dense-staining nucleus surrounded by a narrow cytoplasmic rim

•Life span is from days to months

• Essential in immunologic defense of organism

• When exposed to specific antigens, B lymphocytes form plasma cells in connective tissue

• Plasma cells release antibodies to counteract or destroy invading organisms

• Constitute about 20 to 30% of blood leukocytes

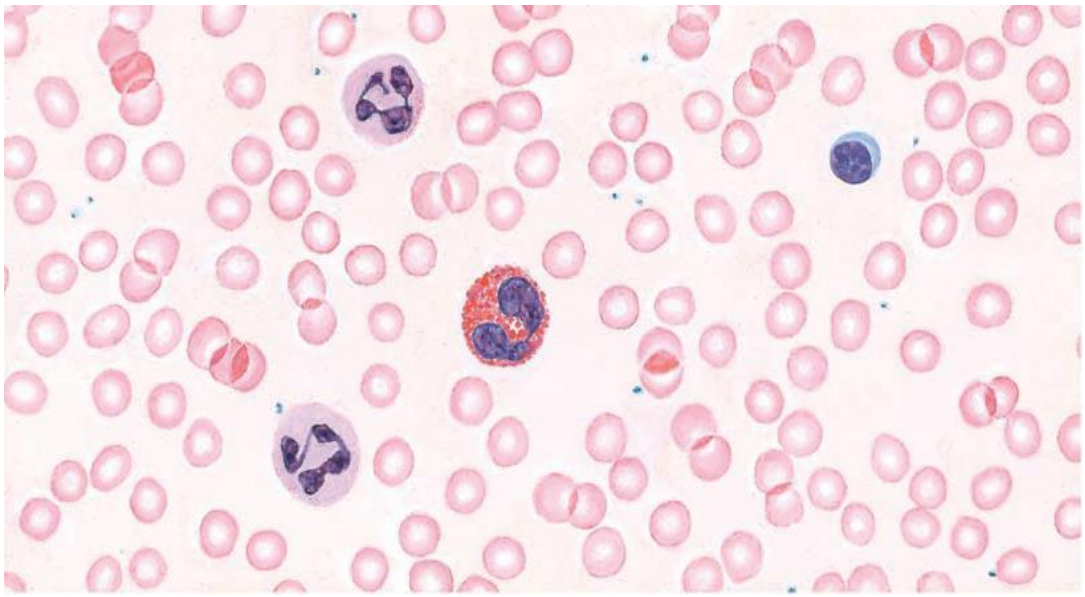
Monocytes

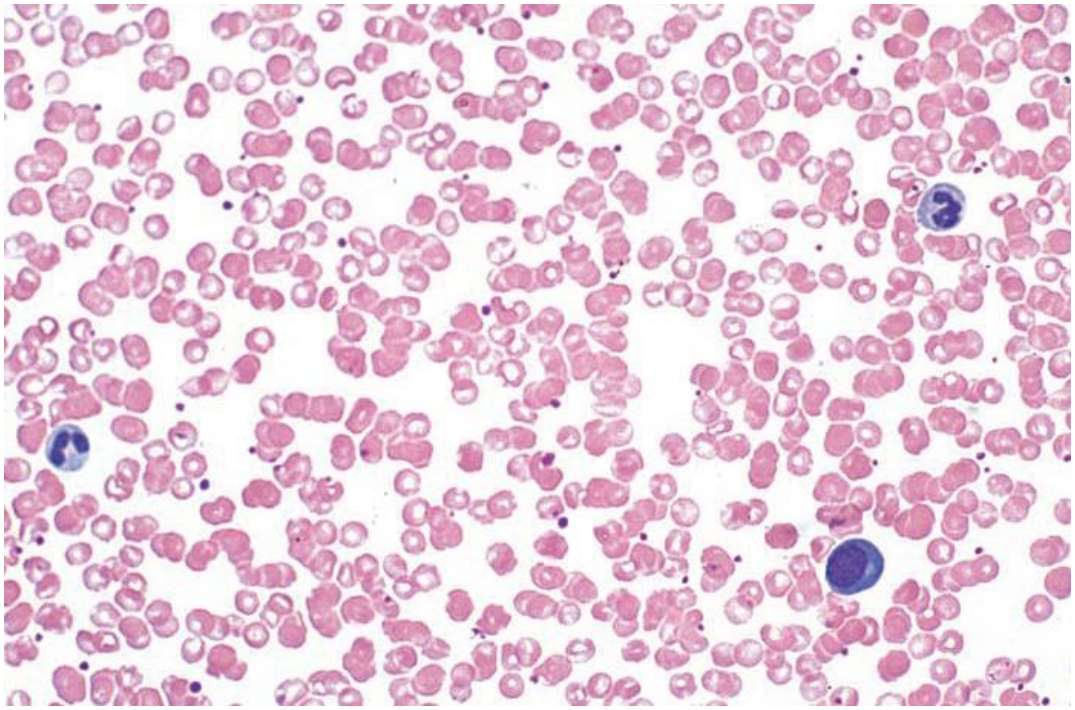
• Largest a granular leukocyte characterized primarily by horseshoe-shaped nucleus

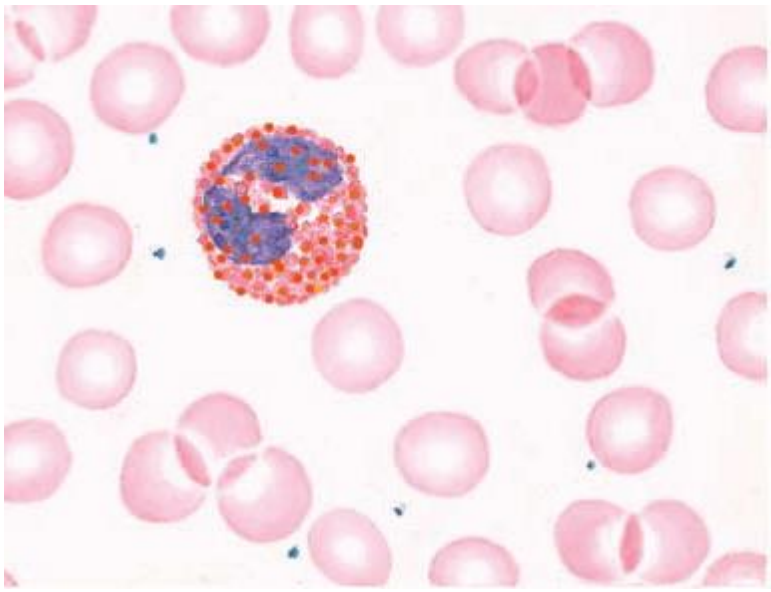
• Live in connective tissue for months where they become powerful phagocytes

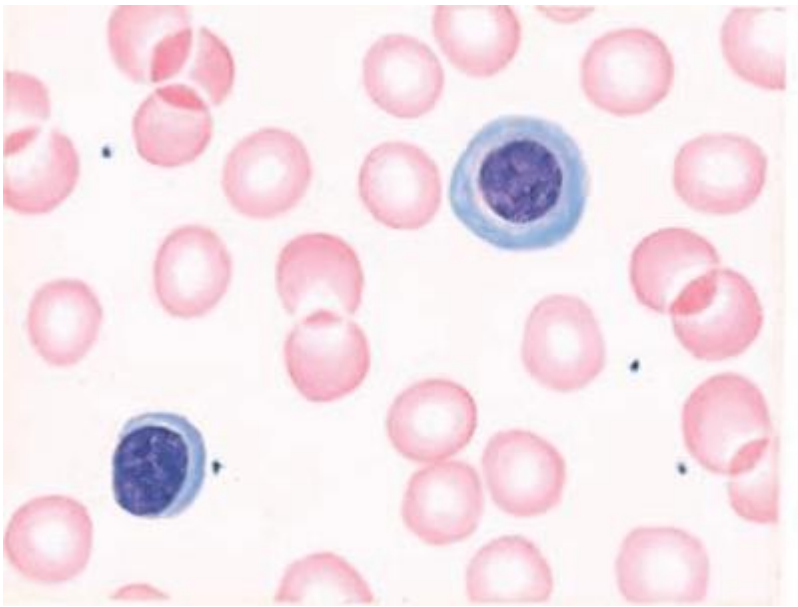
• Are part of the mononuclear phagocyte system

• Constitute about 3 to 8% of blood leukocytes









CONNECTIVE TISSUE

Connective tissue develops from mesenchyme, an embryonic type of tissue Embryonic connective tissu present in the umbilical cord and in the pulp of the developing teeth. With the exceptions of blood and connective tissue consists of:

A-Cells.

Each type of connective tissue has it own characteristic complement of one or more of a wide variety c Connective tissue cells can be subdivided into two major groups:

A-Resident cells: Are derived from mesenchyme and are continuously present in the tissue (e.g., fibrob adipocytes).

B-Migratory cells: Enter and leave the blood stream to migrate through and function in connective tissues (e.g., neutrophils and macrophages [monocytes]).

B-Extracellular matrix. Synthesized and secreted by resident "blast" cells specific for each connective tissue type (e.g., fibroblasts and chondroblasts); the matrix is composed of:

Fibers. Collagen, elastic and reticular

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

Reticular fibers, consist mainly of type III collagen, are thin and form a delicate netlike framework in the liver, lymph nodes, spleen, hemopoietic organs, and other locations where blood and lymph are filtered. Reticular fibers also support capillaries, nerves, and muscle cells. These fibers become visible only when the tissue or organ is stained with silver stain.

Elastic Fibers

Elastic fibers are thin, small, branching fibers that allow stretch. They have less tensile strength than collagen fibers, and are composed of micro fibrils and the protein elastin. When stretched, Elastic fibers are found in abundance in the lungs, bladder, and skin. In the walls of the aorta and pulmonary trunk, the presence of elastic

2-**Ground substance**. The ground substance in connective tissue consists primarily of amorphous, transparent, and colorless extracellular matrix, which has the properties of a semifluid gel and a high water content. The matrix supports, surrounds, and binds all of the connective tissue cells and fibers.

The ground substance contains different types of mixed, unbranched polysaccharide chain. The semifluid consistency of the ground substance in the connective tissue facilitates diffusion of oxygen, electrolytes, nutrients, fluids, metabolites, and other water-soluble molecules between the cells and the blood vessels. Similarly, waste products from the cells diffuse through the ground substance back into the blood vessels. Also, because of its viscosity, the ground substance serves as an efficient barrier. The density of ground substance depends on the amount of extracellular tissue fluid or water that it contains

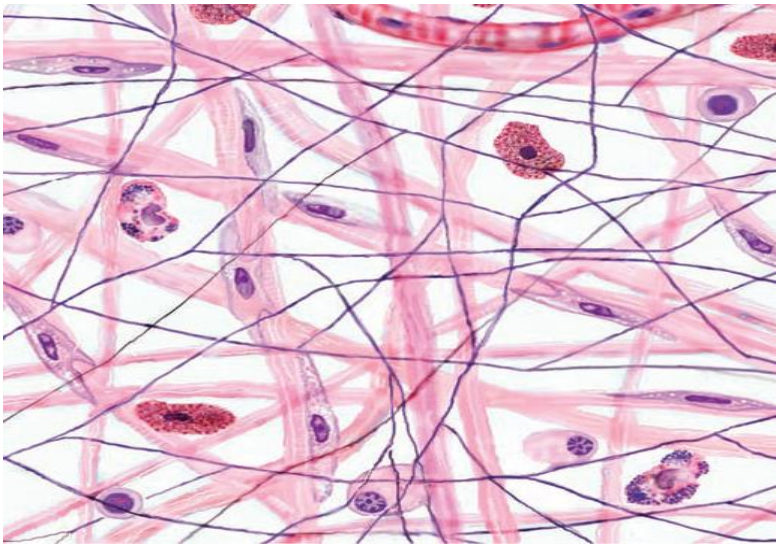
Types of connective tissues :

-**Loose Connective Tissue**

Loose connective tissue is more prevalent in the body than dense connective tissue. It is characterized

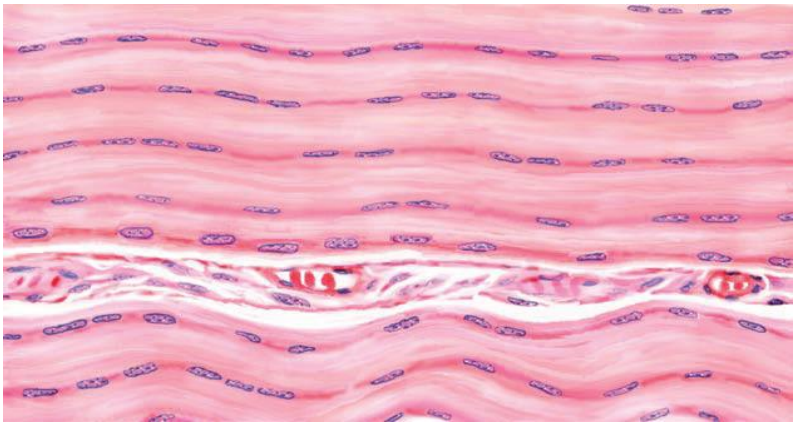
by a loose, irregular arrangement of connective tissue fibers and abundant ground substance.

Numerous connective tissue cells and fibers are found in the matrix. Collagen fibers, fibroblasts, adipose cells, mast cells, and macrophages predominate in loose connective tissue, with fibroblasts being the most common cell types. The overview figure shows the various types of cells and fibers that are present in the loose connective tissue.

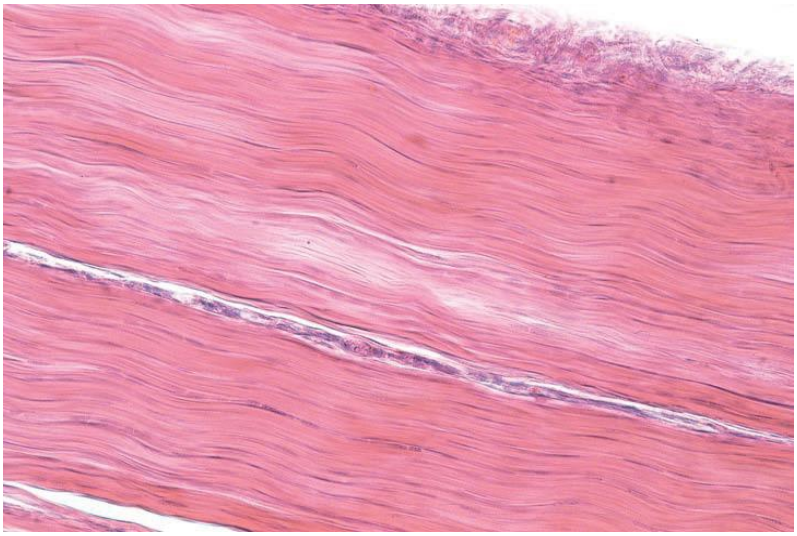


Dense Connective Tissue

In contrast, dense connective tissue contains thicker and more densely packed collagen fibers,with fewer cell types and less ground substance. The collagen fibers in dense irregular connective tissue exhibit a random and irregular orientation. Dense connective tissue is present in the dermis of skin, in capsules of different organs, and in areas that need strong support. In contrast, dense regular connective tissue contains densely packed collagen fibers that exhibit a regular and parallel arrangement. This type of tissue is found in the tendons and ligaments In both connective tissue types, fibroblasts are the most abundant cells, which are located between the dense collagen bundles.



Dense regular connective tissues (tendon)



(ligament)

CONNECTIVE TISSUES WITH SPECIAL PROPERTIES

1-Adipose connective tissue. Consists of accumulations of adipocytes that are partitioned into lobules by septa of connective tissue proper. Provides energy storage and insulation. The two distinct types of adipose tissues in the body are white adipose tissue and brown adipose tissue. These adipose tissues represent the main sites of lipid storage and metabolism in the body.

Cells of the white adipose tissue are large and store lipids as a single large droplet. The lipids stored in adipose cells are primarily triglycerides. White adipose tissue exhibits a wider distribution than brown adipose tissue. White adipose tissue is distributed throughout the body, with the distribution pattern showing variations that are dependent on the sex and age of the individual.In addition to serving as an energy source, white adipose tissue provides insulation under the skin and forms cushioning fat pads around organs. Adipose tissue is also highly vascularized as a result of its high metabolic activity. The adipose cells also have receptors for insulin, glucocorticoids.

2- Blood and hematopoietic (blood-forming) tissues.

3-Elastic connective tissue. Regularly arranged elastic fibers or sheets (e.g., the vocal ligament).

4-Reticular connective tissue. A loosely arranged connective tissue whose fibers are reticular fibers. Forms the stroma of hematopoietic tissue (e.g., bone marrow) and lymphoid organs (e.g., lymph node and spleen).

5-Mucoid connective tissue. Embryonic connective tissue present in the umbilical cord.

Cartilage

Characteristics of Cartilage

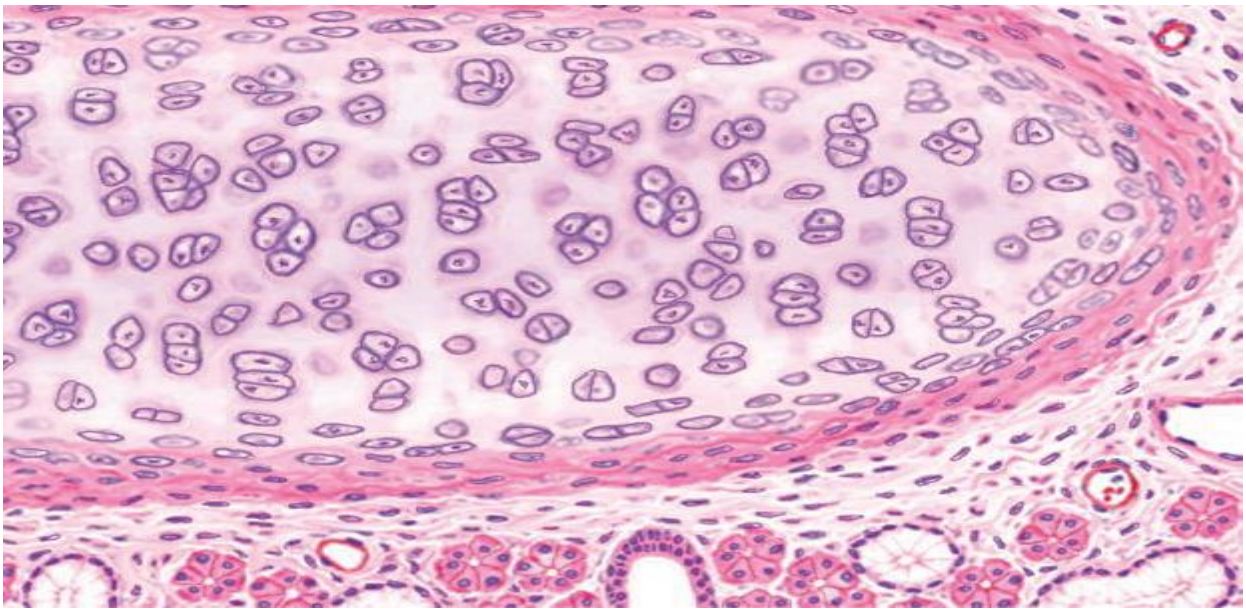
Cartilage is a special form of connective tissue that also develops from the mesenchyme. Similar to the connective tissue, cartilage consists of cells and extracellular matrix composed of connective tissue fibers and ground substance. In contrast to connective tissue, cartilage is nonvascular

(avascular) and receives its nutrition via diffusion through the extracellular matrix. Cartilage exhibits tensile strength, provides firm structural support for soft tissues, allows flexibility without distortion, and is resilient to compression. Cartilage consists mainly of cells called chondrocytes and chondroblasts that synthesize the extensive extracellular matrix. There are three main types of cartilage in the body: hyaline, elastic, and fibrocartilage. Their classification is based on the amount and types of connective tissue fibers that are present in the extracellular matrix.

Cartilage Types

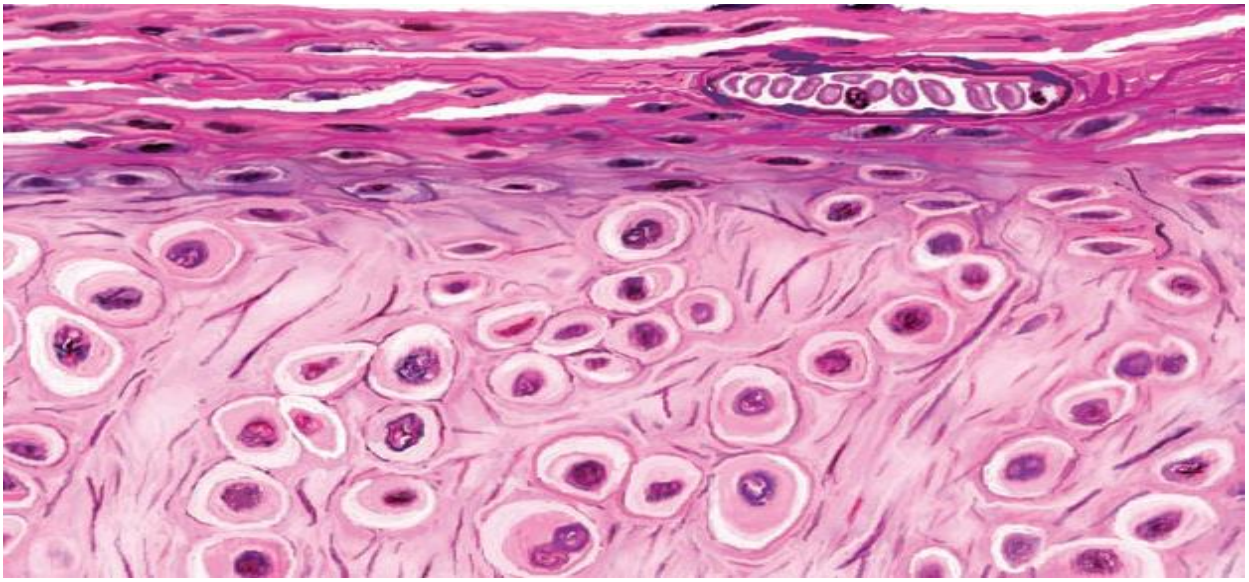
Hyaline Cartilage

Hyaline cartilage is the most common type. In embryos, hyaline cartilage serves as a skeletal model for most bones. As the individual grows, the cartilage bone model is gradually replaced with bone by a process called endochondral ossification. In adults, most of the hyaline cartilage model has been replaced with bone, except on the articular surfaces of bones, ends of ribs (costal cartilage), nose, larynx, trachea, and in bronchi. Here, the hyaline cartilage persists throughout life and does not calcify.



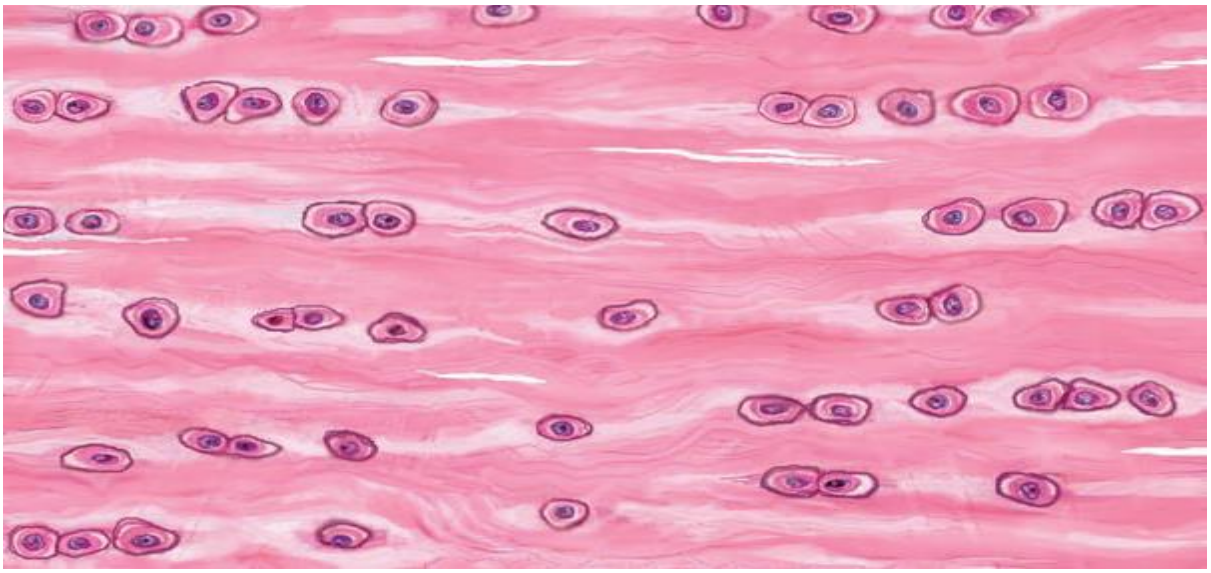
Elastic Cartilage

Elastic cartilage is similar in appearance to hyaline cartilage, except for the presence of numerous branching elastic fibers within its matrix. Elastic cartilage is highly flexible and occurs in the external ear, walls of the auditory tube, epiglottis, and larynx.



Fibrocartilage

Fibrocartilage is characterized by large amounts of irregular and dense bundles of coarse collagen fibers in its matrix. In contrast to hyaline and elastic cartilage, fibrocartilage consists of alternating layers of cartilage matrix and thick dense layers of type I collagen fibers. The collagen fibers normally orient themselves into the direction of functional stress. Fibrocartilage has a limited distribution in the body and is found in the intervertebral disks, symphysis pubis, and certain joints.



Perichondrium

Most of the hyaline and elastic cartilage is surrounded by a peripheral layer of vascularized, dense, irregular connective tissue called the perichondrium. Its outer fibrous layer contains type I collagen fibers and fibroblasts. The inner layer of perichondrium is cellular and chondrogenic.

Chondrogenic cells form the chondroblasts that secrete the cartilage matrix. the articulating surfaces of bones is not lined by perichondrium. Similarly, because fibrocartilage is always associated with dense connective tissue fibers, it does not exhibit an identifiable perichondrium.

Bone

Characteristics of Bone

Similar to cartilage, bone is also a special form of connective tissue and consists of cells, fibers, and extracellular matrix. Because of mineral deposition in the matrix, bones become calcified.

As a result, bones become hard and can bear more weight than cartilage, serve as a rigid skeleton

for the body, and provide attachment sites for muscles and organs.Bone also protects the brain in the skull, heart and lungs in the thorax, and urinary and reproductive organs between the pelvic bones. In addition, bones function in hemopoiesis (blood cell formation) and serve as crucial reservoirs for calcium, phosphate, and other minerals. Almost all (99%) of the calcium in the body is stored in bones, from which the body receives its daily calcium supply. The Process of Bone Formation (Ossification).

Bone development begins in the embryo by two distinct processes: endochondral ossification and

intramembranous ossification. Although the bones are produced by two different methods, they exhibit the same histologic structures.

Bone Types

Examination of bone in cross section shows two types, compact bone and cancellous (spongy)

bone . In long bones, the outer cylindrical part is the dense compact bone.

The inner surface of compact bone adjacent to the marrow cavity is the cancellous (spongy) bone.

Cancellous bone contains numerous interconnecting areas and is not dense; however, both types

of bone have the same microscopic appearance. In newborns, the marrow cavities of long bones are red and produce blood cells. In adults, the marrow cavities of long bones normally are yellow and filled with adipose (fat) cells.In compact bone, the collagen fibers are arranged in thin layers of bone called lamellae that are parallel to each other in the periphery of the bone, or concentrically arranged around a blood vessel. In a long bone, the outer circumferential lamellae are deep to the periosteum. Inner circumferential lamellae surround the bone marrow cavity. Concentric lamellae surround the canals with blood vessels, nerves, and loose connective tissue called the osteons (Haversian systems).

The space in the osteon that contains blood vessels and nerves is the central (Haversian) canal.Most of the compact bone consists of osteons. Lacunae with osteocytes and connected via canaliculi are found between the lamellae in each osteon.

Osteoblasts are present on the surfaces of bone. They synthesize, secrete, and deposit osteoid, the organic components of new bone matrix. Osteoid is uncalcified and does not contain any minerals; however, shortly after its deposition, it is rapidly mineralized and becomes bone.

Osteocytes are the mature form of osteoblasts and are the principal cells of the bone; they are also smaller then osteoblasts. Like the chondrocytes in cartilage, osteocytes are trapped by the surrounding bone matrix that was produced by osteoblasts. Osteocytes lie in the cavelike lacunae and are very close to a blood vessel. In contrast to cartilage, only one osteocyte is found in each lacuna. Also, because mineralized bone matrix is much harder than cartilage, nutrients and metabolites cannot freely diffuse through it to the osteocytes. Consequently, bone is very vascular and possesses a unique system of channels or tiny canals called canaliculi, which open into the osteons.

Osteocytes are branched cells. Their cytoplasmic extensions enter the canaliculi, radiate in all directions from each lacuna, and make contact with neighboring cells through gap junctions. These connections allow passage of ions and small molecules from cell to cell. The canaliculi contain extracellular fluid, and the gap junctions in the cytoplasmic extensions allow.

Process of Bone Formation

Endochondral Ossification

• In endochondral ossification, hyaline cartilage model calcifies and cells die.

• Mesenchyme cells in periosteum differentiate into osteoprogenitor cells and form osteoblasts.

• Osteoblasts synthesize osteoid matrix, which calcifies and traps osteoblasts in lacunae as osteocytes

• Osteocytes establish cell-to-cell communication via canaliculi.

• Primary ossification center forms in diaphysis and secondary center of ossification in epiphysis.

• Epiphyseal plate between diaphysis and epiphysis allows for growth in bone length.

• All cartilage is replaced except the articular cartilage.

Intramembranous Ossification

• Bone develops directly from osteoblasts that produce the osteoid matrix.

• Initially form spongy bone that consists of trabeculae.

• Mandible, maxilla, clavicle, and flat skull bones are formed by this process.

• Fontanelles in newborn skull represent areas where intramembranous ossification is occurring.

The cell

The concept of the cell was used firstly by Robert Hook at 1665 at the seventeenth century . it is believed that the cell membrane is the important part in the cell . then at 19 century Robert Brown was described the nucleus and named it . the recent cell theory : which said that the organism are made of cells and cell project this theory was included the plant and animal cell , so the cell is the structural and functional unit of the tissue and the cell is the smallest unit of living multicellular organism) . the animal cell define as : protoplasm surround by cell membrane . the plant cell define as : a protoplasm surround by cell membrane and cell wall made from cellulose . the protoplasm was divided into two component :

1- Nucleus 2- Cytoplasm

Each of them consist of many different organelles . the nucleus consist of :

1- chromatin material .
2- nuclear membrane .
3- nucleolus .
4- nucleic acid (DNA , RNA) .

The cytoplasmic organelles are specific organized living structure that function is the cell metabolism they found in all types of cell . the ***cytoplasmic organelles include*** :

1-Cell membrane , 2-Mitochondria , 3- Endoplasmic Reticulum (granular E.R , a granular E.R.) , 4- Lysosomes , 5- Centrosomes (central body , diplosome) , 6- Golgi system , 7- Ribosomes . 8- Cytoplasmic skeleton .

Cytoplasm inclusion : they are life less accumulation of some material after temporary in the cells .

the cytoplasm inclusion either product of cellular metabolism or exogenous substances so the cytoplasmic inclusion may be found in the cytoplasm or may not . they are Proteins , Carbohydrate , Pigmented granules , Secretary granules , Crystals .

1-Cell Membrane (plasma lemma) : It is flexible semipermiable . its thickness is about 75-100 A . this membrane regulate the interchange of materials between the cell and its environment . there are many theories to explain the structure of cell membrane but the traditional theory said (all cell membrane consist of trilamina components two of these layer are electron dence separated by an electron – lucent layer. the outer layer are made of phospholipids molecules while the inner layer (light layer) is made of fatty acid side chains . on the external layers (surface) of the cell membrane in animal cells there are many membrane of protein and some of lipid are conjugation with short chains of polysaccharide from glycoproteins and glycolipid which project from the surface of the cell formed outer cover of the cell called as glycogalx . which

provide mechanical and chemical protection . for the cell the function of the cell membrane are :
1- transport across the cell membrane which called selective osmoses .
2-engulfment .

2-Mitochondria :

The mitochondria (Mw) are found in all types of cells there number differ from one type of cell to another they are increase in number in the cell which have high metabolic activity such as liver cell , osteoclast , epithelium , of intestine . the Mw. are consist of two membrane space . the outer membrane is smooth sac like . while the inner one is projected in works as pala of tubules called cristae . the space between the fold is occupied by morface material called matrix . the chief function of Mw is to supply energy the oxidation of nutrient within the cell to provide energy from the synthesis of ATP from ADP .
The Mw have several unusual features which are :
1-the matrix contain strain of DNA arranged as a circle in manner .
2-the matrix contain the ribosomes which have also similar structure to the bacterial ribosomes .
3-the Mw under go self replication by process similar to bacterial cell diffusion . on these bases the Mw may be called as Simi-autonomous organ .

3-The Endoplasmic Reticulum :

1-*Granular E.R. (Rough E.R)*: this reticulum consist of three dimensional network of branching and anatomizing membrane bounded tubules and flattened sac like structure called *Cistrance* . the outer surface is contain ribosomes which account the term granular or rough E.R. this E.R. are well develop in protein secretory cells because both E.R. and ribosomes are involve protein synthesis .
2-*Agranular E.R. (Smooth E.R.)*: this reticulum is consist of three dimensional network of tubules and vesicles with out cistrance . this reticulum is found in cell that deal function including biosynthesis of lipids and then transport . also this reticulum has a role in cholesterol and steroid hormonesbiosynthesis and metabolism .

4-Ribosomes :they are small spherical part composite of 40-60% of RNA and the reminder protein . the ribosomes presented in long number of cells which secret protein . the ribosomes (R) found either single particles or clusters three in the cytoplasm or associated with E.R. the three R. synthesis protein to use intercellular while the R. associated with E.R. synthesis protein and use for secret out side of the cell .

5-Golgi apparatus : this organelles is consisting of different numbers of flatten sacs aggregated like plates or cups . at the periphery of the sac there are golgi cisternea . Golgi (G) found near the nucleus and it is very well develop in secretory cell and its appearance differs depend on the cell type and activity .

the function of Golgi apparatus is a source of membrane unit for the to the cells and also provide membrane unit for the packaging or branching the secretory granules .

6-Lysosomes(L) : they are small particles containing hydrolytic enzymes (about 12 or more enzymes) that break down proteins and nucleic acid and carbohydrate . the L. are found in large number in the cell which have phagocyte function such as the white blood cells and osteoclast . the L. are originated from golgi apparatus as small particles called *primary L*. the foreign particles which inter the cell by endocytosis . surrounded by membrane unit as phagosomes . when the primary L. come close content with phagosomes and these membrane fuse and the continent of two organelles mix . the new body called as *secondary L.* this body exposes the engulfed material to the L. enzymes . when digestion is complete the L. membrane rupture and discharge its contain to the cytoplasm and undigested material may remain within the membrane called *Residual body* . the L. also involve in the degradation of cellular organelles may of which have only a finite life spend therefore replaced this L. called *outophages* .

7-Sentrosome(S) : the S. is a zone in the cytoplasm usually centrally located near the nucleus .the S. contain a pair of sentrioles joint together and known as a*Diplosome* . the S. are perpendicular to each other and each S. is a hallow cylinder consist of 9 triplets of parallel readiness micro tubule . during the interphase stage the sentrioles replicate fore the next mitotic diffusion .at the prophase the two pair move to the apposite side of the cell but remain connected to each other by the micro lobules which called *the spindle* .

Dr.Naser AL-Rrubaie

Muscular Tissue

Muscle tissue is characterized by properties that allow movement. Muscle cells are excitable; they respond to a stimulus. They are contractile, meaning they can shorten and generate a pulling force. When attached between two movable objects, in other words, bones, contractions of the muscles cause the bones to move. Some muscle movement is voluntary, which means it is under conscious control. For example, a person decides to open a book and read a chapter on anatomy. Other movements are involuntary, meaning they are not under conscious control, such as the contraction of your pupil in bright light. Muscle tissue is classified into three types according to structure and function: skeletal, cardiac, and smooth.

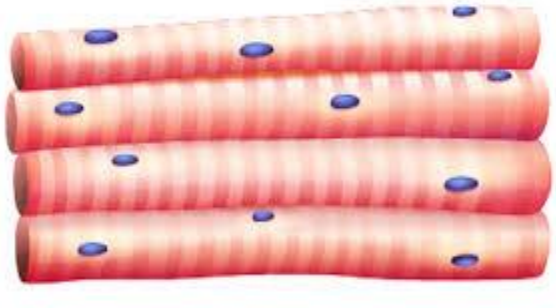
Comparison of Structure and Properties of Muscle Tissue Types (Table 1)

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

Skeletal muscle

is attached to bones and its contraction makes possible locomotion, facial expressions, posture, and other voluntary movements of the body. Forty percent of your body mass is made up of skeletal muscle. Skeletal muscles generate heat as a byproduct of their contraction and thus participate in thermal homeostasis. Shivering is an involuntary contraction of skeletal muscles in response to perceived lower than normal body

temperature. The muscle cell, or **myocyte**, develops from myoblasts derived from the mesoderm. Myocytes and their numbers remain relatively constant throughout life. Skeletal muscle tissue is arranged in bundles surrounded by connective tissue. Under the light microscope, muscle cells appear striated with many nuclei squeezed along the membranes. The striation is due to the regular alternation of the contractile proteins actin and myosin, along with the structural proteins that couple the contractile proteins to connective tissues. The cells are multinucleated as a result of the fusion of the many myoblasts that fuse to form each long muscle fiber.



Skeletal muscle

Cardiac muscle

forms the contractile walls of the heart. The cells of cardiac muscle, known as cardiomyocytes, also appear striated under the microscope. Unlike skeletal muscle fibers, cardiomyocytes are single cells typically with a single centrally located nucleus. A principal characteristic of cardiomyocytes is that they contract on their own intrinsic rhythms without any external stimulation. Cardiomyocyte attach to one another with specialized cell junctions called intercalated discs. Intercalated discs have both anchoring junctions and gap junctions. Attached cells form long, branching cardiac muscle fibers that are, essentially, a mechanical and electrochemical syncytium allowing the cells to synchronize their actions. The cardiac muscle pumps blood through the body and is under involuntary control. The attachment junctions hold adjacent cells together across the dynamic pressures changes of the cardiac cycle.

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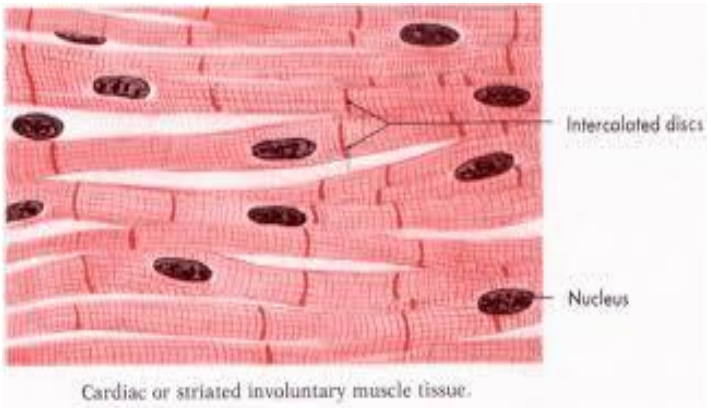
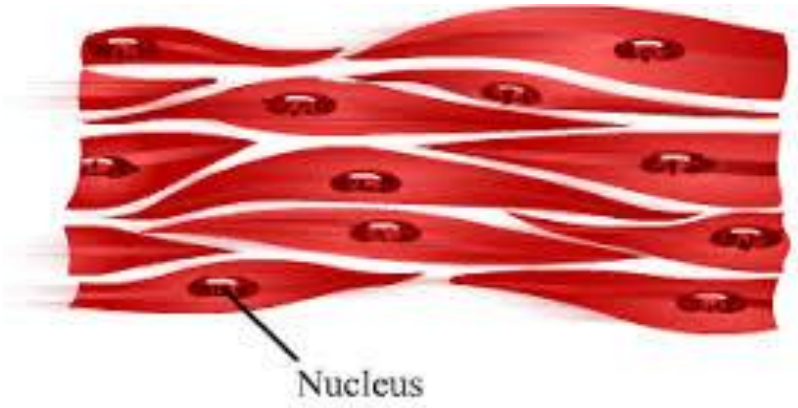


Cardiac or striated involuntary muscle tissue.

Smooth muscle tissue

contraction is responsible for involuntary movements in the internal organs. It forms the contractile component of the digestive, urinary, and reproductive systems as well as the airways and arteries. Each cell is spindle shaped with a single nucleus and no visible striations.



Smooth muscles

Epithelial Tissue

Location of Epithelium

The four basic tissue types in the body are the epithelial, connective, muscular, and nervous tissue. These tissues exist and function in close association with one another.

The epithelial tissue, or epithelium, consists of sheets of cells that cover the external surfaces of the body, line the internal cavities, form various organs and glands, and line their ducts.

Epithelial cells are in contact with each other, either in a single layer or multiple layers. The structure of lining epithelium, however, differs from organ to organ, depending on its location and function. For example, epithelium that covers the outer surfaces of the body and serves as a protective layer differs from the epithelium that lines the internal organs.

Classification of Epithelium

Epithelium is classified according to the number of cell layers and the morphology or structure of the surface cells. A basement membrane is a thin, noncellular region that separates the epithelium from the underlying connective tissue. This membrane is easily seen with a light microscope. An epithelium with a single layer of cells is simple, and that with numerous cell layers is stratified. A pseudostratified epithelium consists of a single layer of cells that attach to a basement membrane, but not all cells reach the surface. An epithelium with flat surface cells is called squamous.When the surface cells are round, or as tall as they are wide, the epithelium is cuboidal. When the cells are taller than they are wide, the epithelium is called columnar.

Epithelium is nonvascular, that is, it does not have blood vessels. Oxygen, nutrients, and metabolites diffuse from the blood vessels located in the underlying connective tissue to the epithelium.

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Types of Epithelia

Simple Epithelium

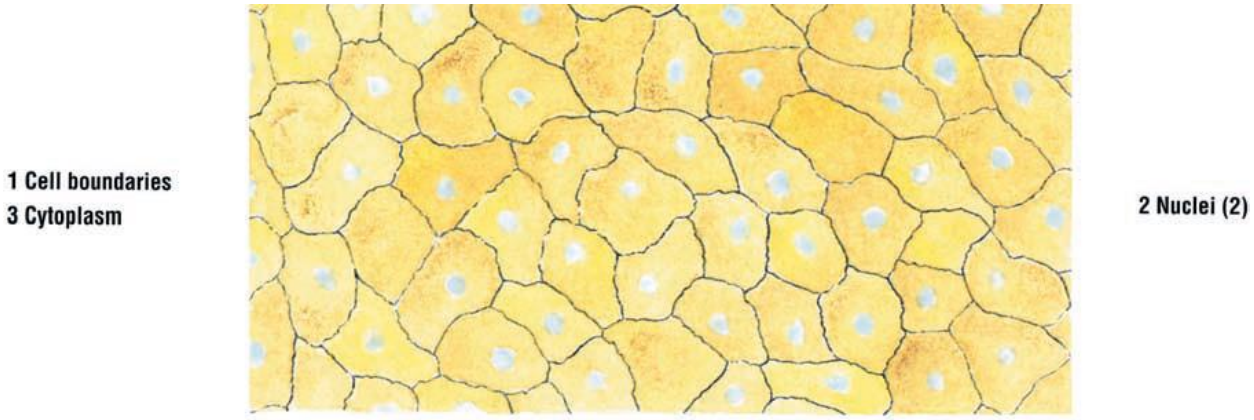
Simple squamous epithelium that covers the external surfaces of the digestive organs, lungs, and heart is called mesothelium. Simple squamous epithelium that covers the lumina of the heart chambers, blood vessles, and lymphatic vessels is called endothelium.

Simple cuboidal epithelium lines small excretory ducts in different organs. In the proximal convoluted tubules of the kidney, the apical surfaces of the simple cuboidal epithelium are lined with a brush border consisting of microvilli.

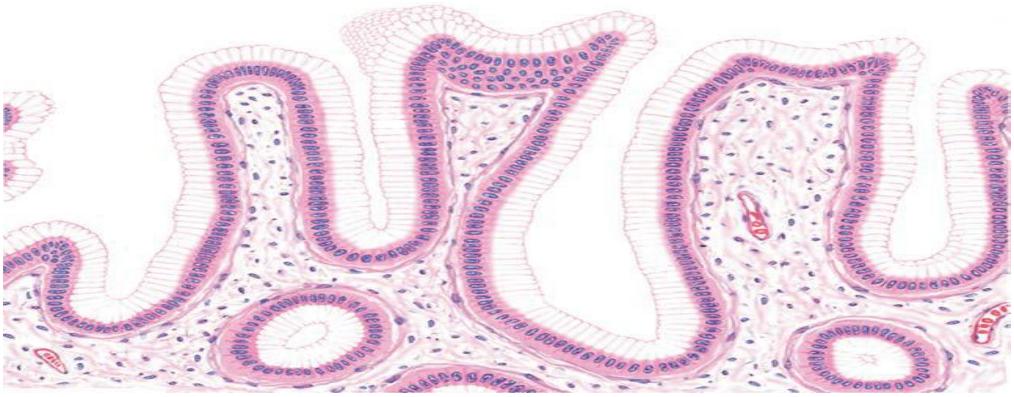
Simple columnar epithelium covers the digestive organs (stomach, small and large intestines, and gallbladder). In the small intestine, simple columnar absorptive cells that cover the villi also exhibit microvilli. Villi are fingerlike structures that project into the lumen of the small intestine. In the female reproductive tract, the simple columnar epithelium is lined with motile cilia.

Pseudostratified Columnar Epithelium

Pseudostratified columnar epithelium lines the respiratory passages and lumina of the epididymis and vas deferens. In trachea, bronchi, and larger brochioles, the surface cells exhibit motile cilia; in the epididymis and vas deferens, the surface cells exhibit nonmotile stereocilia, which are branched or modified microvilli.

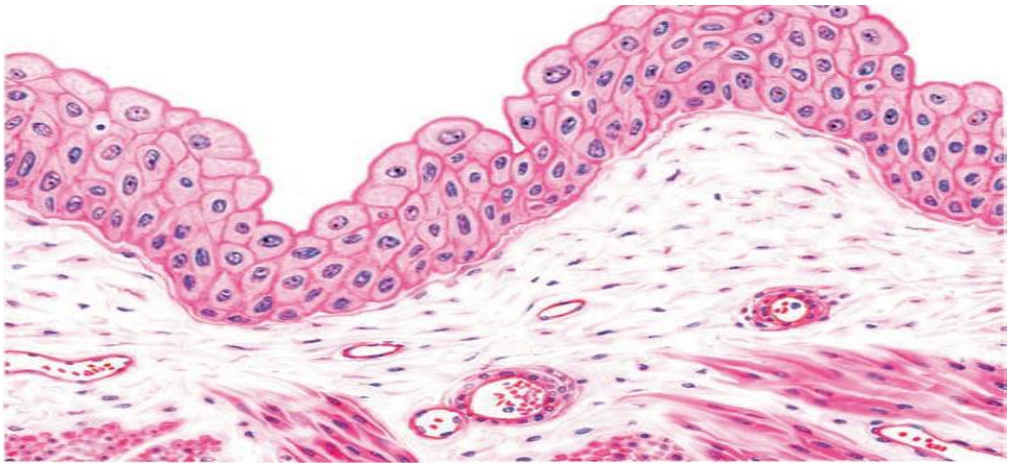


Simple squamous epithelium: surface view of peritoneal mesothelium. Stain: silver nitrate with hematoxylin. High magnification

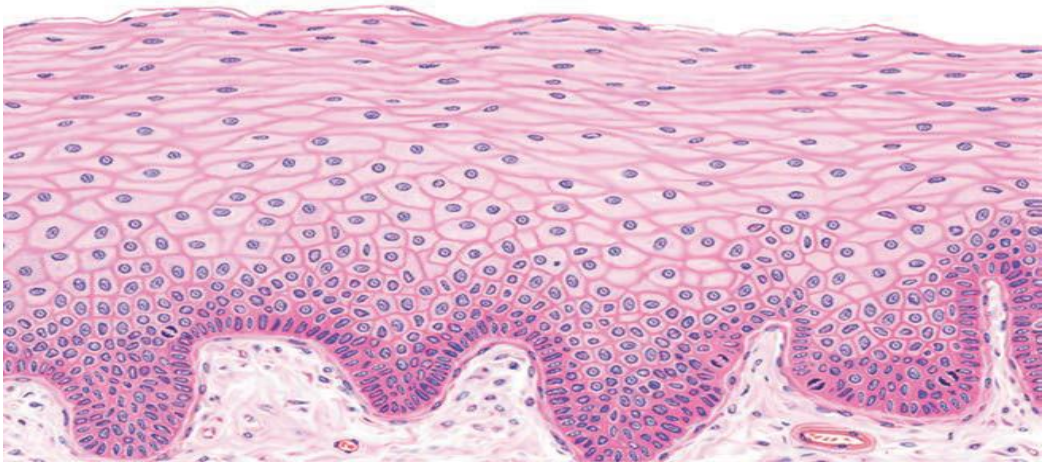


Simple columnar epithelium: surface of stomach

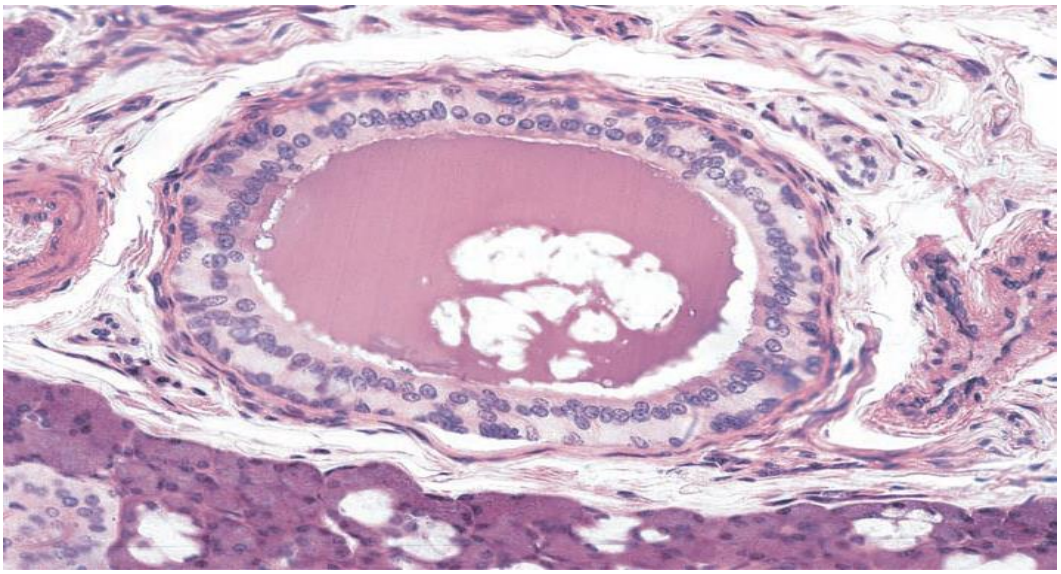
Pseudostratified columnar ciliated epithelium



Transitional epithelium: bladder (unstretched



Stratified squamous nonkeratinized epithelium



Stratified cuboidal epithelium

Stratified Epithelium

Stratified squamous epithelium contains multiple cell layers. The basal cells are cuboidal to

columnar; these cells give rise to cells that migrate toward the surface and become squamous.

There are two types of stratified squamous epithelia: nonkeratinized and keratinized.

Nonkeratinized epithelium exhibits live surface cells and covers moist cavities such as the mouth, pharynx, esophagus, vagina, and anal canal. Keratinized epithelium lines the external surfaces of the body.

Stratified cuboidal epithelium and stratified columnar epithelium have a limited distribution in the body. Both types of epithelia line the larger excretory ducts of the pancreas, salivary glands, and sweat glands. In these ducts, the epithelium exhibits two or more layers of cells. Transitional epithelium lines the minor and major calyxes, pelvis, ureter, and bladder of the urinary system. This type of epithelium changes shape and can resemble either stratified squamous or stratified cuboidal epithelia, depending on whether it is stretched or contracted. When transitional epithelium is contracted, the surface cells appear dome-shaped; when stretched, the epithelium appears squamous.

Function of the Epithelium :

• Protects ducts; transports and absorbs filtered material in kidney tubules

• Lines the lumina of digestive organs

• Secretes protective mucus for stomach lining

• Absorption of nutrients in small intestine

• In respiratory passages, ciliated cells clean inspired air and transport particulate matter across cell surfaces

• In female reproductive tract and efferent ducts of testes, ciliated cells transport oocytes and sperm across cell surfaces

• In epididymis and vas deferens, the lining stereocilia absorb testicular fluid

• Nonkeratinized squamous forms moist and protective layer in esophagus, vagina, and oral cavity

• Keratinized epithelium provides protection against abrasion, bacterial invasion, and desiccation

• Cuboidal epithelium provides protection for the duct

SURFACE SPECIALIZATIONS

Microvilli

1-Finger-like extensions from the free surface of the cell.

2-Are relatively non-motile

3-Increase surface area for absorption

4-Prominent on cells lining the digestive tract and proximal tubules in the kidney

Stereocilia

1-Large, non-motile

2-Increase surface area

3-Present on cells lining the epididymis and ductus deferens in the male reproductive tract

Cilia

1-Multiple hair-like extensions from free surface of the cell.

2-Highly motile.

3--Function to propel material along the surface of the epithelium (e.g., in the respiratory system and the oviduct of the female repro¬ductive system)

GLANDULAR EPITHELIAL TISSUES

GENERAL CONSIDERATIONS

1-Develop from or within a lining or covering epithelium.

2-Invaginate into the underlying connective tissue and remain attached to the lining epithelium

EXOCRINE VS. ENDOCRINE GLANDS

Major classification of glands, which is based on the method by which their secretory product is distributed

Exocrine glands

•Secretory products are released onto an external or internal epithe¬lial surface, either directly or via a duct or duct system.

Endocrine glands

•No ducts; secretory products are released directly into the extracellular fluid where they can affect adjacent cells or enter the bloodstream to influence cells throughout the body (endocrine secretion).

• Secretory products are called hormones.

CLASSIFICATION OF EXOCRINE GLANDS

1- Unicellular glands. Individual cells located within an epithelium, such as goblet cells that secrete mucus

2-Multicellular glands

Classification and types of multicellular glands

1-Simple tubular. (e.g., intestinal glands).

2-Simple, branched tubular. (e.g., fundic glands of stomach)

3-Simple, coiled tubular. Long unbranched duct; the secretory unit is a long coiled tube (e.g., sweat glands).

4-Simple, branched acinar (alveolar). Secretory units are branched and open into a single duct (e.g., sebaceous glands).

5-Compound tubular. Branching ducts with tubular secretory units (e.g., Brunner's gland of the duodenum)

6-Compound acinar (alveolar). Branching ducts with acinar secre¬tory units (e.g., parotid salivary gland)

7-Compound tubuloacinar (alveolar). Branching ducts with both tubular and acinar secretory units (e.g., submaxillary salivary gland)