

Tissues

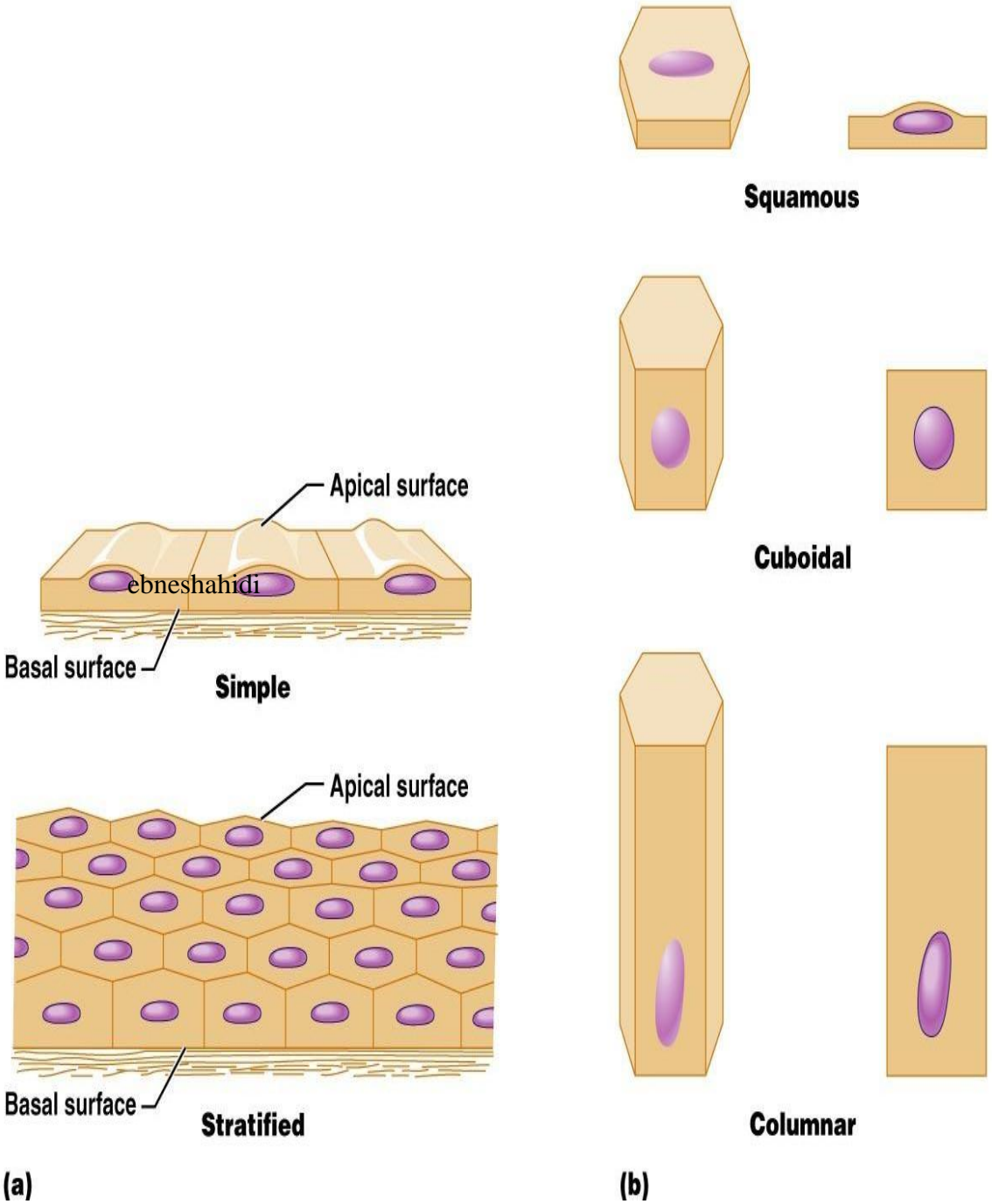
Tissues are composed of cells similar in structure and specialized to perform a specific function for the body.

- The human body is made of four general types of tissues.
 - **Epithelial tissues** – for lining body cavities, covering internal organs and large surfaces.
 - **Connective tissues** – for supporting and linking tissues or organs together; some are specialized to provide protection, to store fat, and even to provide circulatory function in the cardiovascular system.
 - **Muscle tissues** – for providing contraction and relaxation in the body surfaces, in the heart chambers , and in hollow organs such as blood vessels and the digestive tract.
 - **Nerve tissue** – for generating and transmitting electrical signals (nerve impulses) in the brain, spinal cord, and nerves.

Epithelial tissues (Epithelium)

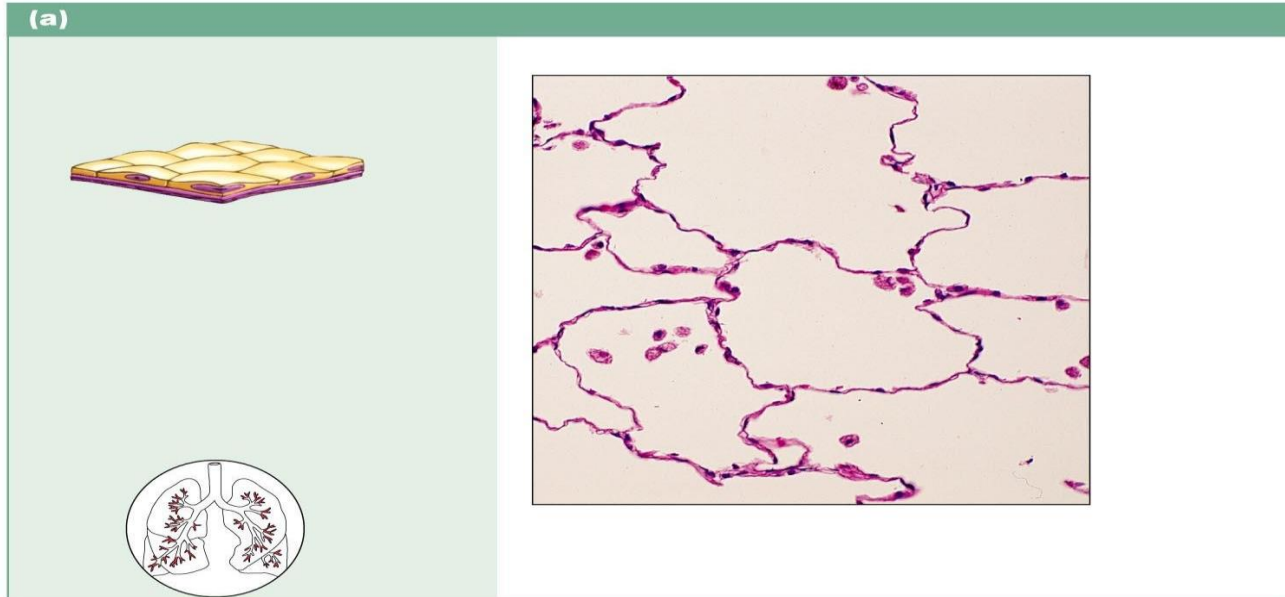
1. Covering of body surfaces and internal organs, and lining of body cavities.
2. Major tissue component of glands.
3. Always has a **free surface** (exposed to an open space) and a **basement membrane** (usually anchored to a connective tissue).
4. Lacks blood vessels , so nourishment comes from the underlying connective tissue by diffusion movement.
5. Other unique characteristics:
 - a. Reproduce rapidly.
 - b. Cells in epithelial tissues are often attached to one another by **desmosomes** which allow the tissue to serve as an excellent protective layer.

- c. The name is derived from the number of layer of cells ("simple" means a single layer while "stratified " means multiple layers) and the shape of cells ("squamous" means flattened , "cuboidal" means cube – shaped ,and "columnar" means elongated).



1. Simple squamous epithelium

- a single layer of thin , flattened cells.
- Found in areas where **diffusion** or **filtration** occurs.
- Examples – air sacs of lungs , kidney tubules , and capillary wall.
- Simple squamous epithelium lining blood vessels and heart is called endothelium.

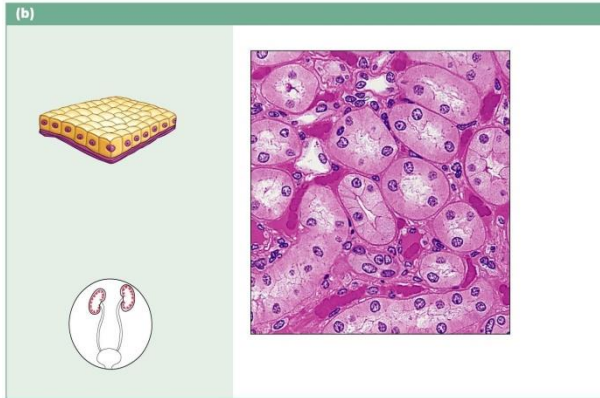


2. Simple cuboidal epithelium

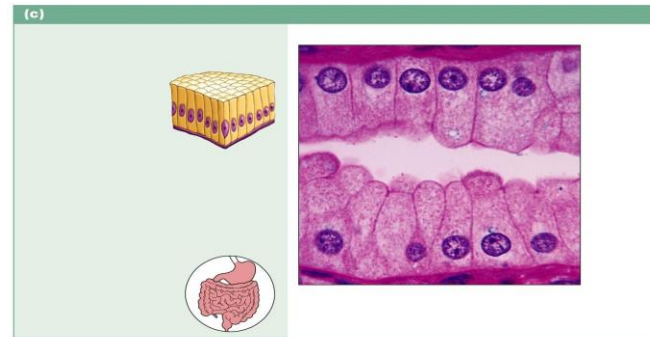
a single layer of cube – shaped cells .

Found in areas where **secretion** or **absorption** occurs.

Examples – kidney tubules, and ducts of glands



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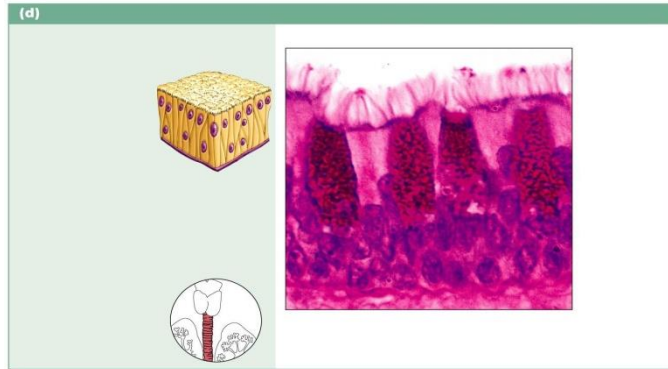
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3. Simple columnar epithelium

- a single layer of elongated cells.
- designed for **protection, secretion, or absorption.**
- examples – lining of uterus and small intestine.
- some columnar cells have finger – like projections called **microvilli** which are extension of the cell membrane for increasing the surface area in absorption.

4. Pseudostratified columnar epithelium

- a single layer of columnar cells that appears to be multiple – layered because of its multiple – layered nuclei .
- the cells have hair – like protein structure called **cilia** on the cell membrane to trap and expel foreign particles or bacteria, or they may be used to propel the egg cell in the uterine tubes.



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5. Stratified squamous epithelium

- many layers of flattened cells .
- cells at the bottom layers are the youngest and cuboidal – shaped, and will become flattened as they move upward to higher layers.
- Forms the epidermis (top skin layer), lining of oral cavity, throat, and vagina.

6. Stratified cuboidal epithelium

- 2-3 layers , cube shaped cells.
- Function: protection.
- Location : lining of larger ducts of sweat glands , salivary gourds and the pancreas.

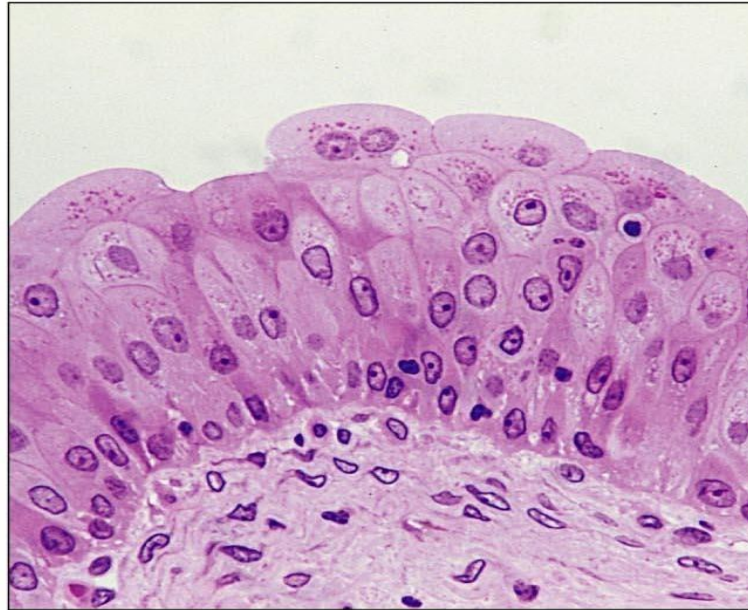
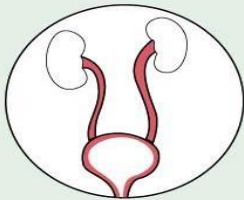
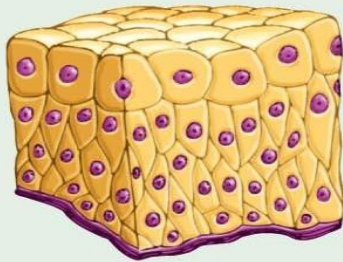
7. Stratified columnar epithelium

- Top layer of elongated cells lower layers of cube-shaped cells .
- Location : use deferens , port of the urethra and pharynx.
- Function : protection, secretion.

7. Transitional Epithelium

- many layers of cube – shaped and elongated cells
- function : Disposability, protection
- location : inner lining of urinary bladder and lining of waters and urethra .

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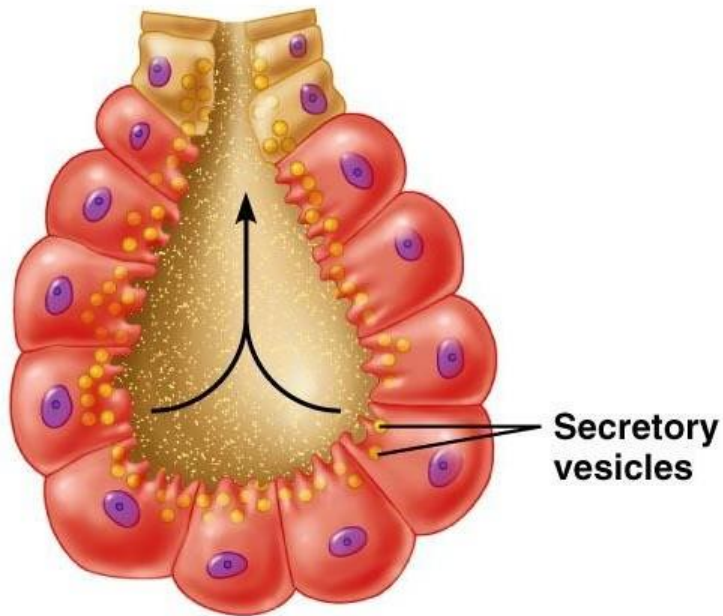
8. Glandular epithelium

- specialized to produce and secrete chemical substances into ducts or body fluids .
- made of cuboidal or columnar cells.
- **Exocrine glands** use ducts to secrete their products into an open space (e.g. sweat glands , oil glands , salivary glands, and tear glands).
- **Endocrine glands** secrete their products (hormones) directly into blood or body fluids (e.g. all hormonal glands are endocrine glands).

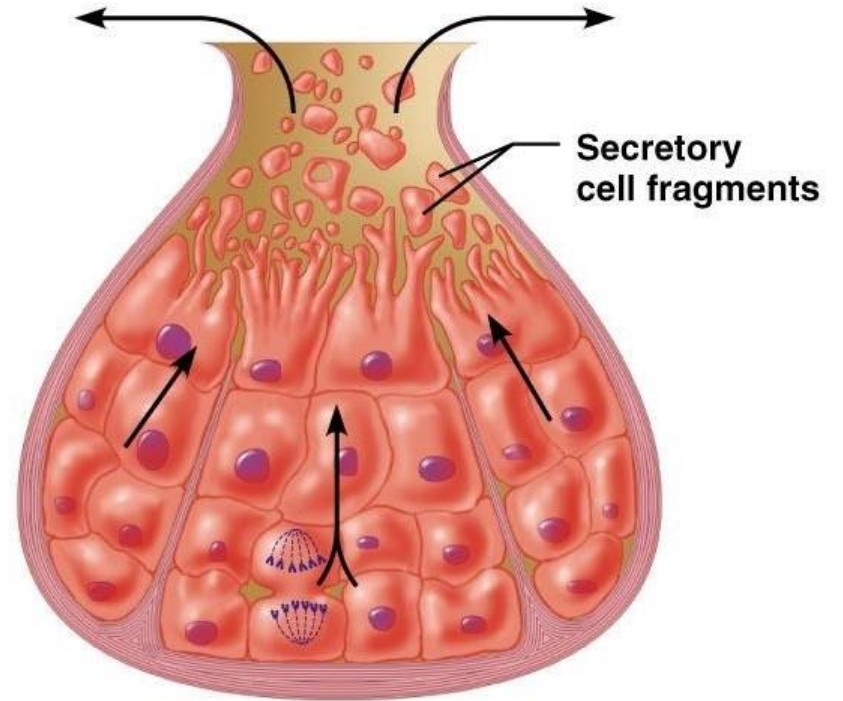
Types of exocrine glands

- Merocrine glands – A fluid product released through the cell membrane by exocytosis . ex: salivary glands , pancreatic glands , sweat glands.
- Apocrine glands – cellular product and portions of the free ends of cells pinch off during secretion. ex : mammary glands .
- Holocrine glands – Entire cell with secretory products rupture Ex : sebaceous glands of skin.

Merocrine and Holocrine gland



(a)

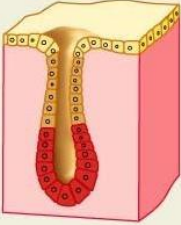
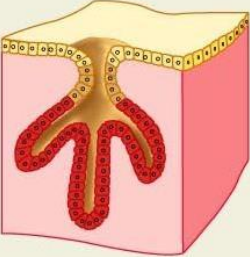
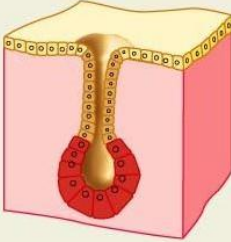

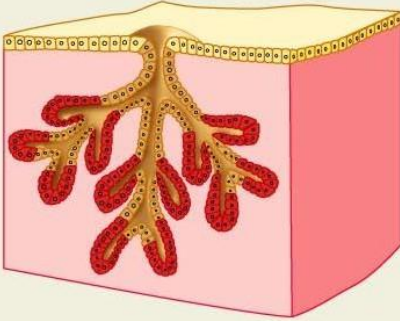




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Multicellular exocrine glands

- Simple – single unbranched duct
- Compound – branched duct
- Multicellular exocrine glands can be:
 - a) Tubular – secretory cells form a tube.
 - b) Alveolar – secretory cells form a sac.
 - c) tubuloalveolar

	Tubular secretory structure	Alveolar secretory structure	
Simple duct structure (duct does not branch)	  <p>(a) Simple tubular Example: intestinal glands</p> <p>(b) Simple branched tubular Example: stomach (gastric) glands</p>	  <p>(c) Simple alveolar Example: No important example in humans</p> <p>(d) Simple branched alveolar Example: sebaceous (oil) glands</p>	
Compound duct structure (duct branches)	 <p>(e) Compound tubular Example: duodenal glands of small intestine</p>	 <p>(f) Compound alveolar Example: mammary glands</p>	 <p>(g) Compound tubuloalveolar Example: salivary glands</p>

Key:  = Surface epithelium  = Duct  = Secretory epithelium

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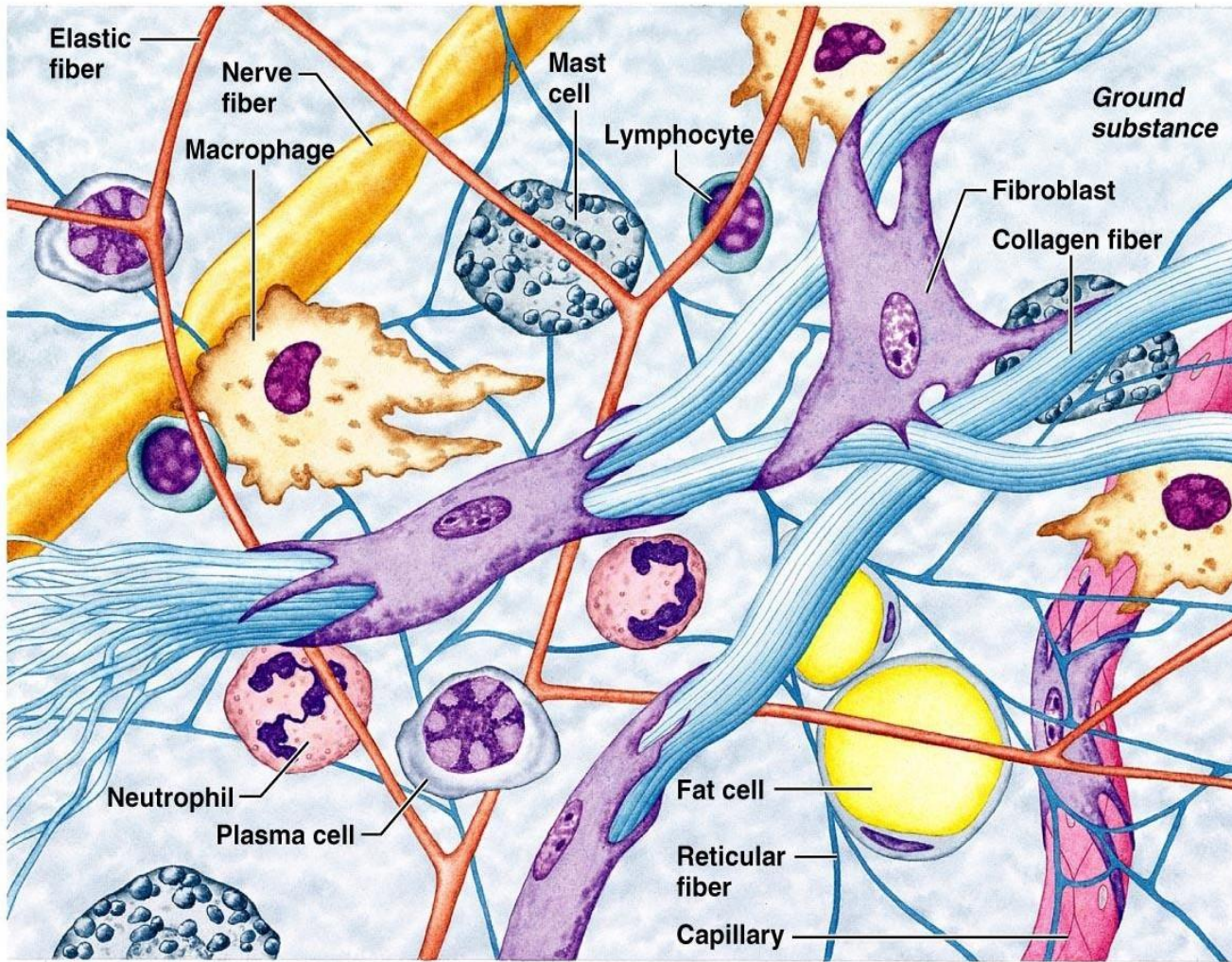
Unicellular Exocrine Glands

- Unicellular exocrine glands;
- Single cells
- Have no ducts
- Produce mucin: forms mucus that protect and lubricate surfaces.

Connective tissue

- Most abundant of the primary tissues by weight.
- Function :
 - 1) Binding and Support
 - 2) Protection
 - 3) Insulation
 - 4) Transportation (blood)
- origin : All C.T. arise from mesenchyme derived from embryonic mesoderm germ layer.
- Have matrix : fills the space between cells.
- Fibers (3 types).
 - ground substance (matrix): fills the space between cells.
- cells

ConnectiveTissue



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- Contain a **noncellular matrix** which is made of protein fibers and ground substances .
- Contain "**resident cells**" and **“wandering cells”**
- **Fibers of connective tissue:**
 1. **Collagen fibers** – provide tensile strength (thickest fibers).
 2. **Elastic fibers** – provide stretch.
 3. **Reticular fibers** – provide a network to support blood vessels and support soft tissue of organs.
- **Cells of connective tissue :**
 1. **Fibroblast** – form connective tissue proper.
 2. **Chondroblast** - cartilage forming.
 3. **Osteoblast** – bone forming.
 4. **Hemocytoblast** – blood forming.

Major classes of connective tissue

		in some	collagen fibers	
General function:	Acts as a binding tissue; resists mechanical stress, particularly tension	Resists compression; cushions and supports body structures	Rigidity that resists compression and tension; support	Fluid tissue; transports oxygen, carbon dioxide, nutrients, hormones, wastes

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- **Other cells in connective tissue :**

1. **White blood cells** (immunity)

2. **Plasma cells** (antibody producing)

3. **Mast cells** (detect bacteria and fungi and initiate local inflammatory -response against them)

3. **Macrophages** (immunity) – engulf and dispose bacteria , and other un wanted substances .

Loose Connective Tissue

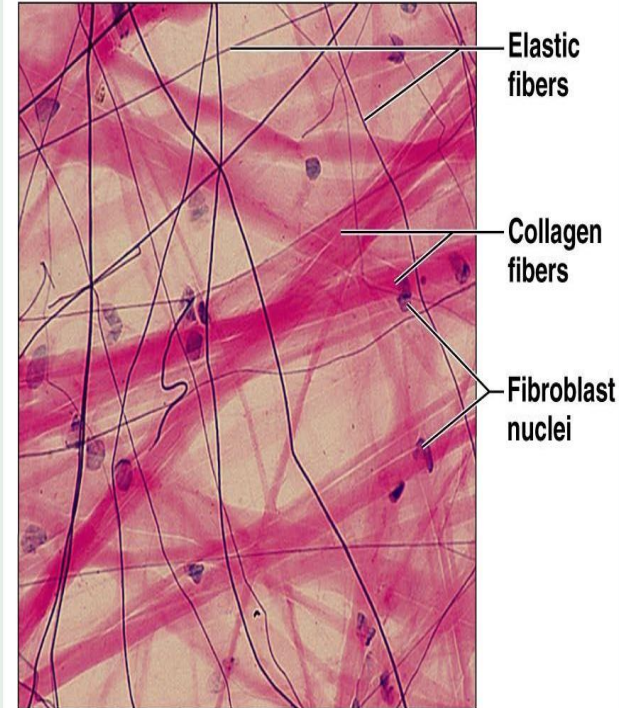
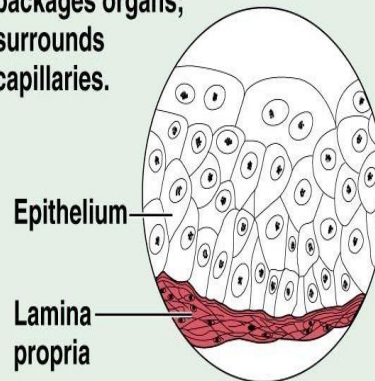
- **Loose connective tissue:** (areola connective tissue)
- Forms delicate , thin membranes throughout the body.
- Binds the skin to underlying organs , fills spaces between muscles and other organs .
- Consists of cells called **fibroblasts** , and both **collagen us and elastic fibers** in the matrix.

(a) Connective tissue proper: loose connective tissue, areolar

Description: Gel-like matrix with all three fiber types; cells: fibroblasts, macrophages, mast cells, and some white blood cells.

Function: Wraps and cushions organs; its macrophages phagocytize bacteria; plays important role in inflammation; holds and conveys tissue fluid.

Location: Widely distributed under epithelia of body, e.g., forms lamina propria of mucous membranes; packages organs; surrounds capillaries.



Photomicrograph: Areolar connective tissue, a soft packaging tissue of the body (400×).

Reticular Connective Tissue: resembles loose areolar C.T.
only has reticular fibers.

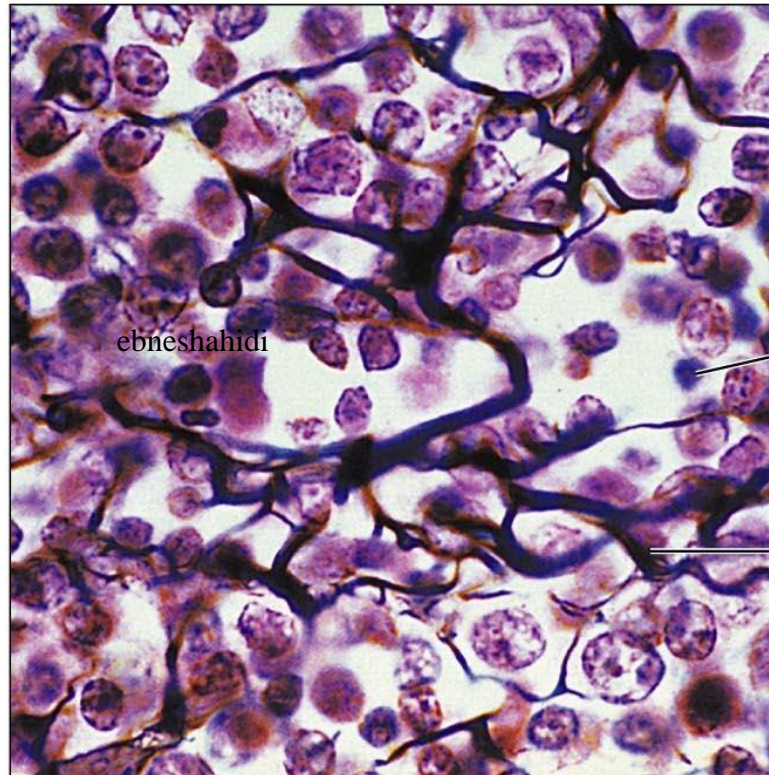
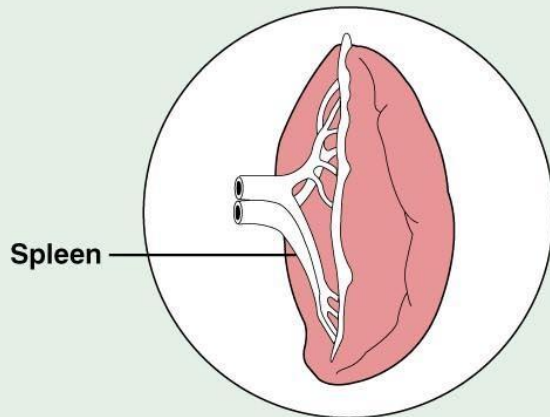
But

(c) Connective tissue proper: loose connective tissue, reticular

Description: Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

Function: Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells, and macrophages.

Location: Lymphoid organs (lymph nodes, bone marrow, and spleen).



White blood cell (lymphocyte)

Reticular fibers

Photomicrograph: Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350 \times).

Adipose Tissue

Modified from loose connective.

Specialized to store fat at the center of ring – shaped cells called **adipocytes**.

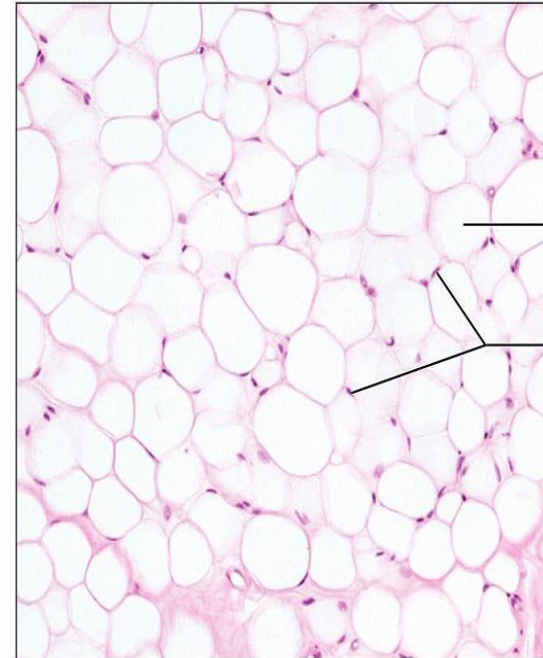
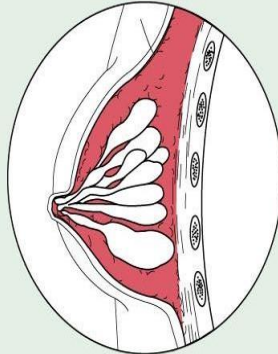
Serves as protective cushion for joints and organs , as heat insulator beneath the skin , and to store energy .

(b) Connective tissue proper: loose connective tissue, adipose

Description: Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by large fat droplet.

Function: Provides reserve food fuel; insulates against heat loss; supports and protects organs.

Location: Under skin; around kidneys and eyeballs; within abdomen; in breasts.



Vacuole containing fat droplet
Nuclei of fat cells

Photomicrograph: Adipose tissue from the subcutaneous layer under the skin (450 \times).

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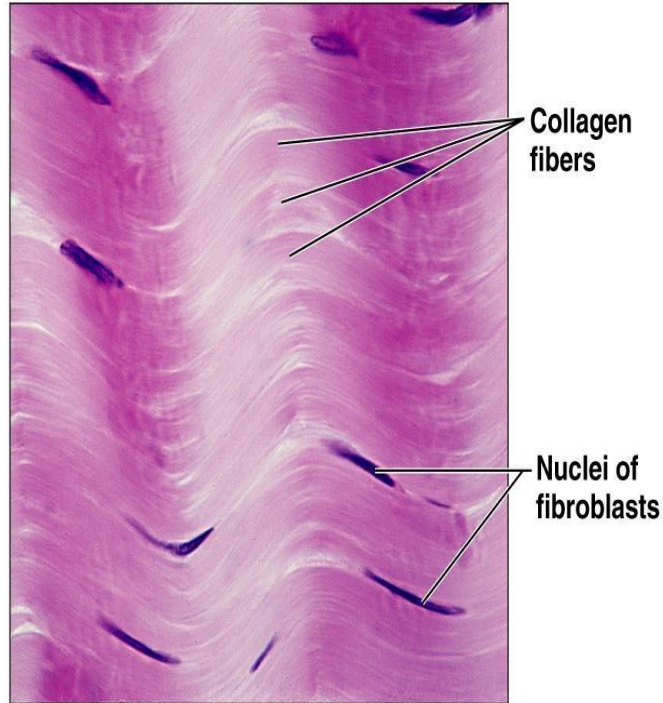
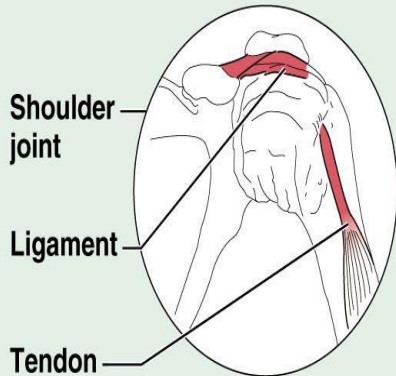
Dense Regular Connective Tissue

(d) Connective tissue proper: dense connective tissue, dense regular

Description: Primarily parallel collagen fibers; a few elastin fibers; major cell type is the fibroblast.

Function: Attaches muscles to bones or to muscles; attaches bones to bones; withstands great tensile stress when pulling force is applied in one direction.

Location: Tendons, most ligaments, aponeuroses.



Photomicrograph: Dense regular connective tissue from a tendon (1000x).

- **Dense regular connective tissue:**
- forms tendons, and ligaments.
- Poor blood supply.
- Contains closely packed bundles of collagen fibers .

Dense irregular Connective tissue

- Arranged irregularly.
- Bundles are much thicker.
- Forms Dermis (inner skin layer).



Photomicrograph: Dense irregular connective tissue from the dermis of the skin (400×).

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Blood

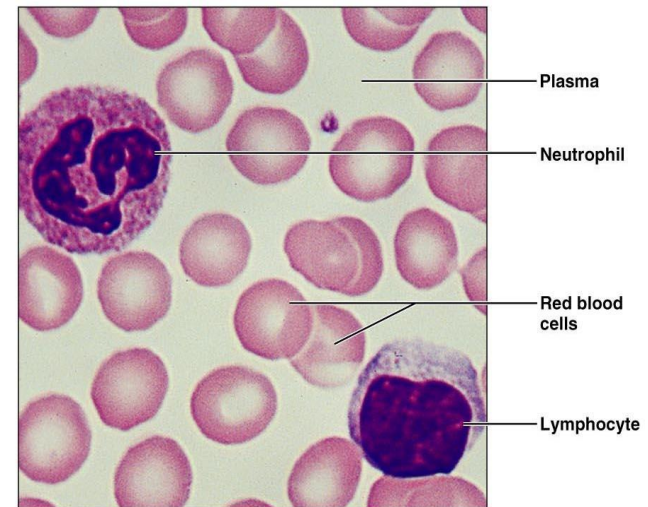
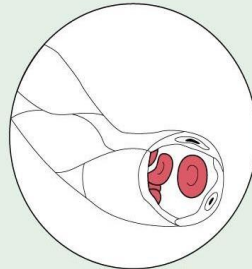
- Blood: most atypical connective tissue. it is composed of cells that are suspended in a fluid intercellular matrix called blood plasma.

(j) Others: blood

Description: Red and white blood cells in a fluid matrix (plasma).

Function: Transport of respiratory gases, nutrients, wastes, and other substances.

Location: Contained within blood vessels.



Photomicrograph: Smear of human blood (1500x); two white blood cells (neutrophil in upper left and lymphocyte in lower right) are seen surrounded by red blood cells.

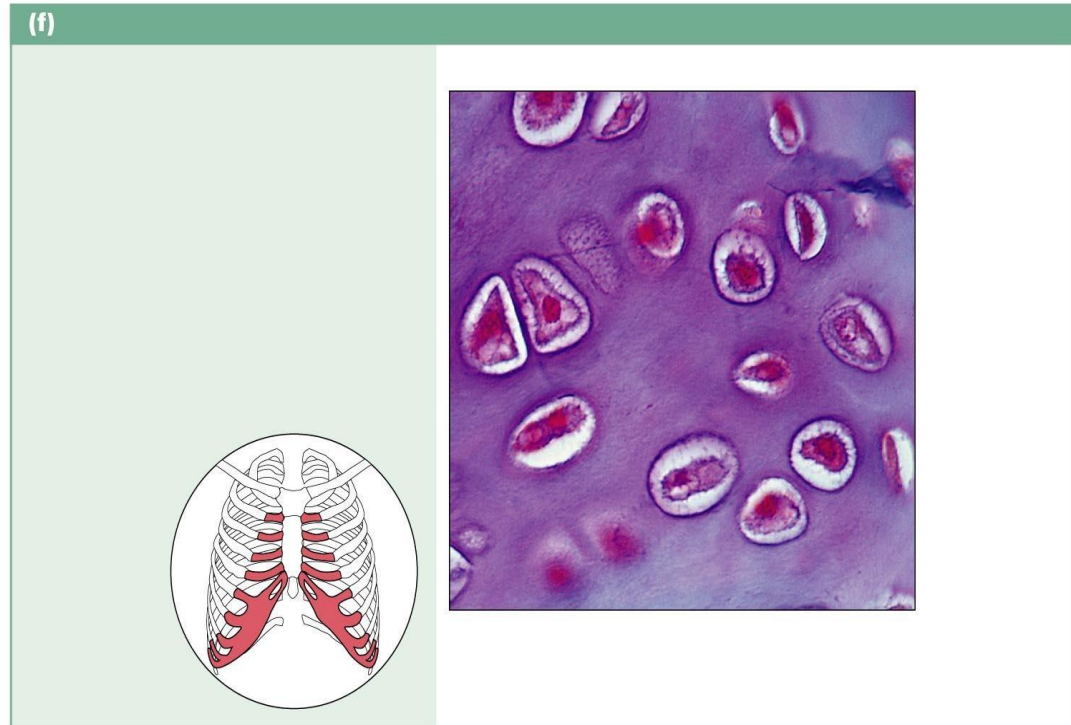
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Cartilage

- Support body parts , provide frameworks and attachments , protect underlying tissues, and form a model for developing bones.
- Contain a rich matrix made of protein fibers and protein – rich ground substances.
- Consist of cells called **chondrocytes** which are found in cavities called **lacunae**. The cells obtain their nutrients by diffusion from the matrix, since cartilage is the only C.T. that is avascular.

Hyaline cartilage

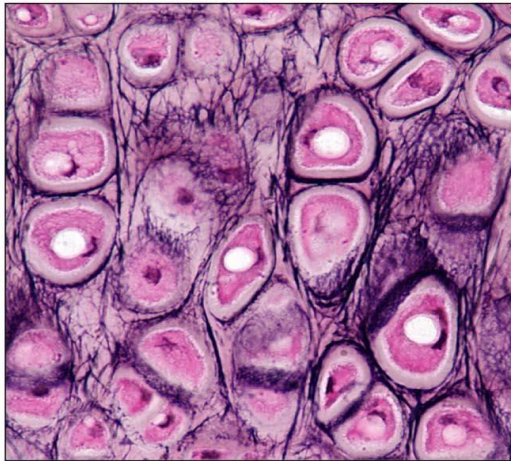
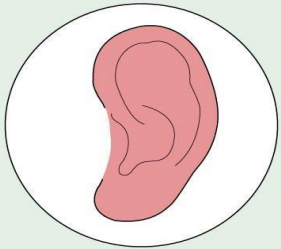
- **Hyaline cartilage**
- contains fine collagen fibers in the matrix.
- The most common type of cartilage.
- Found in the ends of bones at the joints , and surrounding the trachea.



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Elastic Cartilage

(g)

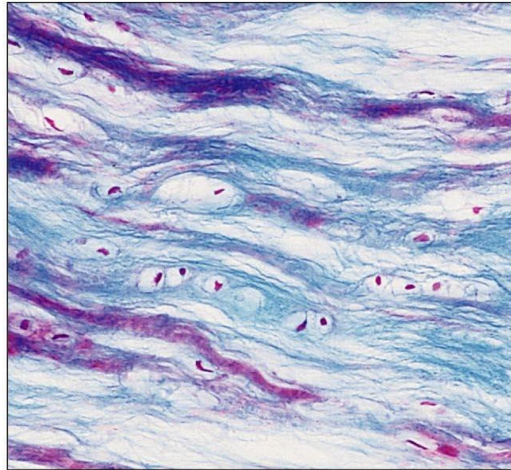
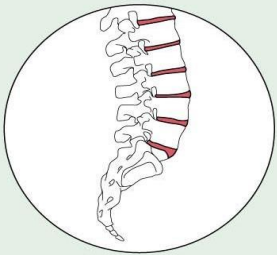


- Contains elastic fibers in the matrix.
- Provides framework for the external ear and the larynx.

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Fibrocartilage

(h)



- contains thick collagen us fibers in the matrix.
- Serves as shock absorber in the inter vertebral disks, and between bones in the knee and pelvis.

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Bone

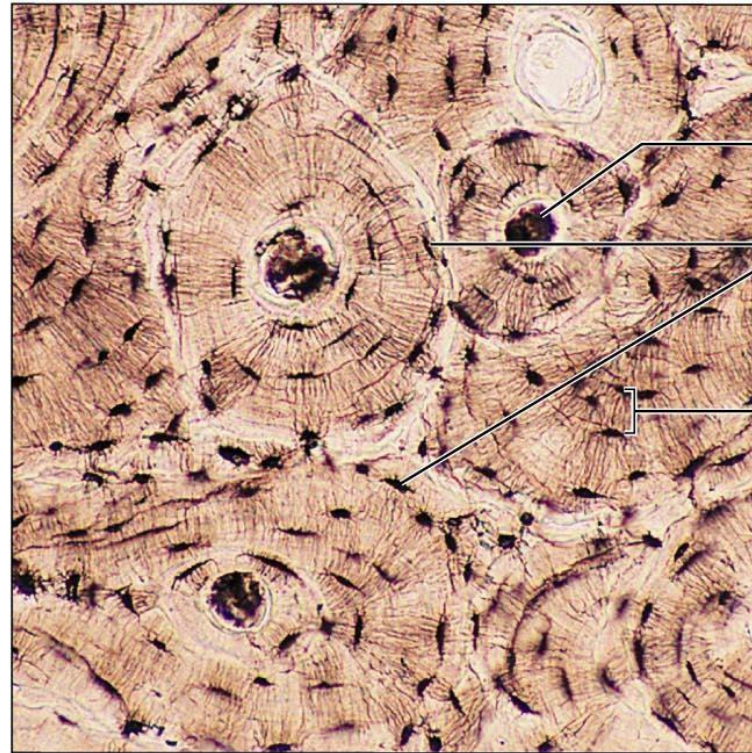
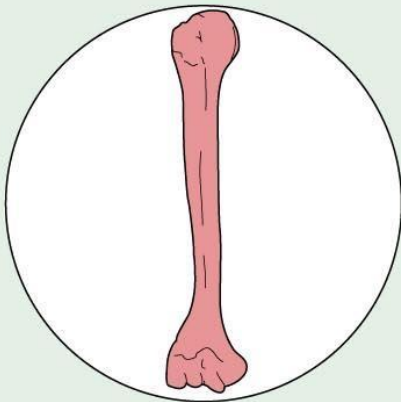
- **Bone tissue** (or osseous tissue):
- The most rigid connective tissue because of the **calcium** deposited in the matrix.
- Provides internal support for the body, protects vital organs , and serves as attachment for most skeletal muscles.
- Consists of many functional units called **osteos** . Each osteon is composed of cells called **osteocytes** (surrounded by **lacunae**) forming concentric circles around the **osteonic canal**.
- Blood vessels in the isotonic canal allow nutrients to diffuse into fine channels called **canaliculi** for distributing the nourishment to all osteocytes .

(i) Others: bone (osseous tissue)

Description: Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. Very well vascularized.

Function: Bone supports and protects (by enclosing); provides levers for the muscles to act on; stores calcium and other minerals and fat; marrow inside bones is the site for blood cell formation (hematopoiesis).

Location: Bones



Central canal
Lacunae
Lamella

Photomicrograph: Cross-sectional view of bone (70×).

Muscle tissue

- Consist of muscle cells called **muscle fibers** which contain long protein filaments called **myofibrils** that allow the cells to contract and produce body movements .
- Function: movement
- Location: attached to bones in the walls of hollow internal organs
- Characteristics: contractile
- Types: 3 types

Skeletal Muscle

- **Skeletal muscle** (striated muscle)
- under voluntary control , multinucleated, striated, and can contract with powerful force.

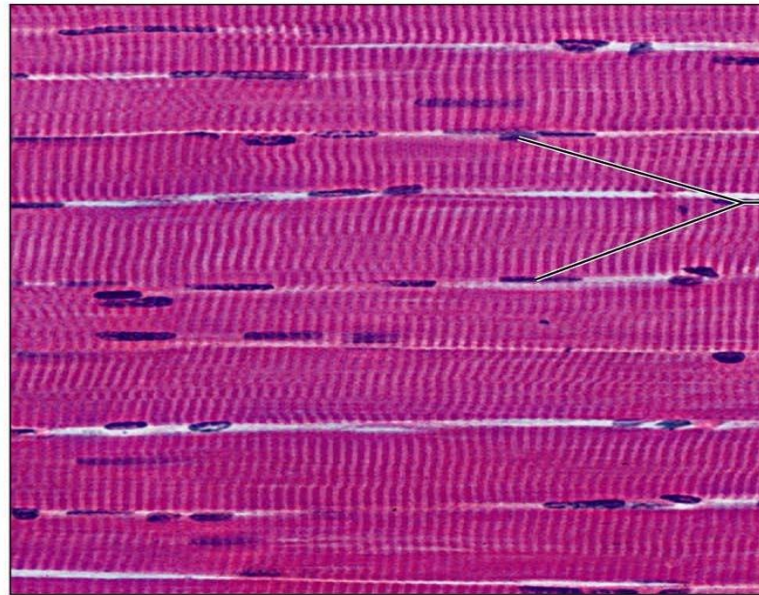
(a) Skeletal muscle

Description: Long, cylindrical, multinucleate cells; obvious striations.



Function: Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

Location: In skeletal muscles attached to bones or occasionally to skin.

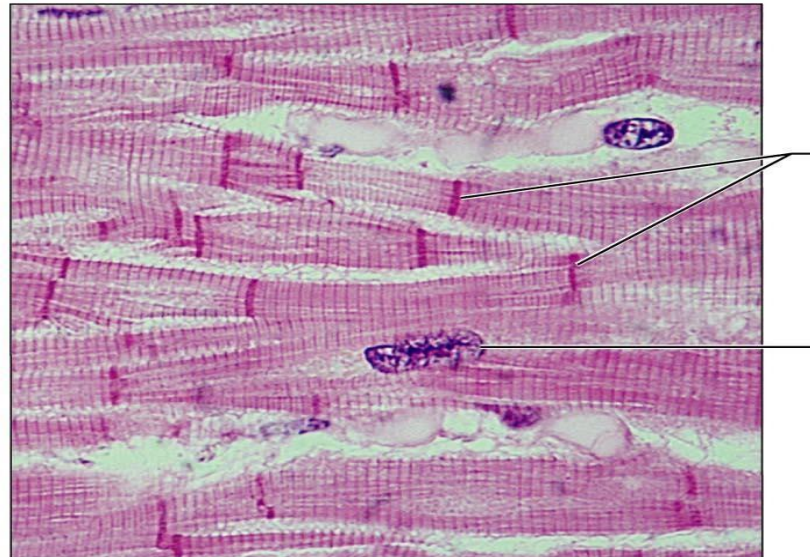
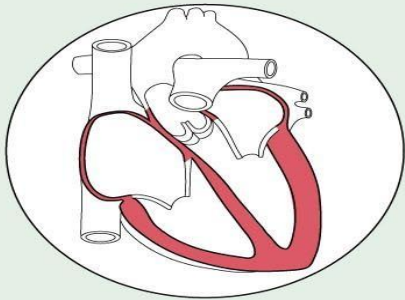


Photomicrograph: Skeletal muscle (approx. 300 \times). Notice the obvious banding pattern and the fact that these large cells are multinucleate.

Cardiac Muscle

- mostly under involuntary control, uninucleated, cross-striated, form interconnected branching, contain specialized intercellular junctions called **intercalated disk**, and can contract continuously and rapidly .

(b)

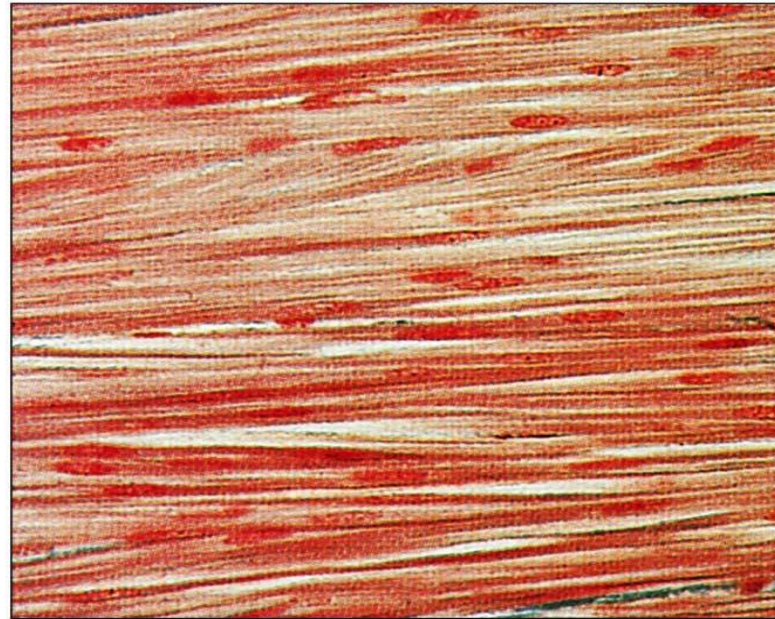
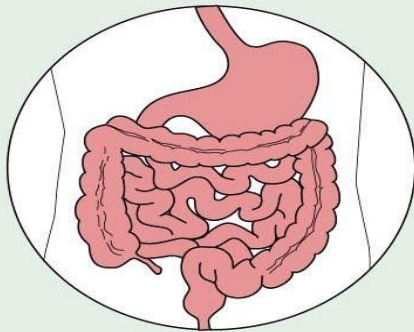


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Smooth muscle

- **Smooth muscle** (or involuntary, visceral muscle)
- under involuntary control, uninucleated, not striated, and contracts with less force but longer duration.

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Nervous Tissue

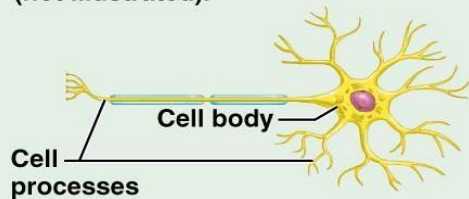
- found in the brain , spinal cord , and nerves.
- consists of cells called **neurons** that are sensitive to changes (stimuli) in the environment and within the body , resulting in generating and transmitting **nerve impulses** through their nerve fibers.
- 2 types of nerve fibers
- **axon** – only 1 per neuron ; transmits impulses away from the cell.
- **Dendrite** – thousands per neuron ; transmits impulses to the cell.

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Nervous Tissue

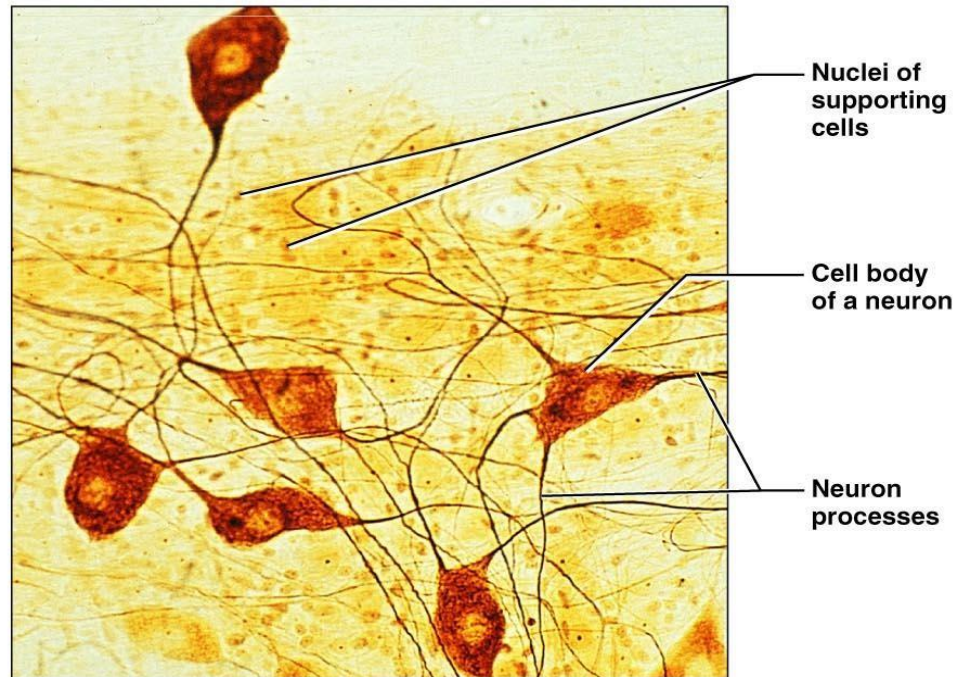
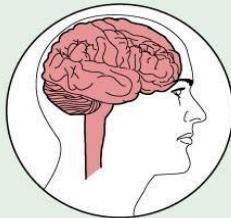
Nervous tissue

Description: Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body; also contributing to nervous tissue are nonirritable supporting cells (not illustrated).



Function: Transmit electrical signals from sensory receptors and to effectors (muscles and glands) which control their activity.

Location: Brain, spinal cord, and nerves.

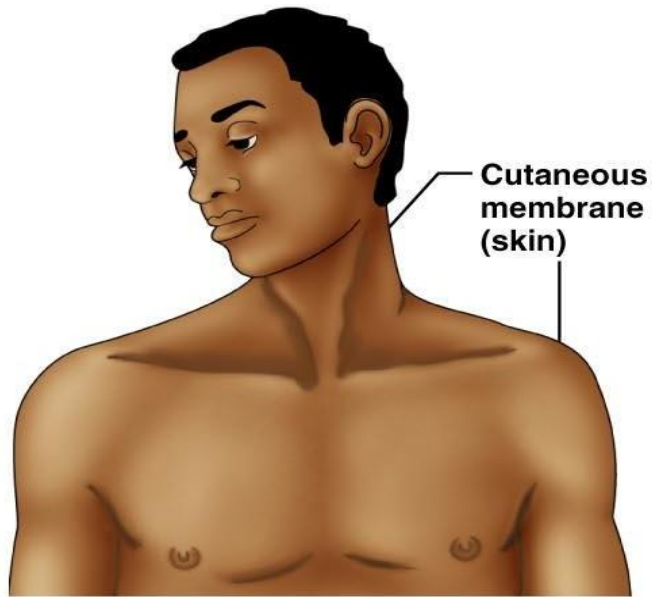


Photomicrograph: Neurons (100x)

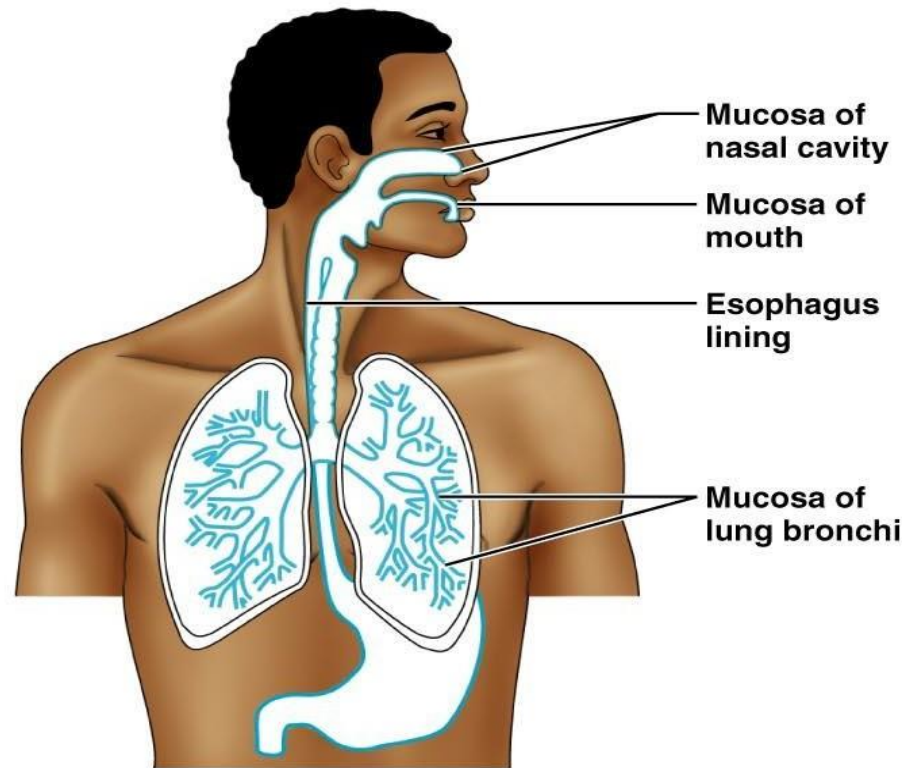
Epithelial membranes

- It is a continuous multicellular sheet composed of at least 2 layer
 - epithelium
 - underlying layer of connective tissue
- 1. Cutaneous membranes:
- The coetaneous membrane is the skin which has :
- keratinized squamous epithelium known as epidermis.
- underlying layer of dense irregulars connective tissue or dermis.

Mucous membranes: line body cavity
underlying layer of loose connective tissue called lamina propria.



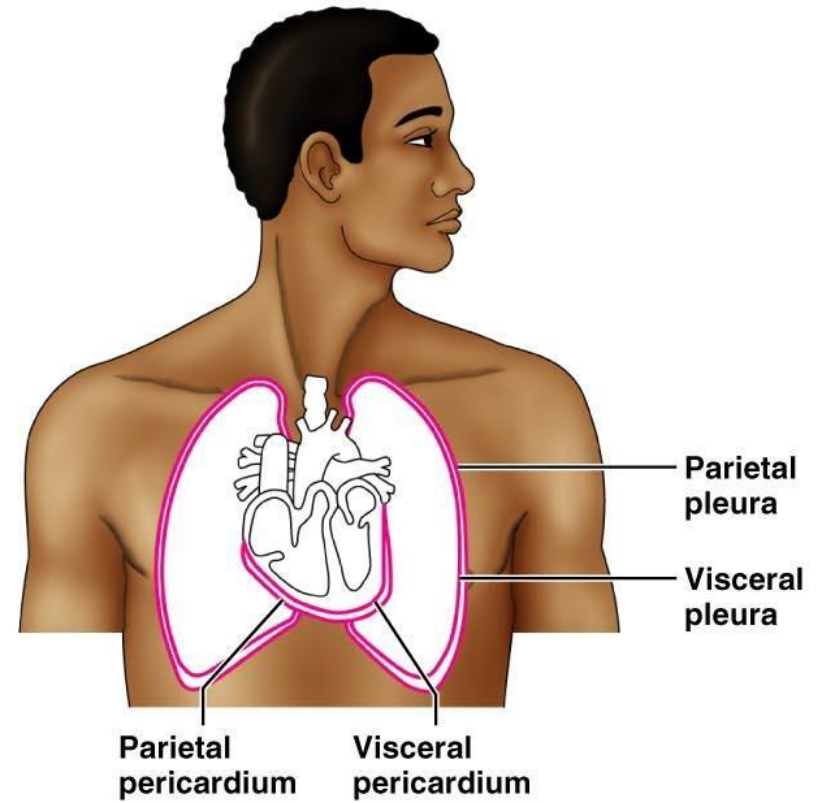
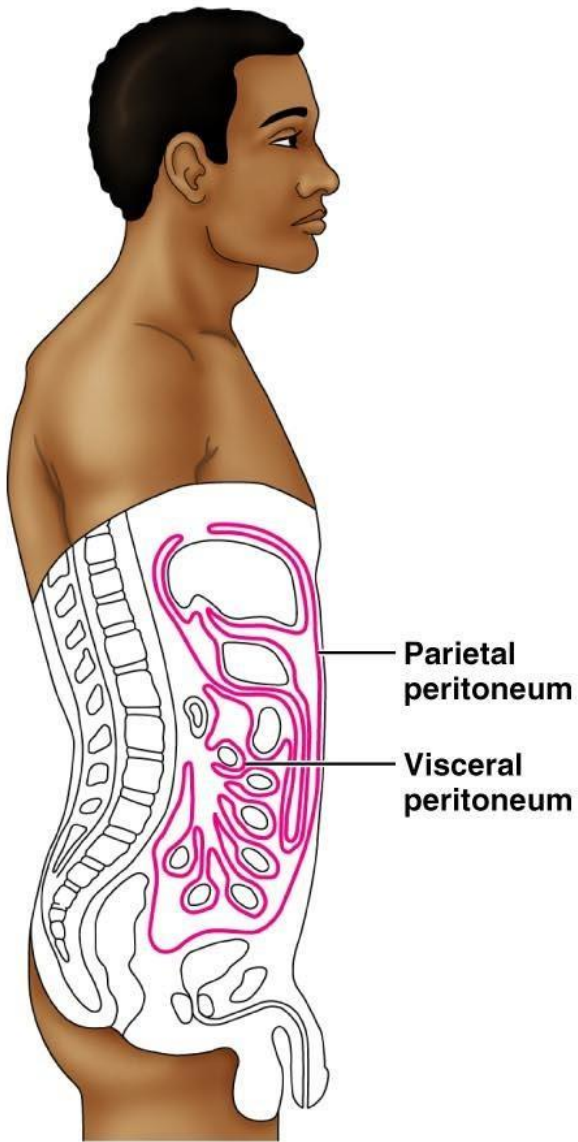
(a) Cutaneous membrane



(b) Mucous membranes

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- serous membranes:
- moist membrane found in ventral body cavity. it has a parietal layer that lines the cavity wall and a visceral layer that covers the outer surface of organs within the cavity .
- Between the above layers is a thin clear serous fluid that act as a lubricant .
- The serous lining the thoracic cavity and covering lung is the pleura .
- The serous enclosing the heart is the pericardium .
- The serous enclosing the abdomen pelvic cavity and viscera are the peritoneums.



(c) Serous membranes

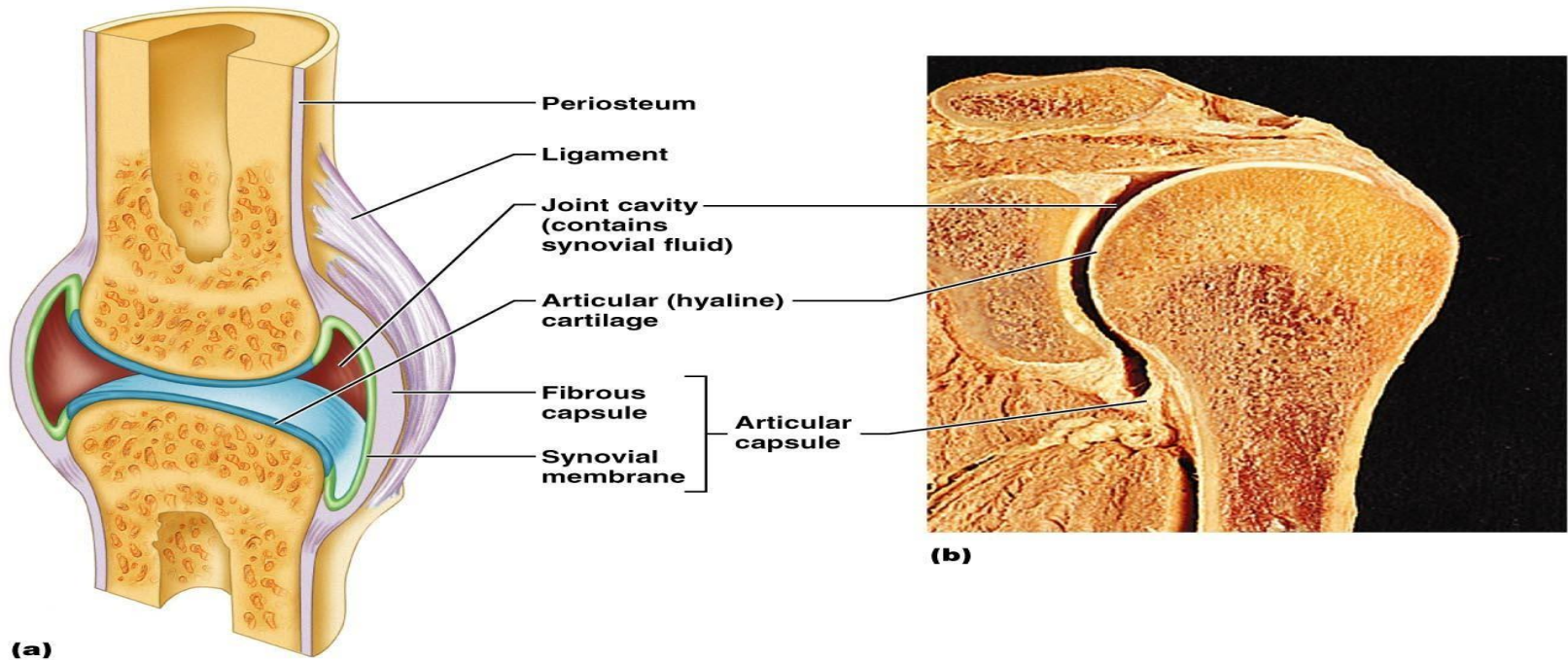
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- synovial membrane

- forms inner lining of joint cavities at the synovial joints (freely movable joints)

- made of a layer of cuboidal epithelium over a layer of connective tissue .

- secretes **synovial fluid** to lubricate the synovial joints .

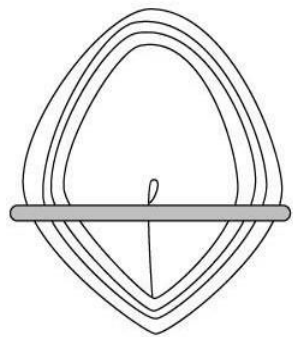


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Developmental aspects of tissue




- There are 3 primary germ cell embryonically.
- 1) Ectoderm
- 2) Mesoderm
- 3) Endoderm
- These germ cells specialize to form the 4 primary tissues from which all body organs are derived .
- Epithelial tissues are formed by all 3 germ layers .
- Mucosal epithelium is from endoderm
- Endothelium is from mesoderm
- Epidermis is from ectoderm
- Muscle and connective tissue are derived from mesoderm
- nervous tissue is form ectoderm

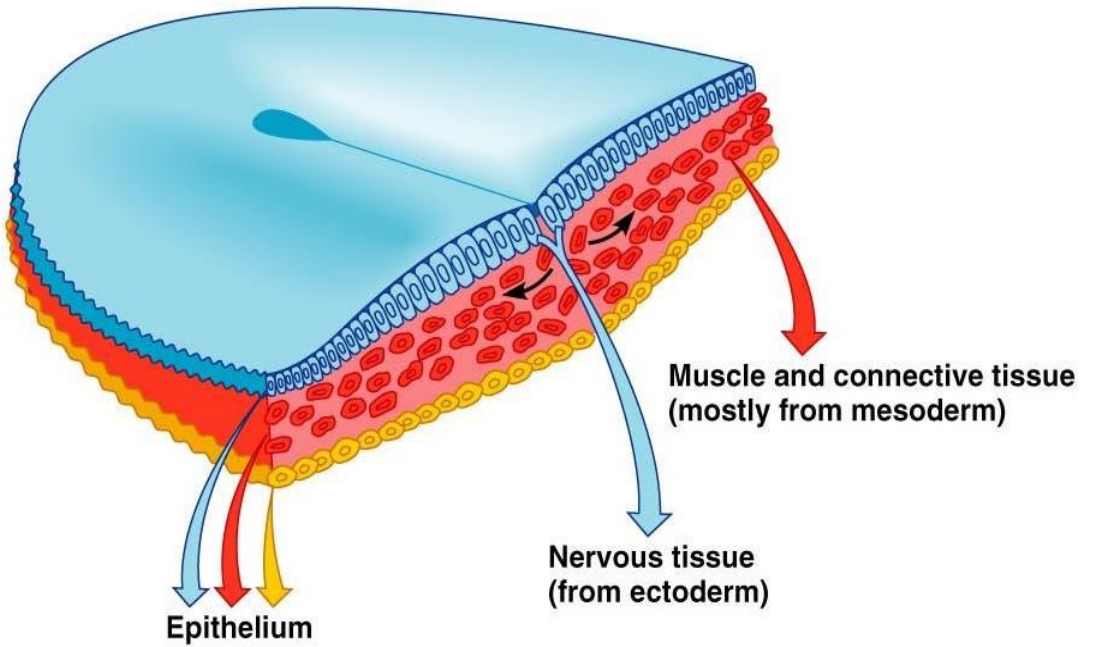
Embryonic germ layers



16-day-old embryo
(dorsal surface view)

Key:

-  = Ectoderm
-  = Mesoderm
-  = Endoderm



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Clinical Terms

- Adenoma: tumor of glandular Epithelium.
- Carcinoma: cancer arising in an epithelium.
- Sarcoma: cancer arising from mesenchyme – derived tissue, that is in connective tissue and muscle.
- Lesion: an injury or wound.
- Pathology: study of changes in organ and tissues produced by disease.