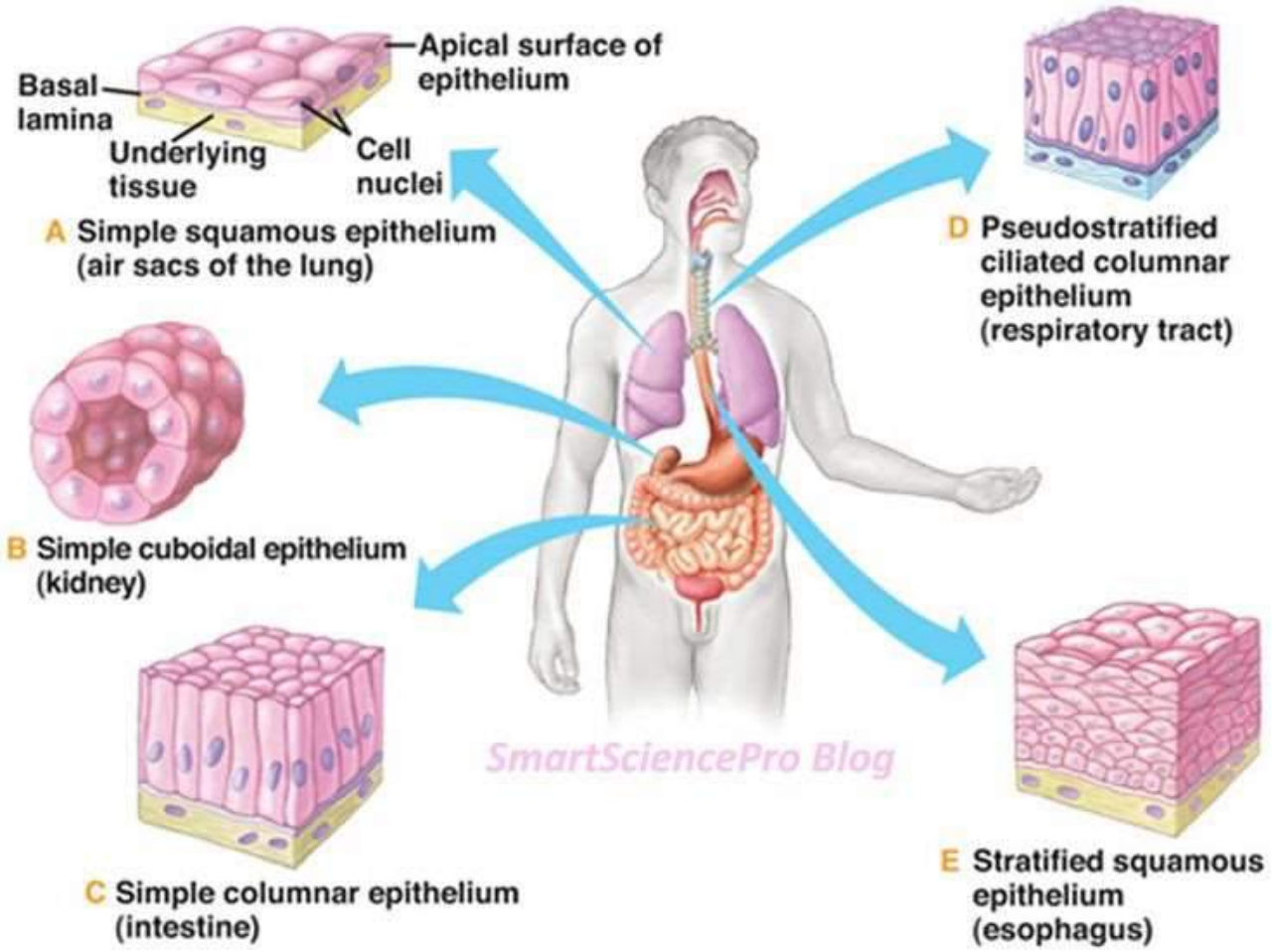
General histology



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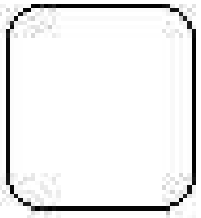
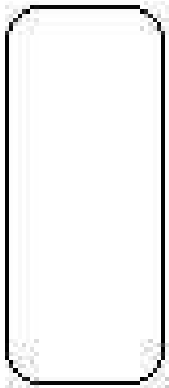
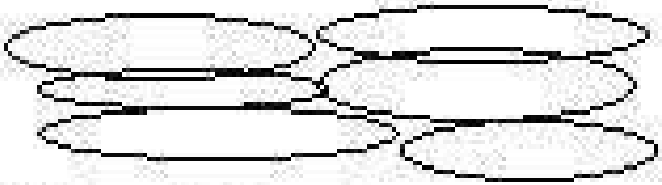
Squamous



Cuboidal



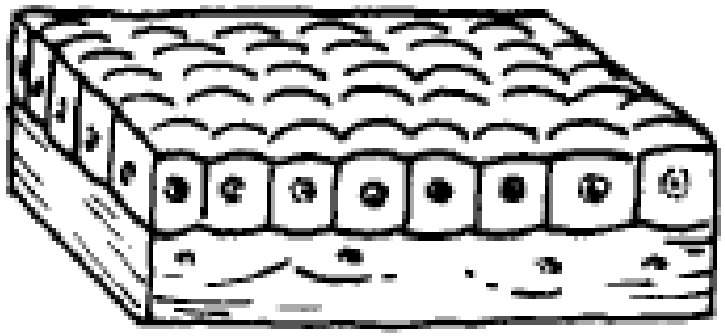
Columnar



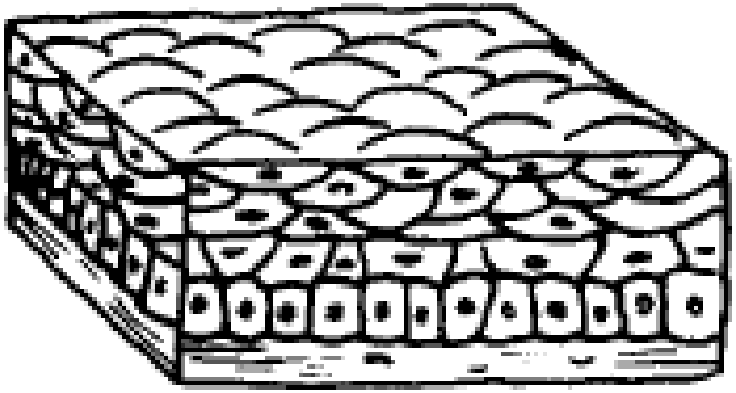
Stratified

Simple

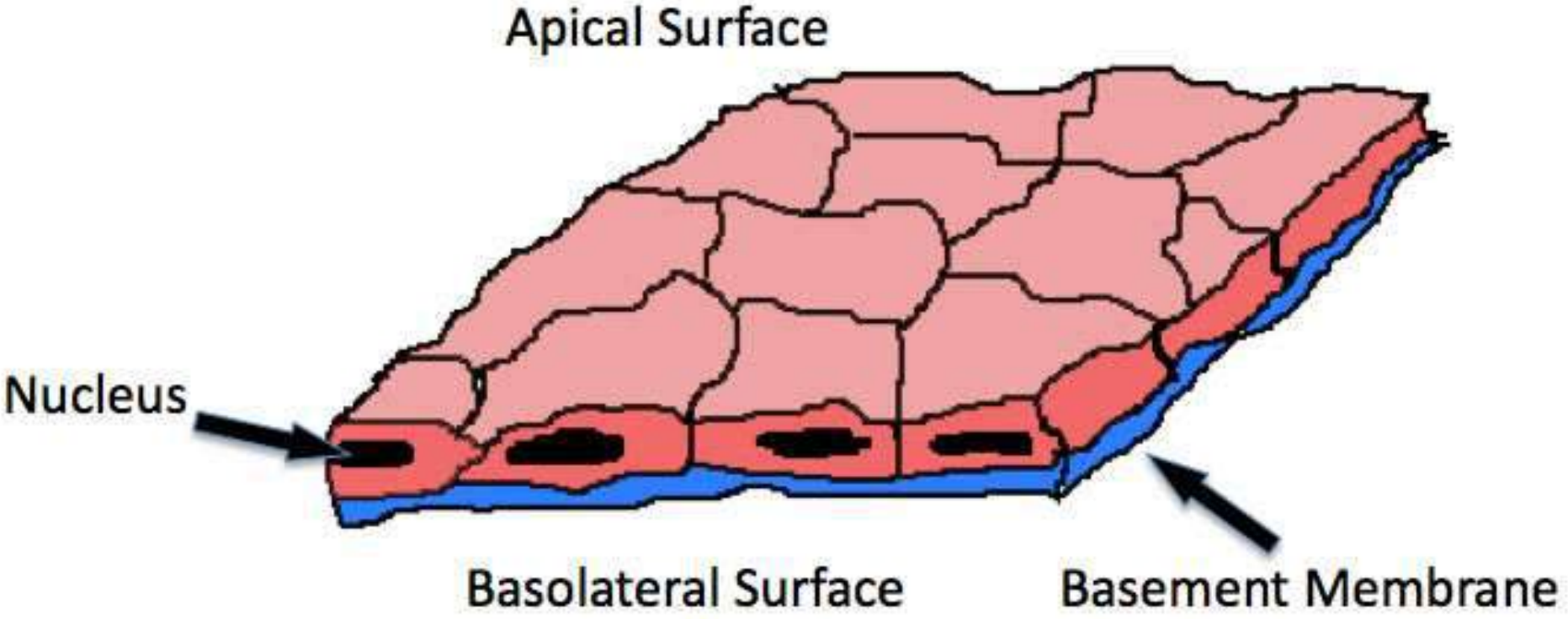
a. SIMPLE

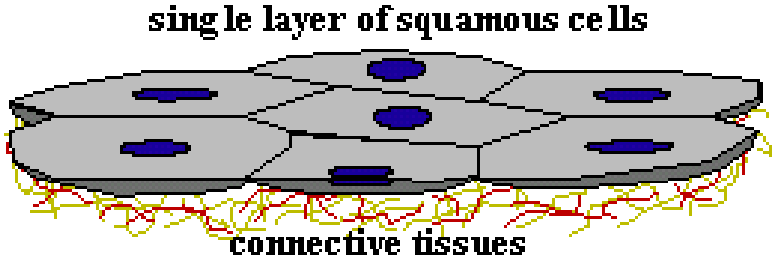


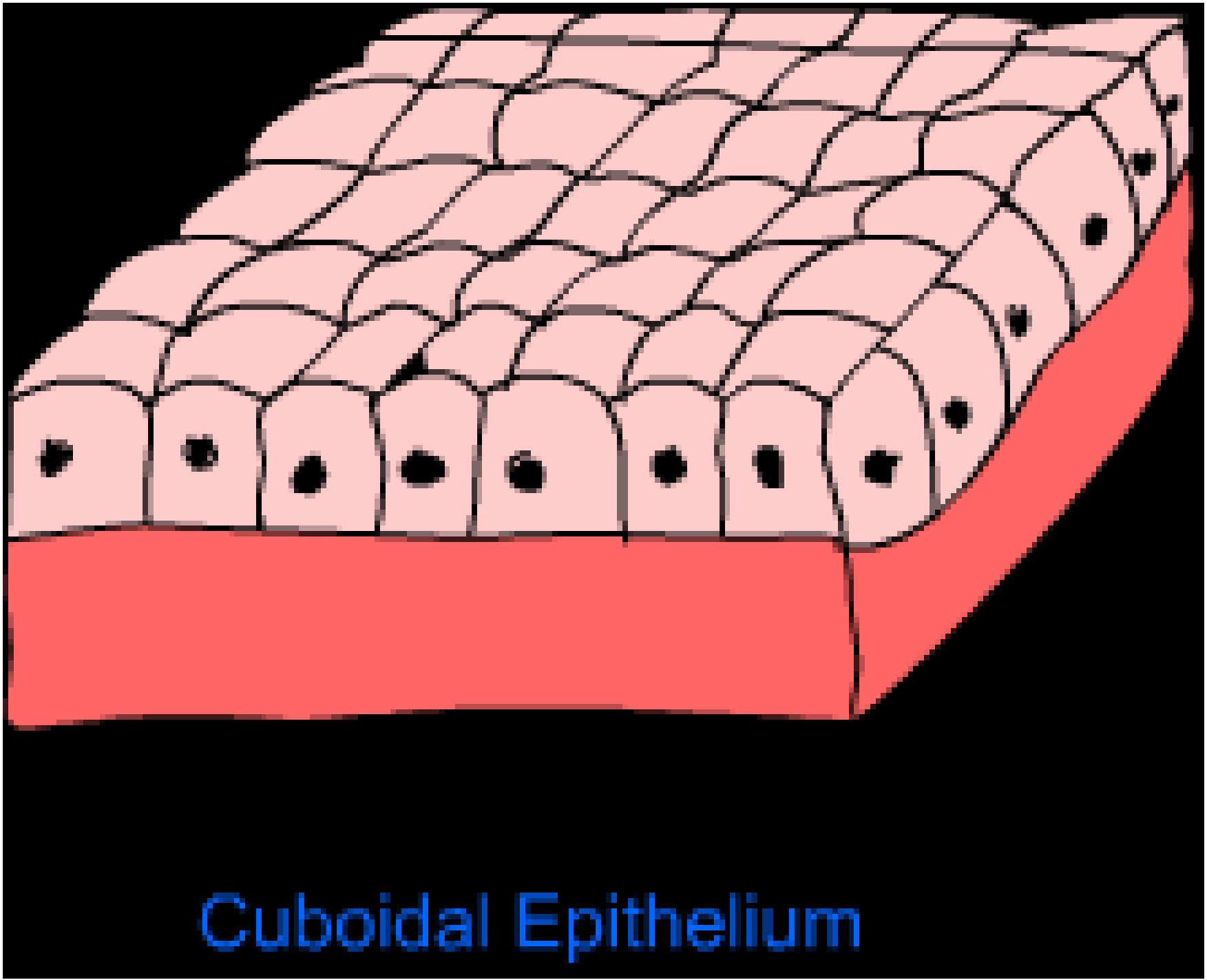
b. STRATIFIED



Simple squamous epithelium

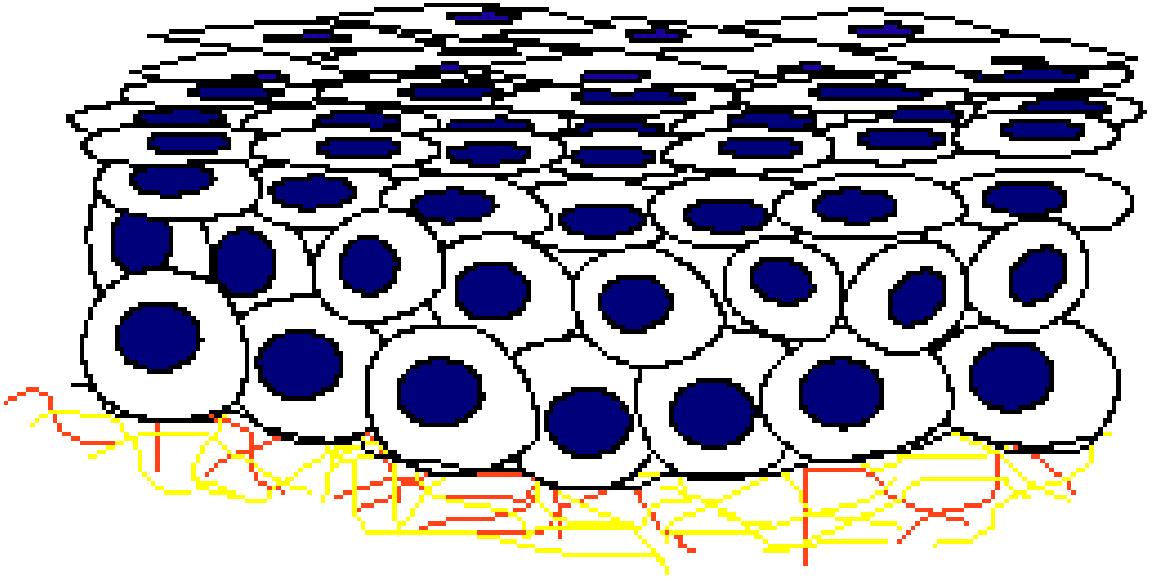





Cuboidal Epithelium

non-keratinized stratified squamous

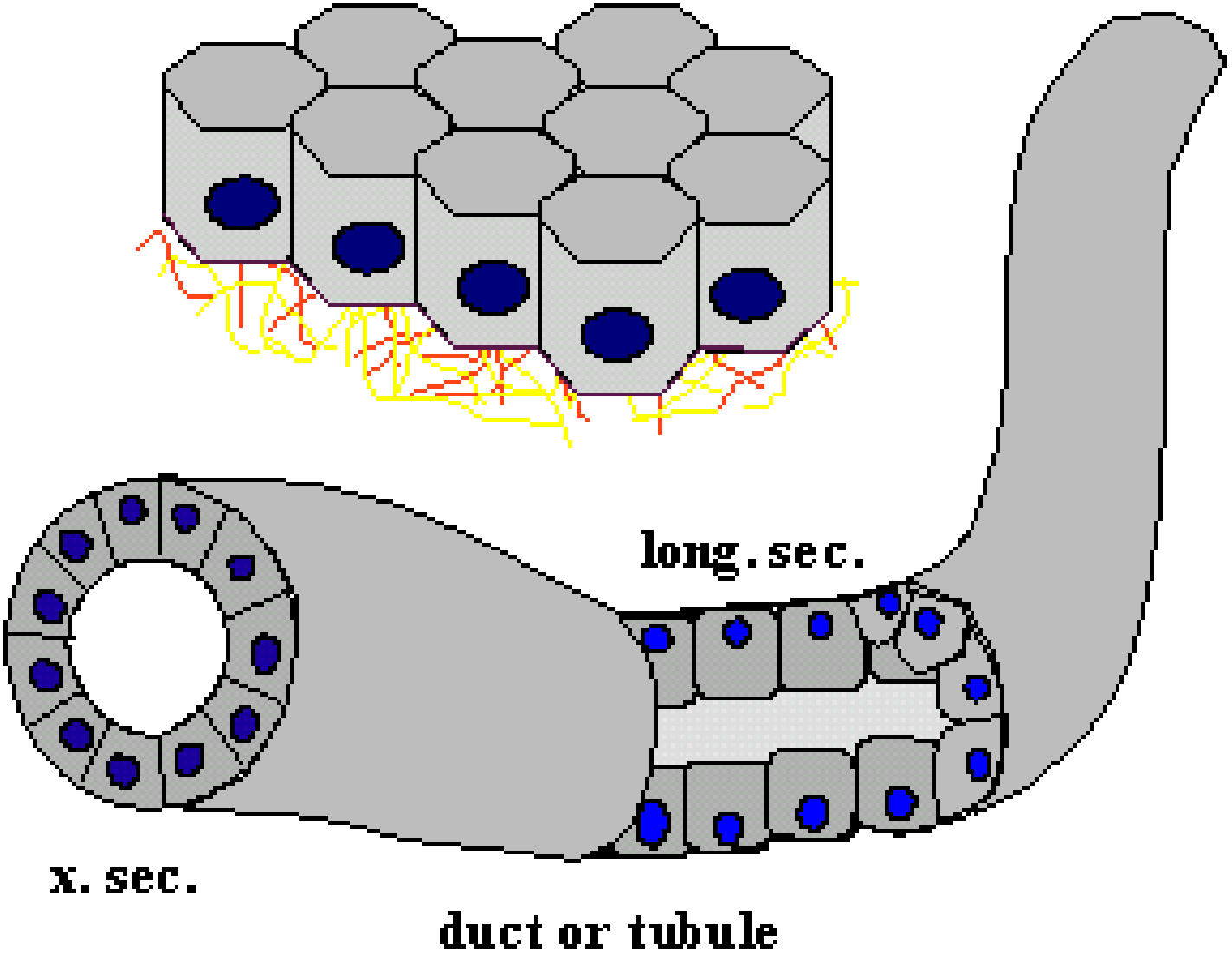
living, nucleated cells at surface



cells flatten
toward surface

mitotic divisions

Simple Cuboidal Epithelia



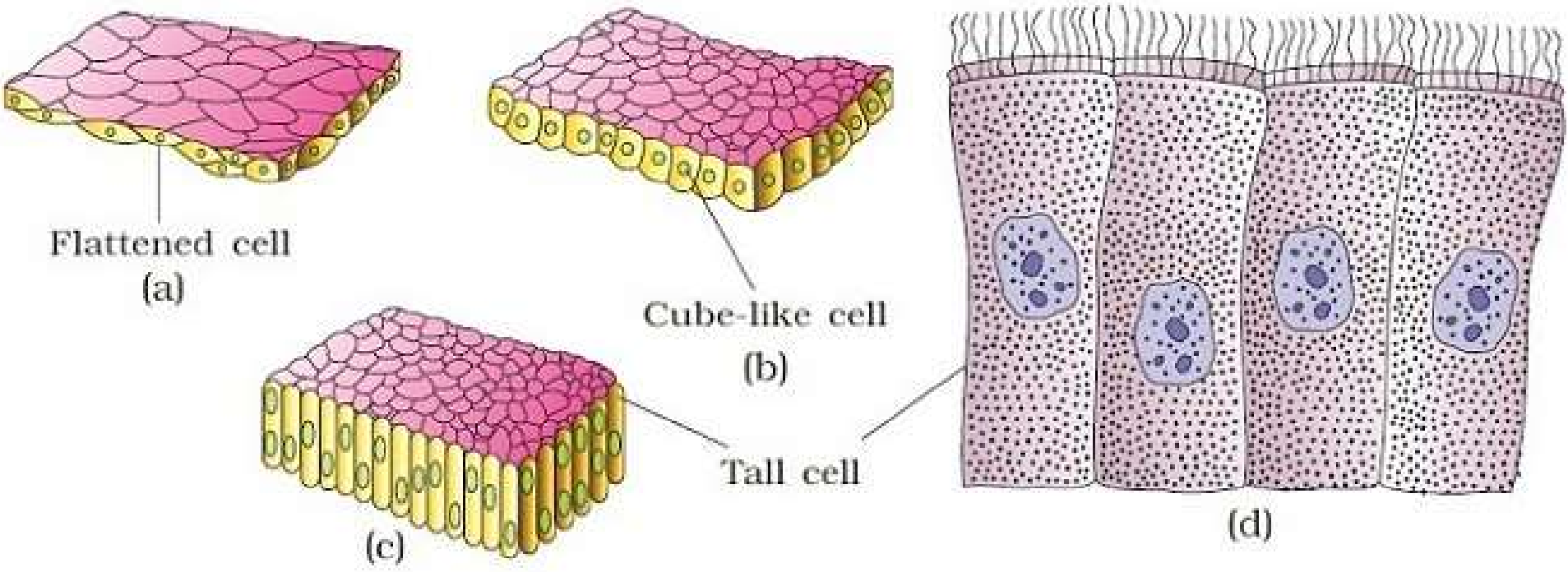
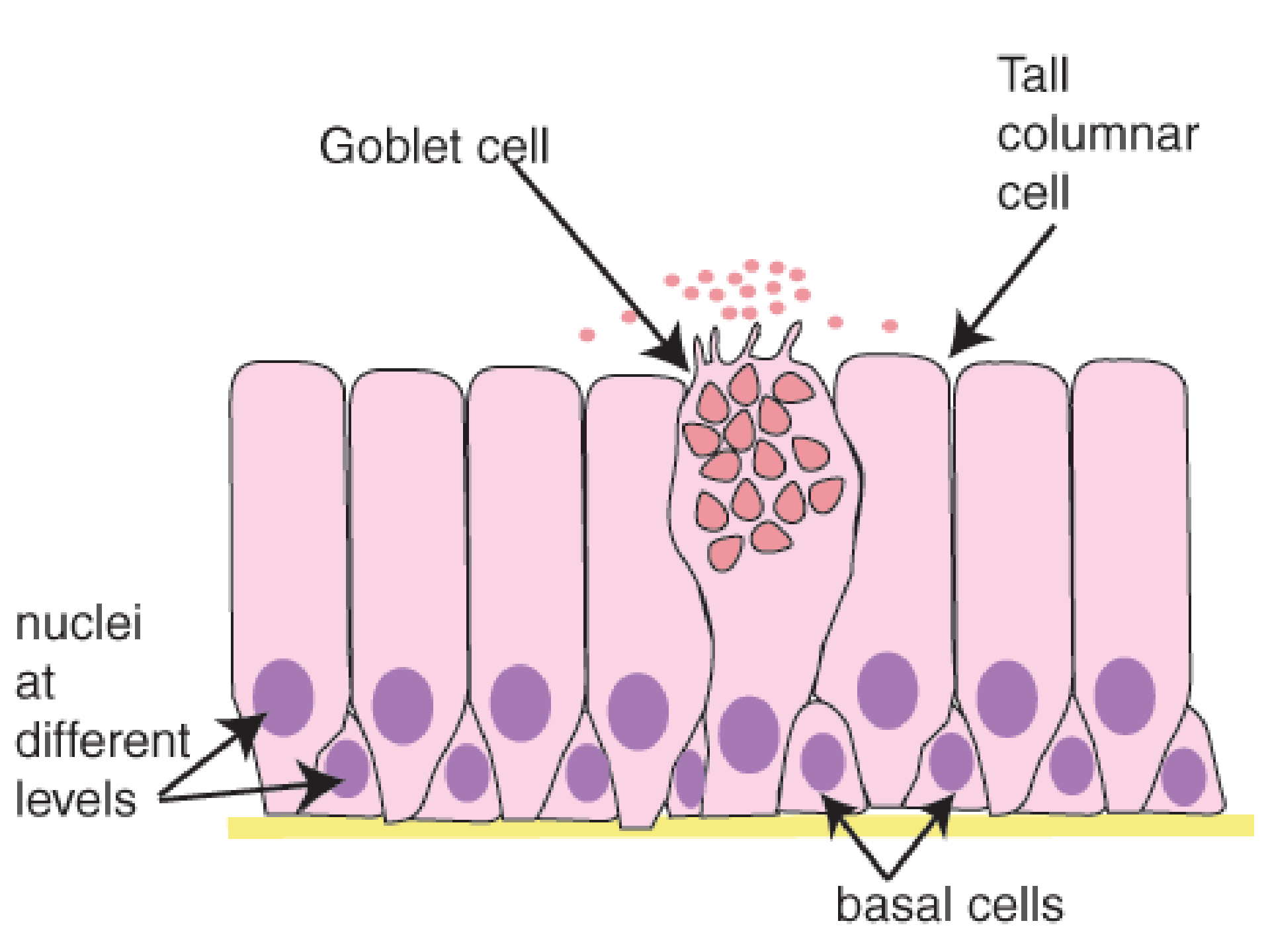
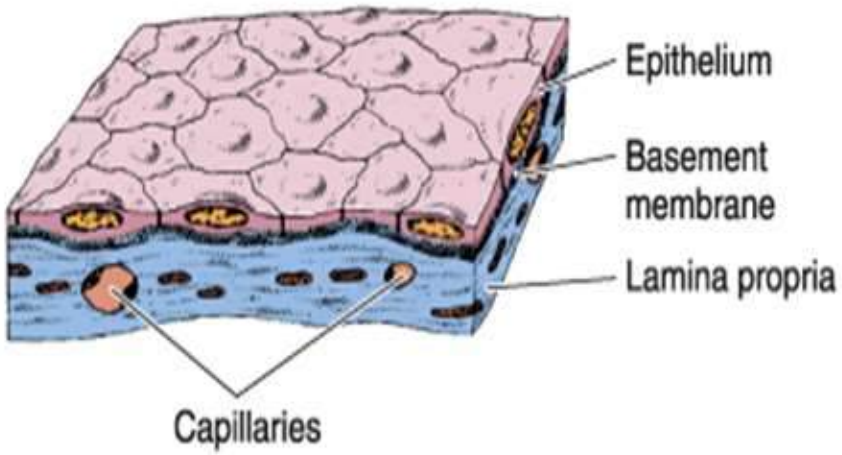


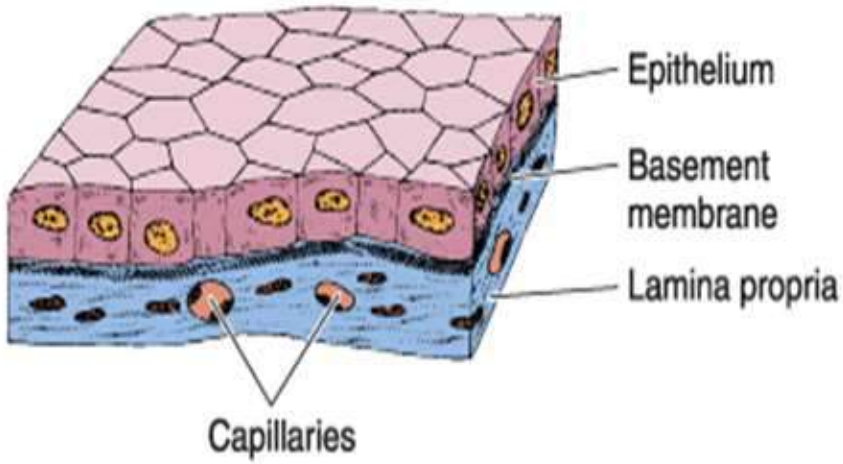
Figure 1. Simple epithelium: (a) Squamous (b) Cuboidal (c) Columnar (d) Columnar cells bearing cilia


Goblet cell
Tall columnar cell
nuclei at different levels
basal cells

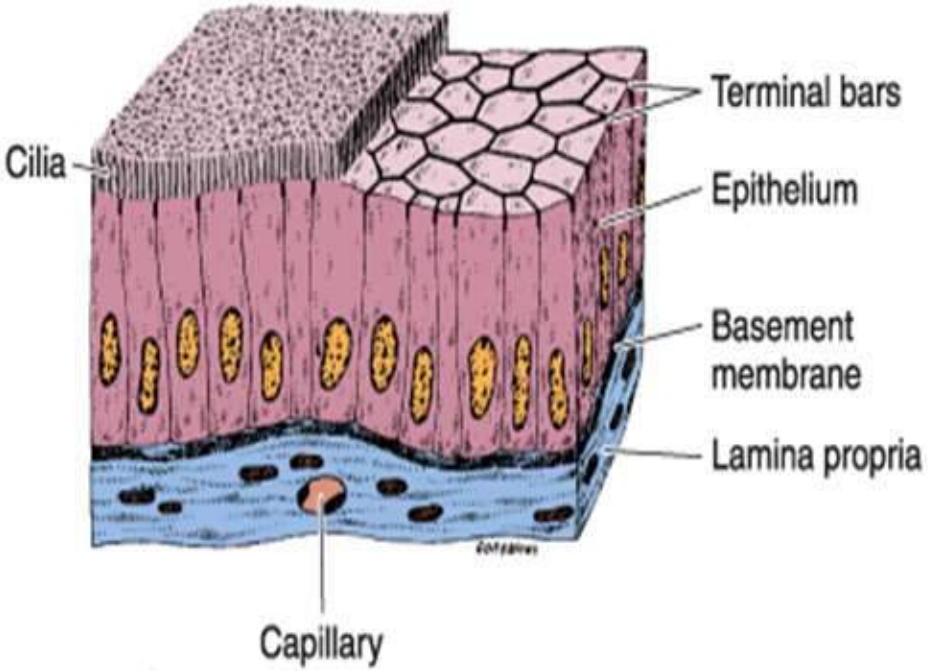
A Simple squamous epithelium



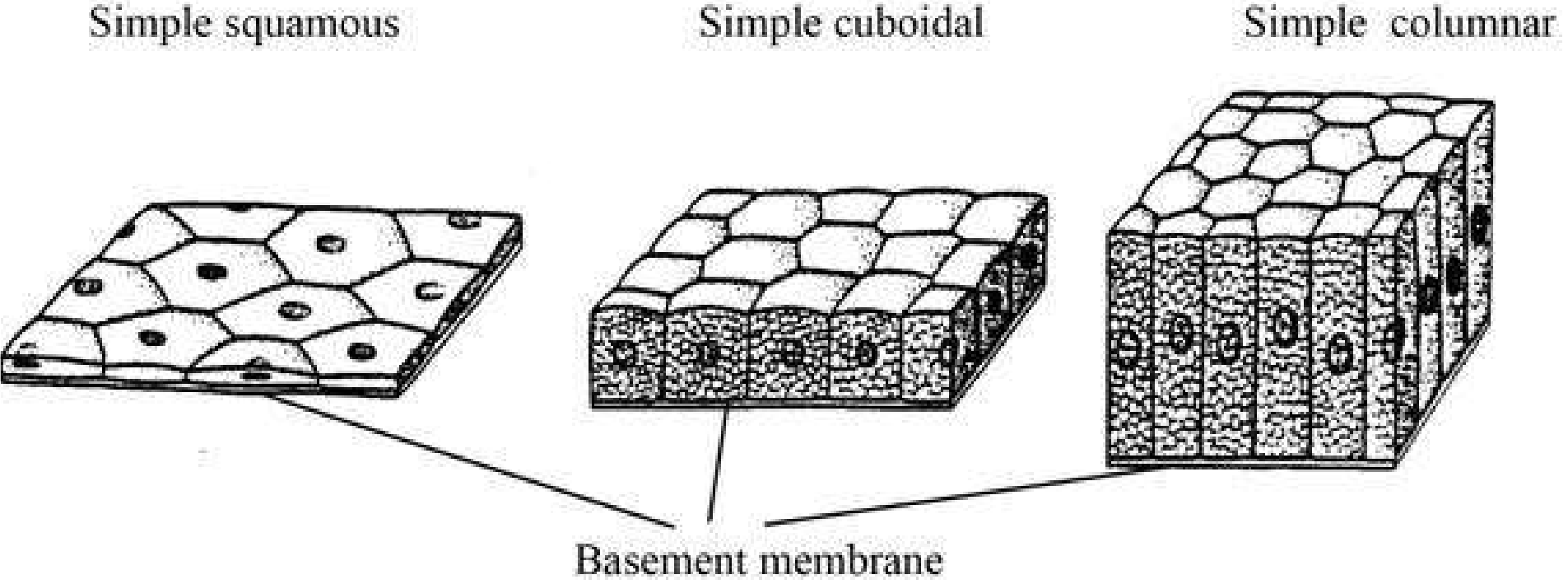
B Simple cuboidal epithelium



C Simple ciliated columnar epithelium



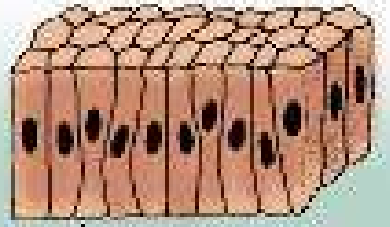
Zonula occludens


Simple squamous
Simple cuboidal
Simple columnar
Basement membrane

Types of Epithelium

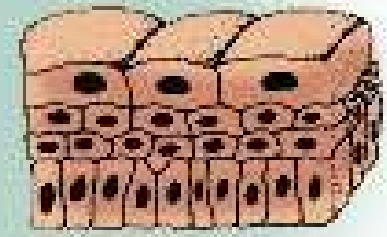
Simple squamous

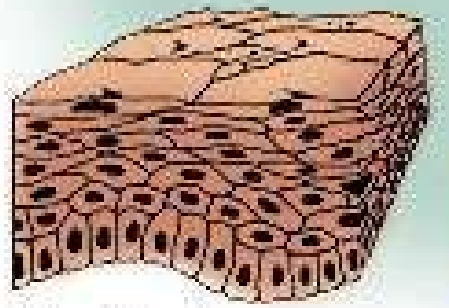
Simple cuboidal



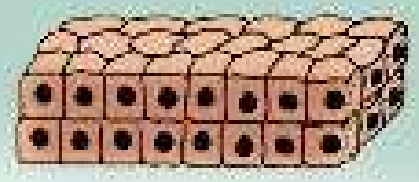
Simple columnar

Transitional

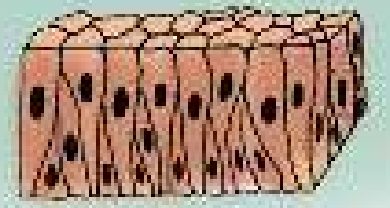




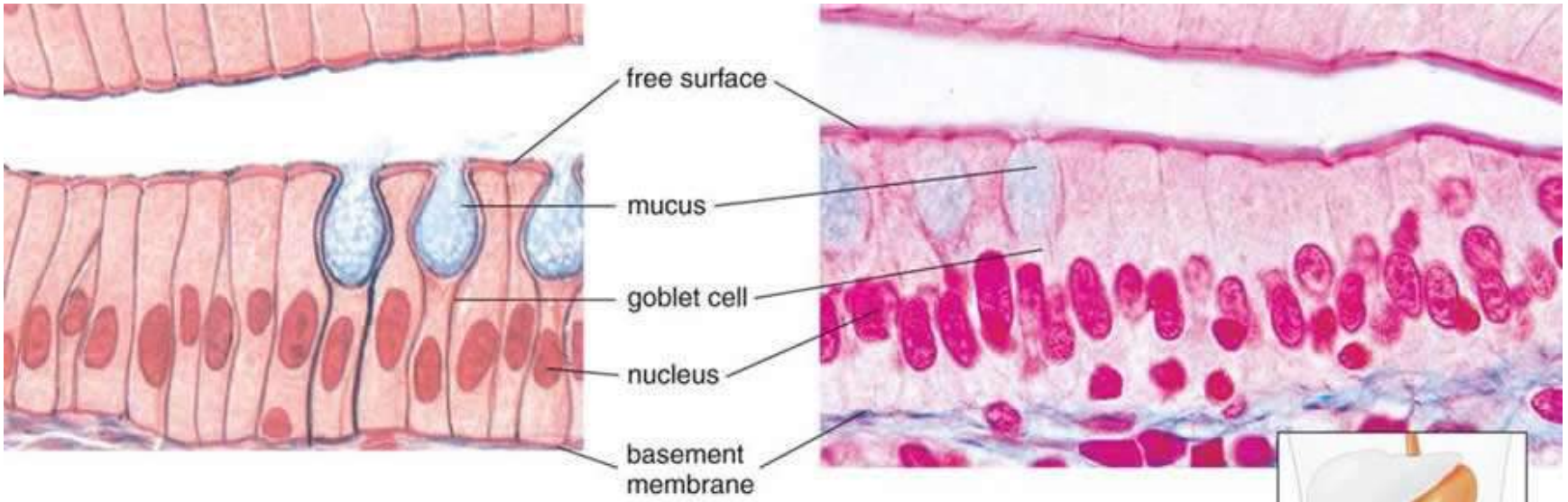
Stratified squamous



Stratified cuboidal



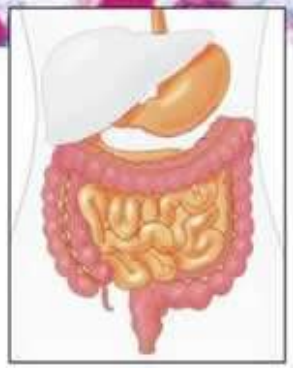
Pseudostratified columnar



Simple Columnar Epithelium

Location:
Lines gastrointestinal tract; the ducts of many glands

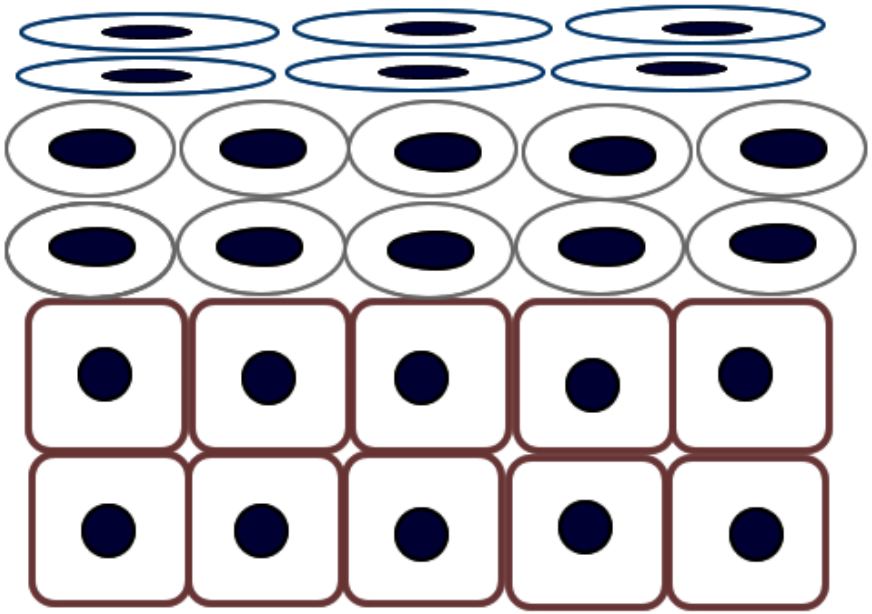
Function:
Protection; secretion; absorption



Epithelial Tissue

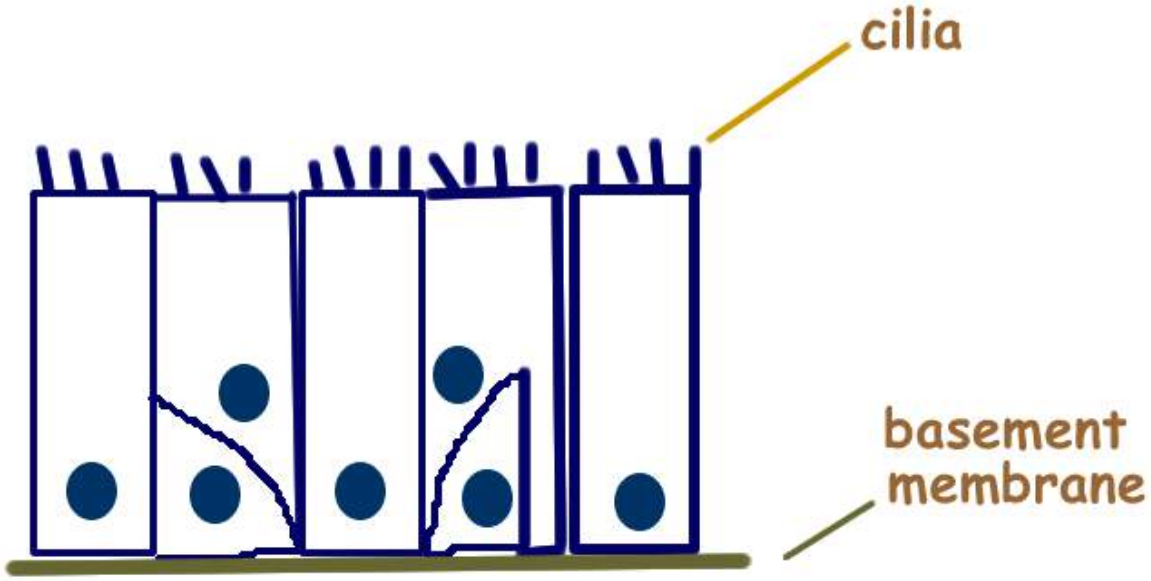
Squamous

Simple Squamous

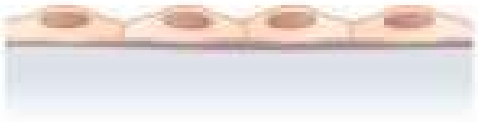
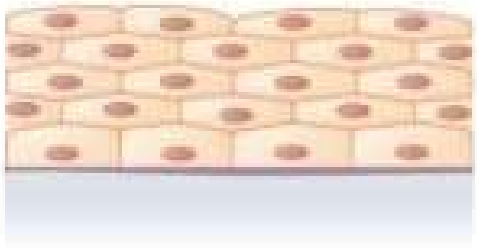
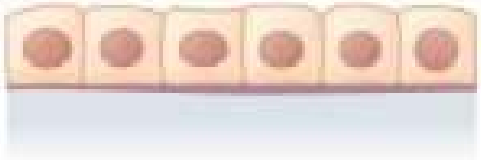
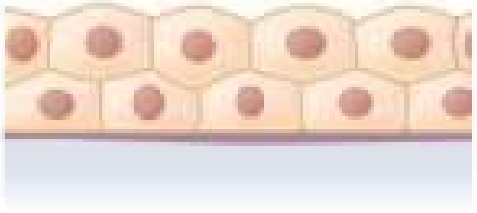
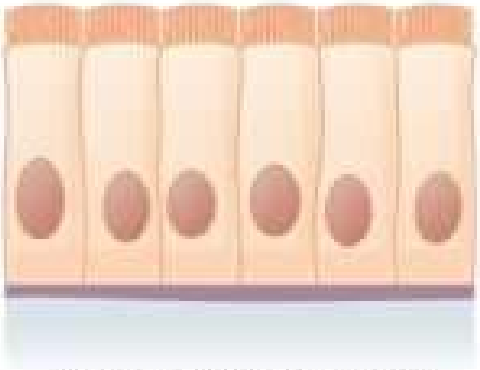
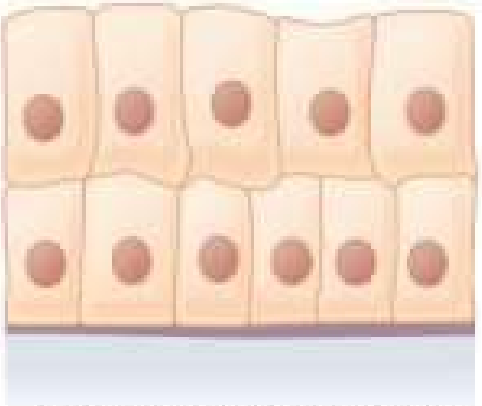
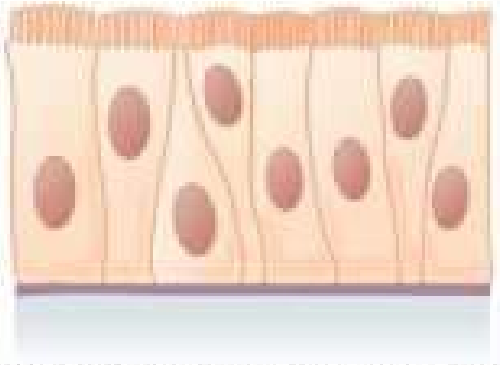


Stratified Squamous

Epithelial Tissues



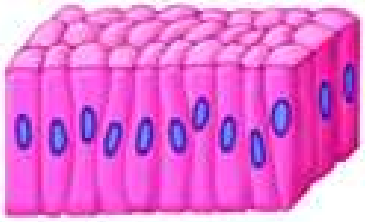
Pseudostratified Columnar epithelia with cilia

	Simple	Stratified	Pseudostratified
Squamous	 Simple squamous epithelium	 Stratified squamous epithelium	
Cuboidal	 Simple cuboidal epithelium	 Stratified cuboidal epithelium	
Columnar	 Simple columnar epithelium	 Stratified columnar epithelium	 Pseudostratified columnar epithelium

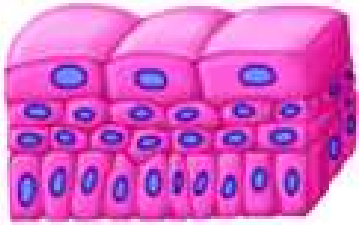
Types of Epithelium

Simple squamous

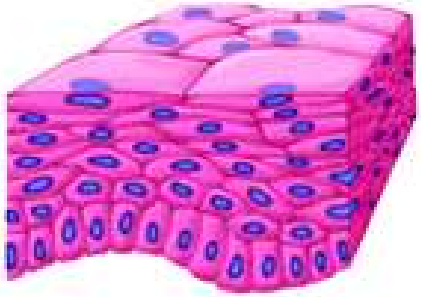
Simple cuboidal



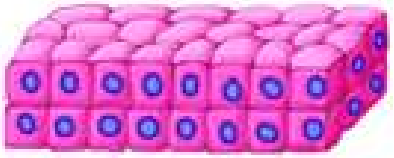
Simple columnar



Transitional

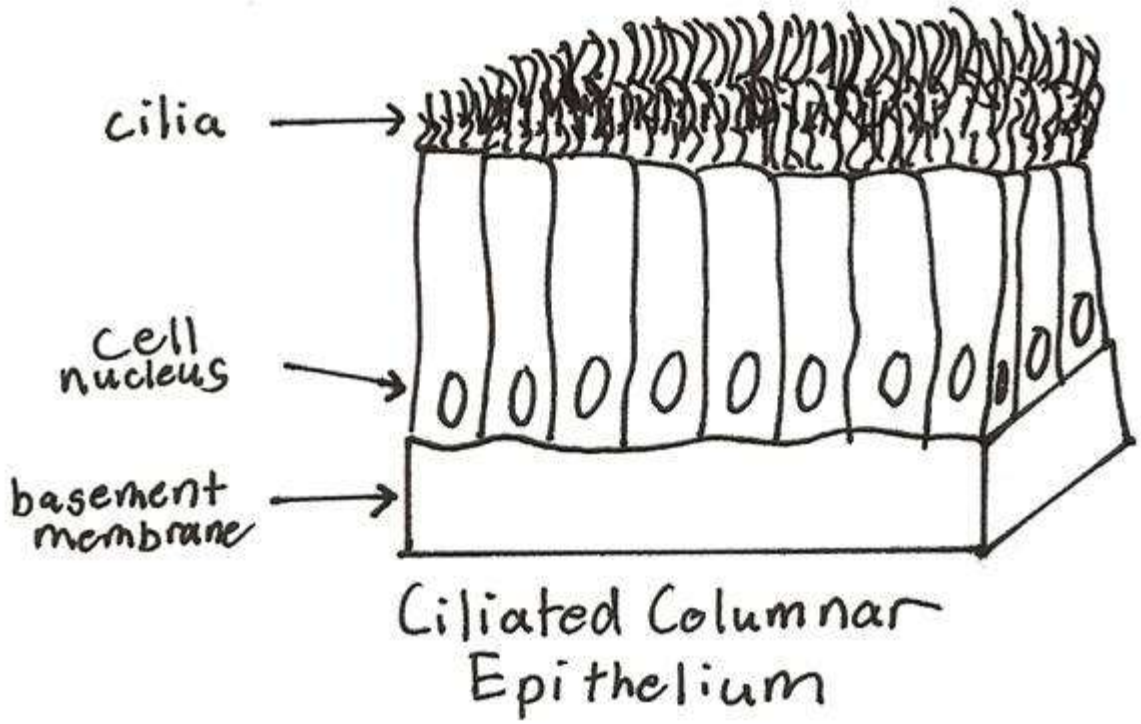


Stratified squamous



Stratified cuboidal

Pseudostratified columnar



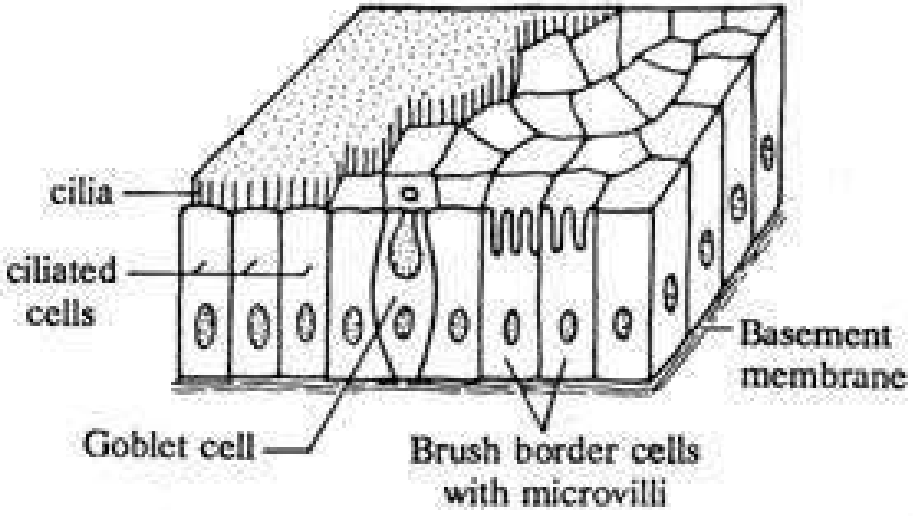
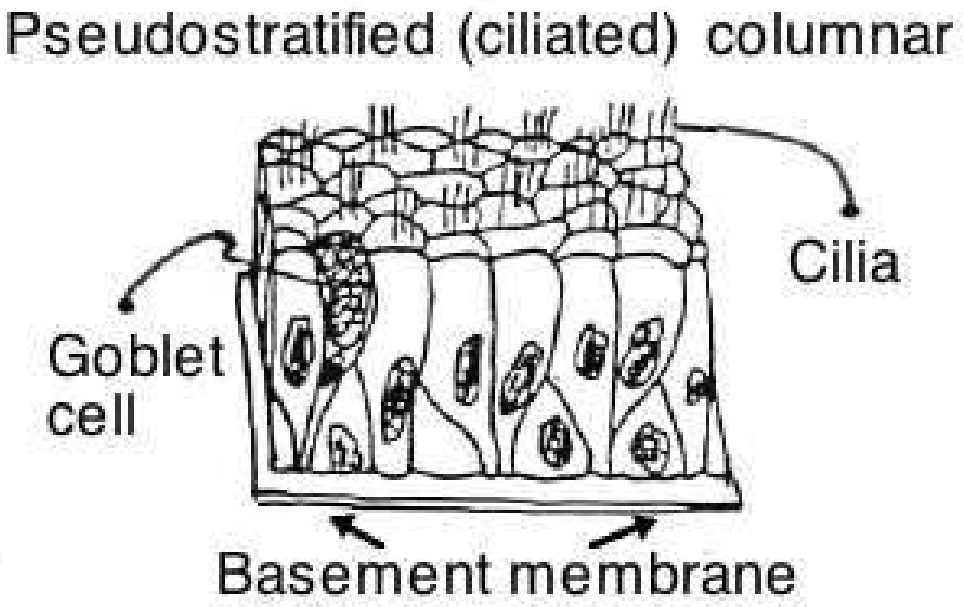
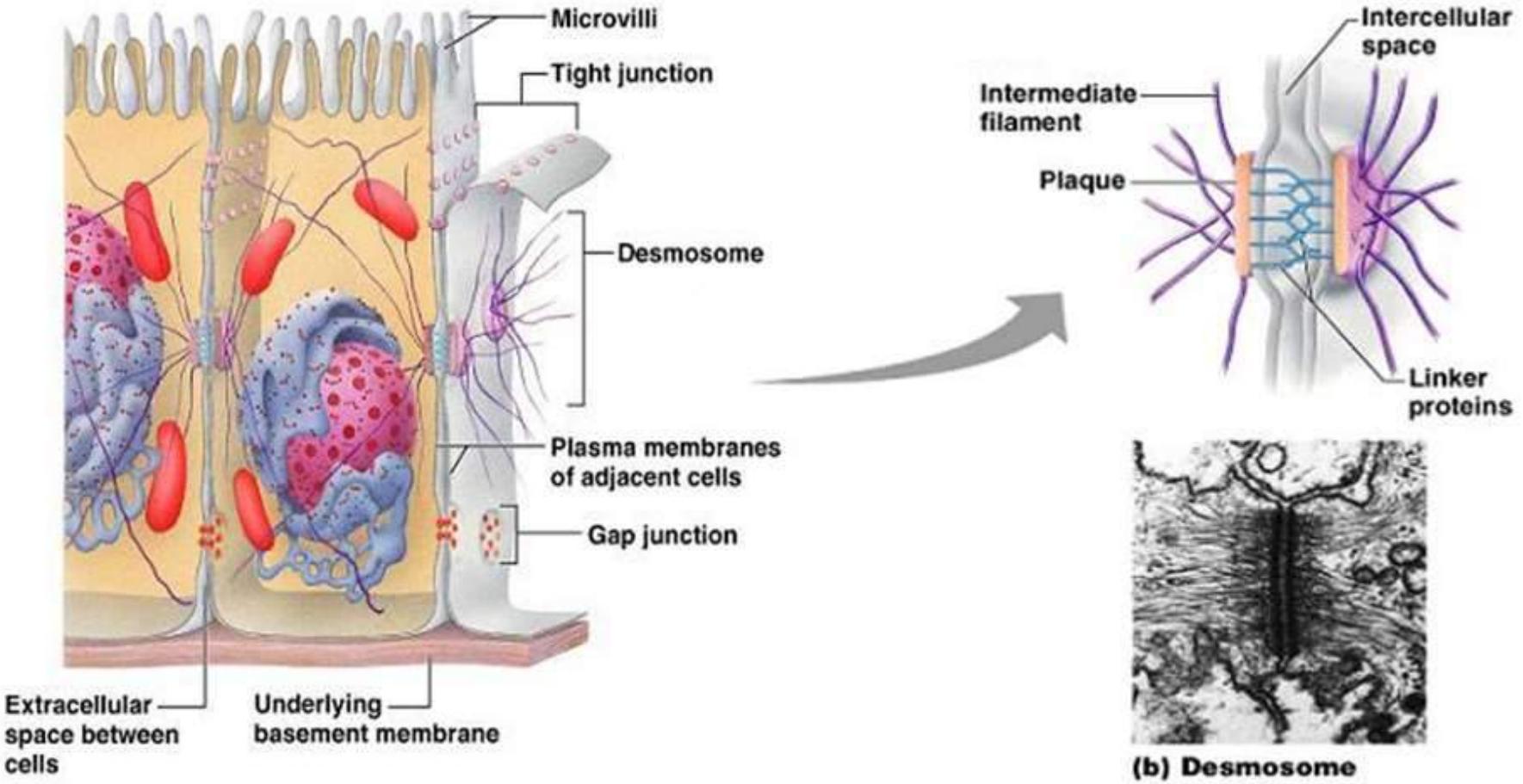
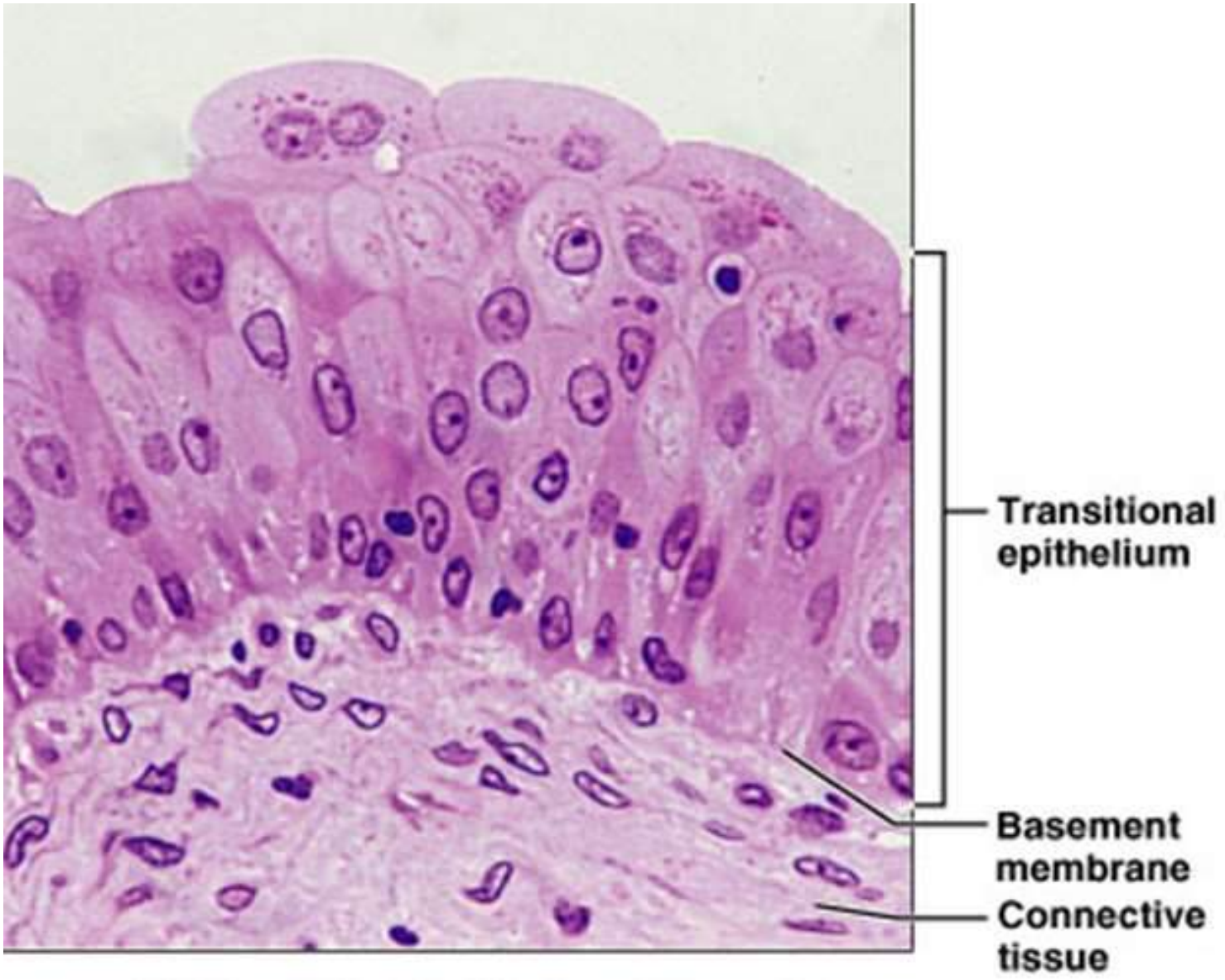


Fig. 4-3 – Simple columnar epithelium

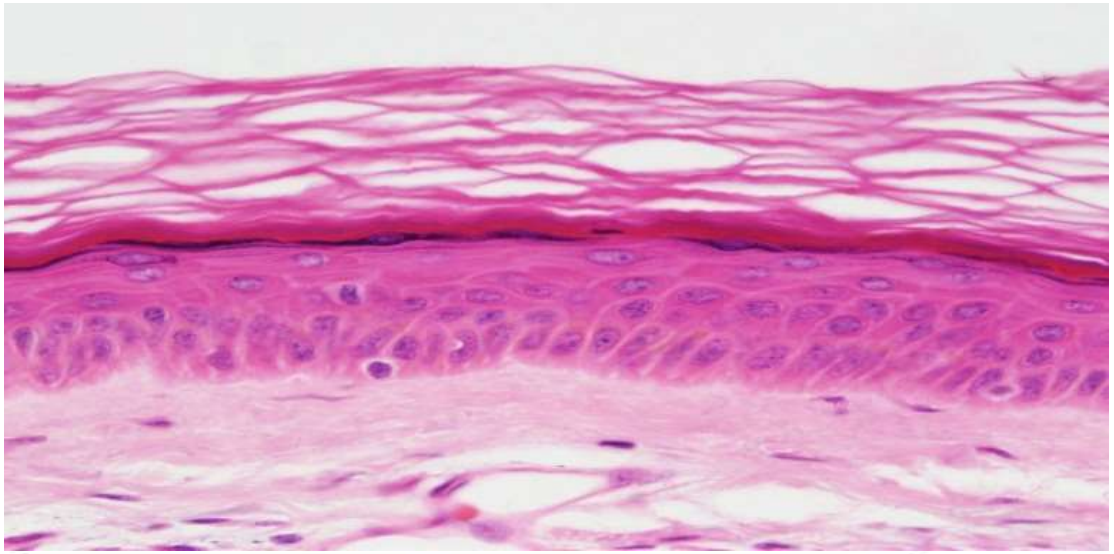


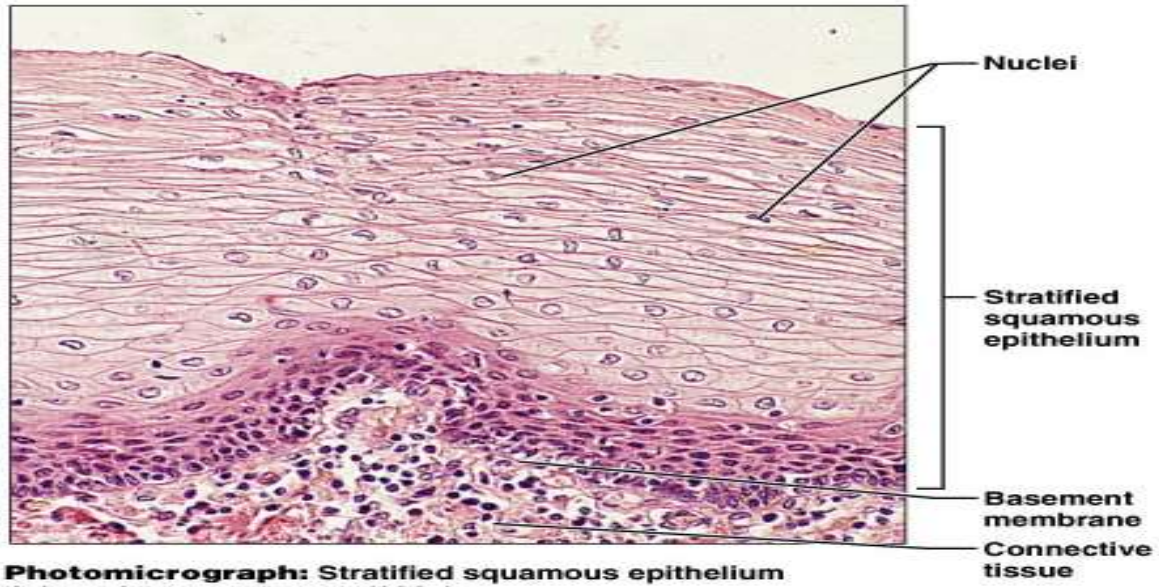

Microvilli
Tight junction
Desmosome
Plasma membranes of adjacent cells
Gap junction
Extracellular space between cells
Underlying basement membrane
Intercellular space
Intermediate filament
Plaque
Linker proteins
(b) Desmosome

Transitional Epithelium



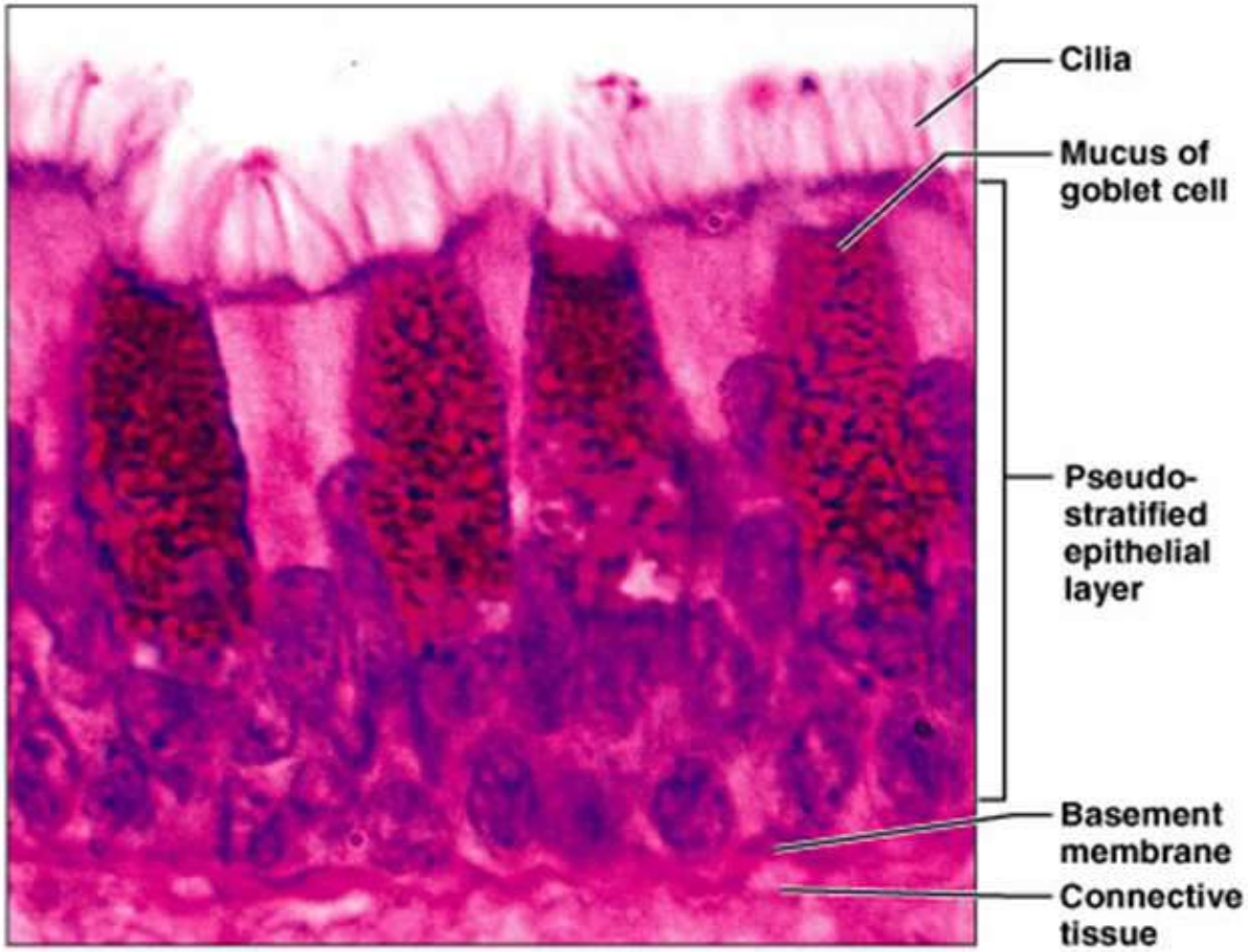
Stratified Squamous Epithelium





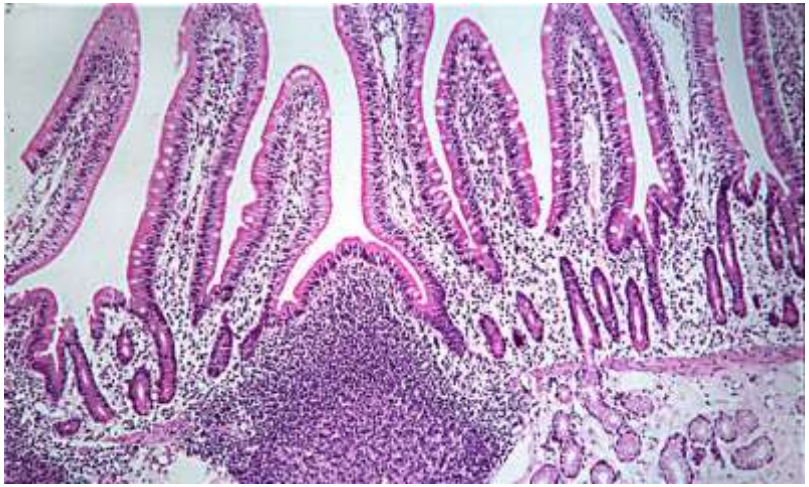
Photomicrograph: Stratified squamous epithelium lining of the esophagus (300×).

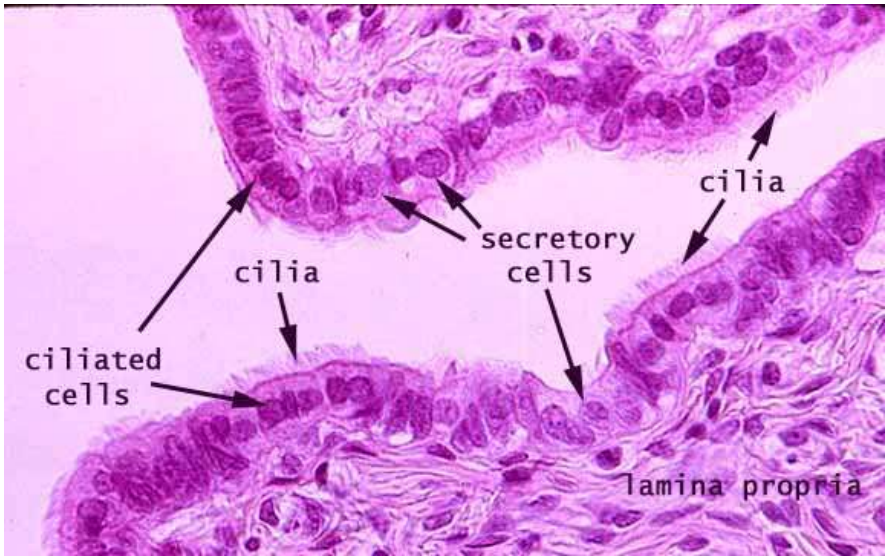
Pseudostratified Columnar Epithelium



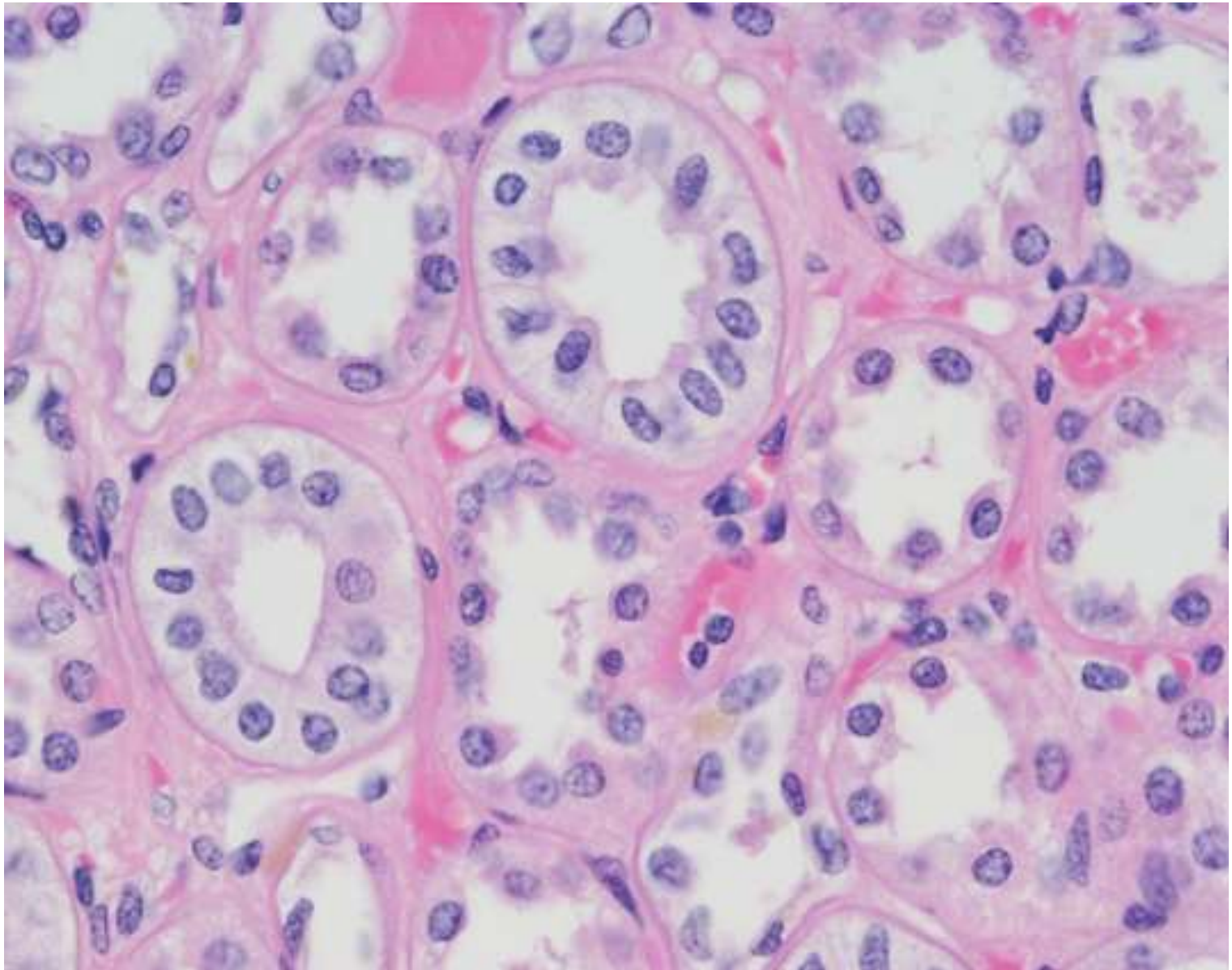
Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (400×).

Simple Columnar Epithelium

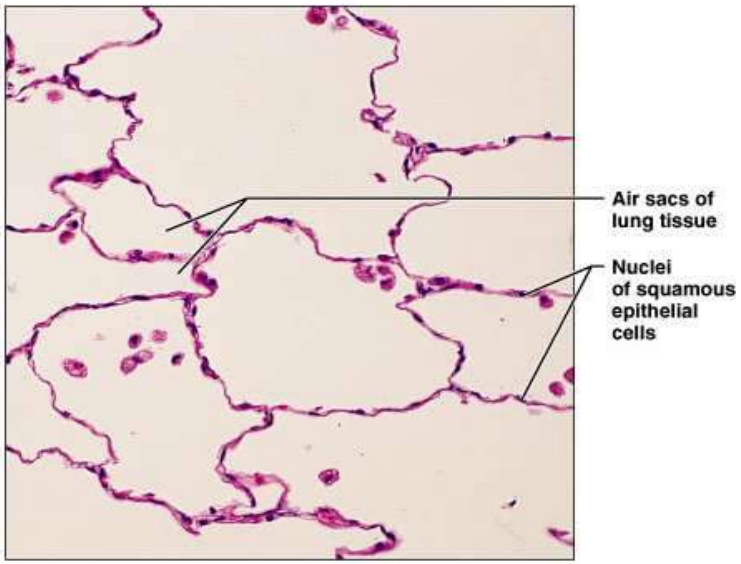




Simple Cuboidal Epithelium

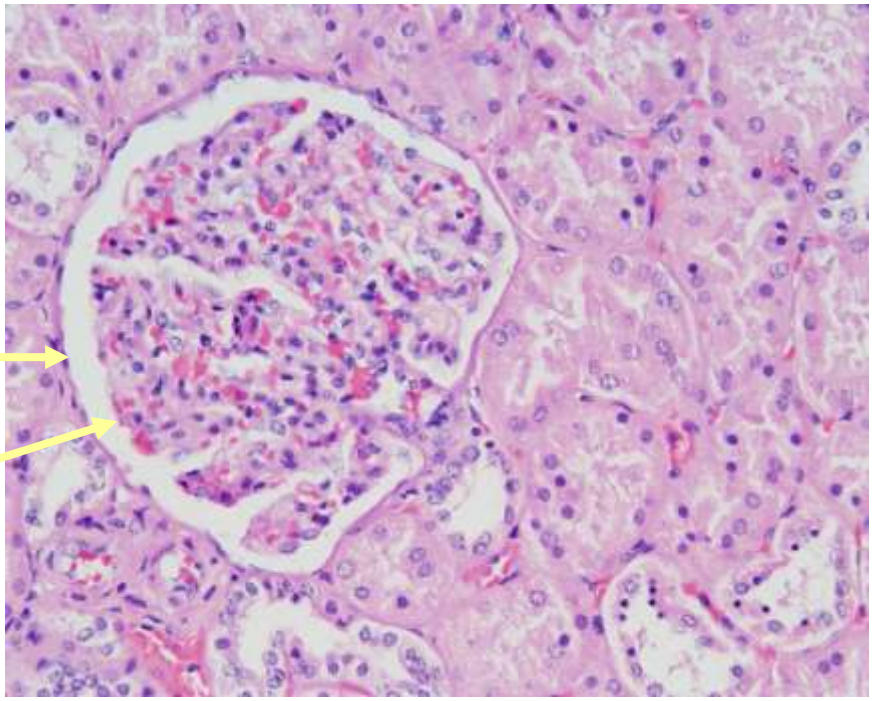


Simple Squamous Epithelium

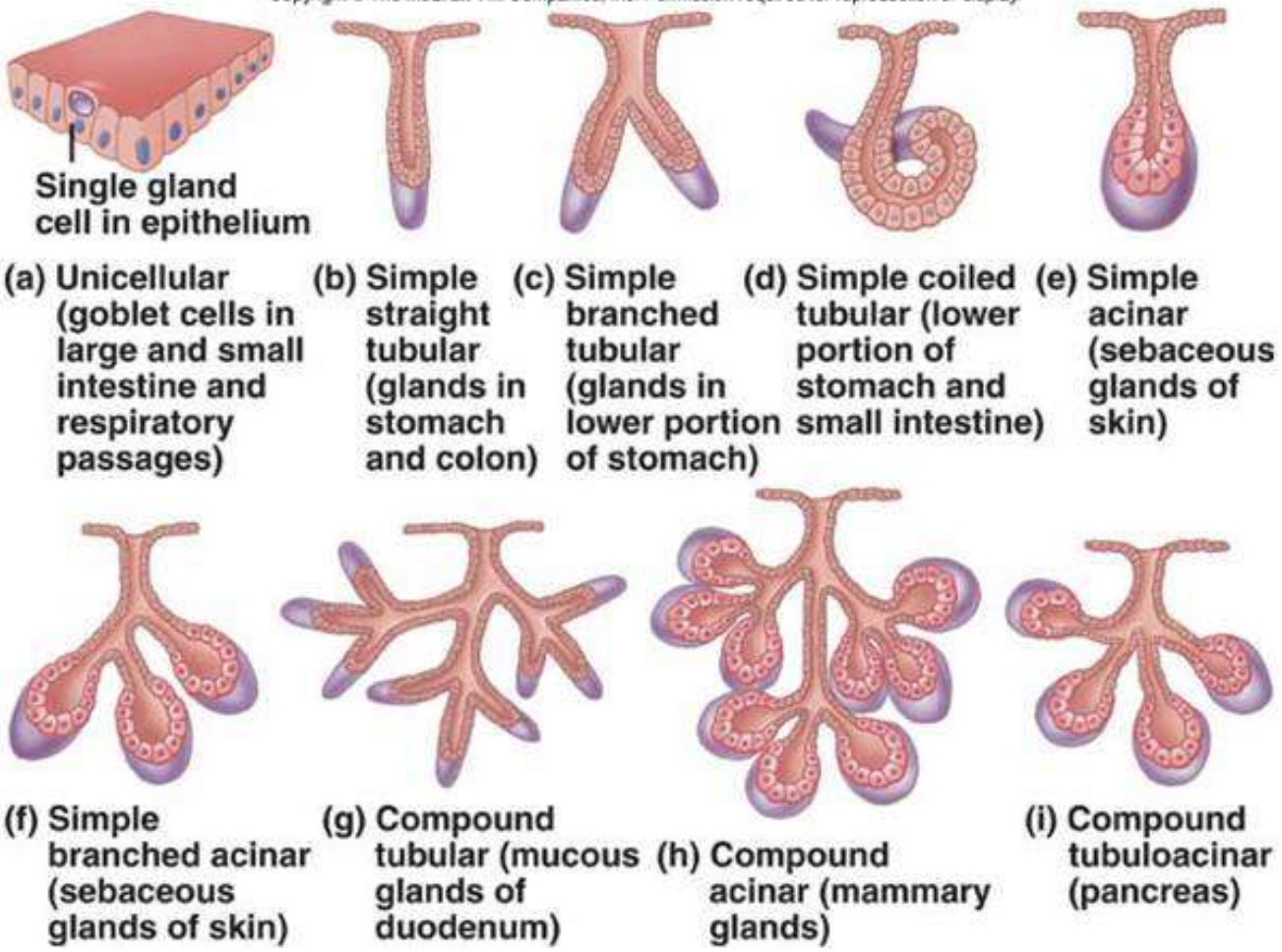


Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (400×).

Simple squamous lining the walls of the capillary



Glands



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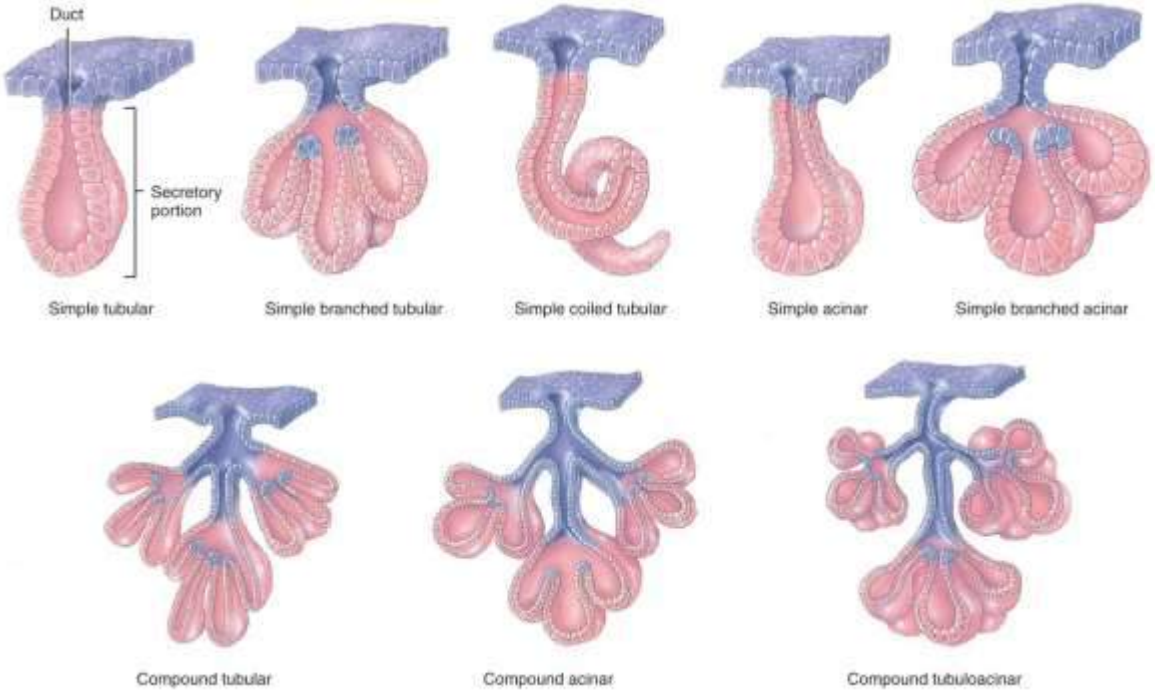
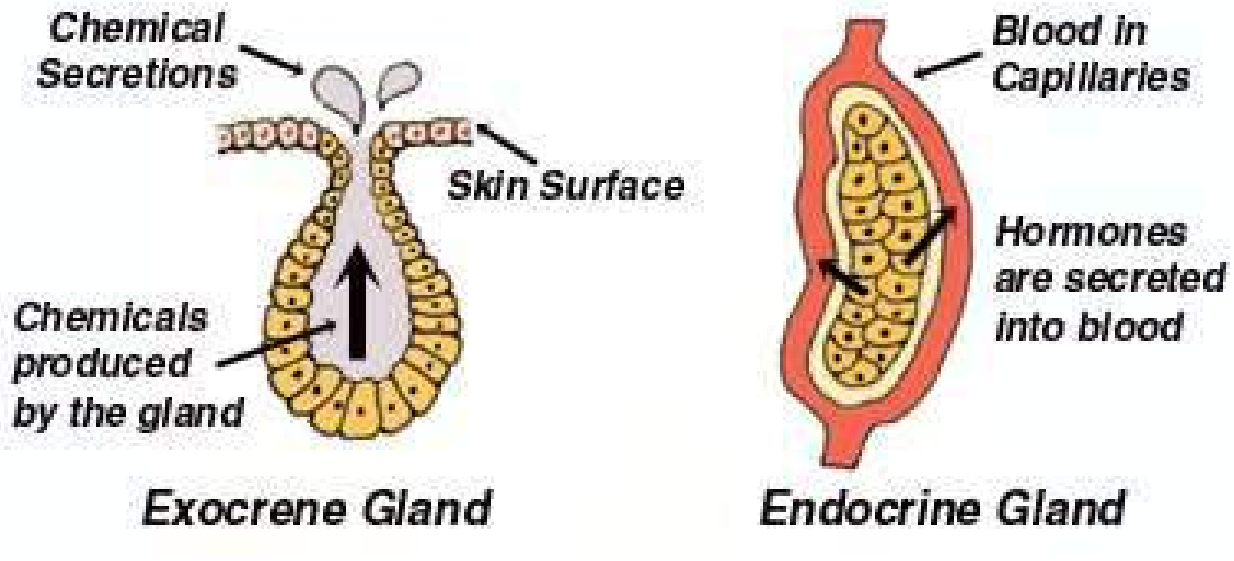
Glands

- As membranous epithelial tissue develops in the embryo, small invaginations from this epithelium into the underlying connective tissue give rise to specialized secretory structures called glands.



Endocrine and exocrine glands

- Glands are classified as either endocrine or exocrine depending upon whether they have a duct connecting the surface.
- **Endocrine glands:** endocrine glands lack ducts and- secrete their products directly into the interstitial fluid and blood stream. The secretions of endocrine glands called hormones act as chemical messengers to influence cell activates elsewhere in the body.
- **Exocrine glands:** typically originate from an invagination of epithelium that burrows into the deeper connective tissue. These glands usually maintain their contact with the epithelial surface by mean of a duct.



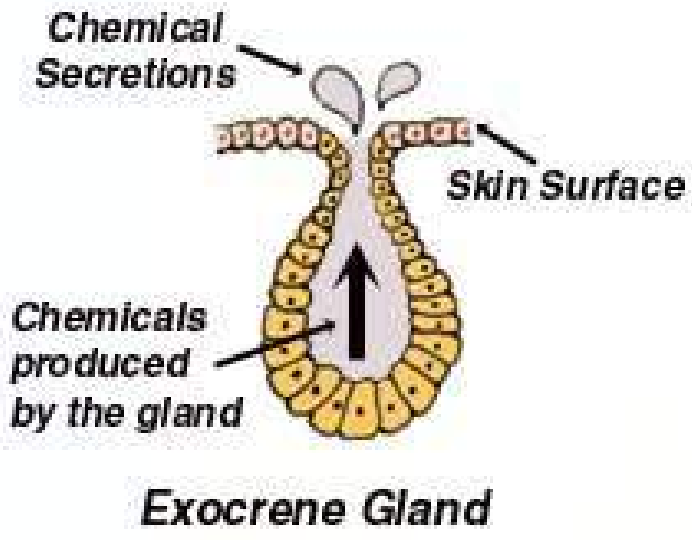
Classification of exocrine glands

- Multicultural exocrine glands maybe classified according to three criteria:

❖Form

❖Structure (morphology)

❖Method of secretion (type of secretion).



Form and structure

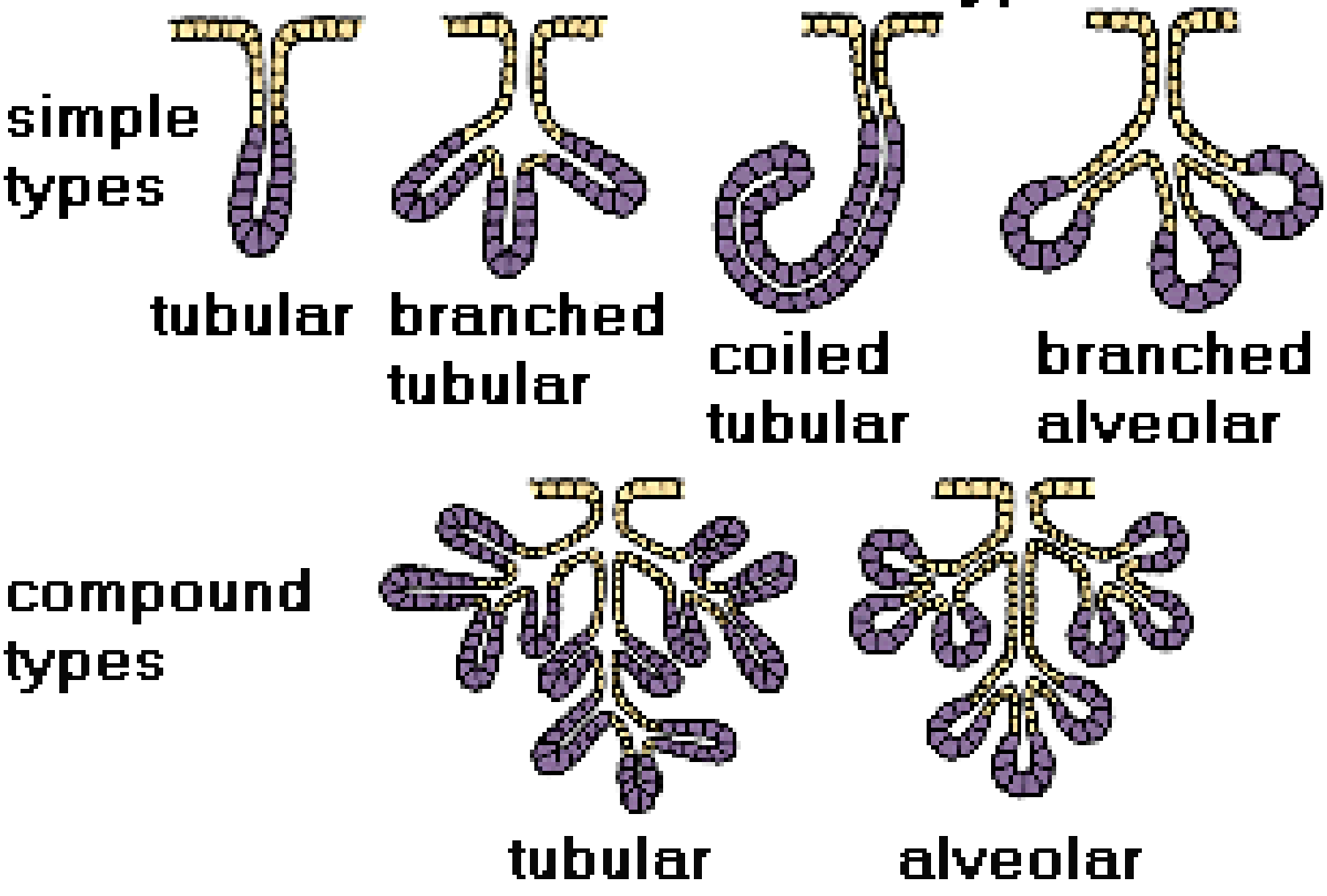
- Based on the structure of their ducts
- Exocrine glands are considered either simple or compound.

1. Simple glands have a single un branched duct
2. Compound glands exhibit branched ducts.

❖ Exocrine glands are also classified according to the organization of their secretory portions.

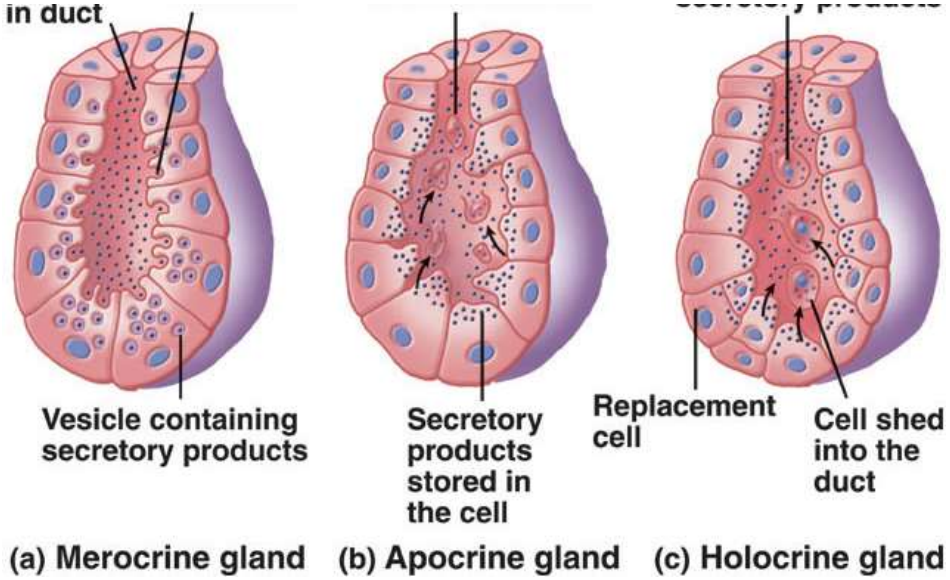
1. If the secretory portions and the duct are of uniform diameter the glands are called tubular.
2. If the secretory cells form an expanded sac, the gland is called a acinar and the sac is an acinus.
3. Finally, a gland with both secretory tubules and secretory acini is called tubuloacinar gland.

Exocrine Gland Types



Secretion types:

- exocrine glands are classified by the nature of their secretions as **serous glands, mucous glands, or mixed glands.**
- **Secretion Methods:**
- Glands can also be classified by their mechanism of discharging secretory products as, **merocrine glands, holocrine glands, or apocrine glands**



Merocrine glands	Holocrine glands	Apocrine glands
a. package their secretions in structures called secretory vesicles.	a. formed from cells that accumulate a product and then the entire cell disintegrates.	a. are composed of cells that accumulate their secretory products within the apical portion of their cytoplasm.
b. the secretory vesicles travel to apical surface of the glandular cell and release their secretion by exocytosis.	b. holocrine secretion is a mixture of the cell fragments and the product the cell synthesized	b. their mode of secretion is a decapitation.
c. the glandular cells remain intact are not damaged in any way by producing the secretion such as lacrimal glands, salivary glands and some sweat glands.	**c.** the ruptured dead cells are continuously replaced by other epithelial cells undergoing mitosis such as sebaceous glands.	c. apical portion of cytoplasm is pinched off into the lumen of the gland such mammary glands and some sweat glands.

Merocrine glands

- a. package their secretions in structures called secretory vesicles.
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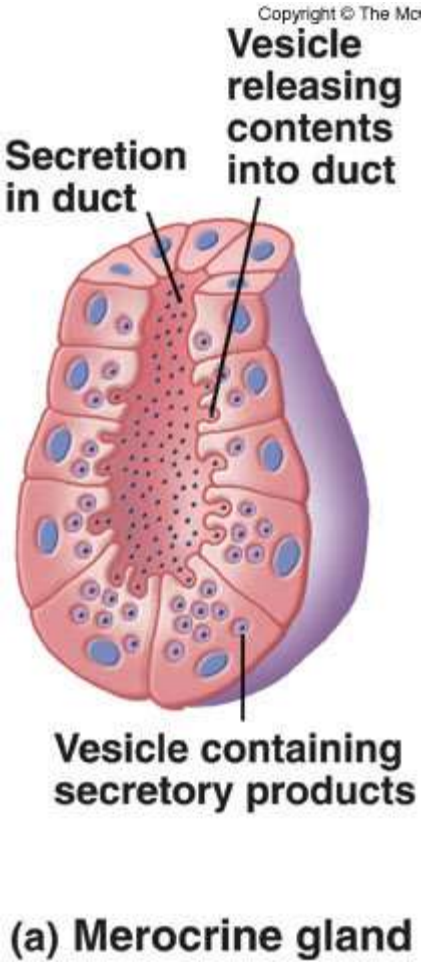
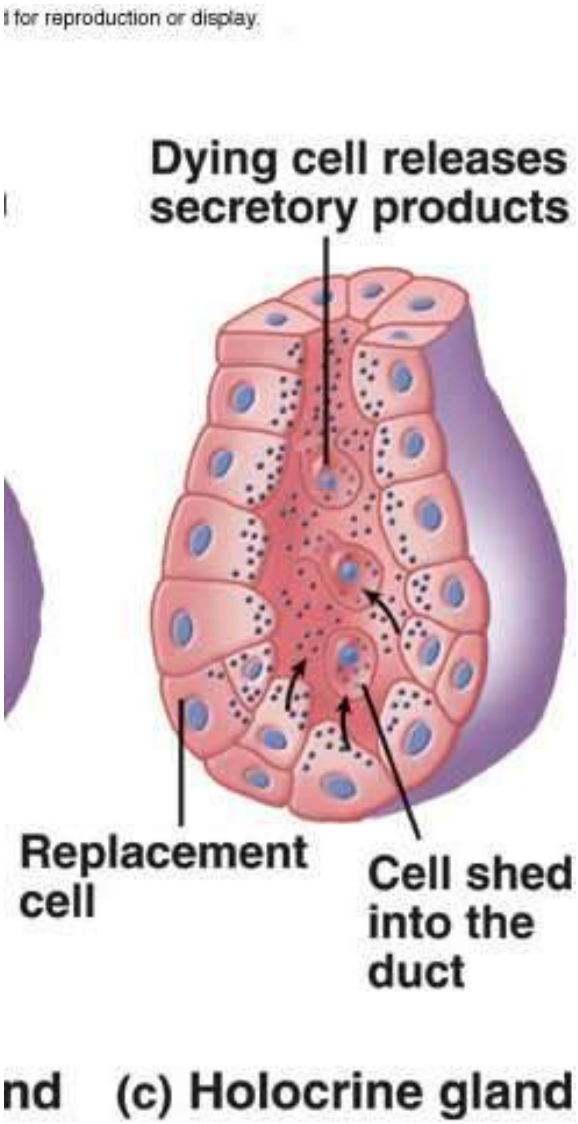


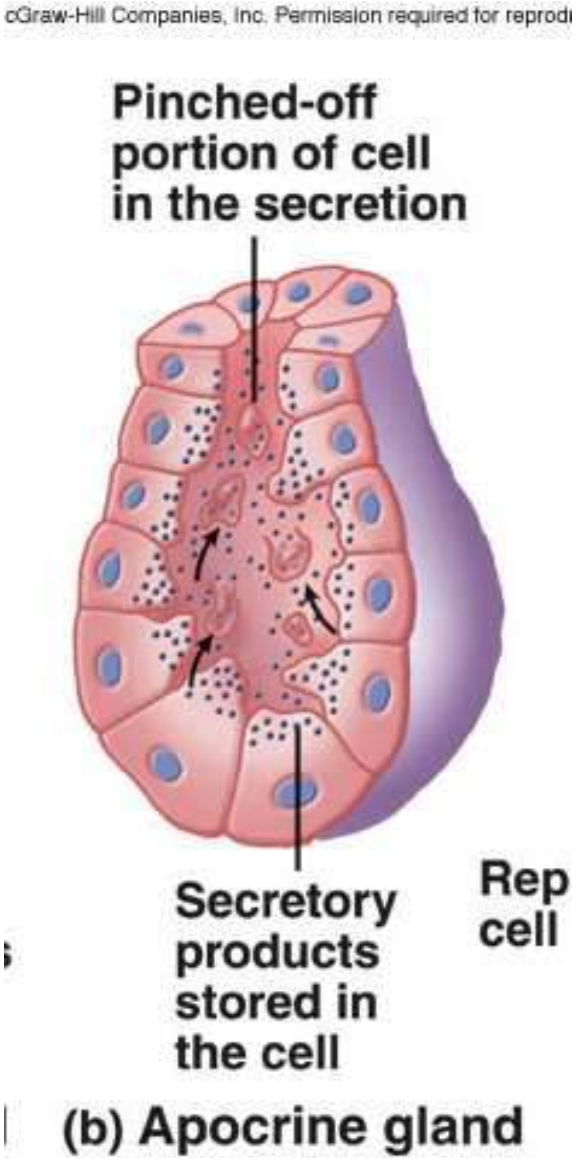
Holocrine glands

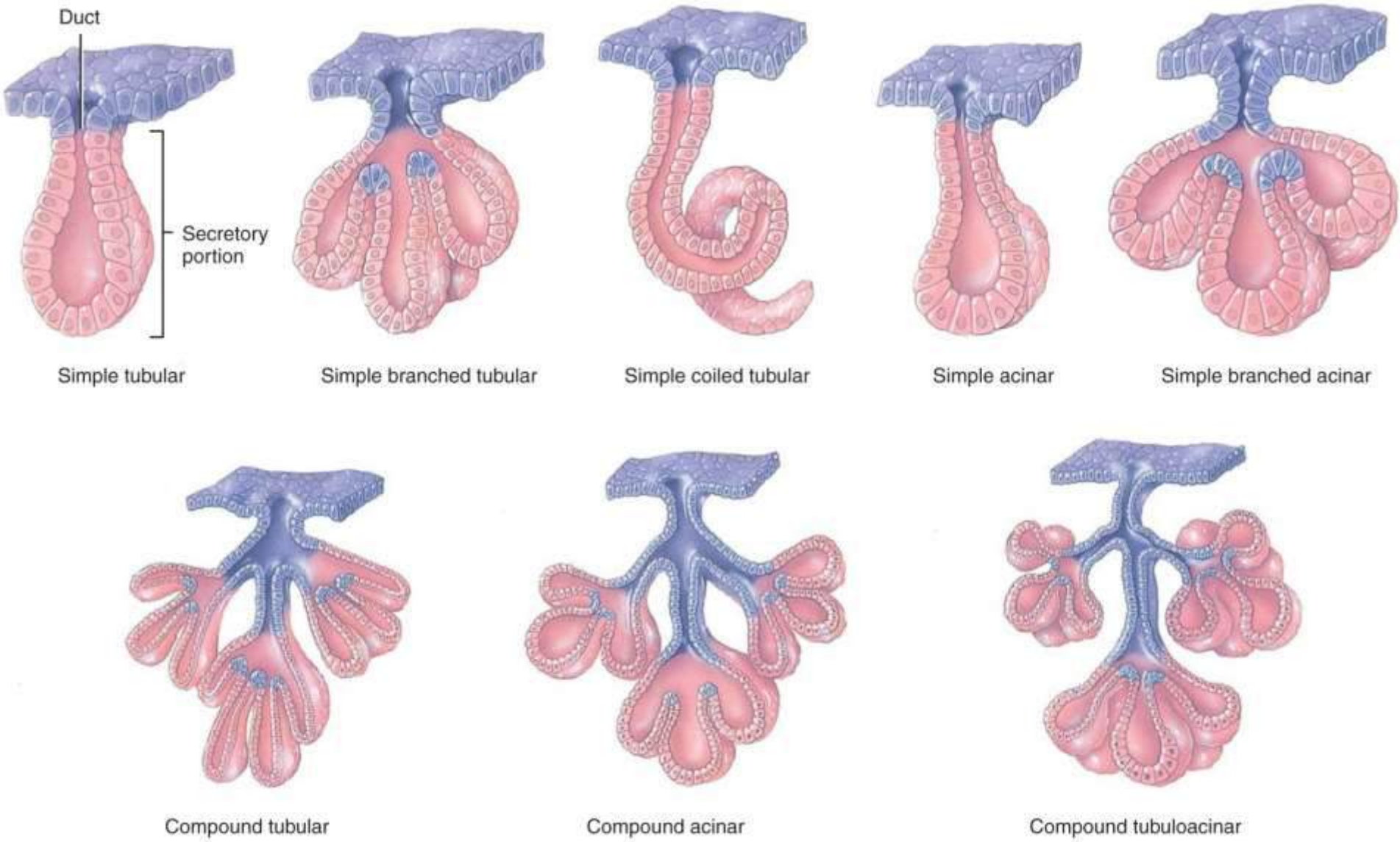
- a. formed from cells that accumulate a product and then the entire cell disintegrates.
- b. holocrine secretion is a mixture of the cell fragments and the product the cell synthesized
- **c.** the ruptured dead cells are continuously replaced by other epithelial cells undergoing mitosis such as sebaceous glands.



Apocrine glands

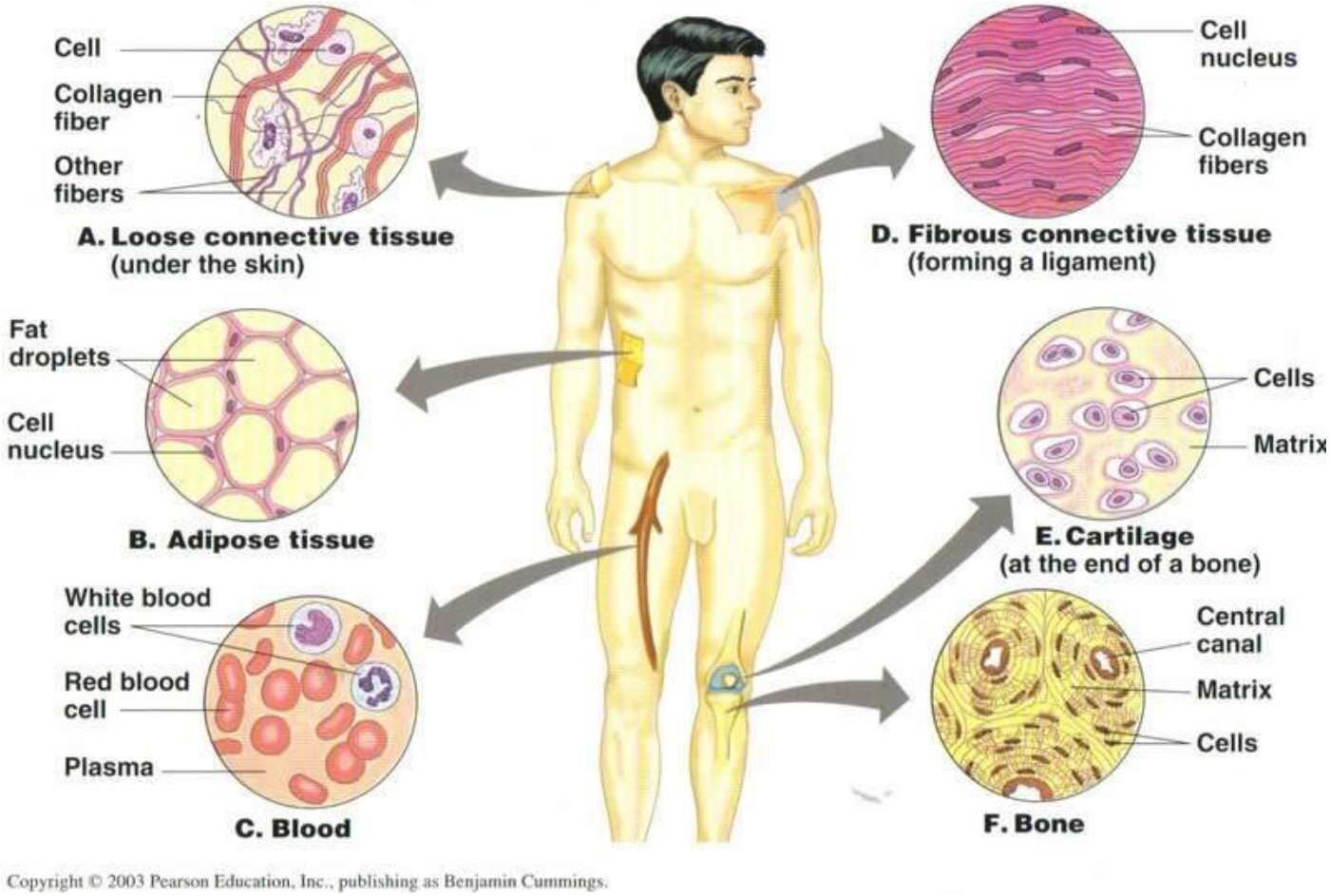
- a. are composed of cells that accumulate their secretory products within the apical portion of their cytoplasm.
- b. their mode of secretion is a decapitation.
- c. apical portion of cytoplasm is pinched off into the lumen of the gland such mammary glands and some sweat glands.




Duct
Secretory portion
Simple tubular
Simple branched tubular
Simple coiled tubular
Simple acinar
Simple branched acinar
Compound tubular
Compound acinar
Compound tubuloacinar

Connective tissue

Fig. 20.5 Types of connective tissue



Lec. Dr.Ruwaidah F. Khaleel

Connective tissue

- **is designed to support, protect, and bind organs, as its name implies.**

✓ **Connective tissue includes:**

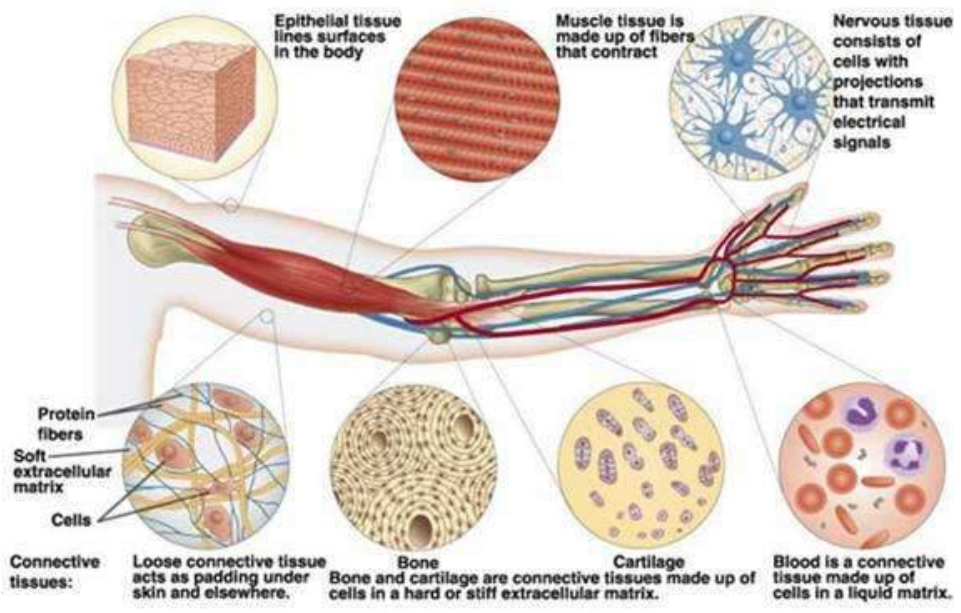
❖ Fibrous tendons and ligaments

❖ Body fat

❖ Cartilage that connects the ends of ribs to the sternum.

❖ Bones of the skeleton

❖ Blood.

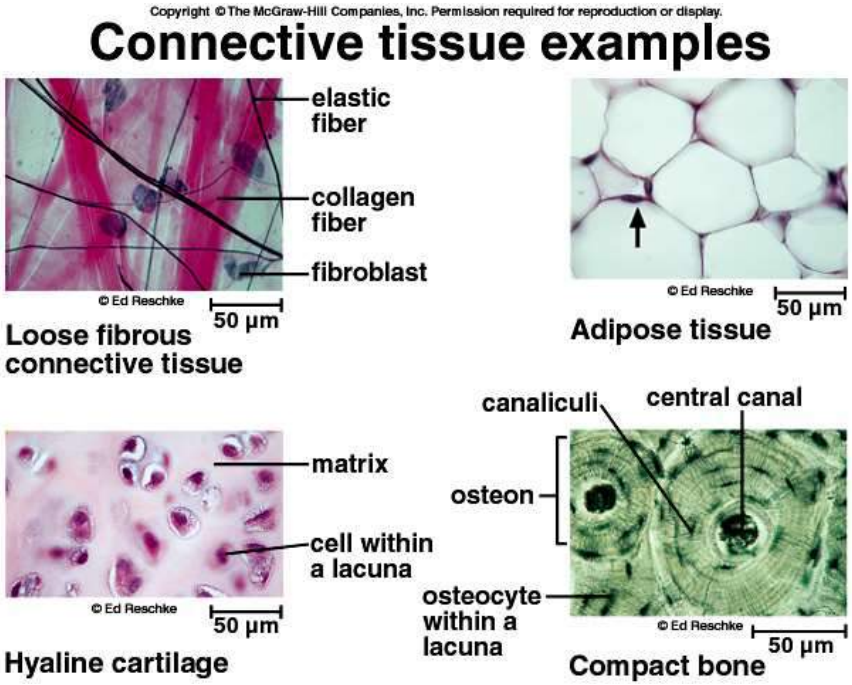


Characteristics of connective Tissue

- Although the types of connective tissue are diverse,

❑ **All of them share three basic components**

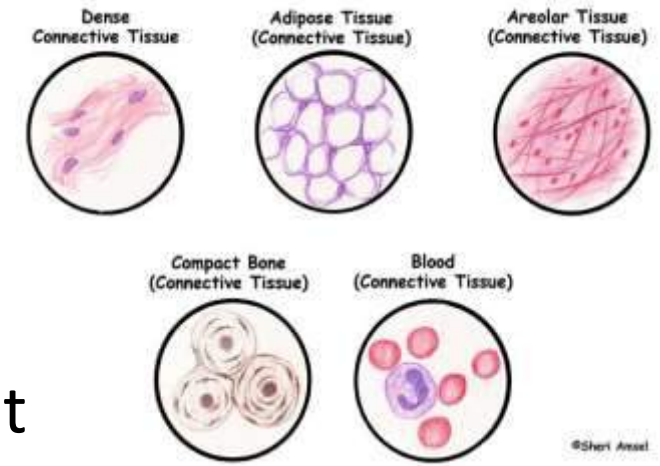
1. **cells**
2. **Protein**
3. **Fibers**
4. **Ground substance.**



The diversity is due to varying proportions of these components:

1. Cells

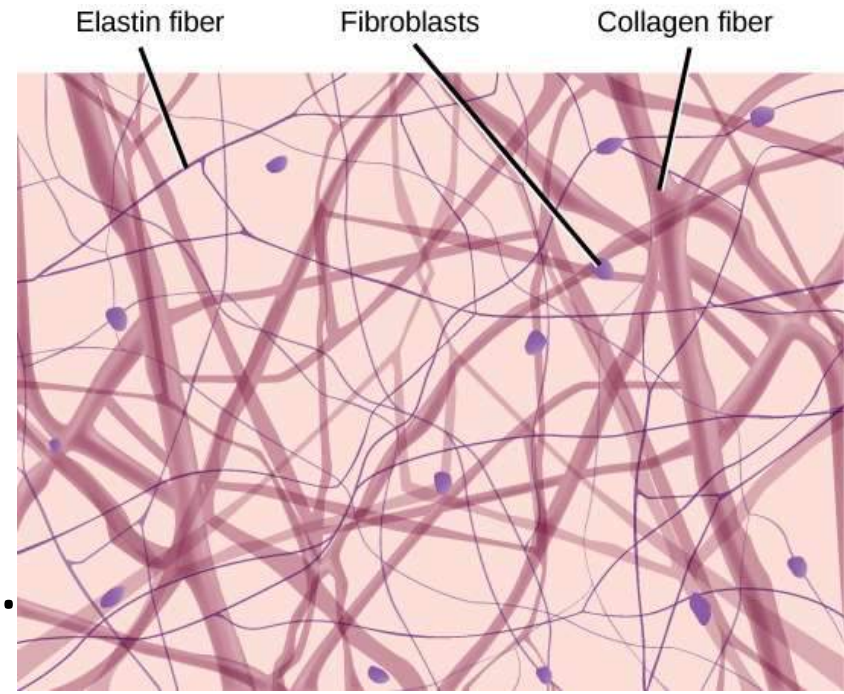
1. Connective tissue contains specific types of cells, depending on its type, for example, connective tissue proper contains fibroblast, fat contains adipocytes, cartilage contain chondrocytes, and bone contains osteocyte.
2. Many connective tissues contain white blood cells, such as macrophages, which phagocytize (eat up) foreign material.
3. Most connective tissue cells are not in direct contact with each other but are scattered throughout the tissue.



2. *Protein Fibers*

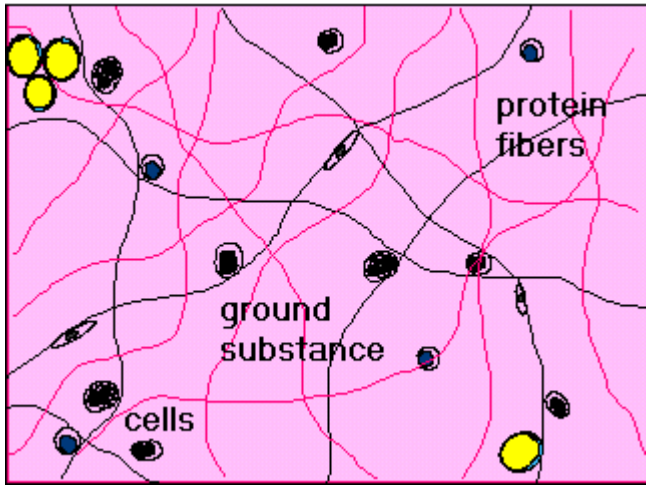
- Most connective tissue contains protein fibers throughout the tissue. These fibers strength and support connective tissue.
- **Three basic types of protein fibers may be found in Connective tissue:**

1. Collagen Fibers, which are strong and strong - resistant.
2. Elastic Fibers, which are Flexible and resilient.
3. Reticular Fibers, which Form an interwoven Framework.



3. Ground substance

- Both the cells and the protein fibers reside within a material called **ground substance**.
- **ground substance :** its nonliving material is produced by the connective tissue cells. It primarily consists of molecules composed of protein and carbohydrate and amount of water. The ground substance may be viscous (as in blood), semisolid (as in cartilage), or solid (as in bone).



- **Together, the ground substance and the protein fibers form an extra cellular matrix.**

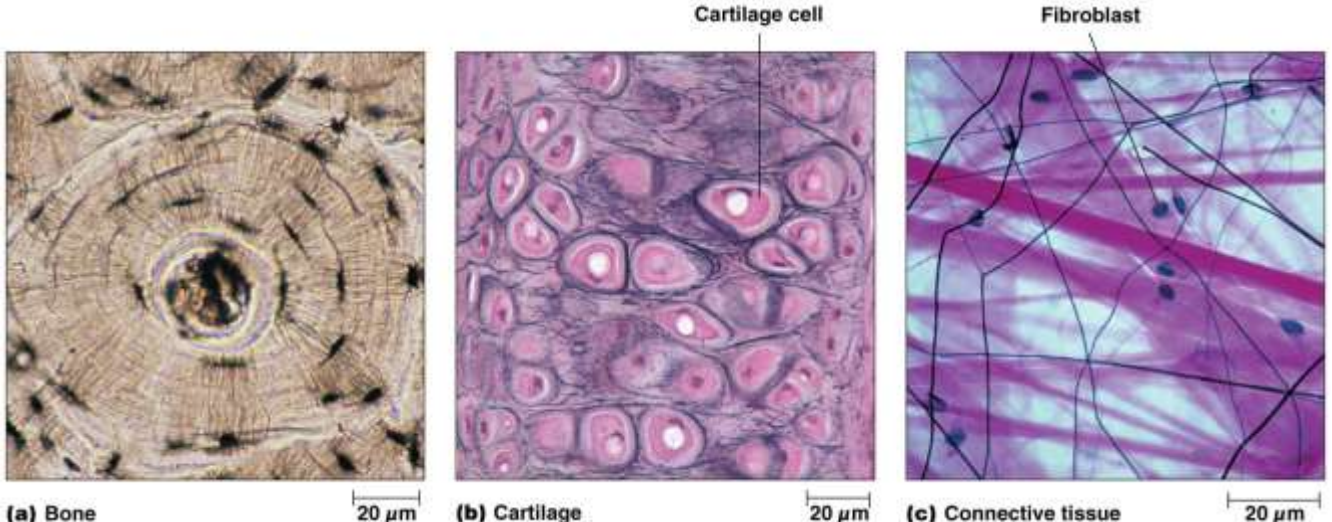
Functions of connective Tissue

1. Physical protection

- The bones of the cranium, sternum, and thoracic cage protect delicate organs, such as the brain, heart and Lungs: Fat Packed around the kidneys and at the posterior side of the eyes within the skull protects these organs.

2. Support and structural Framework

- Bones support the soft tissues of the body and provide the framework for the adult body: cartilage supports such body structures as the trachea. Bronchi, ears, and nose: connective tissue sheets form capsules to support body organs such as the spleen and kidney.



3. Binding of structures:

- Ligments bind bone to bone tendons bind muscle to bone: dense irregular connective tissue binds skin to underlying muscle and bone.

4. Storage:

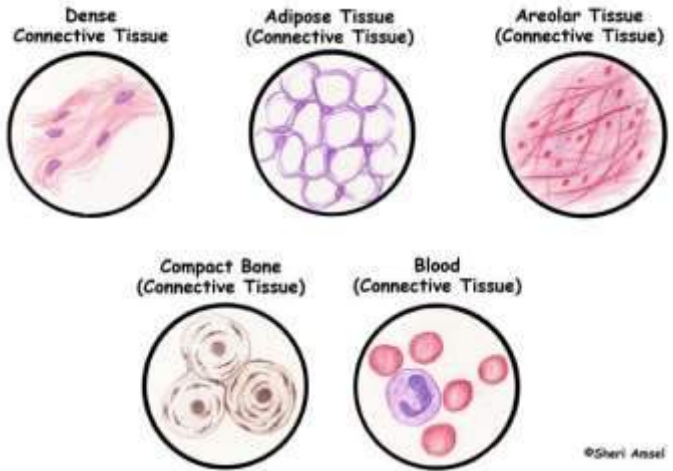
- Fat is the major energy reserve in the body: bone is large reservoir for calcium and phosphorus.

5. Transport:

- Blood carries nutrients: gases, hormones, wastes, and blood cells between different regions of the body.

6. Immune protection:

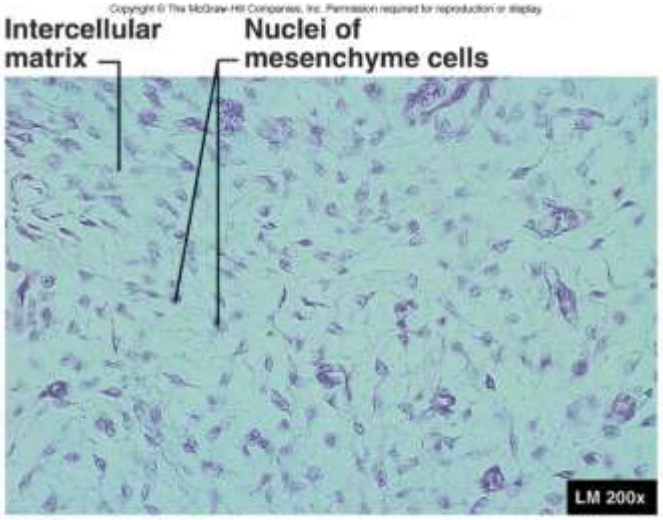
- Many connective tissues contain white blood cells (leukocytes), which protect the body against disease and mount an immune response when the body is exposed to something foreign.



Development of connective Tissue

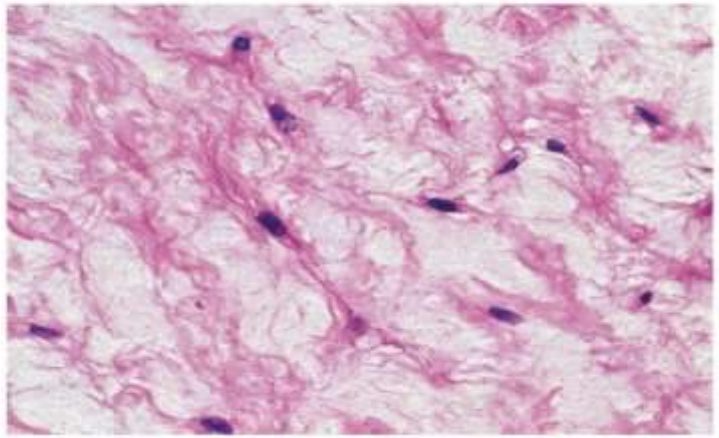
- The primary germ layer mesoderm forms off connective tissue.
- There are two types of embryonic connective tissue:

1. **Mesenchyme:** is the first type connective tissue to emerge. It has star - shaped or spindle - shaped cells dispersed within a gel - like ground substance that contains fine protein fibers. Mesenchyme is the source of all other connective tissues. Adult connective tissues often house numerous mesenchyme of (stem) following damage or injury.
2. **Mucous connective tissue:** The collagen fibers in mucous connective tissue are more numerous than those within mesenchyme. Mucous connective tissue is primarily located within the umbilical cord, it is absent in adults.



(a) Mesenchyme

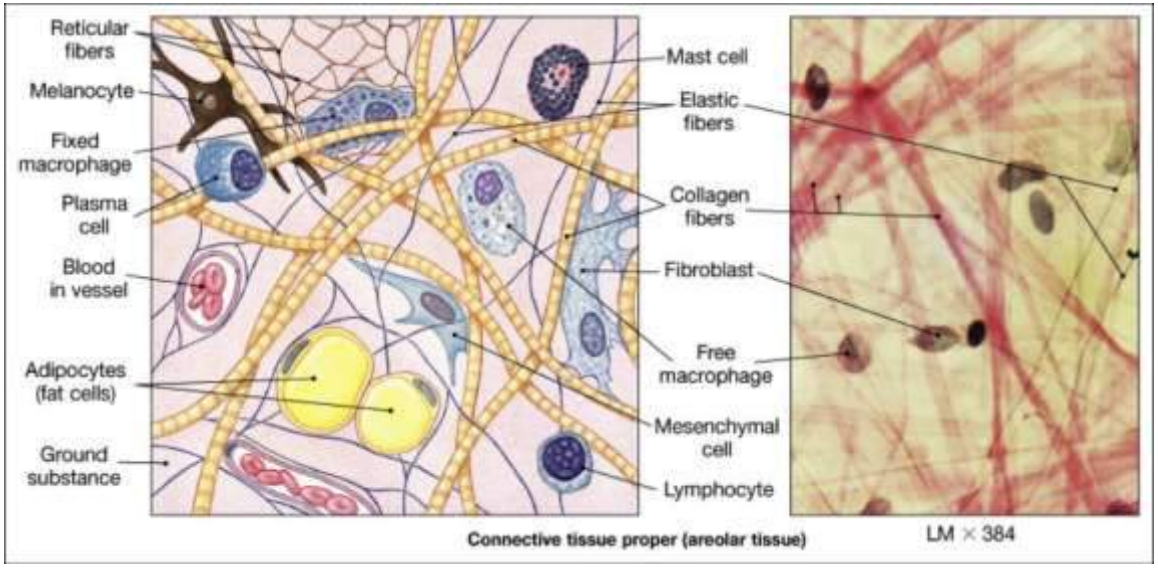
MUCOUS TISSUE



Classification of Connective Tissue

- The connective tissue types present a feature birth are classified into three broad categories: connective tissue proper, supporting connective tissue, and Fluid connective tissue.

1. **Connective tissue proper:** includes those types of connective tissue that exhibit a variable mixture of both connective tissue cell types and extra cellular protein fibers within a viscous ground substance. These connective tissue types' differ with respect to their numbers and types of cells and the relative properties and proportions of their Fibers and ground substance.

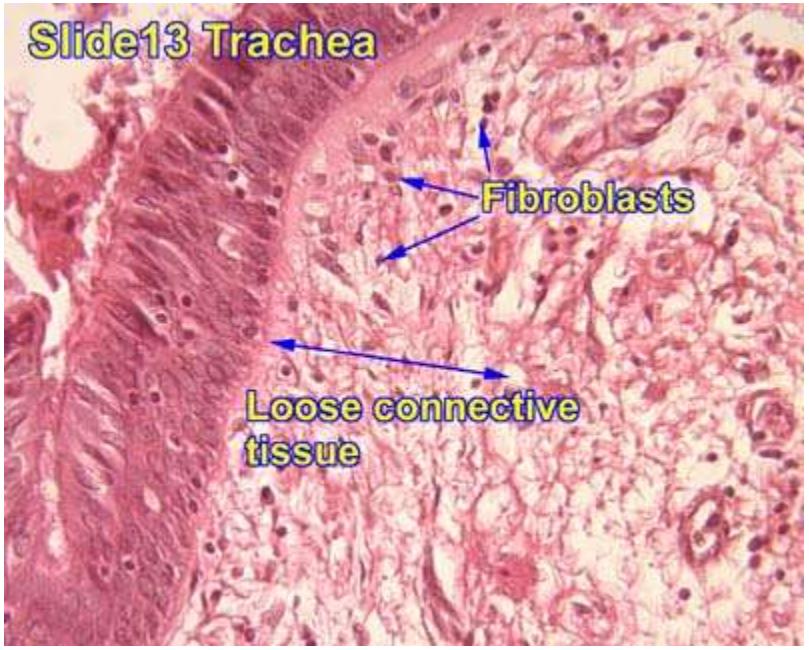


Cells of Connective Tissue Proper

- Two classes of cells form the connective tissue proper:

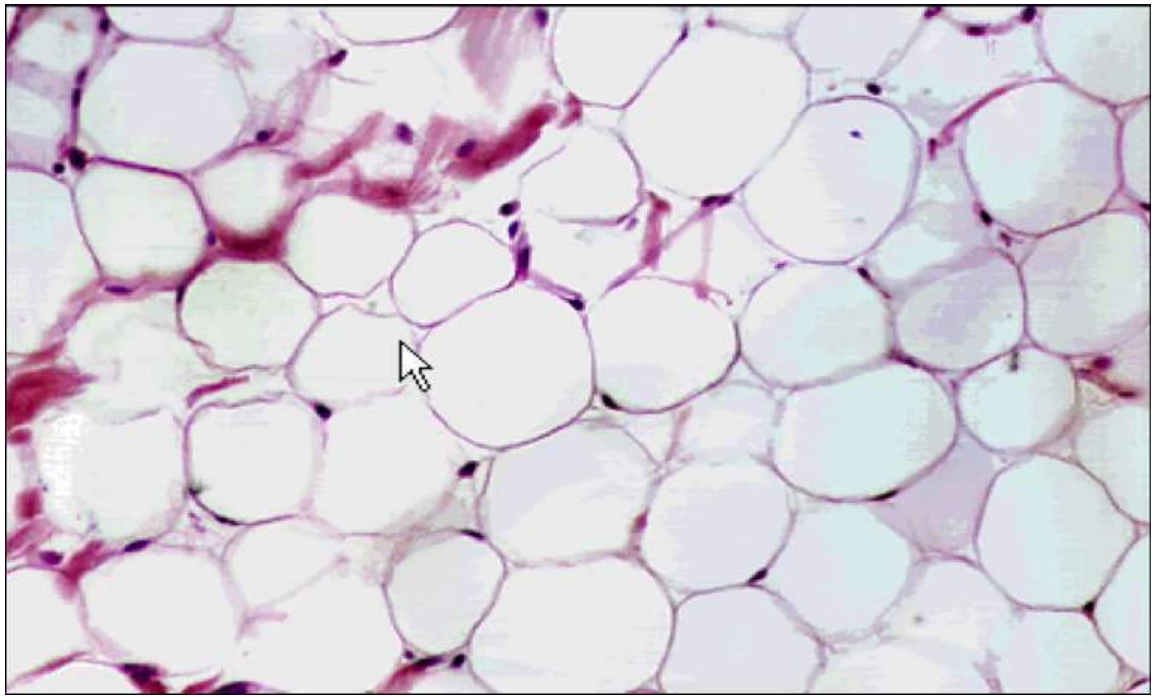
A. **Resident cells:** These stationary cells help support, maintain, and repair the extra cellular matrix. They include the following types:

1. **Fibroblast:** are large, flat cells with tapered ends. They produce the fibers and ground substance components of the extra cellular matrix.

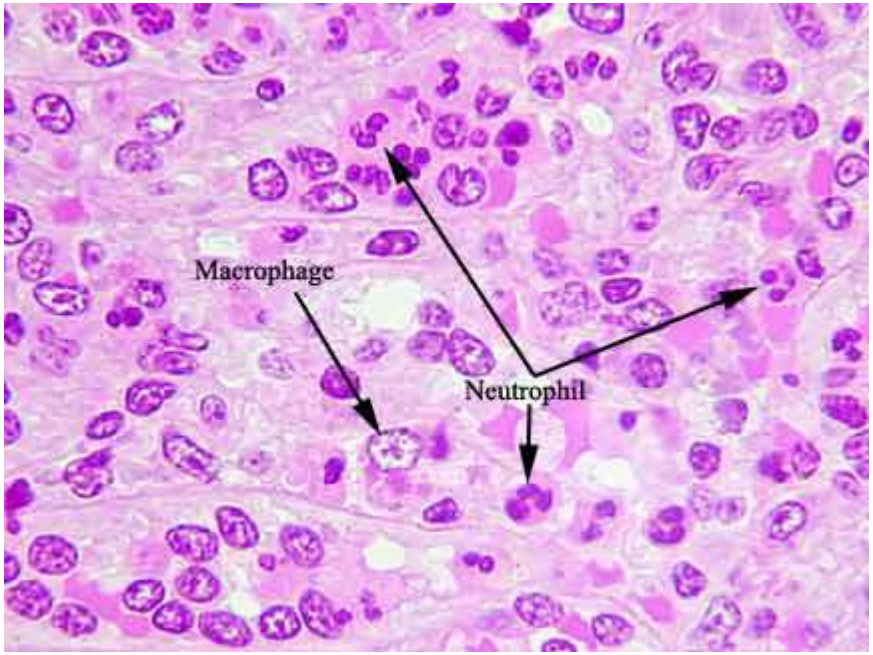


2. Adipocytes:

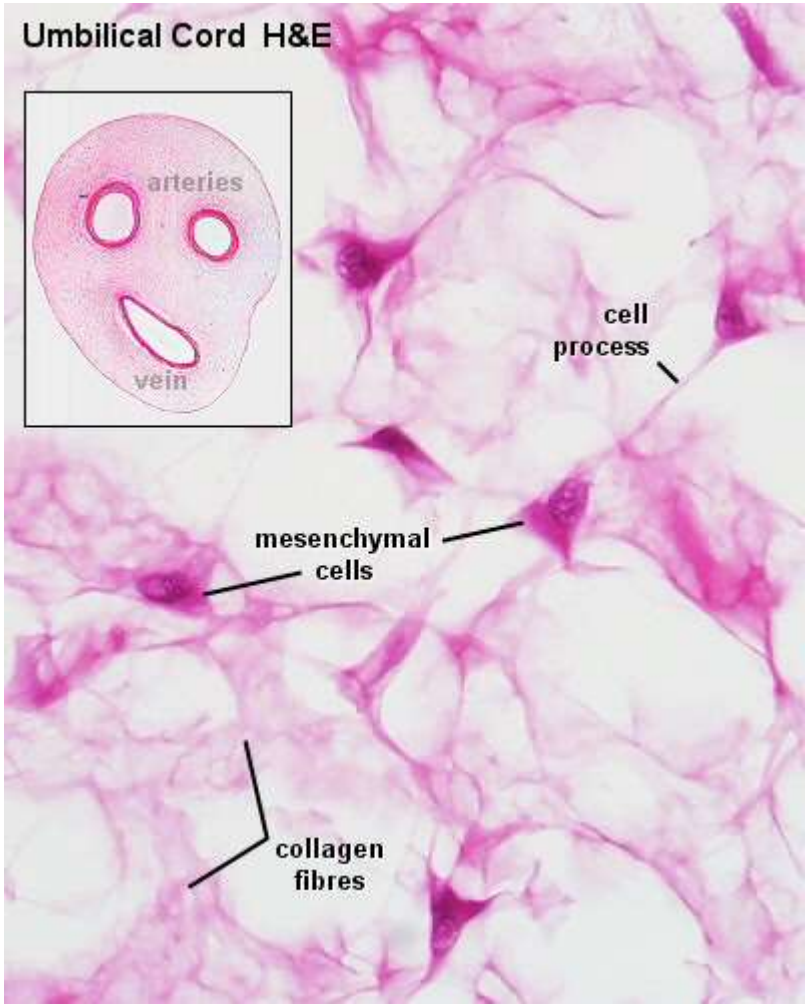
- are also called fat cells. Often they appear in small clusters with in the connective tissue proper. If a larger cluster of these cells dominates an area, the tissue is called adipose connective tissue.



3. **Fixed macrophages:** are relatively large. Irregular shaped cells with numerous surface folds and projection. They phagocytize (eat up) damaged cells or pathogens. When the fixed macrophages encounter foreign materials, the cells release chemicals that stimulate the immune system and large numerous wandering cells involved in body defense to the foreign materials.

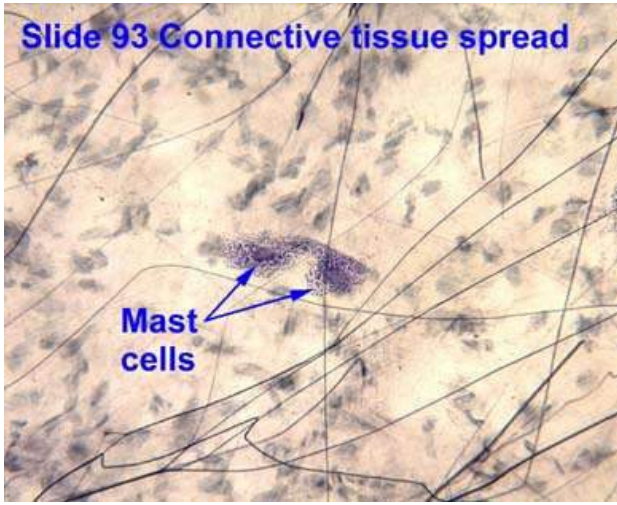


4. Mesenchymal cells : are a type of embryonic stem cell, as a result of local injury connective tissue damage. Mesenchymal stem cells divide. One of the cells produced is the replacement Mesenchymal cell, and the other becomes a committed cell that moves into the damaged injured area and differentiates into the type of connetive tissue cell that is needed

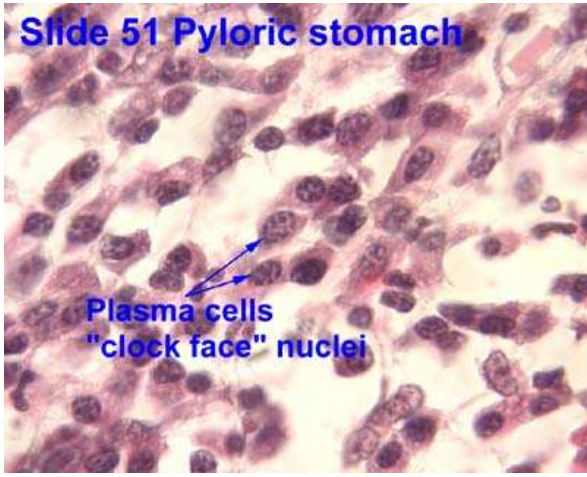


B- The wandering cells

- The wandering cells of the connective tissue proper are primarily types of leukocytes also called white blood cells, and each type performs certain functions that help us overcome illness or fight foreign invaders in our bodies. They include the following:

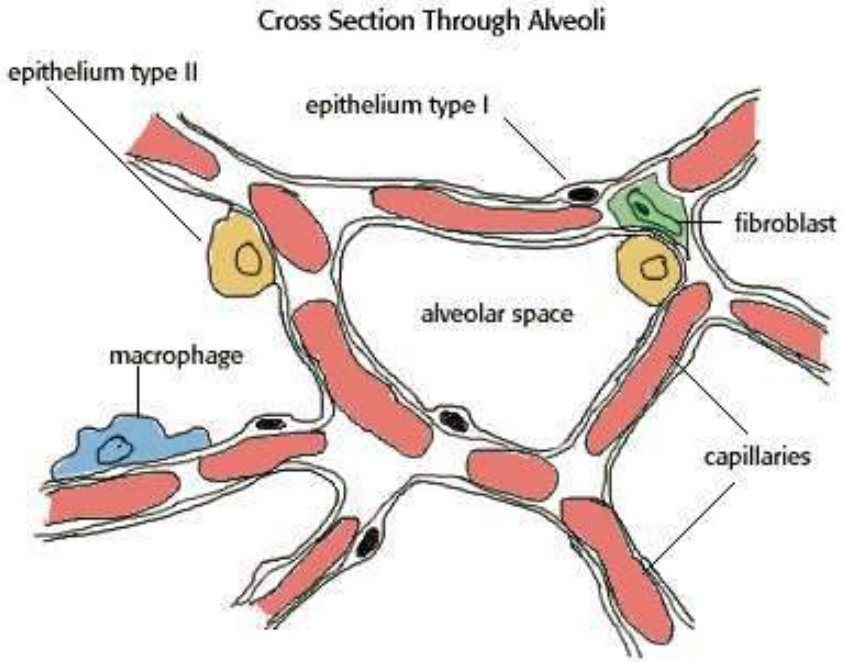


1. **Mast cells:** These small, mobile cells contain a granule - filled cytoplasm. They usually found close to blood vessels. They secrete heparin to inhibit blood clotting, and histamine to dilate vessels and increase blood flow.



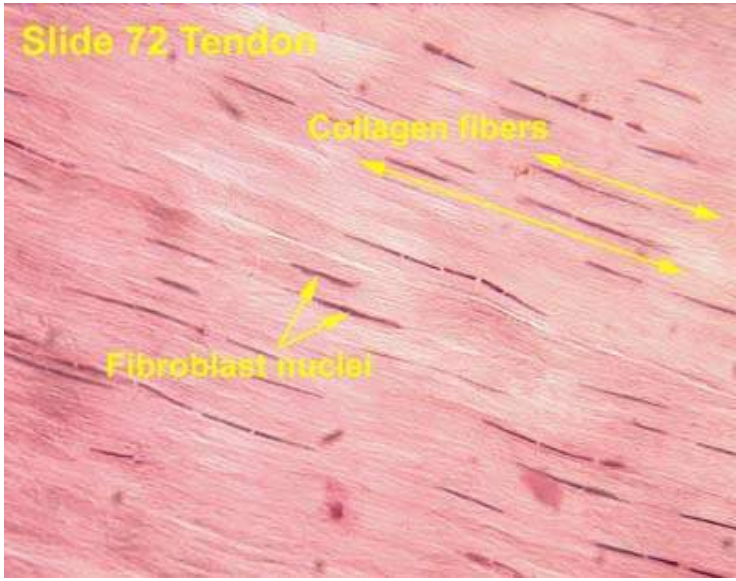
2. **Plasma cells:** when B- lymphocytes are activated by exposure to foreign materials, the cells mature into plasma cells. These cells synthesize disease - fighting proteins called antibodies. Plasma cells are usually found only in the intestinal walls and in the inflamed.

3. **Free macrophages:** These mobile, phagocytic cells are formed from monocytes that migrates out of the blood stream. They wander through connective tissue, and engulf and destroy bacteria, foreign particles, or damaged cells and debris they encounter.
4. **Other leukocytes:** in addition to the leukocytes just mentioned, other leukocytes migrate through the blood vessel walls into the connective tissue, where they spend most of their time. The majority of these leukocytes are neutrophils, a type white blood cells that seeks out phagocytizes bacteria.



Fibers of connective Tissue proper

- Three types of protein fibers are found in connective tissue proper: collagen fibers, elastic fibers and reticular fibers. Fibroblasts synthesize the components of three fiber types.



1. ***Collagen fibers.***

A. are long, unbranched extra cellular fibers composed of protein collagen

B. They are strong, flexible, and resistant to stretching.

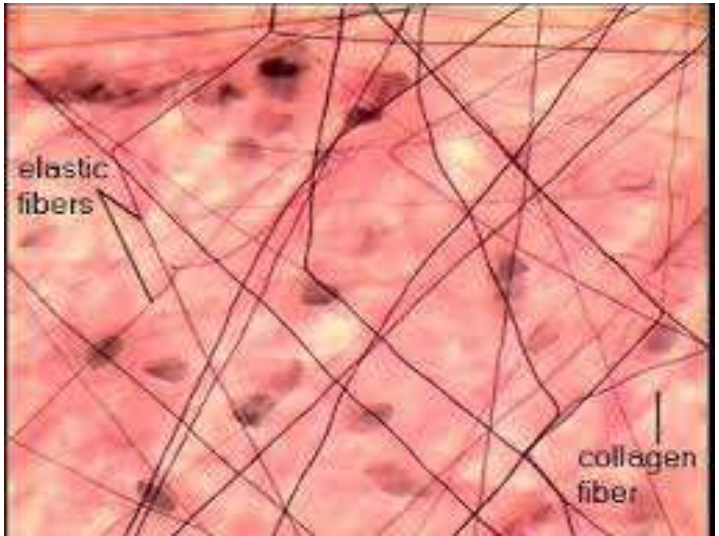
C. Collagen forms about 25% of the body's protein.

D. Tendons and ligaments consist almost entirely of collagen fibers.

E. Tendons connect skeletal muscles to bones, and ligaments connect some bones together.

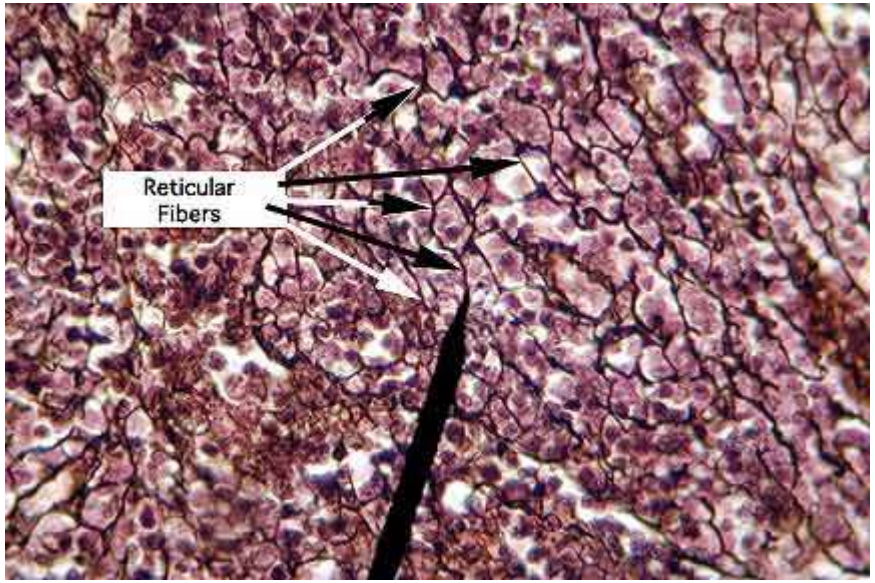
2. Elastic Fibers

A. Contain the protein elastin and are thinner than collagen Fibers.
B. They stretch easily, branch, rejoin and appear wavy.
C. Elastic fibers permit the skin, lungs, and arteries to return to their normal shape, after being stretched.



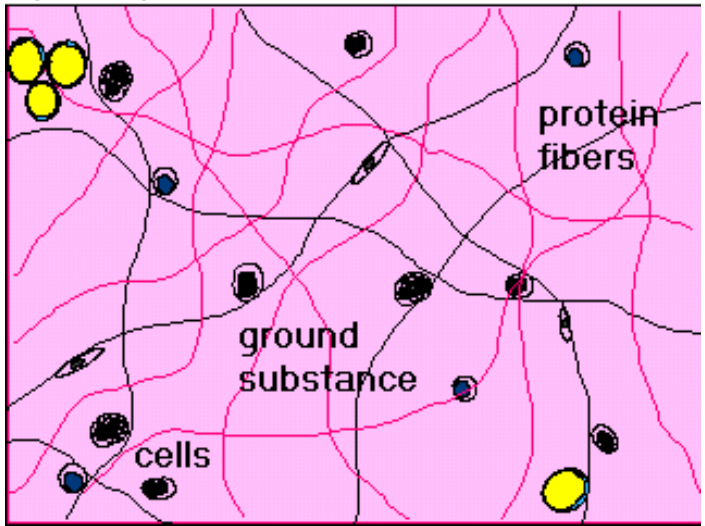
3- Reticular Fibers

A. Reticular fibers are thinner than collagen fibers.
B. They contain the same protein subunits as collagen has, but their subunits are combing in a different way. and they are coated with glycoprotein.
C. These fibers form a branching, interwoven framework that is tough but flexible.
D. These found in the stroma of organs such as the lymph nodes, spleen and liver.



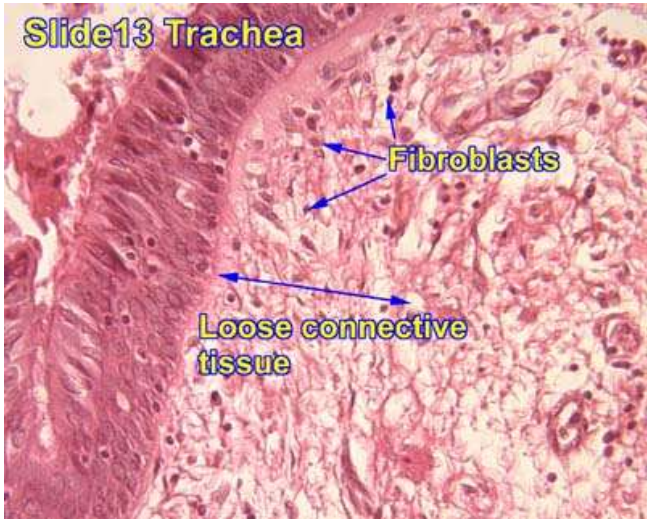
Ground Substance of Connective Tissue Proper.

A. Colorless, featureless and viscous solution.
B. Ground substance usually has gelatinous, almost rubbery consistency resulting from the mixture of its component molecules.
C. Ground substances vary both in their size and in their proportions of proteins and carbohydrates.
D. The different molecules in the ground substance are specifically called glycosaminoglycans, proteoglycans, and structural glycoproteins



Categories of Connective Tissue Proper

- Connective tissue proper is divided into two broad categories: Loose connective tissue and dense connective tissue. This classification is based on the relative proportions of cells, fibers, and ground substance.

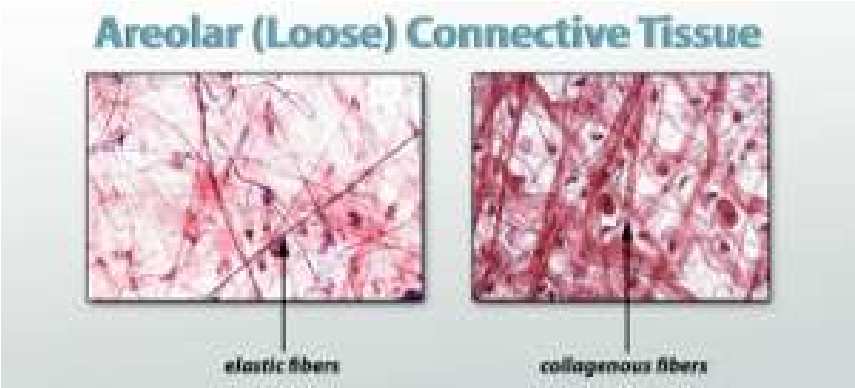


➢ *Loose connective Tissue*

1. Contains relatively fewer cells and fibers than dense connective tissue.
2. The protein fibers in loose connective tissue are loosely arranged rather than tightly packed together.
3. This tissue occupies the spaces between and around organs. They support and surround blood vessels and nerves.
4. Store Lipids, and provide a medium for the diffusion of materials.

There are three types of loose connective tissues

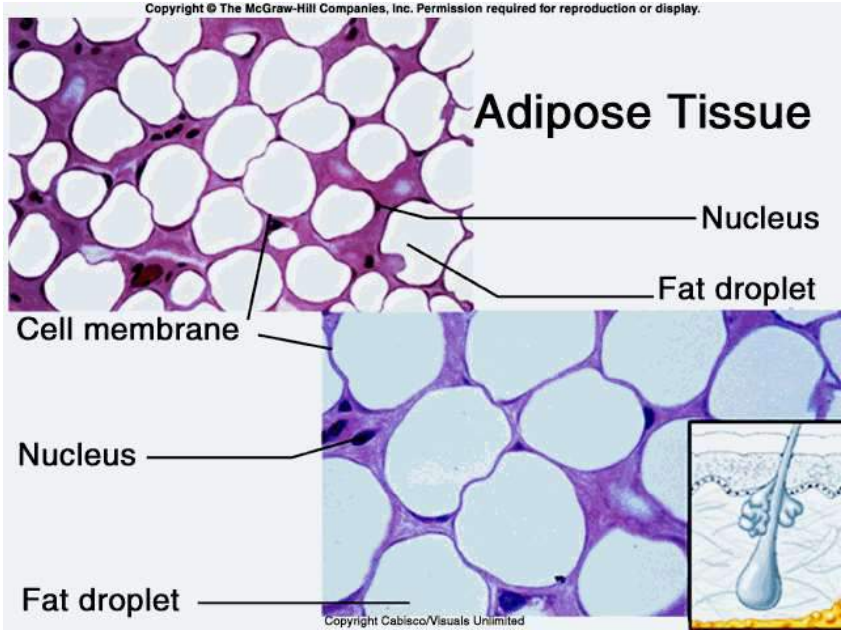
A. **Areolar connective tissue**
B. **adipose connective tissue**
C. **reticular connective tissue**
D. **Areolar connective tissue,** is highly variable in appearance and the least specialized connective tissue in the body areolar connective tissue contains all of the cell types of connective tissue proper and has loosely organized array of collagen and elastic fibers . Viscous ground substance occupies the spaces between fibers and accounts for most of the volume of areolar connective tissue.



B. Adipose connective tissue.

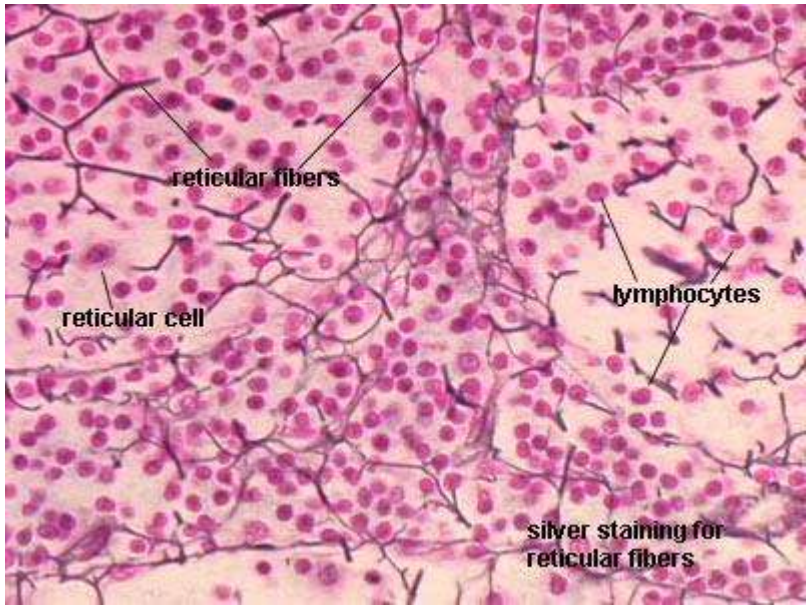
Adipose connective tissue :

- Is a loose connective tissue composed primary of cells called **adipocytes.**
- Adipose connective tissue serves as packing around structures and provides padding, cushions shocks.
- Acts as an insulator to slow heat loss through the skin.



C. Reticular connective tissue:

- Contains a meshwork of reticular fibers, fibroblast, and Leukocytes. This forms the structural framework (Stroma) of many Lymphatic organs, such as the spleen, thymus, Lymph node, and bone marrow.

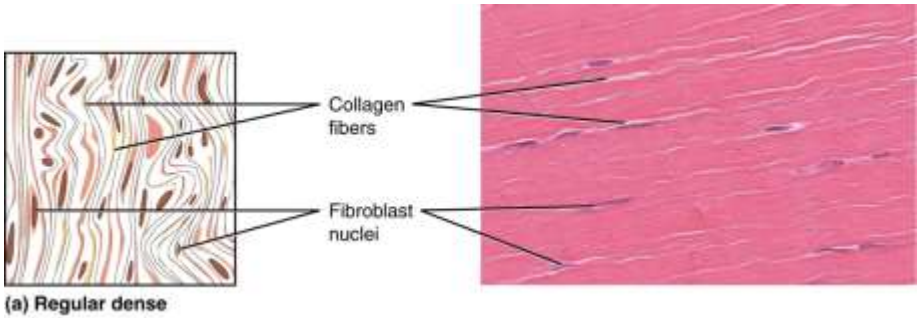


Dense connective tissue

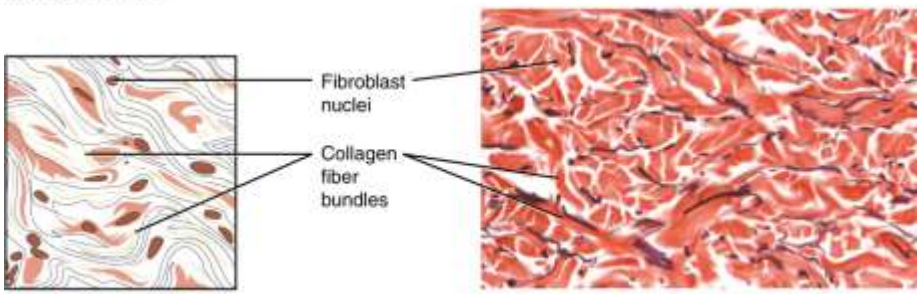
- Dense connective tissue is composed primarily of protein fibers and has proportionately less ground substance than do loose connective tissue.
- Dense connective tissue is often called collagenous tissues collagen fibers are the dominant fiber type.

✓ **There are three categories of dense connective tissue :**

1. **Dense regular connective tissue**
2. **Dense irregular connective tissue**
3. **Elastic connective tissue**



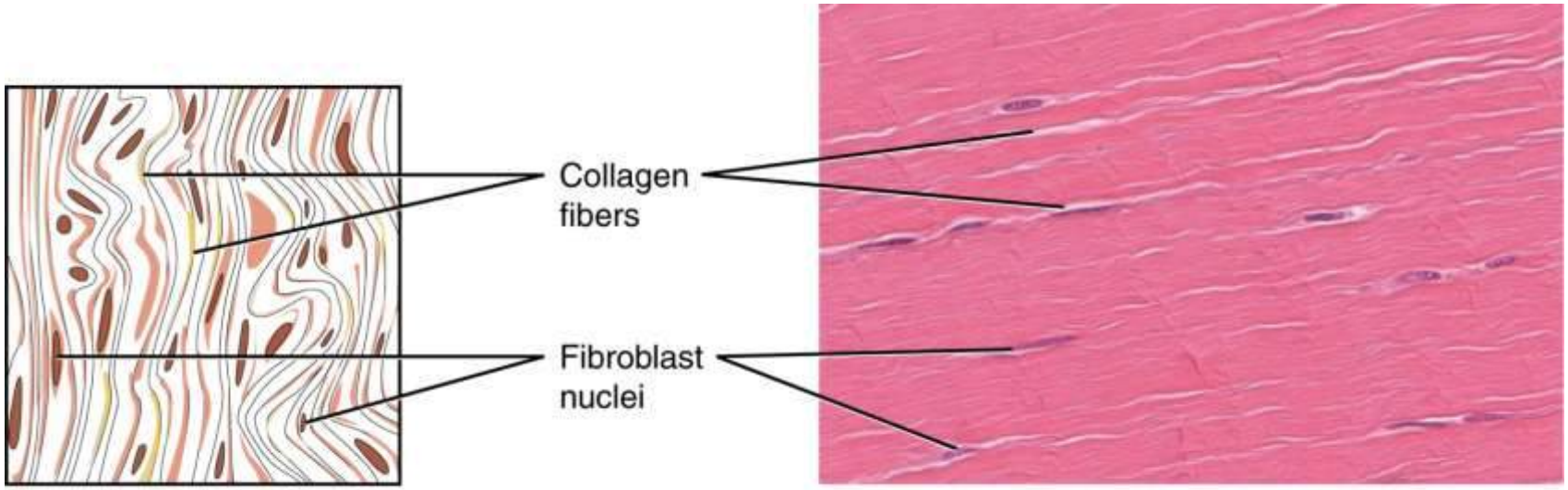
(a) Regular dense



(b) Irregular dense

Dense regular connective tissue :

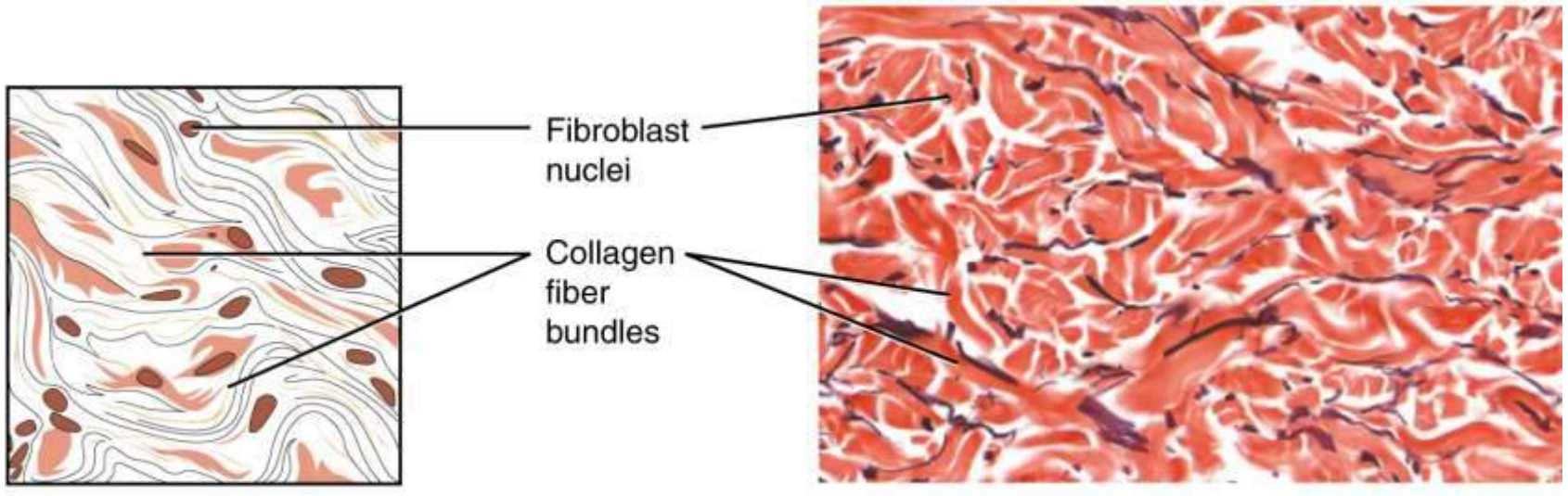
- Collagen fibers are packed tightly and aligened parallel to applied forces.
- The parallel wavy collagen fibers resemble lasagna noodles stacked one on top of another.
- This tissue type is found in tendons (which attach muscle to bone) and Ligaments (which attach bone to bone).
- Dense regular connective tissue has few blood vessels, and thus it takes a long time to heal following injury, since a rich blood supply is necessary for good healing.



(a) Regular dense

Dense irregular connective tissue :

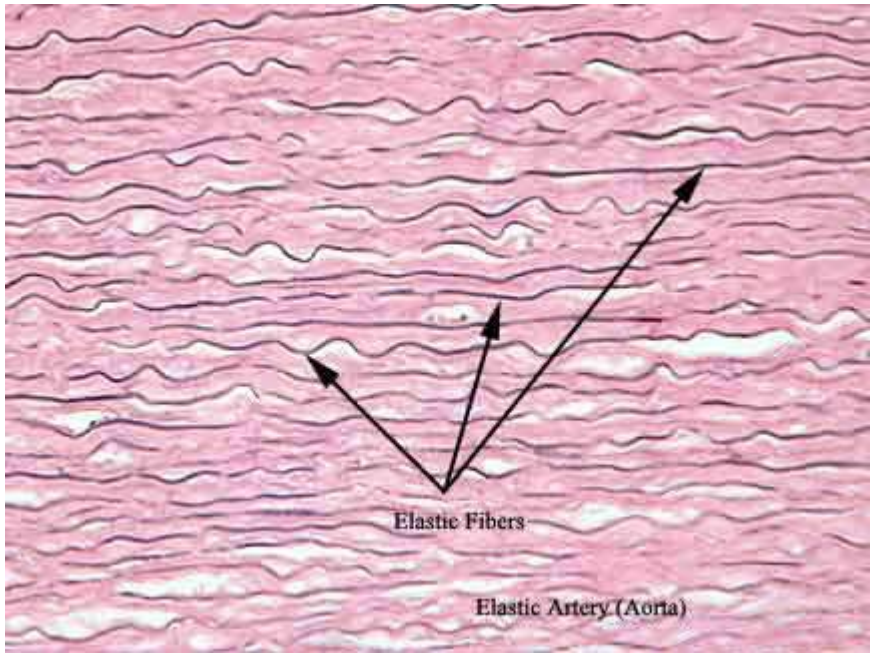
- Individual bundles of collagen fibers extend in all directions in a scattered meshwork.
- These bundles of collagen fibers appear in clumps throughout the tissue.
- Dense irregular connective tissue provides support and resistance to stress in multiple directions.
- An example of dense irregular connective tissue is the deep portion of the dermis, which lends strength to the skin and permits it to with stand applied forces from any direction.



(b) Irregular dense

Elastic connective tissue :

- Have branching elastic fibers and more fibroblasts than in loose connective tissue in addition to its densely packed collagen fibers.
- The elastic fibers provide resilience and the ability to deform and then return to normal shape. Such as vocal cords and the walls of large and medium arteries.

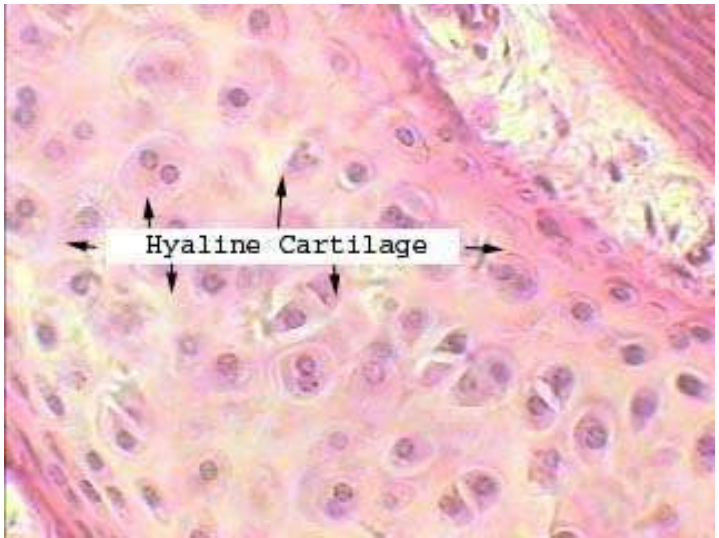


Supporting connective tissues

- **Why cartilage and bone are called supporting connective tissue?**

- because they form a strong, durable framework that protects and supports the soft body tissue.

- The extracellular matrix in supporting connective tissue contains many protein fibers and ground substance that ranges from semisolid to solid.
- In general, cartilage has a semisolid extracellular matrix while bone has a solid extracellular matrix.



CARTILAGE

- Cartilage has a firm, gel-like extracellular matrix composed of both protein fibers and ground substance.
- Mature cartilage cells are called **chondrocytes.**
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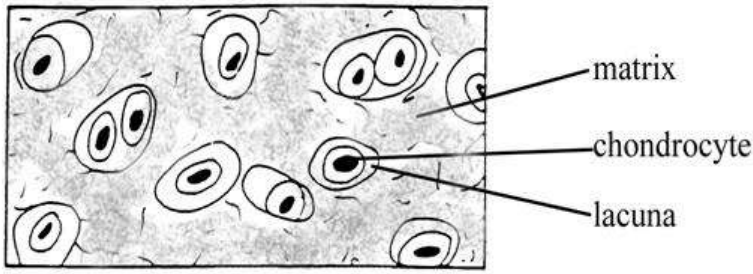

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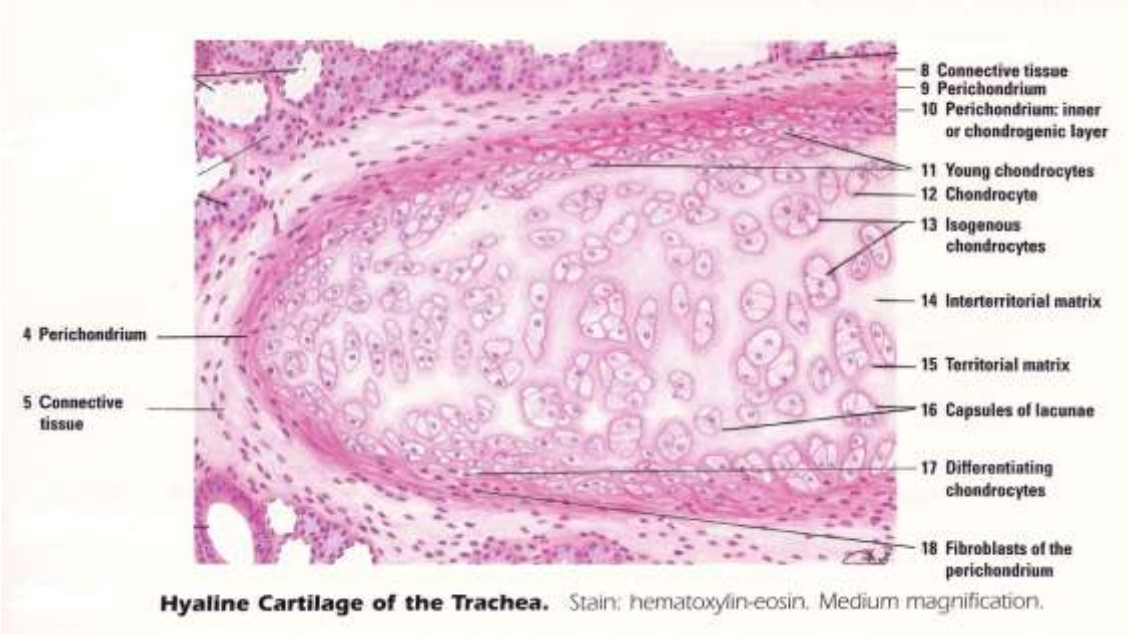

Hyaline Cartilage of the Trachea. Stain: hematoxylin-eosin. Medium magnification.

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TYPE OF CARTILAGE

- There are three major types of cartilage are found in the body:

1. **Hyaline cartilage :**

- Is the most common type of cartilage and also the weakest, the chondrocytes within their lacunae are irregular scattered throughout the extracellular matrix and readily visible.
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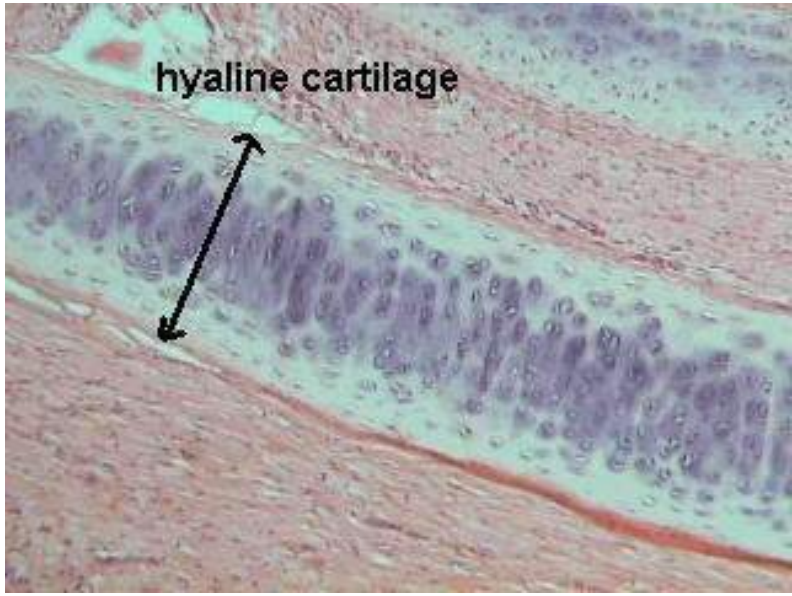

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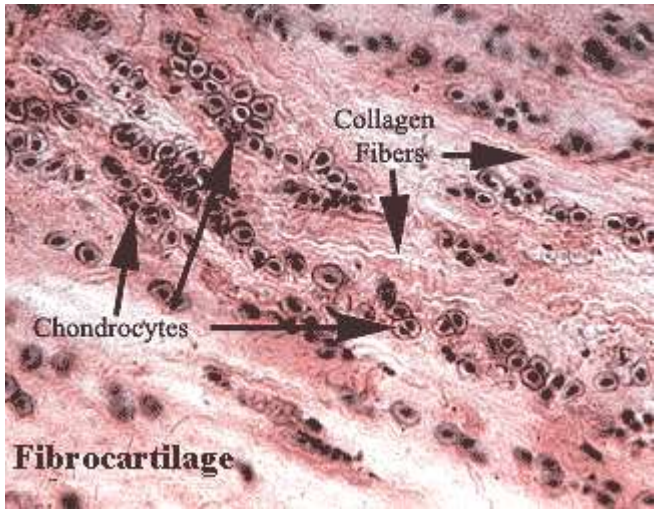

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Interstitial Growth:	Appositional Growth:
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3. As the cells begin to synthesize and secrete new cartilage matrix, they are pushed apart and now reside in their own lacunae.	3. These chondroblasts located at the periphery of the old cartilage begin to produce and secret new cartilage matrix. As a result they push a part and become chondrocytes, each occupying its own lacuna.
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Growth patterns of Cartilage:

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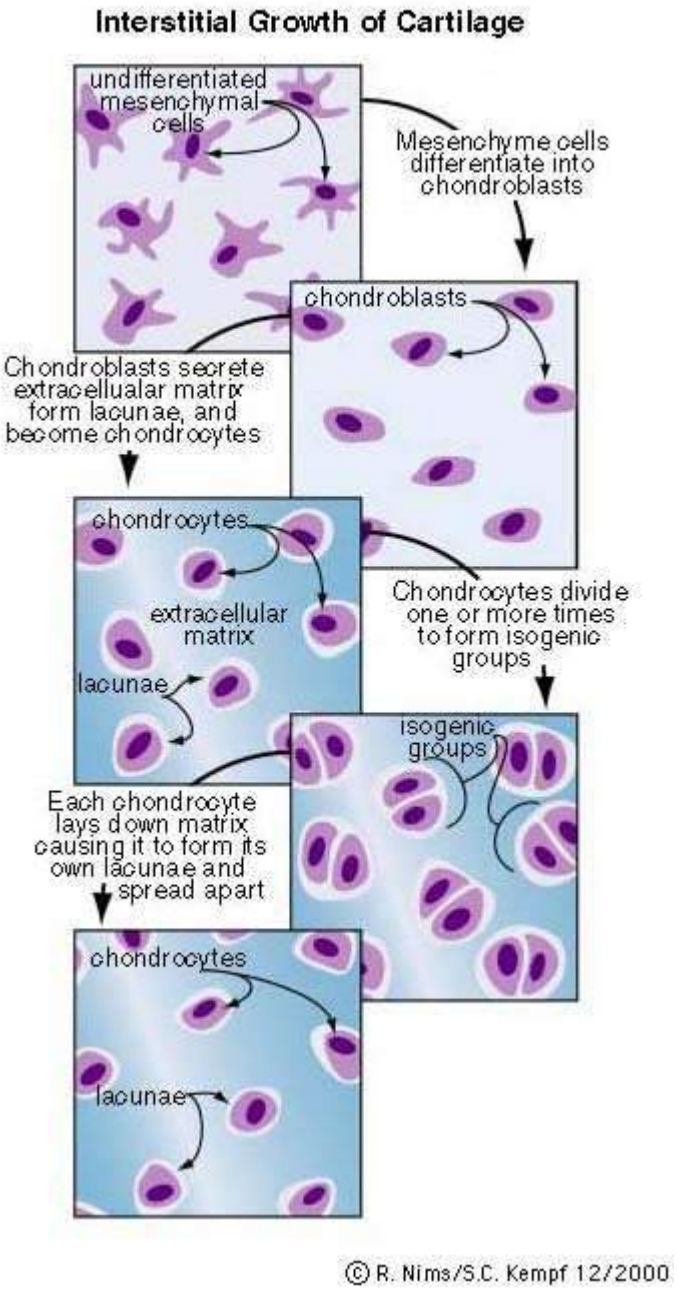

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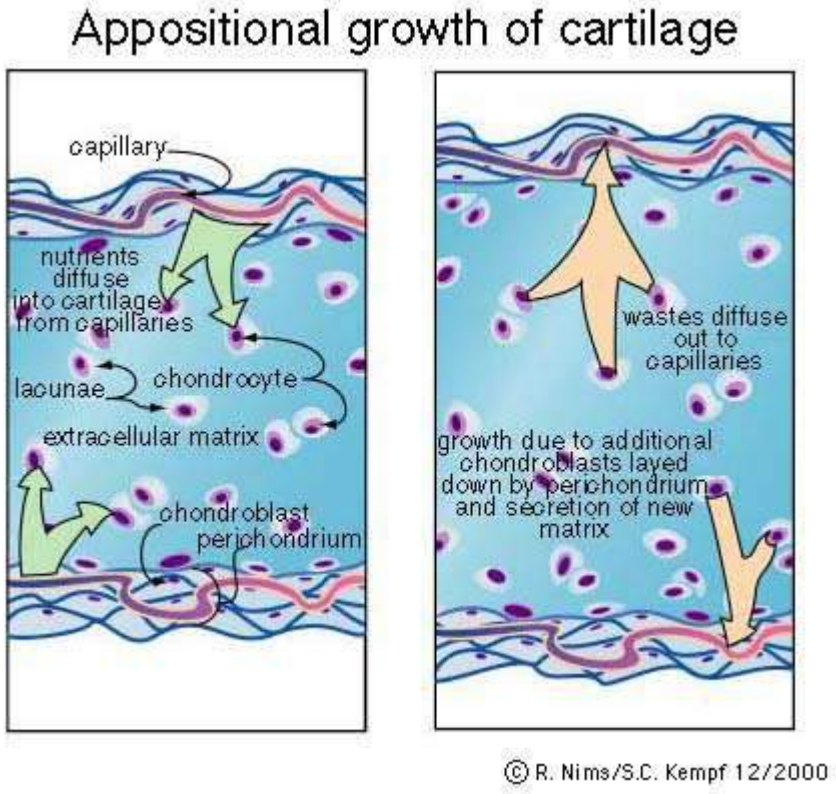

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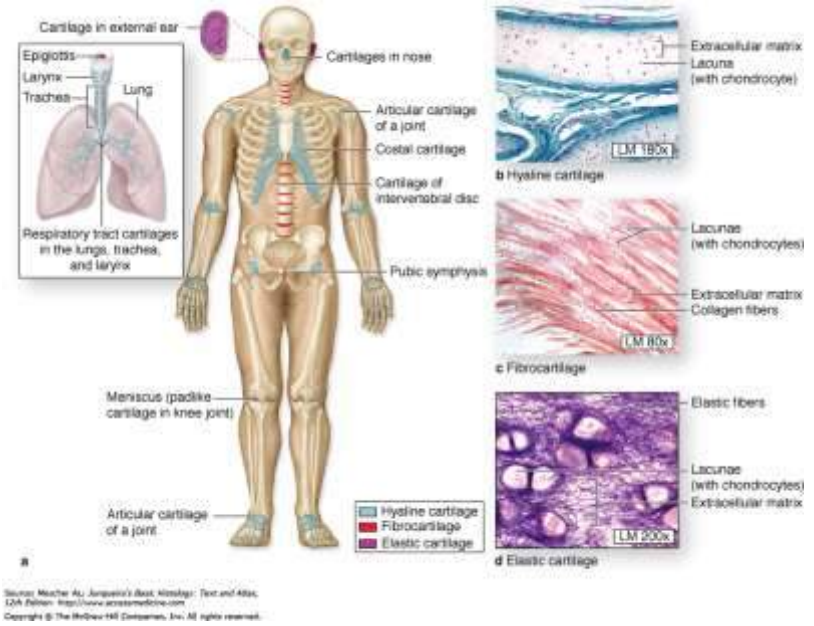
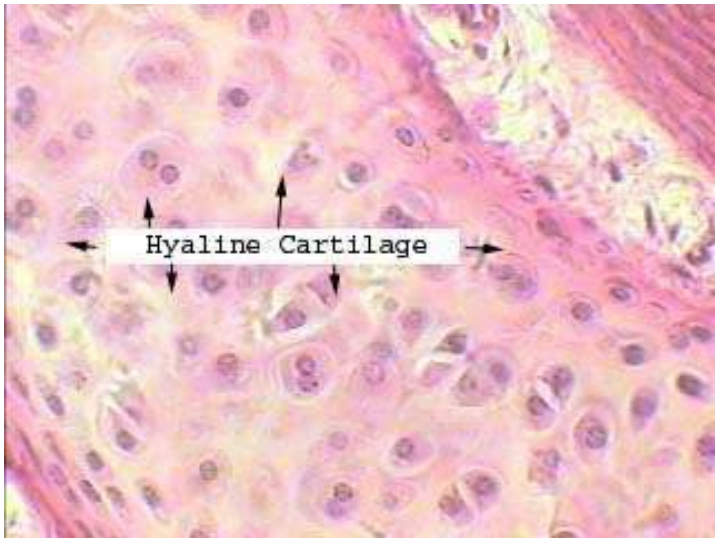


Supporting connective tissues

- **Why cartilage and bone are called supporting connective tissue?**

- because they form a strong, durable framework that protects and supports the soft body tissue.

- The extracellular matrix in supporting connective tissue contains many protein fibers and ground substance that ranges from semisolid to solid.
- In general, cartilage has a semisolid extracellular matrix while bone has a solid extracellular matrix.



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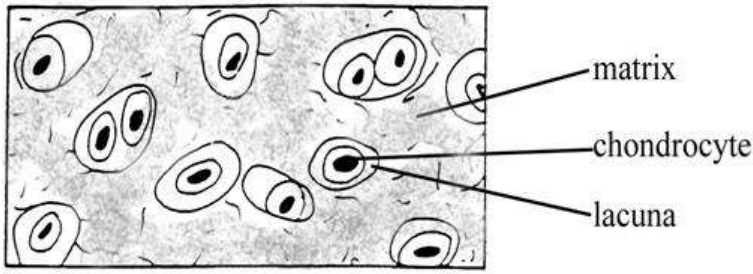

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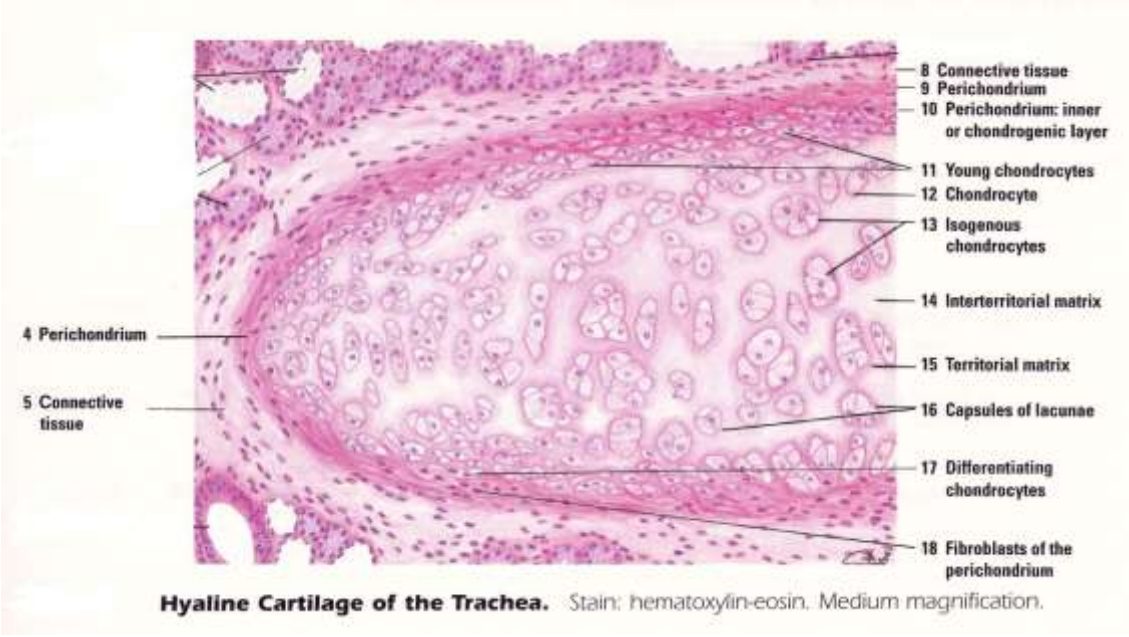

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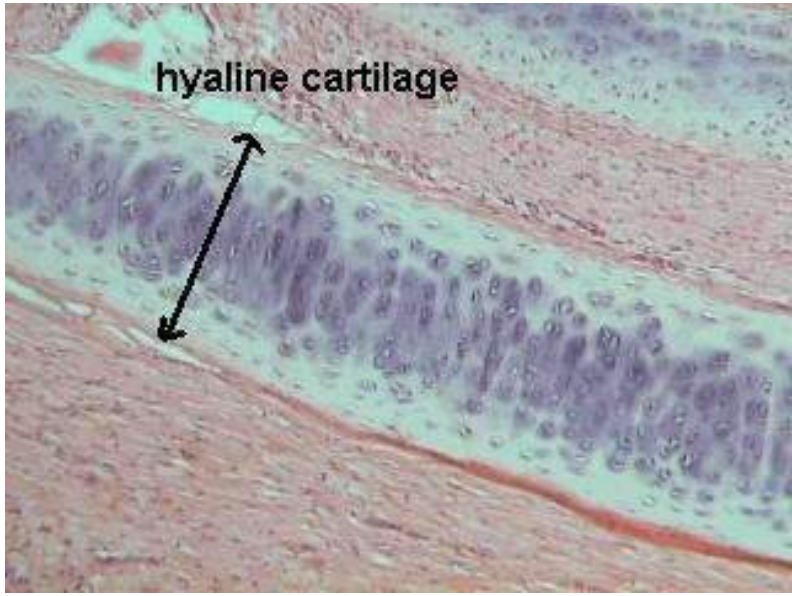

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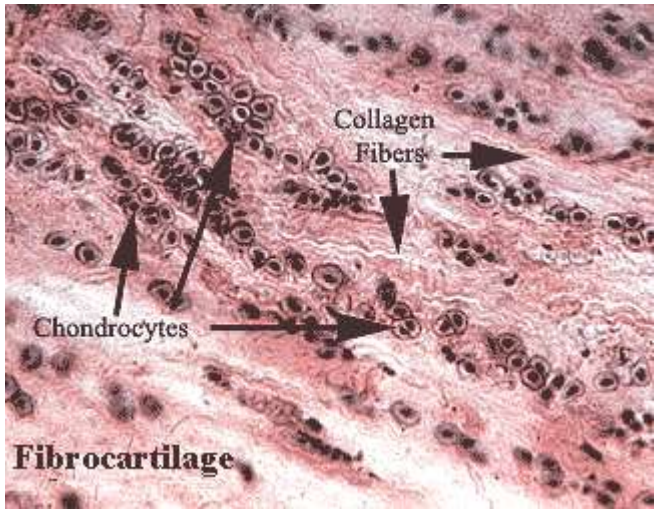

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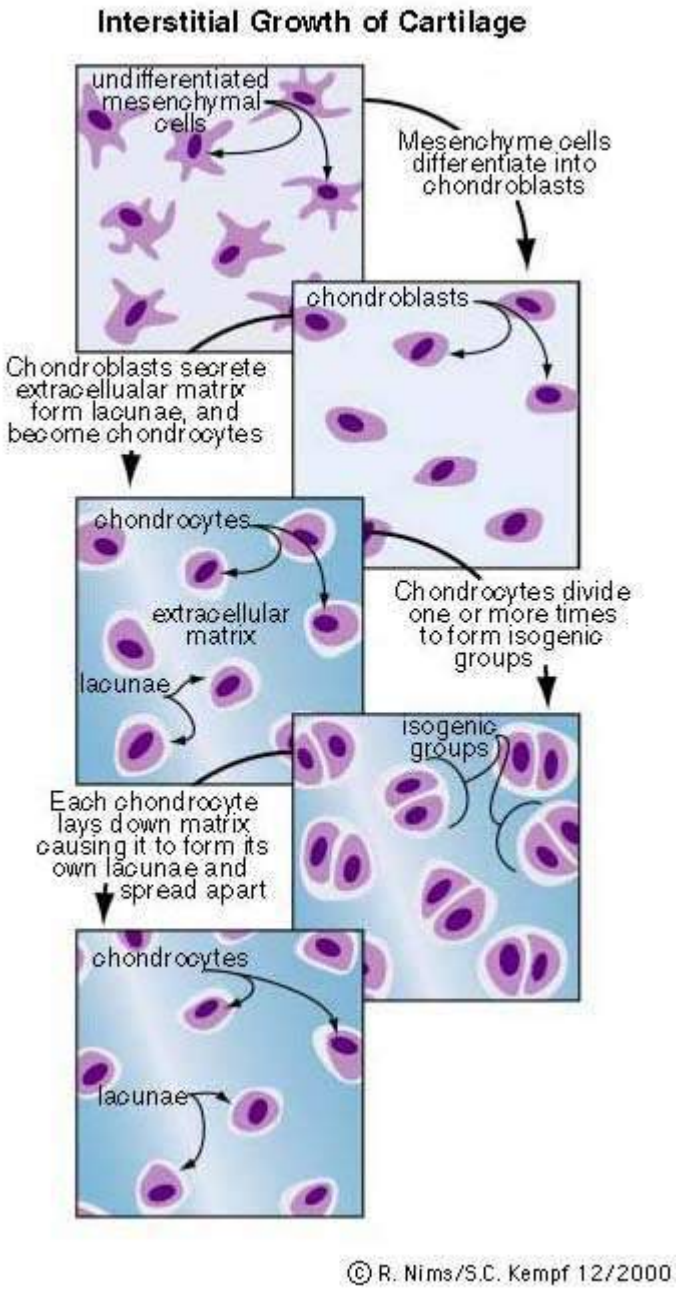

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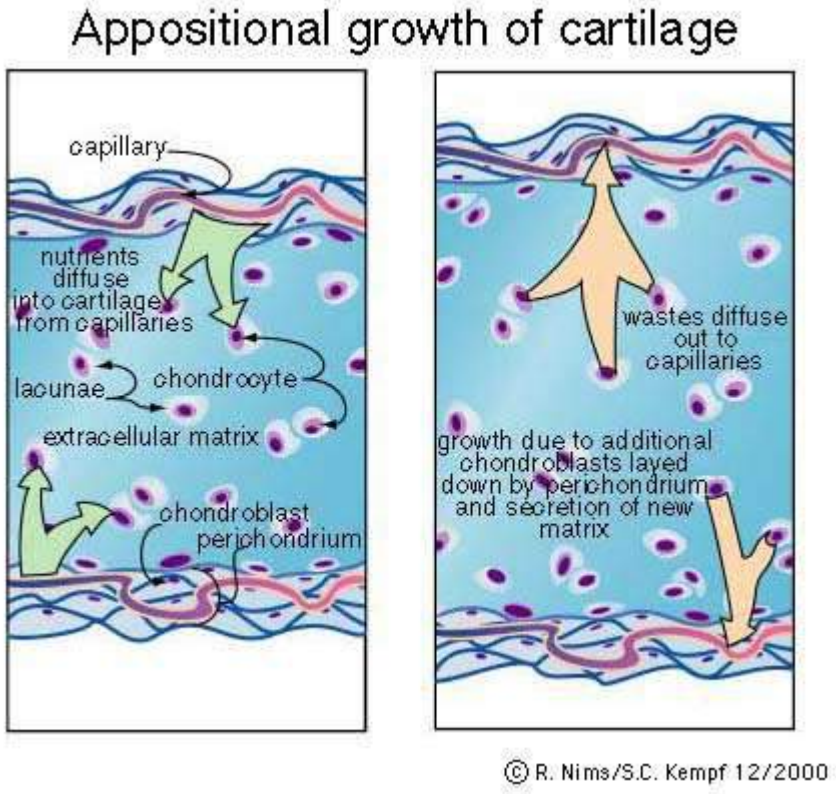

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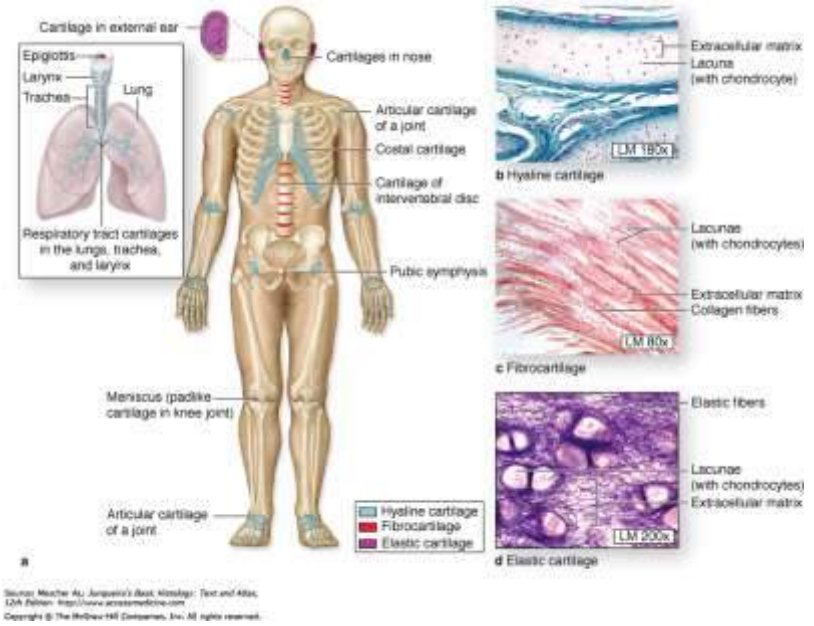
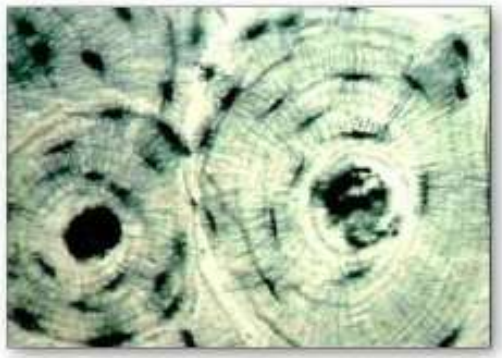
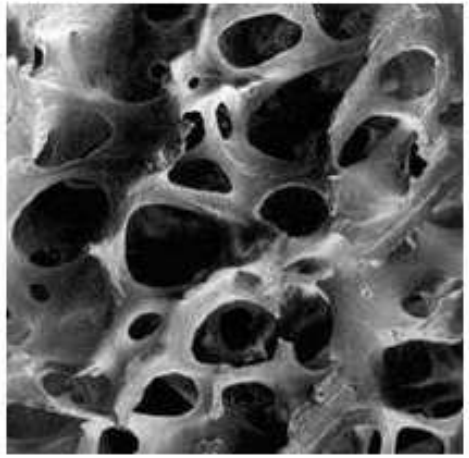
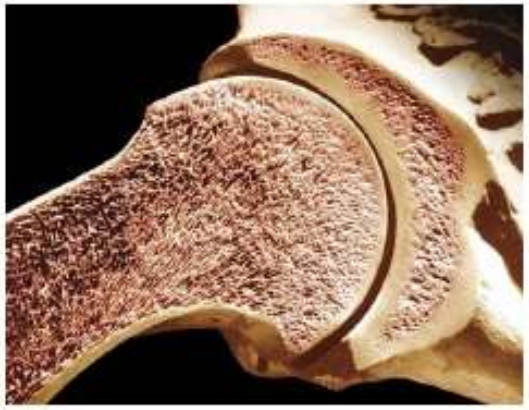
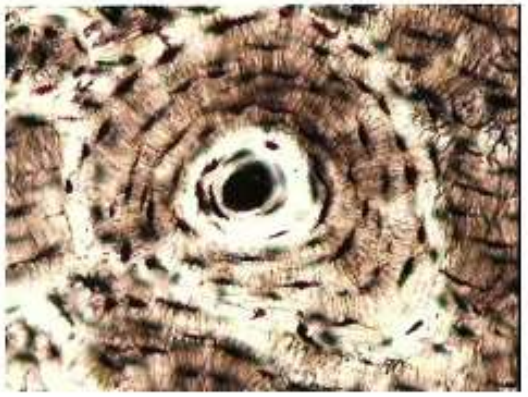


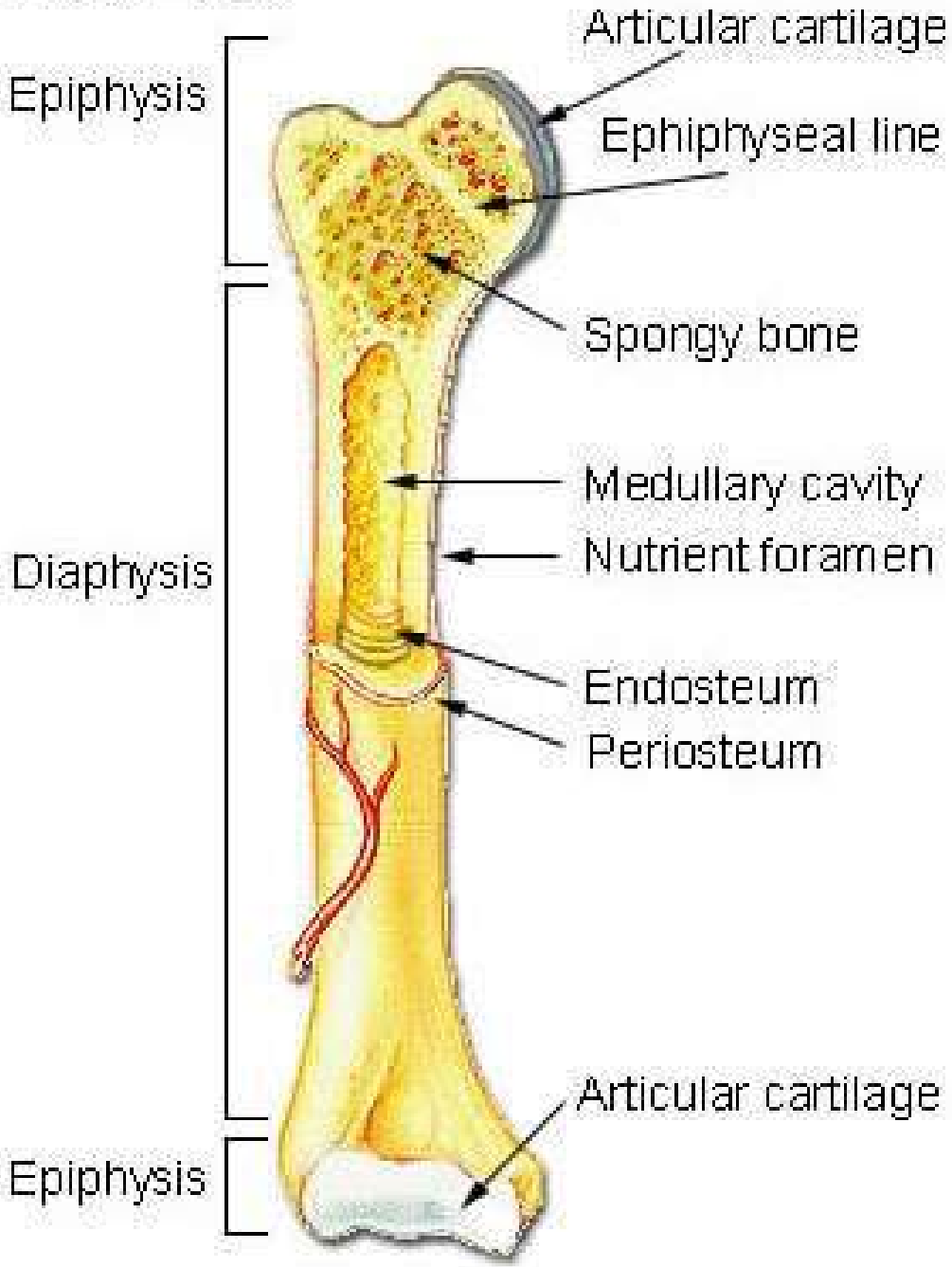
Bone Tissue

Lec. Dr. Ruwaidah F. Khaleel

Long Bone


Articular cartilage
Epiphysis
Ephiphyseal line
Spongy bone
Medullary cavity
Diaphysis
Nutrient foramen
Endosteum
Periosteum
Articular cartilage
Epiphysis

Bone

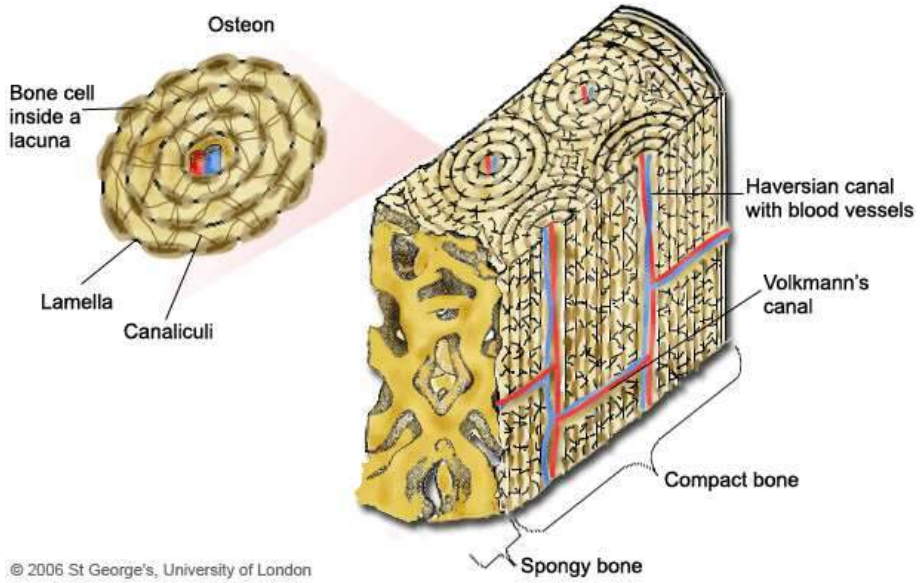
- Bone or osseous connective tissue makes up the mass of most of the body structures referred to as bones

➢ **Bone is more solid than cartilage and provides greater support**

A. About one- third of the dry weight of bone is composed of **organic components** (collagen, fibers and different protein –carbohydrate molecules)

B. two - thirds consist of **inorganic components** (a mixture of calcium salts, primarily calcium phosphate) are covered by dense irregular connective

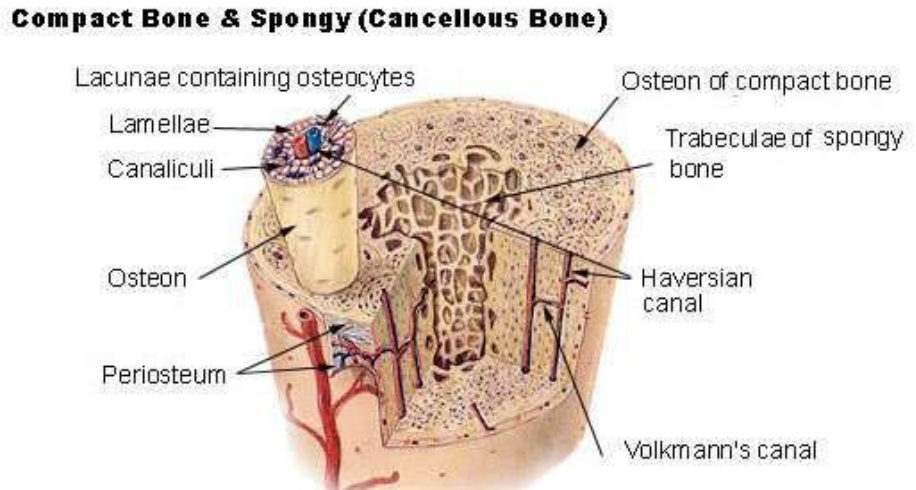
- Tissue called the periosteum which is similar to the perichondrium of Cartilage.



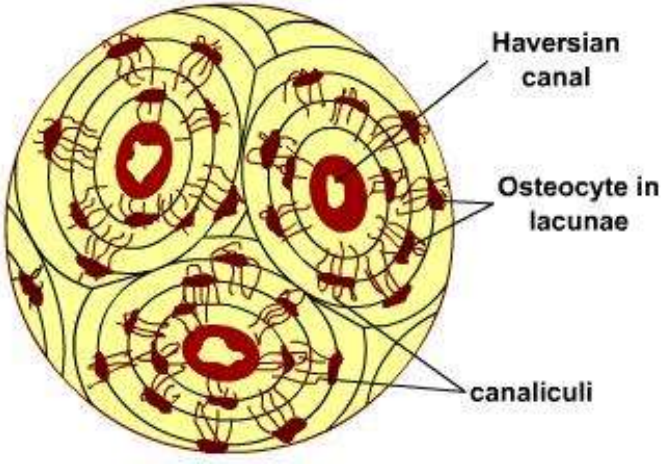
There are two forms of bone tissue

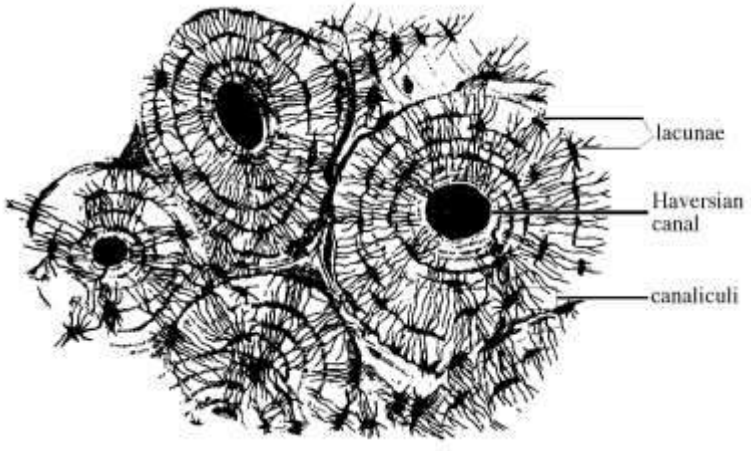
Both types are found in all bones of the body.

1. **Compact bone:** is completely solid and usually forms the hard outer shell of the bone. Compact bone has an ordered histological pattern it's formed from cylindrical structures called osteons or Haversian system, osteons run parallel to the shafts of long bones
2. **Spongy bone:** fills the interior of bone being completely solid, spongy bone contains spaces and the bone tissue connective tissue forms **a latticework structure** that is very strong, yet Light weight This design allows our bones to be both, strong and-light weight at the same time



- Each osteon contains concentric rings of bone called **Lamella**, which encircle a central **(Haversian canal),** blood vessels, and nerves travel through the central canal of osteons
- Lacunae between neighboring lamella house bone cells called osteocytes.
- Diffusion of nutrients and waste products can not occur through the hard matrix of bone, so osteocytes must communicate with one another and ultimately with the blood vessels in the central canal
- Minute passage ways in the matrix called canaliculi. Together all of the canaliculi form a branching network throughout compact bone for the exchange of materials between the blood vessels and the ostyocytes within the Lacunae.

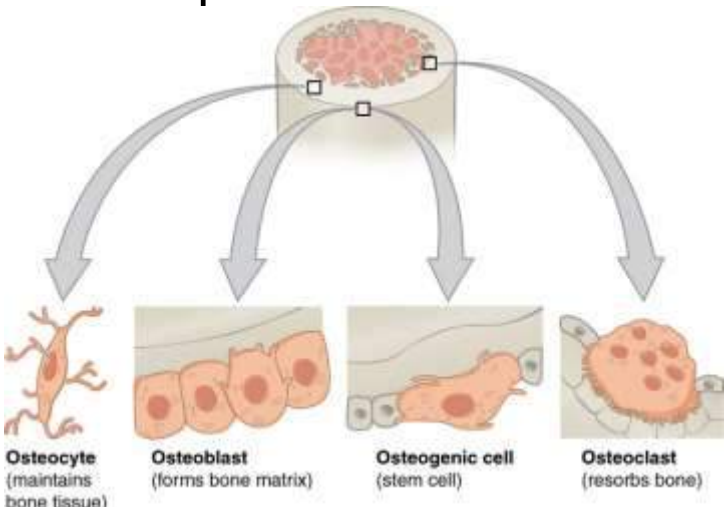


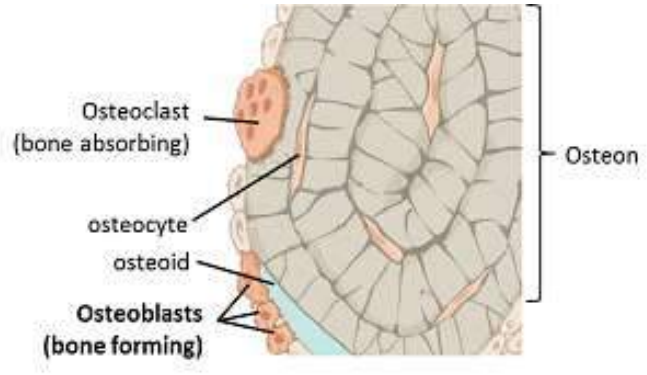


Cells of bone

- Four types of cells are associated with bone connective tissue: osteoprogenitor cells, osteoblasts, osteocytes and osteoclasts.

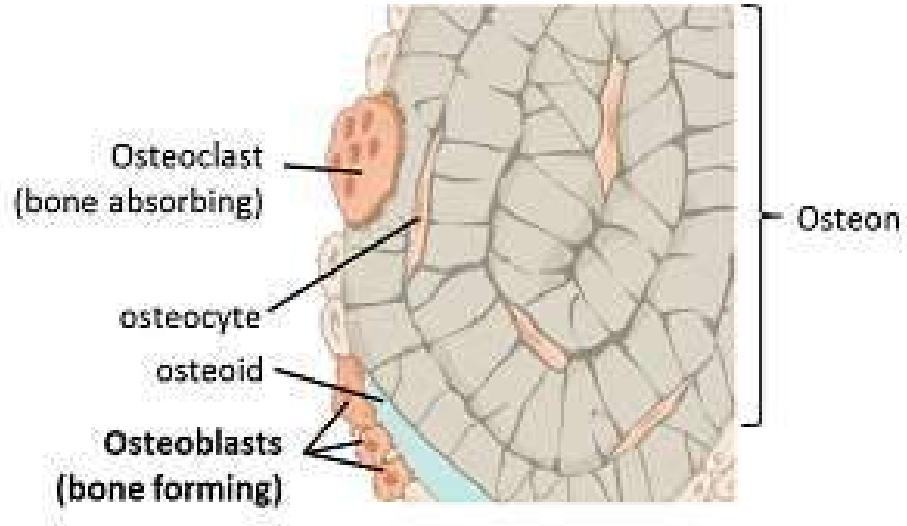
1. **Osteoprogenitor cells:** are stem cells derived from mesenchyme, when they divide them produce a mother stem cell and a committed cell that mature to become an osteoblast. These stem cells are within both the periosteum and the endosteum.
2. **Osteoblasts:** are formed from osteoblast exhibit a some what cuboidal structure, they secret the initial semi solid form of hope matrix called **osteoid**. Osteoid later calcifies as a result of calcium salt deposition. Osteoblast produce new bone, they differentiate into osteocytes.
3. **Osteocytes:** are mature bones cells derived from osteoblasts that, have become entrapped in the matrix they secreted. They reside in small spaces within the matrix called **Lacunae.**





4. Osteoclasts:

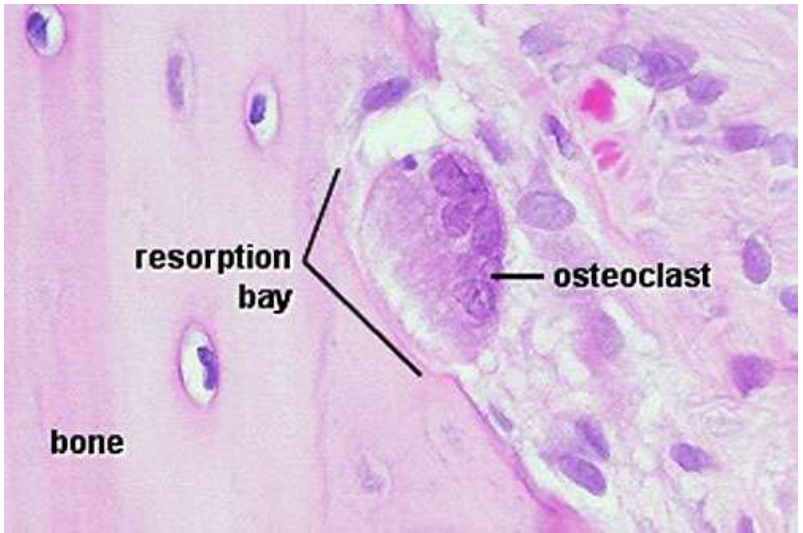
- Are large, multinuclear, phagocytic Cells. They appear to be derived from bone marrow cells similar to those that produce monocytes,
- These cells exhibit a ruffled border where they contact the bone which increases their surface area exposure to the bone.
- An osteoclast often in located within or adjacent to a depression or pit on the bone surface called a **How ships Lacunae.**



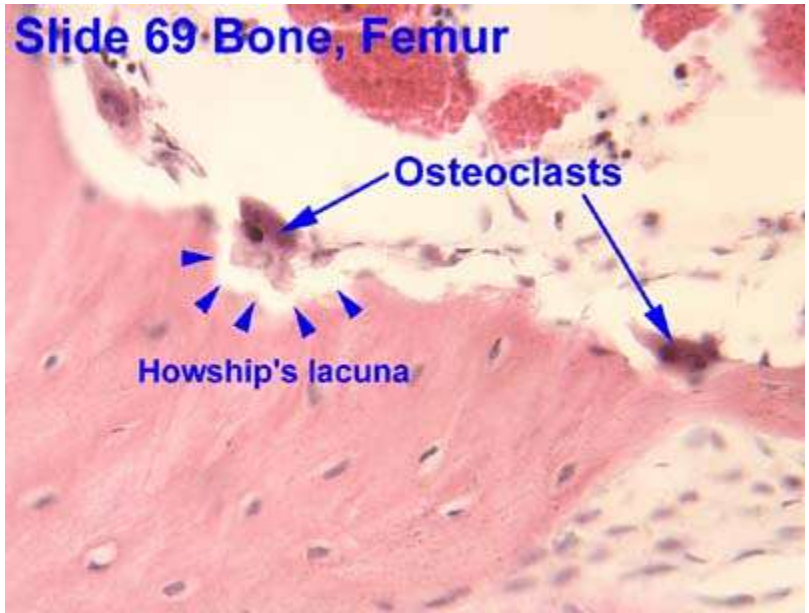
Osteoclasts are involved in and important process called bone resorption:

1. **osteoclasts,** secrete hydrochloride acid which dissolves the mineral parts (calcium and phosphate) of the bone matrix
2. **lysosomes within the osteoclasts** secrete enzymes that dissolve the organic part of the matrix.
3. **The release of the stored calcium and phosphate** from the bone matrix is called **osteolysis.**

- The liberated calcium and phosphate ions enter the tissue fluid and then the blood.



- Osteoclasts continuously remove matrix and osteoblast continuously add to it, maintaining a delicate balance.
- If osteoclasts resorb the bone to remove calcium salts at a faster rate than osteoblast produce matrix to stimulate deposition
- Bones lose mass and become weaker, in contrast when osteoblast activity out paces osteoclast activity, bones have a greater mass and become stronger.



Compact Bone Microscopic anatomy

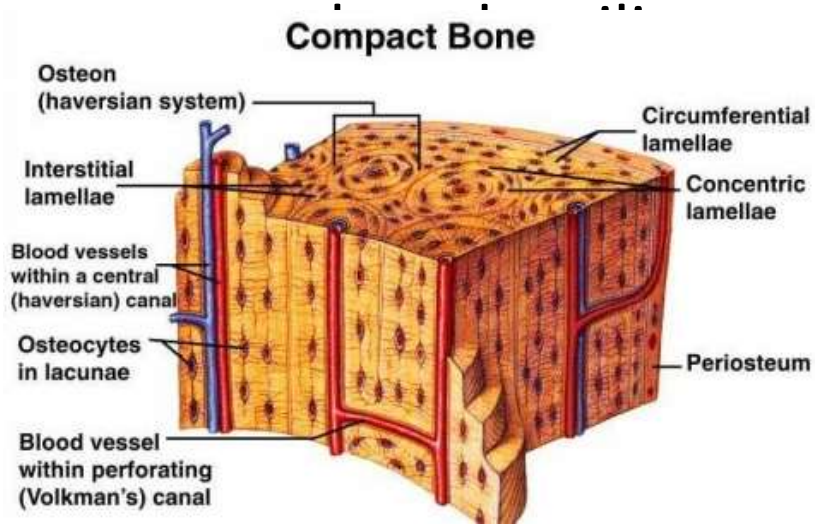
- Compact bone has an organized' structure when viewed under the microscope.
- A Cylindrical osteon or Haversian system is the basic functional and structural unit of a mature compact bone.
- Osteons run parallel to the diaphysis of the long bone. An osteon is a three-dimensional structure that has several component.

➢ ***The Central (Haversian) canal***: is a cylindrical canal that lies in the center of the osteon and runs parallel to it. Traveling within the central canal are the blood vessels and nerves that supply the bone.

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

Concentric Lamella:

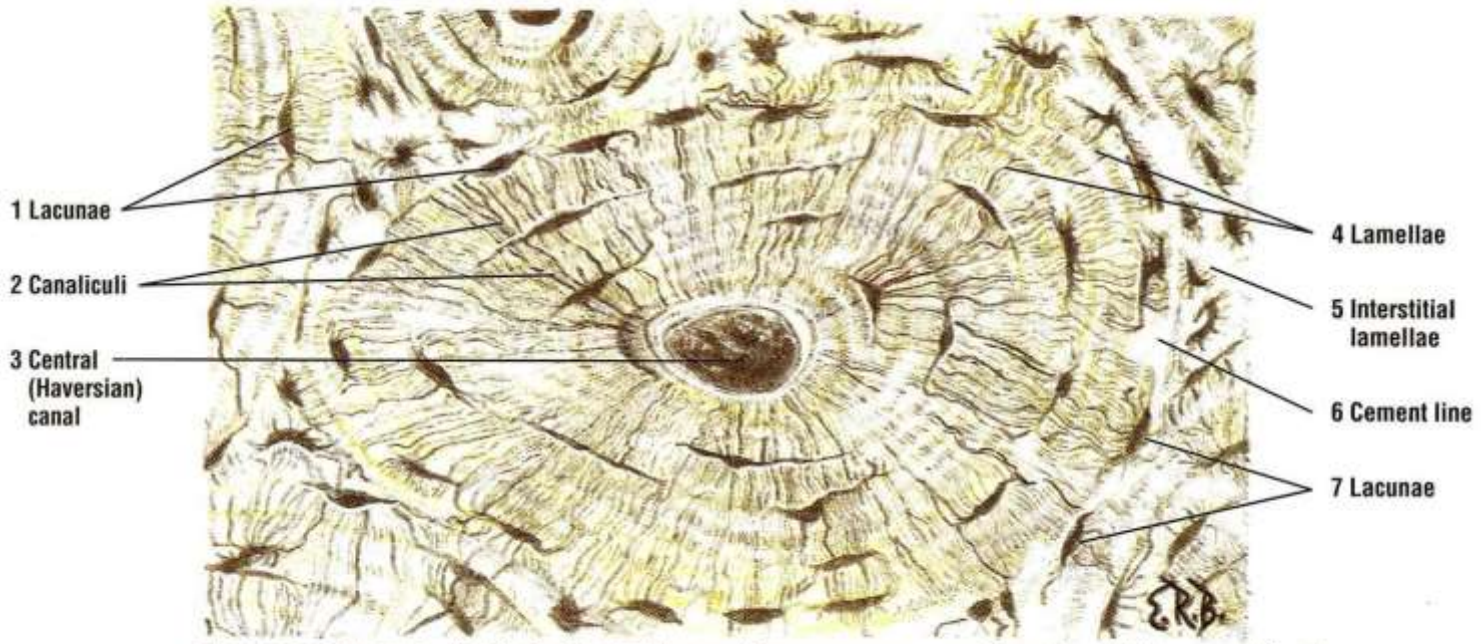
- are rings of bone connective tissue that surround the central canal forming the bulk of the osteon. The numbers of concentric lamella vary among osteons, each lamella contains collagen fibers oriented in one direction, adjacent lamella contain collagen fiber oriented in alternating directions in other words, if one lamella, has collagen fibers directed superiorly and to the right, the next lamella with have collagen fibers directed superiorly and to the left. This alternating collagen fiber direction gives bone part of its



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

- ***Osteocytes:*** Is mature bone cells found between adjacent concentric Lamella. These cells maintain the bone matrix.
- ***Lacunae:*** are spaces that each houses an osteocyte.
- ***Canaliculi***: are tiny, interconnecting cannels within the bone connective tissue that extend from each Lacuna, travel through the Lamella and connect to other Lacunae and the central canal. Canaliculi house osteocyte cytoplasm projections that permit intercellular contact and communication.

✓ Thus nutrients minerals, gases and wastes can travel through these passage ways between the central canal and the osteocytes.



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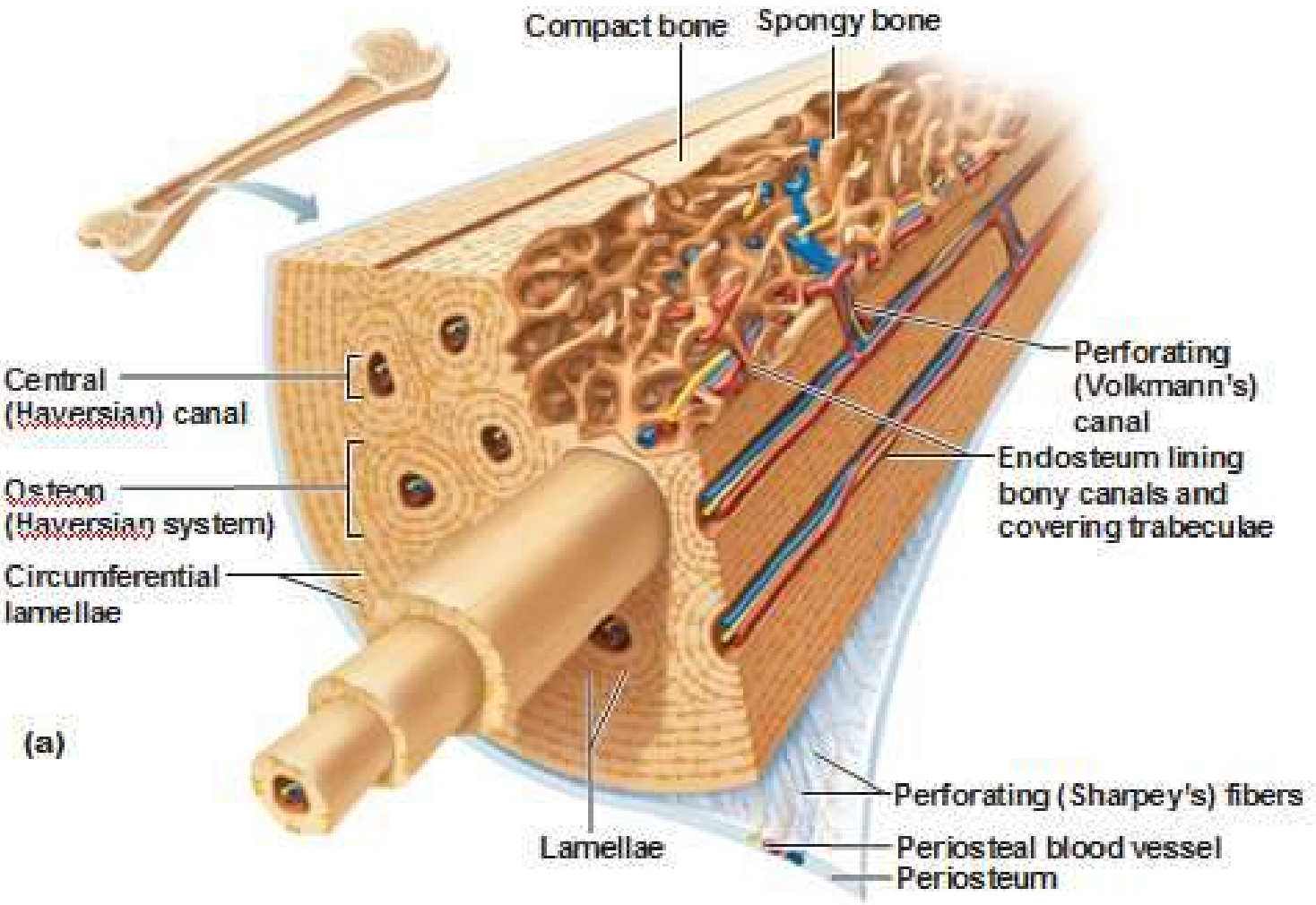
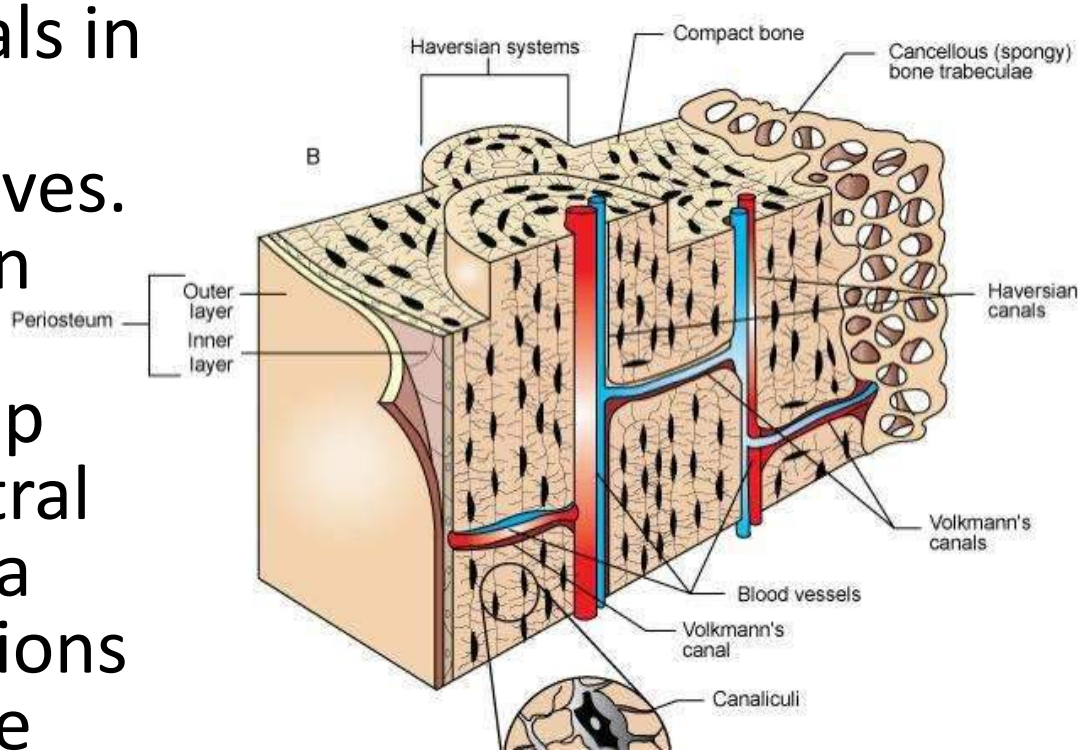
Microscopic Structure of Compact Bone

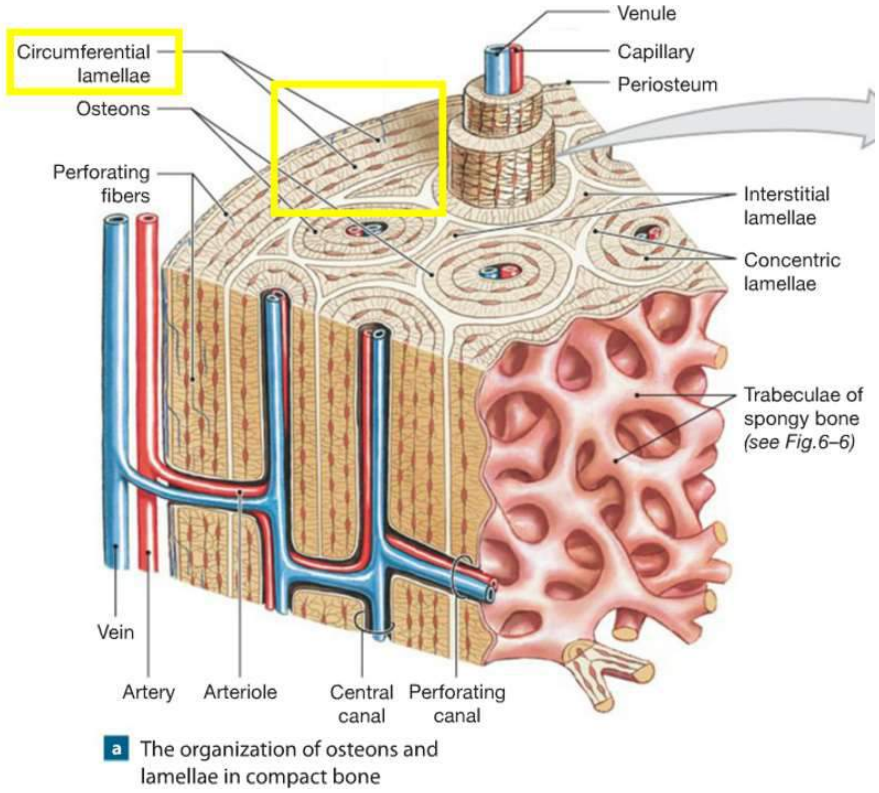


Several other structures are found in compact bone but are not part of the osteon proper, including the following:

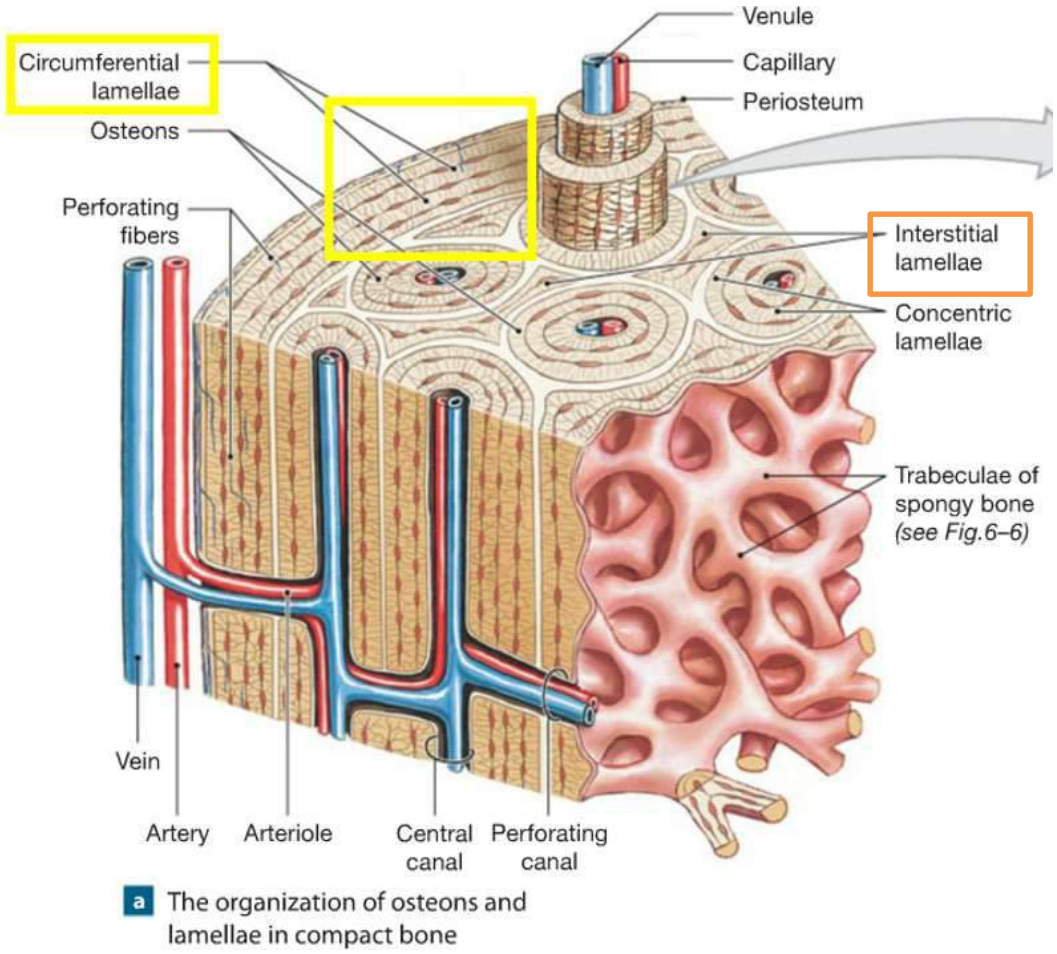
- ***Perforating canals:*** **(Volkmann canals)** resemble central canals in that they also contain blood vessels and nerves. Perforating, canals run perpendicular to the central canals and help connect multiple central canals. Thus creating a vascular and innervations connection among the multiple osteons.



- ***Circumferential lamellae***: are rings of bone immediately internal to the periosteum of the bone (external circumferential lamella) or internal to the endosteum (internal circumferential lamella) these two distinct regions originate during the original osseous formation of the bone. Both external and internal circumferential lamella runs the. Entire circumference of the bone itself

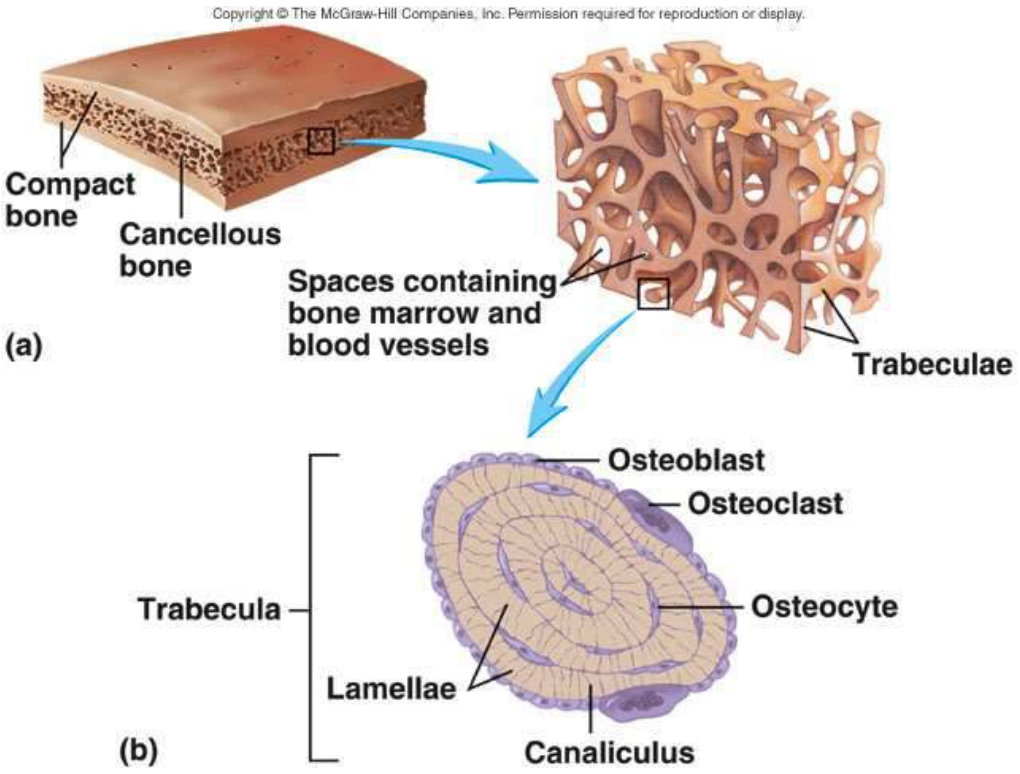


- ***Interstitial lamellae:*** are the left over parts of osteons that have been partially resorbed. They often look like a bit has been taken out of them. The interstitial lamella is incomplete and typically has no central canal.

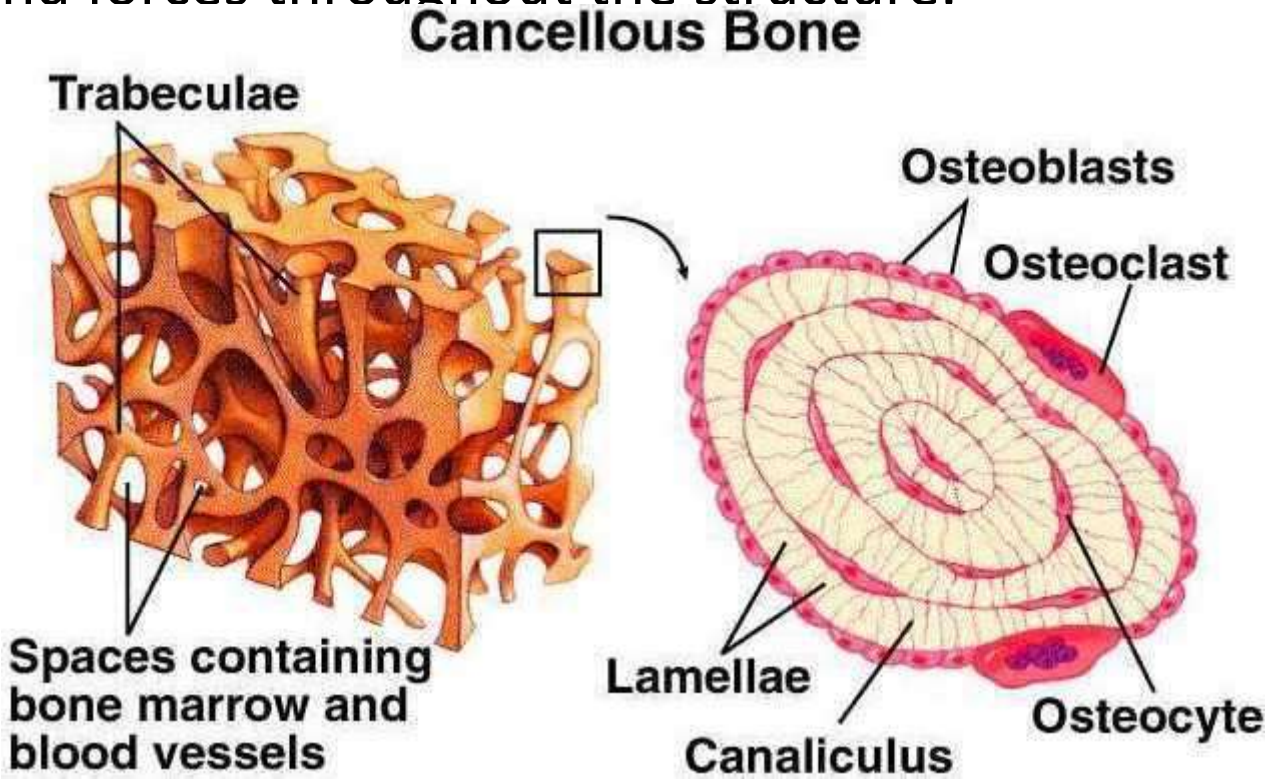


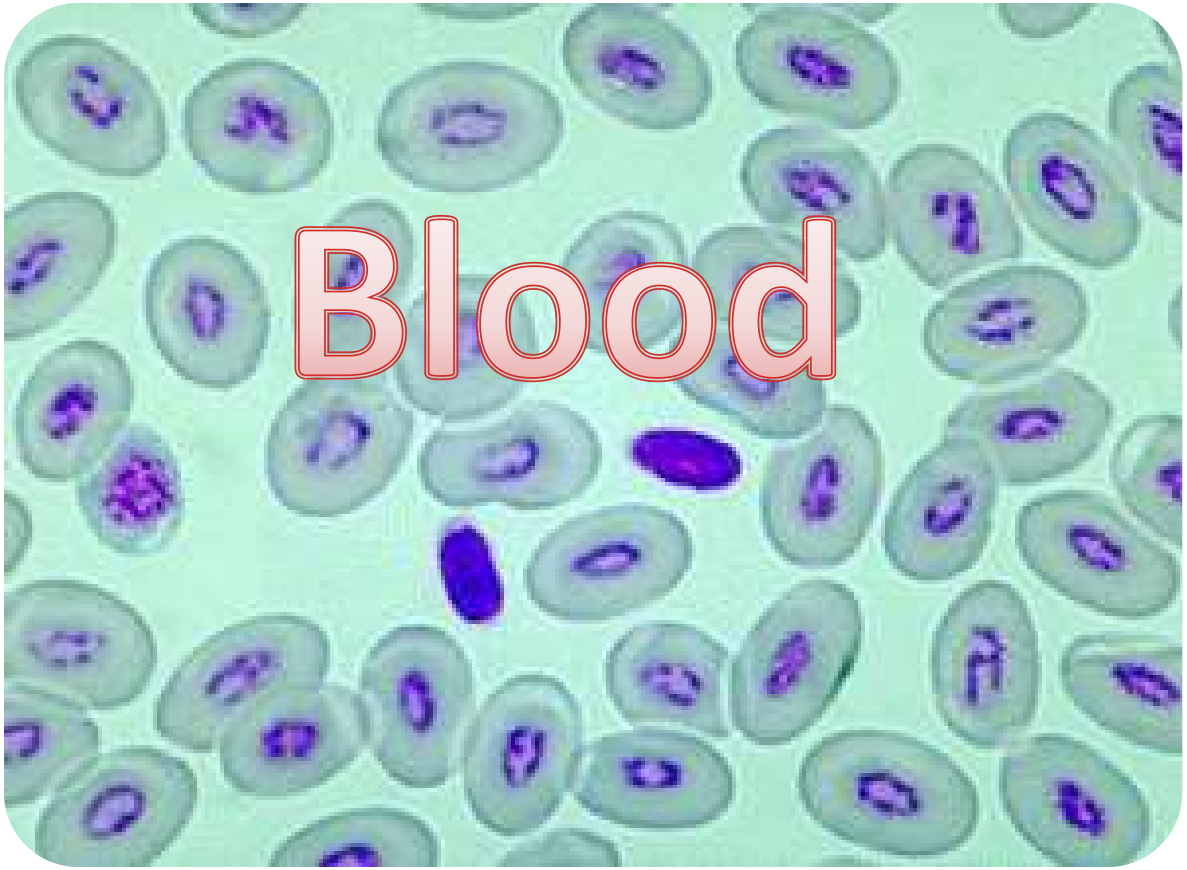
Spongy Bone (concellous bone) Microscopic anatomy

- Spongy bone contains no osteons" instead of the trabeculae of spongy bone are composed of parallel lamella. Between adjacent lamella are osteocytes resting in lacunae with numerous canaliculi radiating from the lacunae.
- Nutrients reach the osteocytes by diffusion through canaliculi that open into the surface of the trabeculae.



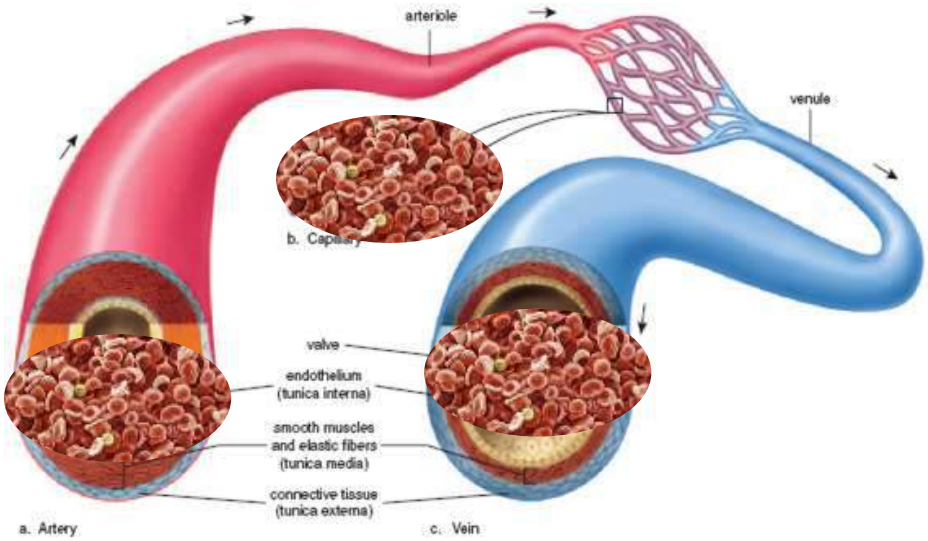
- Note that the trabeculae often from a meshwork of crisscrossing bars and plates of bone pieces. This structure provides great resistance to stresses applied in many directions by distributing the stress throughout the entire framework. As an analogy visualizes the jungle gym climbing apparatus on children play ground. It is capable of supporting the weight of numerous children whether they are distributed throughout its structure or all localized in one area. This is accomplished through the distribution of stresses and forces throughout the structure.




Blood

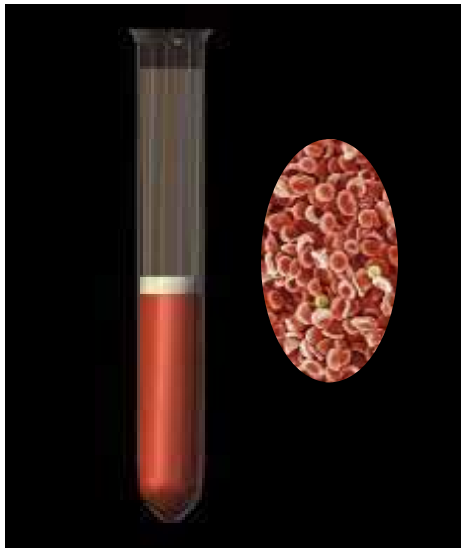
Blood

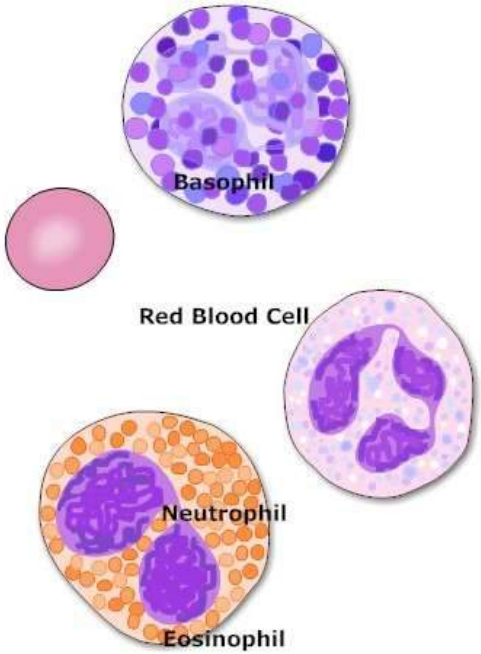
- Is type of connective tissue
- About four time more viscous than water
- The temperature of blood is about 38 ^{o}C It bright red in the arteries and dark in the vein
- Liquid ground substance called plasma and dissolved proteins



Component of blood

- Erythrocytes: make up about 44% of blood sample
- Leukocytes (W.B.C): include tow type (granulocyte and Agranulocyte), make up about 5000-10000 permicroliter of blood
- Platelets: less than 1% of blood sample
- Plasma: make up about 55% of blood





Functions of blood

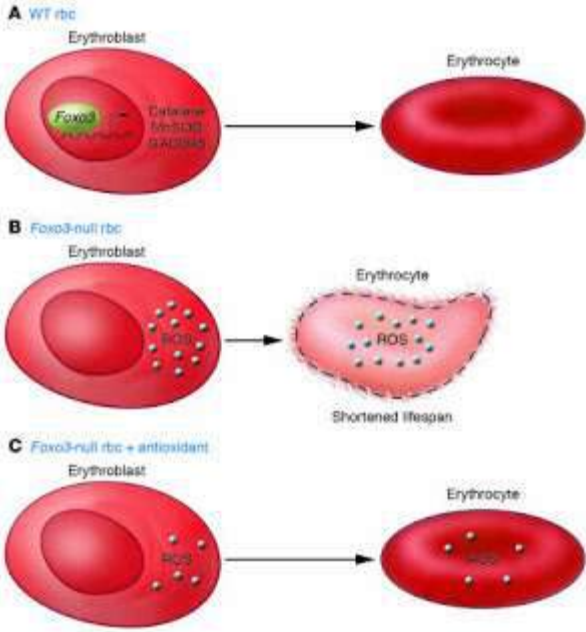
1. **Transportation:** blood transports numerous elements and compound throughout the body. For example, erythrocyte carry oxygen from the lungs ,the body cells and then transport carbon dioxide from the cells back to the lungs for expulsion from the body
2. **Regulation**

A. Blood regulate body temperature in multiple ways

B. Blood helps to regulate PH levels in the body's tissues

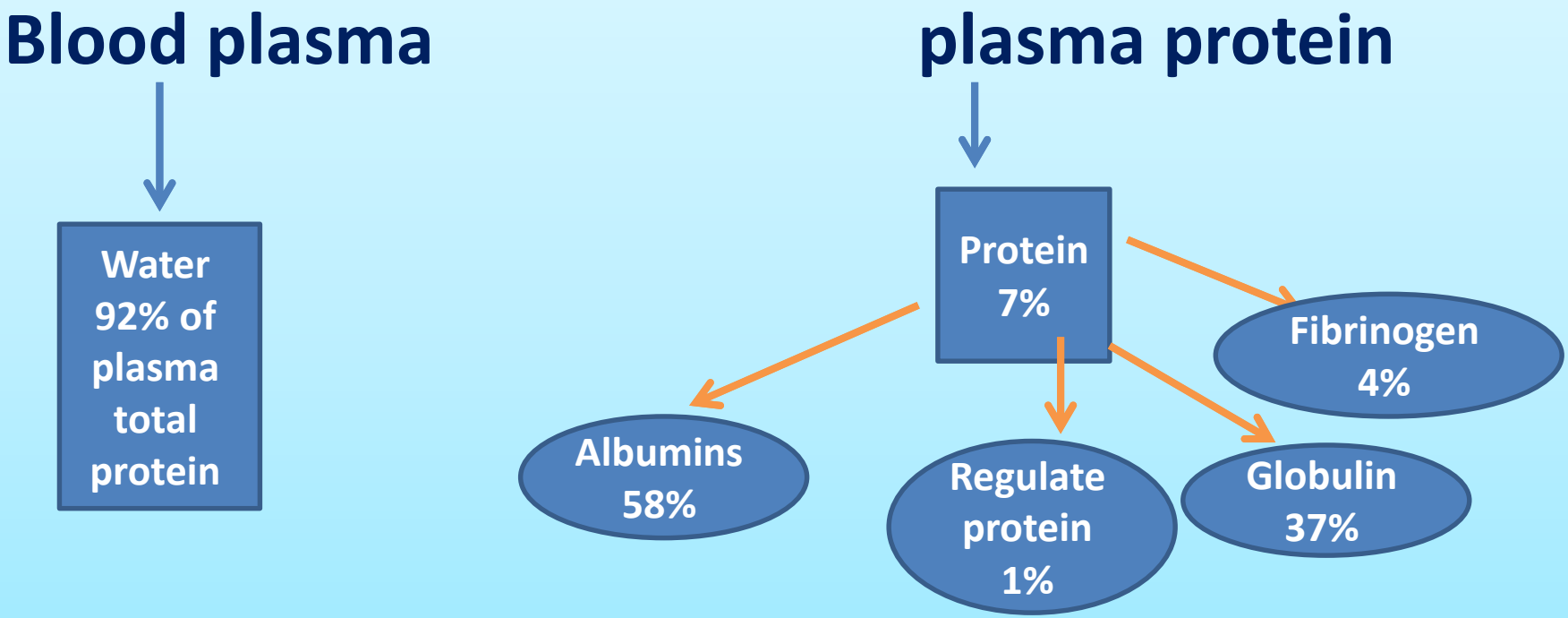
C. Blood maintain normal fluid levels in the cardio vascular system and prevents fluid loss

3. **Protection:** Leukocyte (white blood cells) help guard against infection by mounting an immune response



Blood plasma

- Is a complex mixture of water, proteins and other solutes.



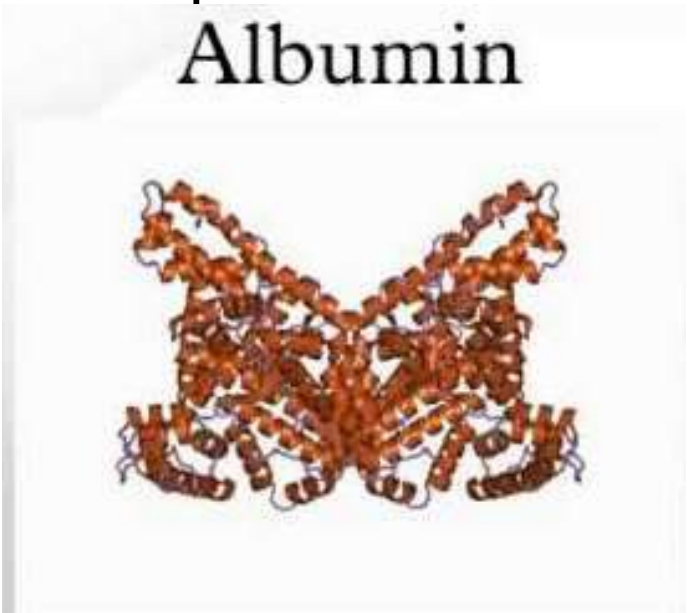
Plasma protein

1. **Albumins:** are the smallest and most abundant of the plasma proteins making up approximately 58% of total plasma proteins;

- **Function:**

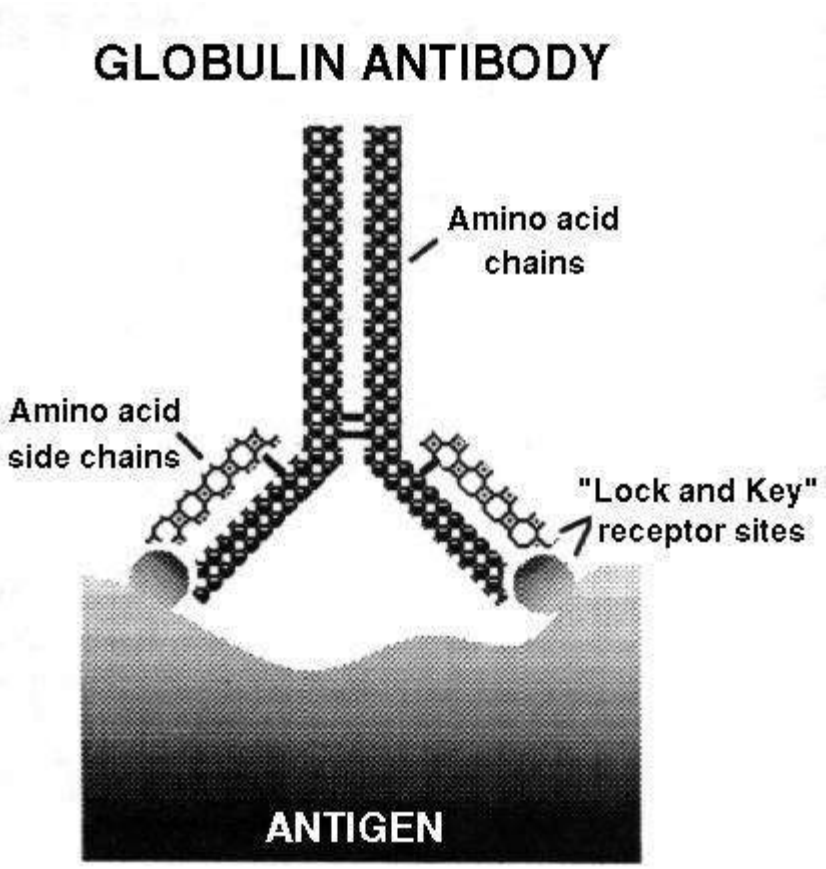
A. They regulate water movement between the blood and interstitial fluid.

B. Albumins act as transport proteins that carry ions, hormones, and some lipids in the blood.



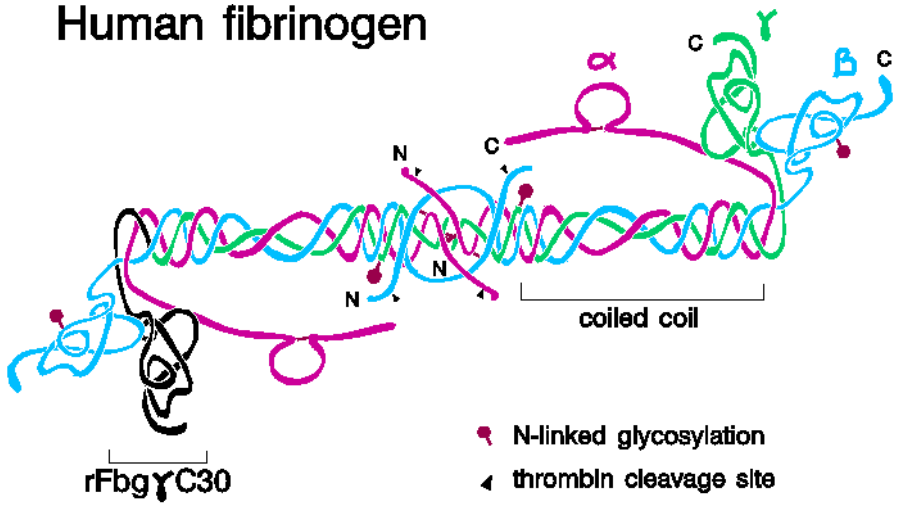
2. Globulins

- Is the second largest group of plasma proteins forming about **37%** of all plasma proteins
- **Function**
- Bind, Support, Protect certain water insoluble or hydrophobic molecules, hormones and ion



3. Fibrinogen

- Make up about **4%** of all plasma proteins
- **Function:**
- Responsible for blood clot formation
- **Mechanism**
- Following trauma to the walls of blood vessels >>> fibrinogen is converted into long insoluble strands of **fibrin** >>> which help to form a blood clot

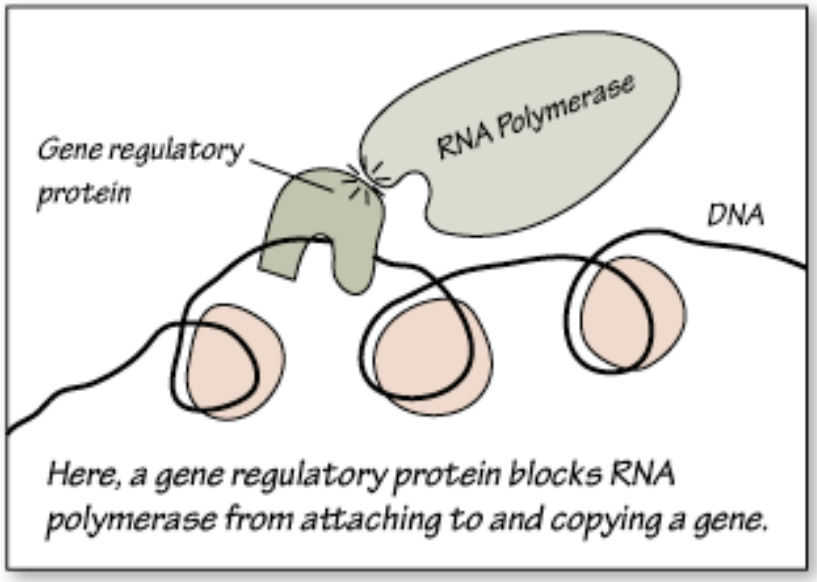


(H. Cote, adapted from R. F. Doolittle)

4. Regulatory proteins

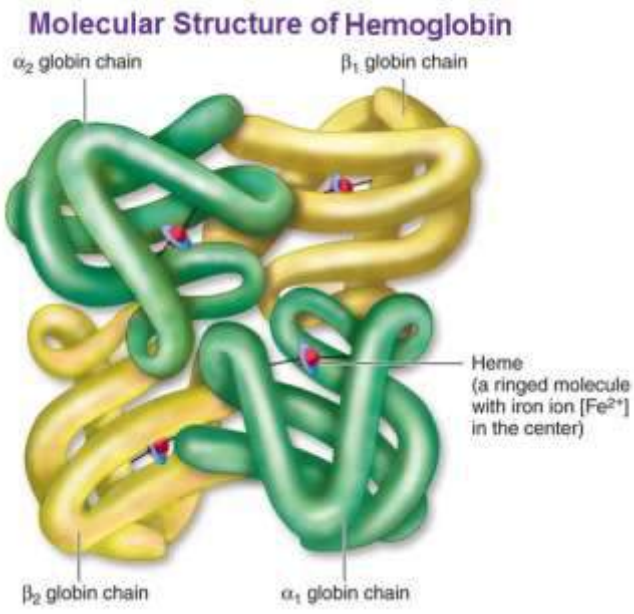
- Form very minor class of plasma protein **(less than 1 % of total plasma protein)**include enzymes and hormones
- **Function**

1. **Enzymes:** to accelerate chemical reactions in the blood
2. **Hormones**: being transported throughout the body to target cells



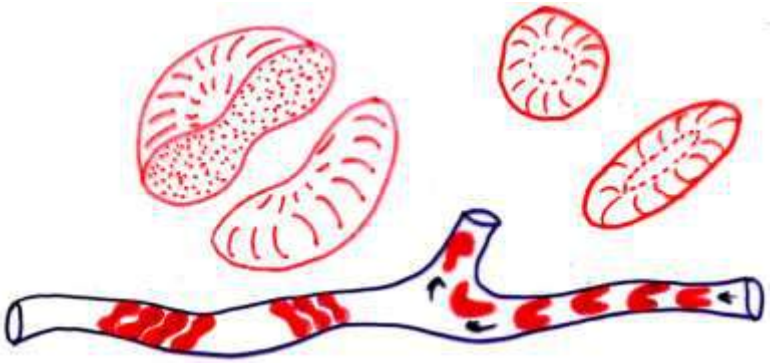
Erythrocytes

- **(Red blood cell)** is misnomer because mature erythrocytes lack nuclei
- Each hemoglobin molecule consists of four protein building blocks called **globins,** two of these globins are called **alpha chains** and the other two which are slightly different are called **beta chains**
- Each hemoglobin molecule has four iron ions and is capable of binding four molecule of **oxygen**



Erythrocyte life cycle

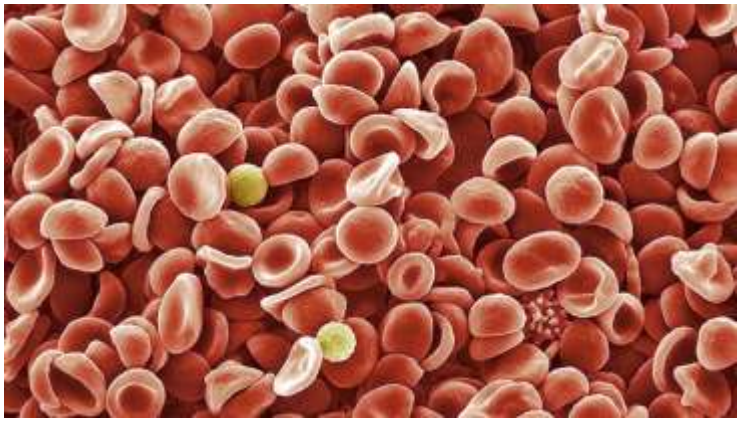
Himi group (Minus the iron ion) → convert → Green pigment (biliverdin) → Yellow green pigment (bilirubin)



Yellow green pigment (bilirubin) → Bile produced by liver cell → Inter digestive tract → Breakdown fats → Bilirubin in digestive → Modified into → Other products in urine and feces

Erythrocyte life cycle

iron ion component in Hb is removed → transport by → Globulin protein (transferring) → liver → Passed to → Another protein (ferritin) for storage → transport → Red bone marrow → Erythrocyte production

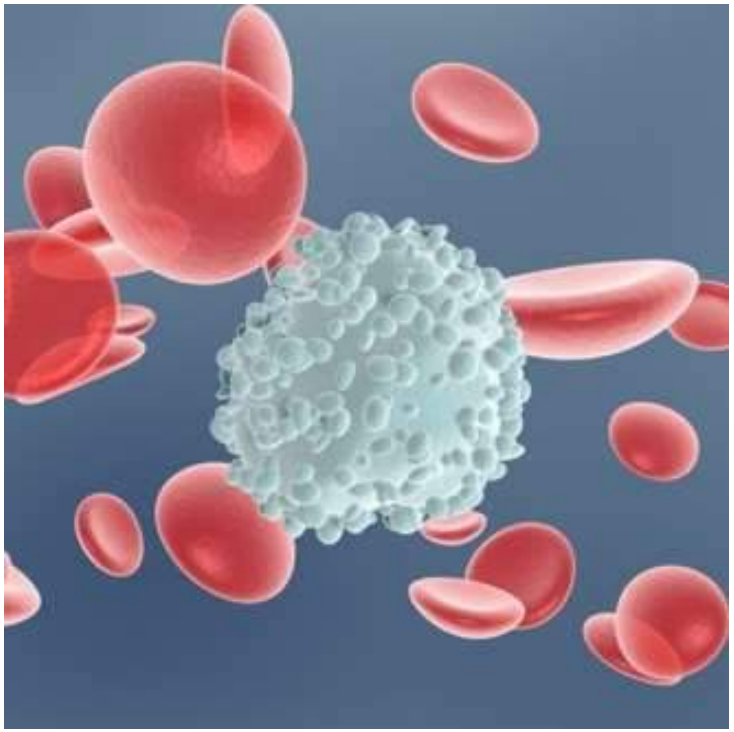


Erythrocyte life cycle

erythrocyte membrane protein and globin protein → Broken down → Free amino acid → Protein synthesis → New erythrocyte

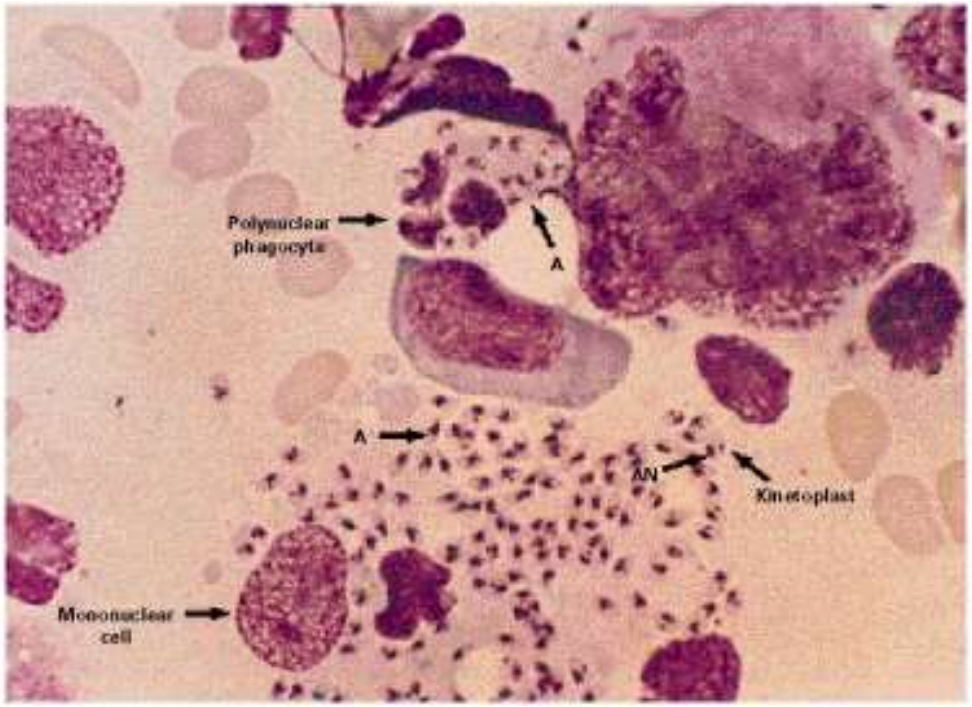
Leukocyte

- Help initiate an immune response and defend the body against pathogens, and its true cells because contain nucleus and cellular organelles



Leukocyte

Leukopenia is reduced number of leukocytes caused serious disorder this condition may result from viral or bacterial infection

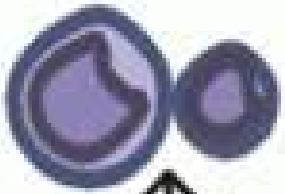


Leukocytes

white blood cells ~ WBC

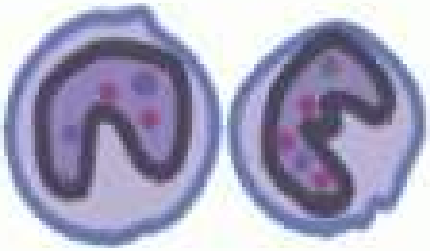
agranular

lymphocytes
20 - 25 %



T-cell, B-cell, NK Cell

monocytes
3 - 8%

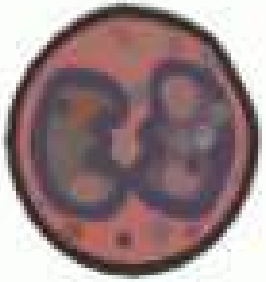


granular

basophils
.5 - 1%

neutrophils
60 - 70%

eosinophils
2 - 4%



Granulocyte

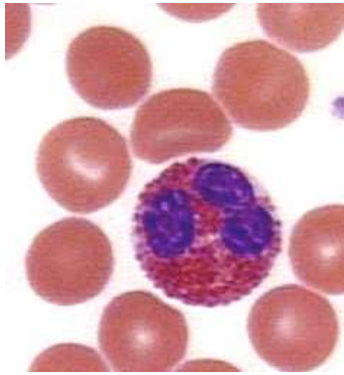
1. Neutrophils

- The most numerous leukocytes in the blood are the neutrophil consisting about 60-70% of the total number of leukocytes.
- **Function:**
- Specifically, neutrophils target and kill bacteria by secreting lysozyme, an enzyme that helps destroy component of bacteria cell walls.

2. Eosinophils:

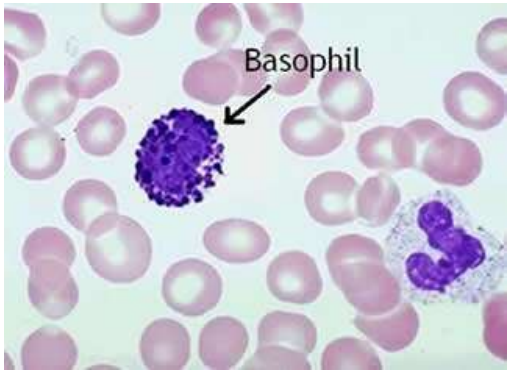
- Have reddish or pink-orange granules in their cytoplasm.
- Typically, eosinophil's constitute about 2-4% of the total number of leukocytes.
- The nucleus is bilobed, where the two lobes are connected by a thin strand.
- Eosinophils are about 1.5 times larger in diameter than an erythrocyte
- **Function**:

1. Eosinophils increase in number when they encounter and react to or phagocytize antigen-antibody complexes or allergens (antigens that initiate a hypersensitive or allergic reaction)
2. If the body is infected by parasitic worms, the eosinophils will release chemical mediators that attack the worms.



3.Basophiles

- Are usually about, **1.5 times** larger than erythrocytes. They are the least numerous of the granulocytes;
- Basophiles constitute about **0.5-1%** of the total number of leukocytes.
- Basophiles always exhibit a bilobed nucleus and abundant blue-violet granules in the cytoplasm.-
- **Function:**
- The primary components of basophile granules are histamine and heparin, The release of heparin from basophiles inhibits blood clotting

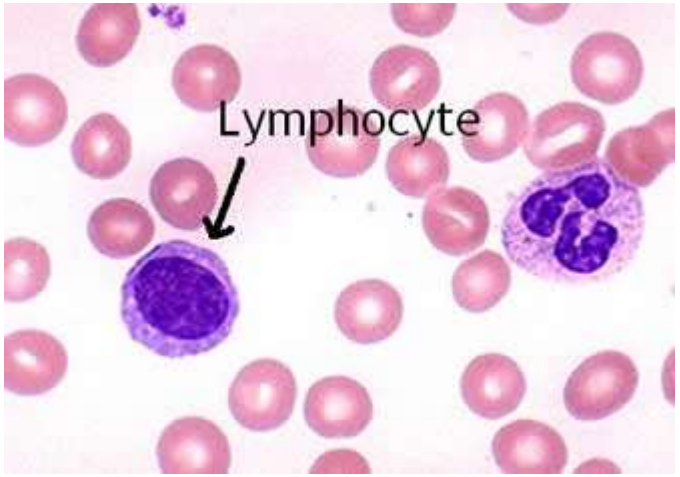


Agranulocyte

1. **Lymphocytes:** constitute about 20-25% of the total number of leukocytes.

- Their dark staining nucleus is typically rounded and smaller lymphocytes exhibit only a thin rim of blue-gray cytoplasm around the nucleus.
- **There are three categories of lymphocytes.**

1. **T-lymphocytes (T-cell)** :manage and direct an immune response, some directly attack foreign cells and virus infected cells.
2. **B-lymphocytes (B-cell):** are stimulated to become plasma cells and produce antibodies
3. **Natural killer cells (NK cells):** attack abnormal and infected tissue cells.



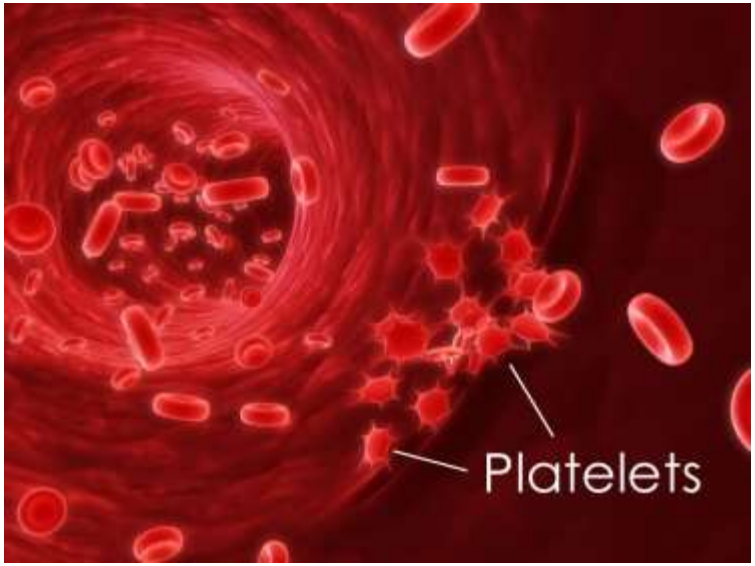
2.Monocyte

- They usually constitute about 3-8% of all leukocytes. The nucleus of a monocyte is kidney in shape or C-shaped.
- **Function:**
- Where they change into large phagocytic cells called macrophages. Macrophages phagocytize bacteria, cell fragments, dead cells and debris.

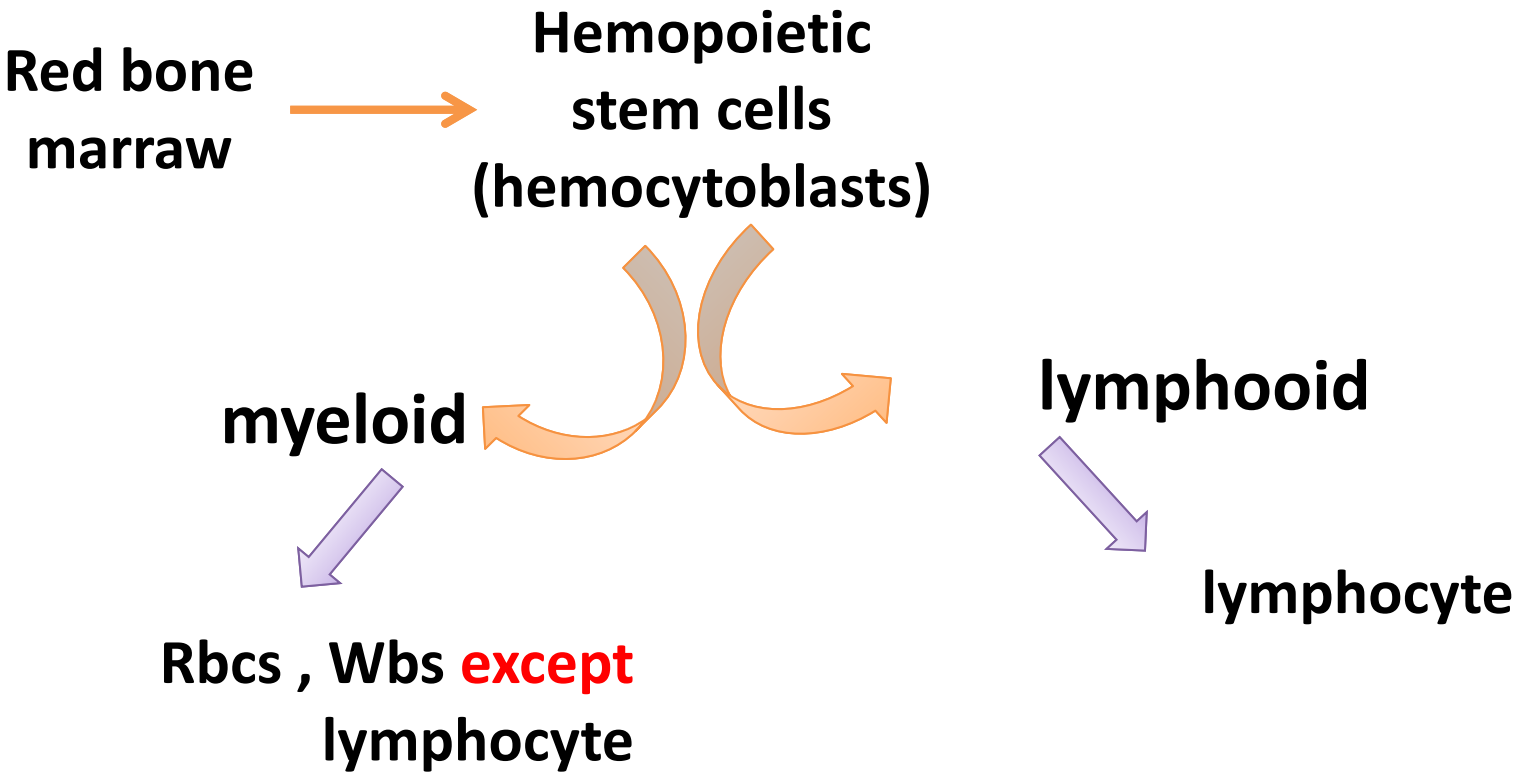
R.B.C		W.B.C
Physical features	RBCs are bi-concave disc shaped, and have no nucleus. size is roughly approximately 6-8 µm	WBCs are irregular in shape, but have a nucleus and an outer buffer coat.
Life span	120 days.	4-30 days depending on body
Types	There is only one type of RBCs found in the blood.	There are various types of WBCs with distinct functions in the blood:neutrophils, T lymphocytes, B lymphocytes (plasma cell) monocytes (macrophage), eosinophils, basophils.
Circulatory system	Cardiovascular system	Cardiovascular and lymphatic systems.
Functions	Supplies oxygen to different parts of the body and carries carbon dioxide and other waste products.	Producing antibodies to develop immunity against infections. Some are phagocytic
Production	Produced in red bone marrow.	Produced in lymph nodes, spleen, etc.
Movement	they move in blood vessels eventually squeezing through capillaries giving O2 and nutrients to body cells.	they leave the blood vessels and move to the injury site. Capable of diapedesis-squeeze between cells of blood vessel walls to exit circulation.
Nuclei	RBC do not have nuclei in humans	WBC have nuclei in humans

platelets

- Irregular, membrane enclosed cellular fragments that are about (2) micrometer in diameter.
- In stained preparation, they exhibit a dark central region.
- Platelets are some time called thrombocyte

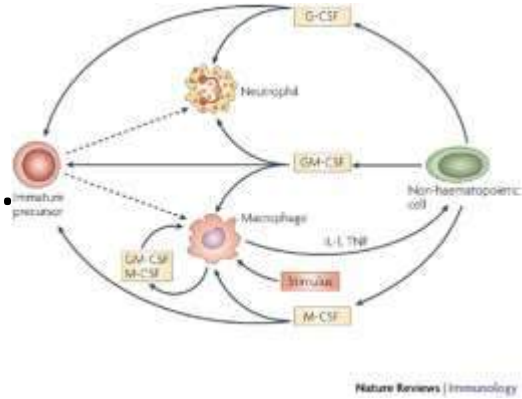


Hemopoisis


Red bone marraw
Hemopoietic stem cells (hemocytoblasts)
myeloid
lymphooid
Rbcs , Wbs except lymphocyte
lymphocyte

Colony-stimulating factors (CSFs)

- **Multi-CSF:** increases the formation of erythrocytes as well as all classes of granulocytes, monocytes, and platelets from myeloid stem cells.
- **GM-CSF:** is a growth factor accelerates the formation of all granulocytes and monocytes from their progenitor cells.
- **G-CSF:** is a growth factor that stimulates the formation of granulocytes from myeloblast cells.
- **M-CSF:** is a growth factor that stimulates the production of monocytes from monoblasts.
- **Thrombopoietin:** is a growth factor that stimulates both the production of megakaryocytic in the bone marrow and the subsequent formation of platelets
- **Erythropoietin (EPO):** is a hormone produced by the kidneys to increase the rate of production and maturation of erythrocyte progenitor and erythroblast cells



Erythropoiesis

the process of erythrocyte production

Myeloid stem cell

Progenitor cell

proerythroblast

hemoglobin

Normoblast

More hemoglomin

Reticulocyte produced

hemoglobin

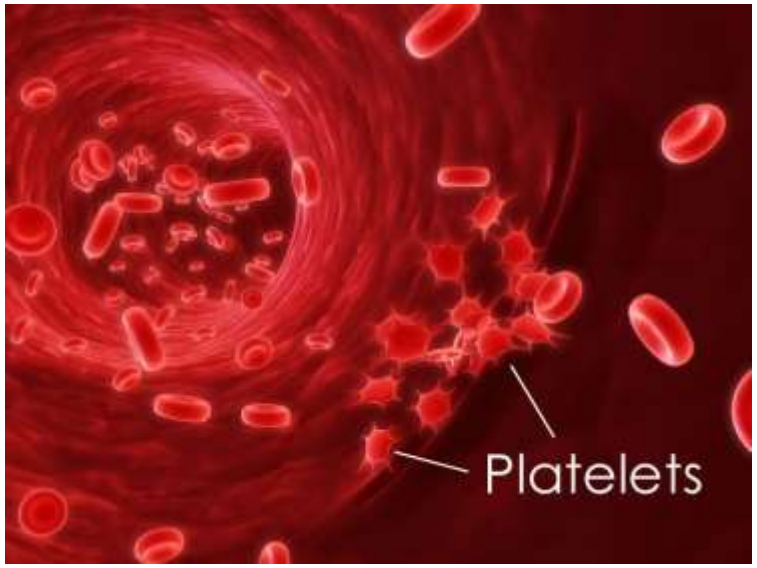
Thrombopoiesis
the production of platelets

Thrombopoietin

Myeloid stem cell
Megakaryoblast

Megakarycytic

platelets



Leuckopoises:production of leukocyte

Granulocyte maturation

Myeloid stem cell

↓

Progenitor cell

↓

Myeloblast

↓

One of three type of wbc

monocyte maturation

Myeloid stem cell

↓

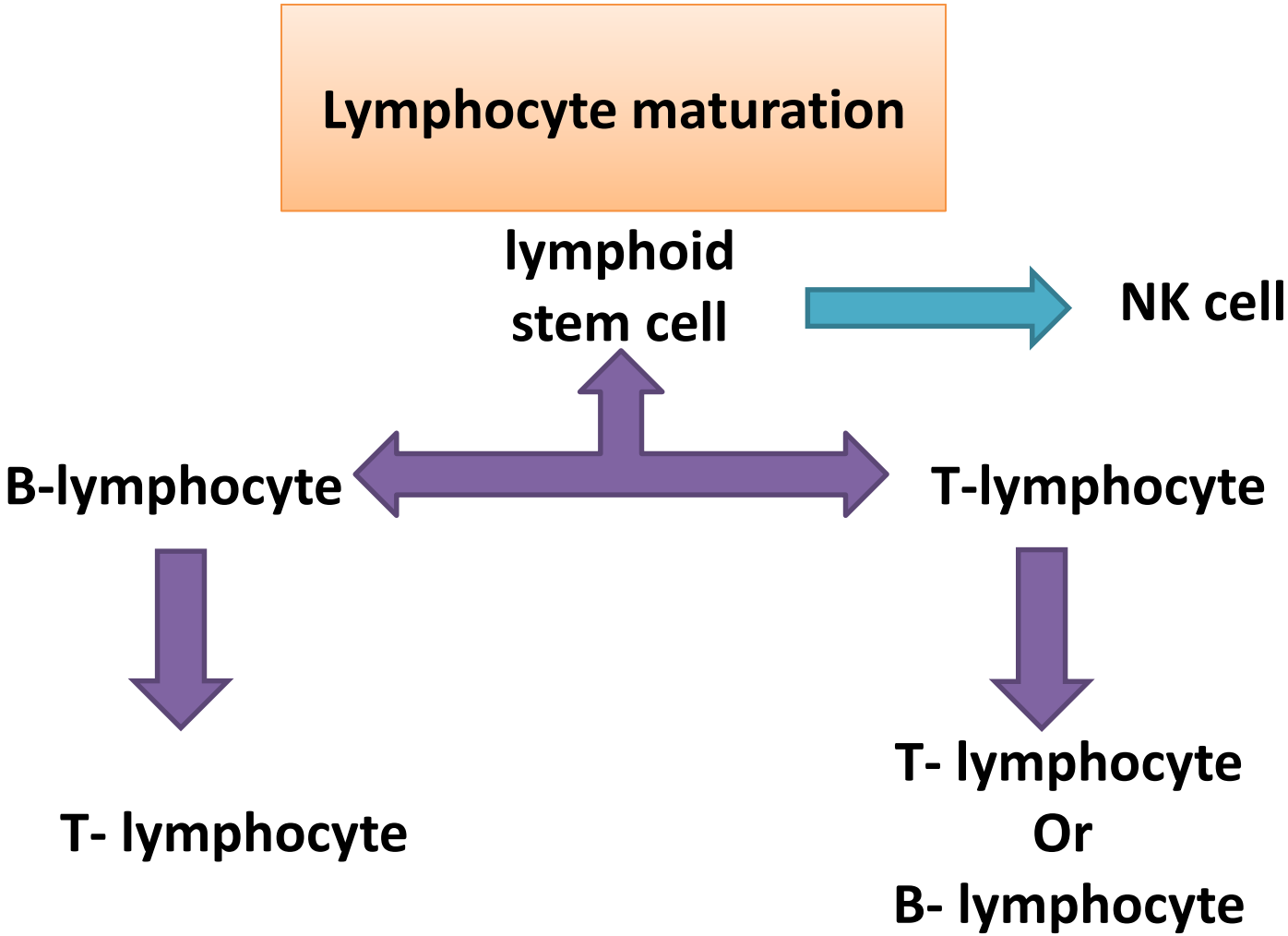
Progenitor cell

↓

monoblast

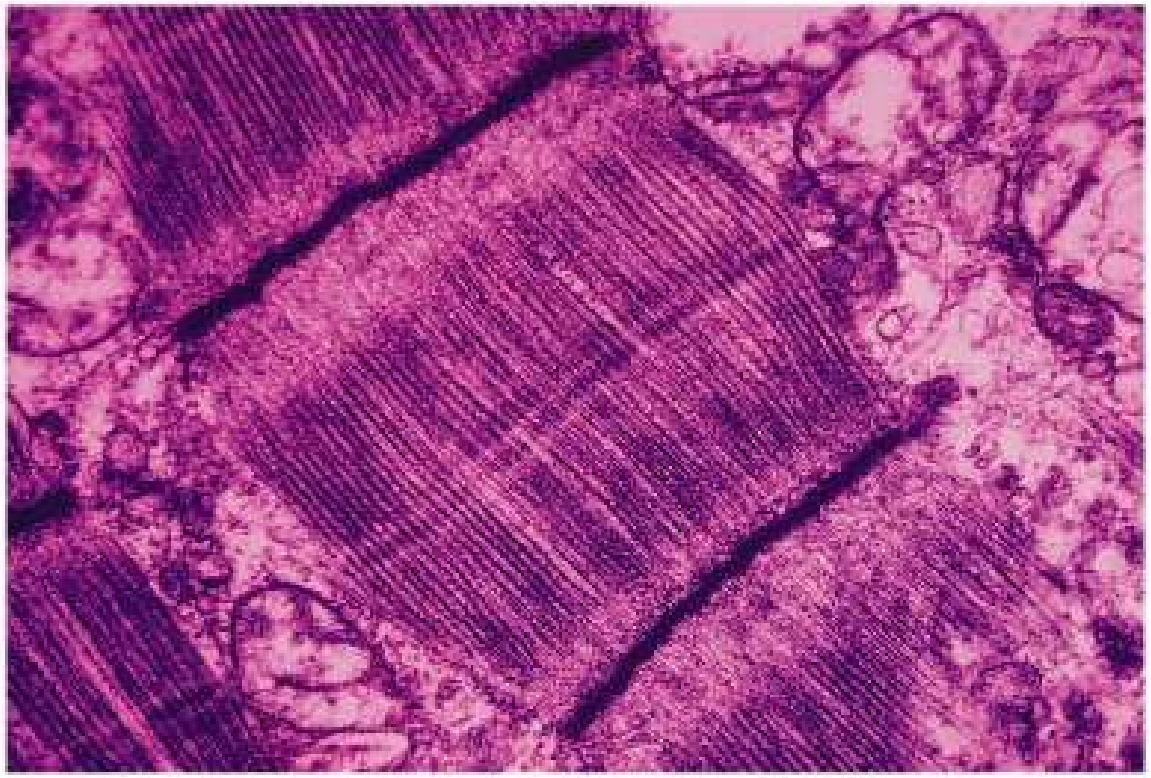
↓

monocyte


Lymphocyte maturation
lymphoid stem cell
NK cell
B-lymphocyte
T-lymphocyte
T- lymphocyte
T- lymphocyte Or B- lymphocyte


Thank You

Muscle Histology



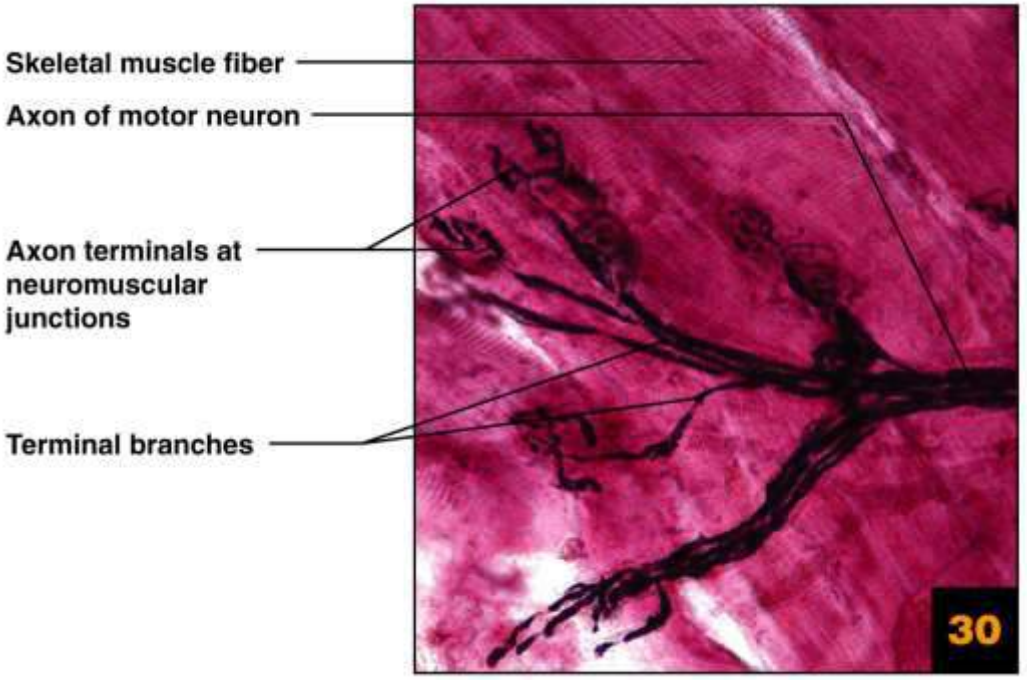
Lec.Dr.Ruwaidah F. Khaleel

Muscle tissue

Are grouped into bundle composed of specialized cells (Fibers) and have rich network of blood capillaries to provide food and O2 and to eliminate toxic waste products.

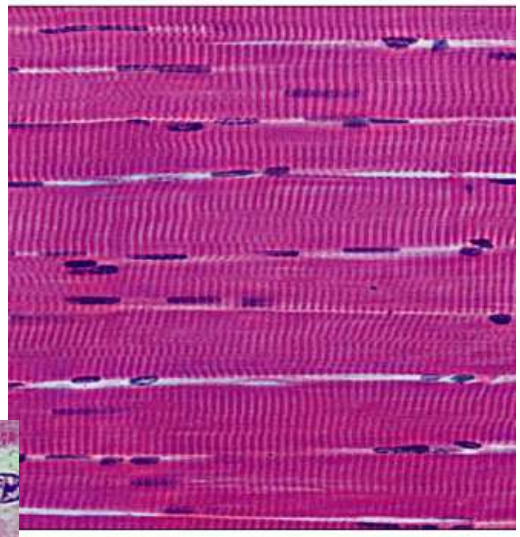
It exert movement include:

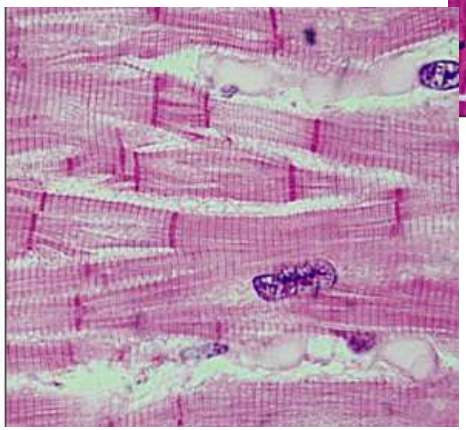
- **Voluntary motion of body part**
- **Blood circulation**
- **Respiratory activities**
- **Population of material along digestive tract and waste elimination.**



Type of muscle

- Skeletal muscle
- Cardiac muscle
- smooth muscle



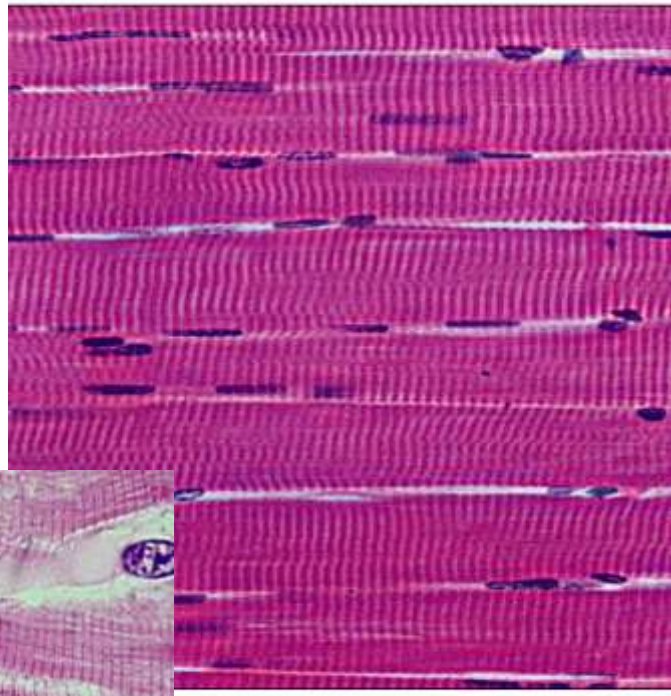


They are vary in their:

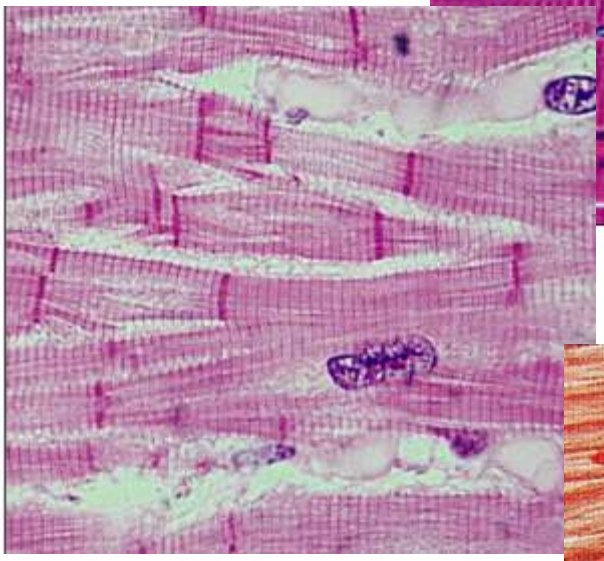
- Appearance
- Location
- Physiology
- Internal organization
- Mean of control by nervous system

Types of Muscle Tissue

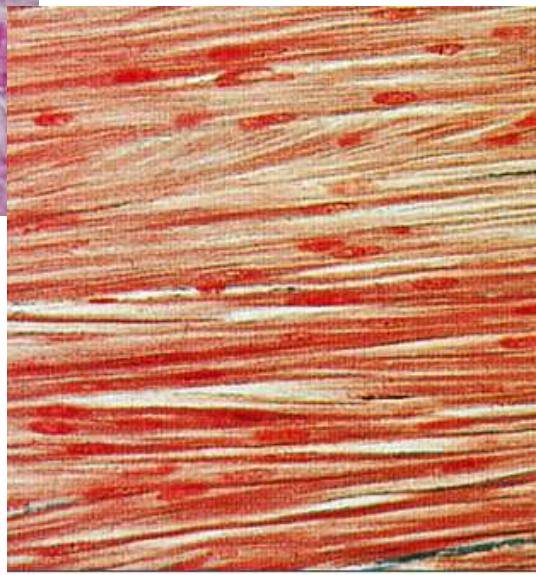
- ✓ Skeletal muscle



- ✓ Cardiac muscle



- ✓ Smooth muscle



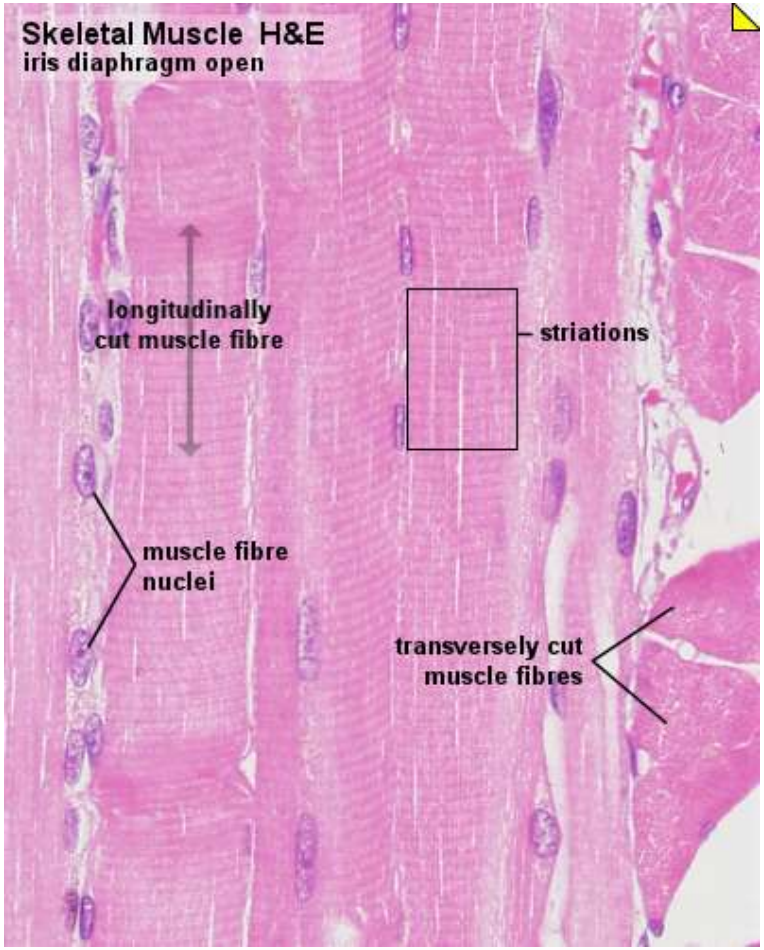
Compare between skeletal and cardiac muscle tissue

	Skeletal muscle tissue	Cardiac muscle tissue
Structure	Fiber are long, cylindrical, parallel, un branched, multinucleated, striated	Fiber are short, bifurcated, with one or two centrally located nuclei, intercalated discs between cells
Function	Move skeleton, responsible for voluntary body movement, heat production	Involuntary contraction and relaxation help pump blood in heart
Location	Attaches to bone or some times to skin (eg. facial muscle) also in the voluntary sphincters- lips, urethra, anus	heart wall (myocardium)

Skeletal muscle tissue

Is composed of:

- Long cylindrical muscle cells **(Fiber)**
- Individual muscle fiber or cell are striated in both longitudinal and transverse direction
- Vary from **1-40mm** in length and **10-100 microns** in diameters
- Multinucleated, nuclei are ovoid and located in edge called **(periphery)** adjacent to the **sarcolemma**
- Striated and voluntary.



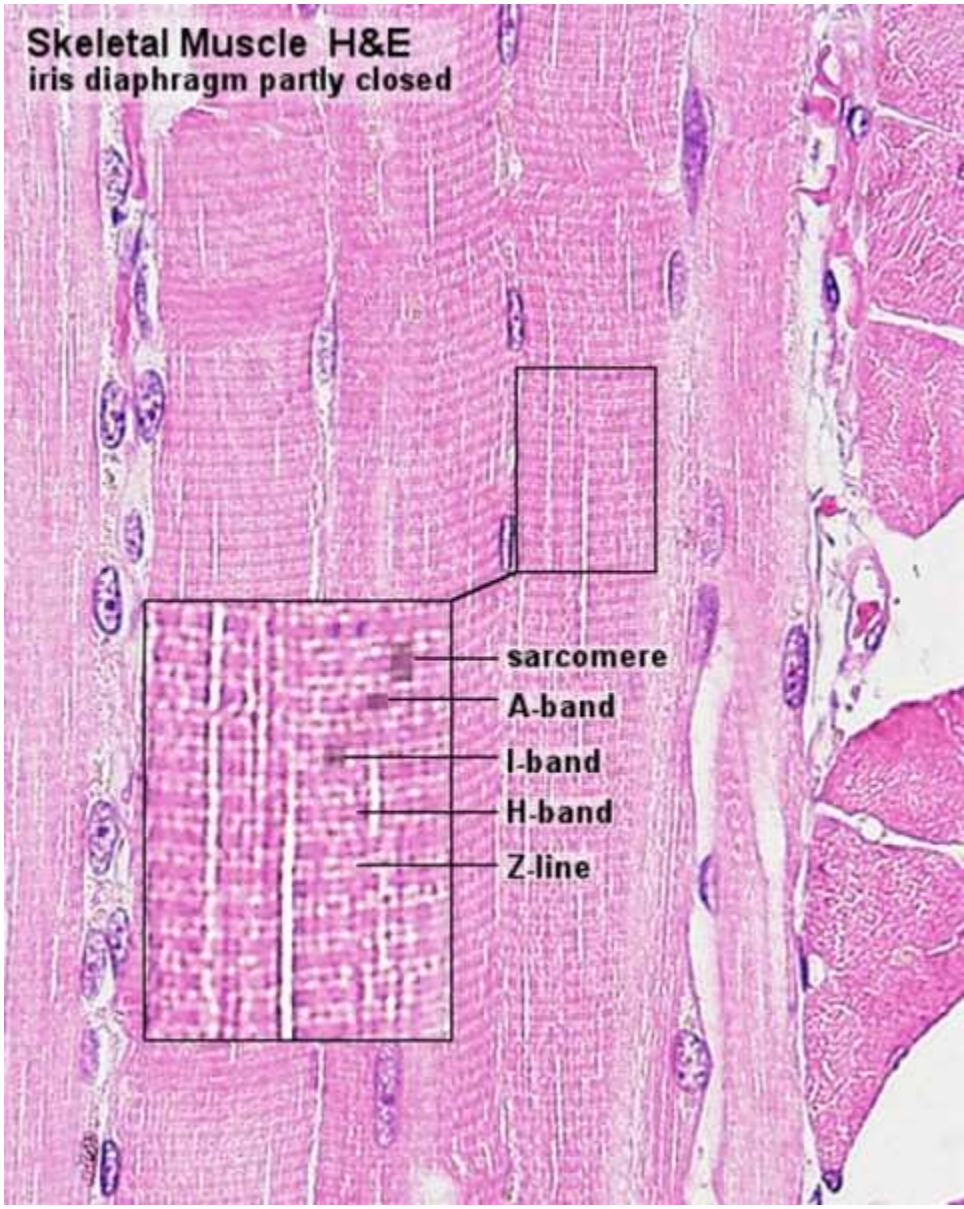
Under light microscope

Striation mean:

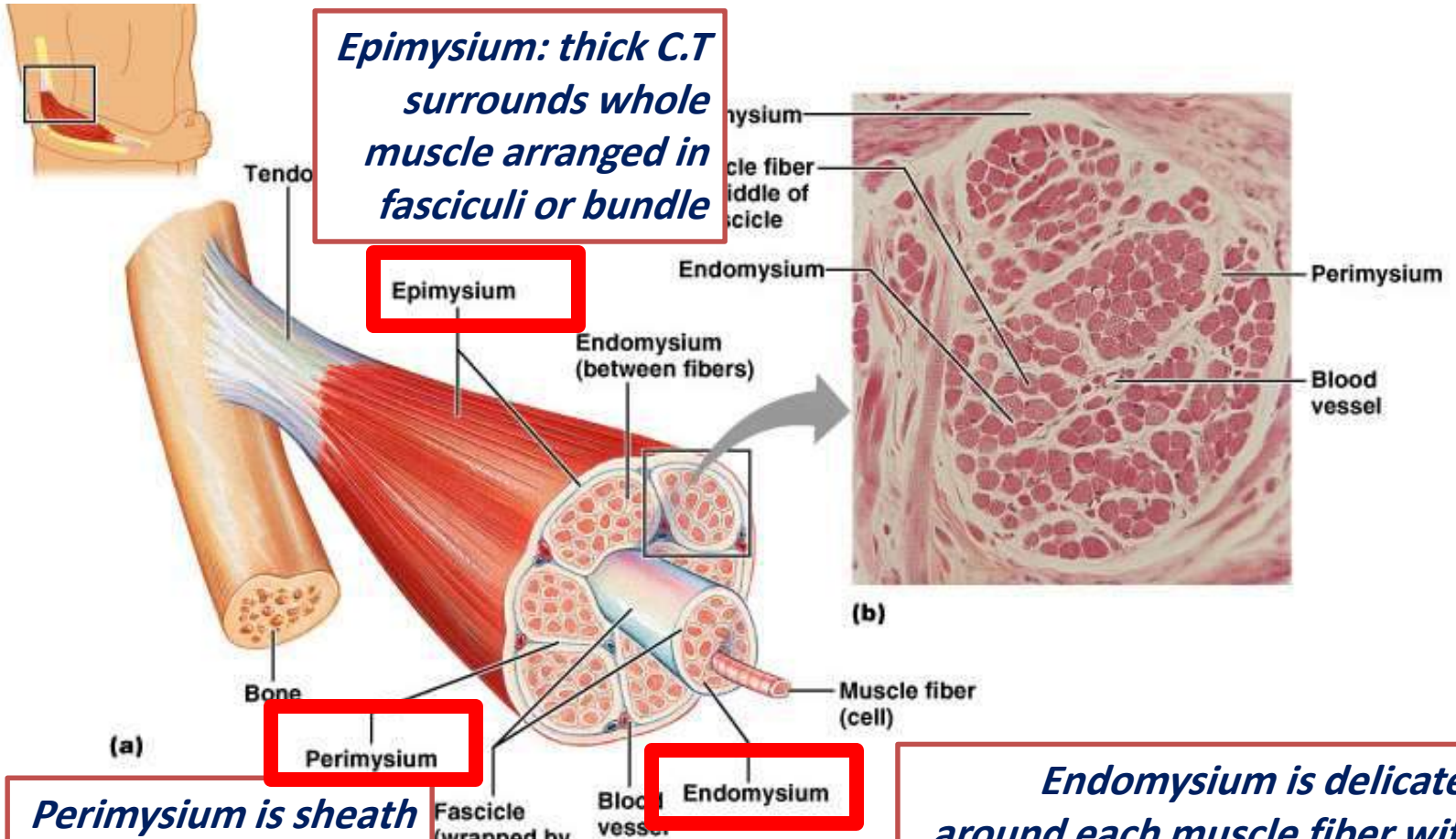
- **Light band and dark band**

The power of muscle is dependent **not upon the length of the component muscle fibers** but upon the **total number** of fibers found present in the muscle

- With exercise muscles increase in size is due to an **increase in size** of each individual fiber **(hypertrophy)** not to an **increase number** of fibers **(hyperplasia).**

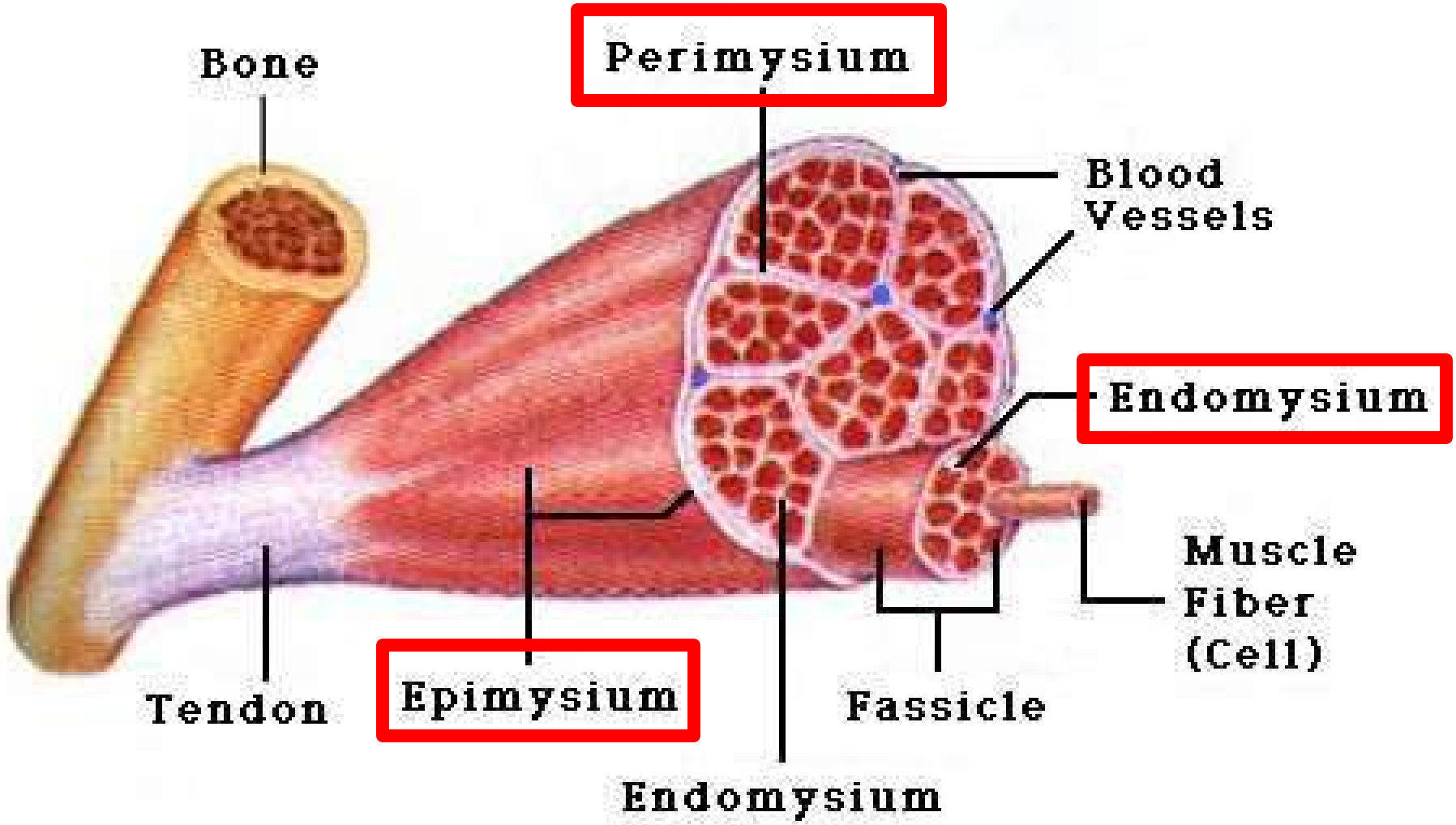


Epimysium: thick C.T surrounds whole muscle arranged in fasciculi or bundle



Perimysium is sheath thinner C.T around fascicle

Endomysium is delicate C.T around each muscle fiber with in fascicle


Bone
Perimysium
Blood Vessels
Endomysium
Muscle Fiber (Cell)
Tendon
Epimysium
Fassicle
Endomysium

Microscopic anatomy of skeletal muscle

- **Sarcolemma**

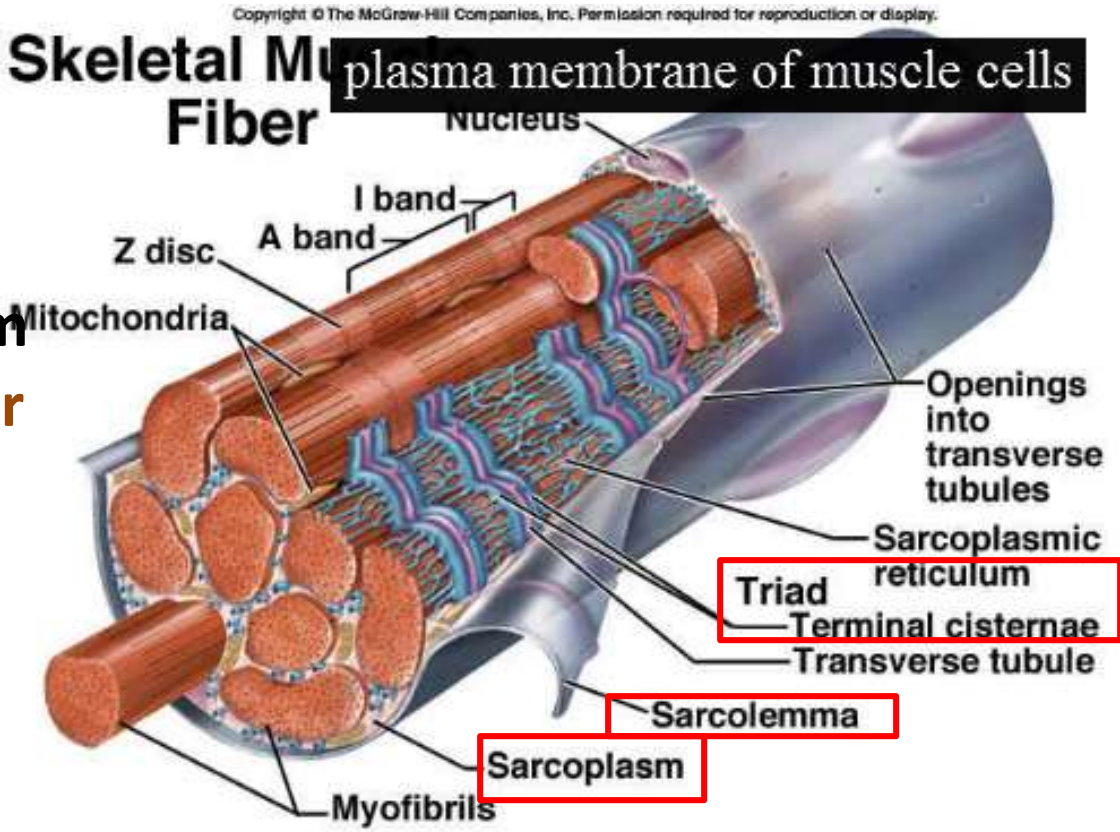
Is plasma membrane of skeletal muscle fiber

- **Sarcoplasm**

Is occupied mainly by long, cylindrical, parallel, filamentous bundles **1-3 mm**

Typical skeletal muscle fiber contains

- ❖ Abundant mitochondria **(300),**for energy
- ❖ Lysosomes
- ❖ Small colgi apparatus
- ❖ Small lipid droplets
- ❖ glycogen



Main structure of muscle fibers

- **T-tubule (transverse tubule)**

Deep invagination of sarcolemma that extent into sarcoplasm of skeletal muscle fibers as a network of narrow membranous tubules

- **SR (sarcoplasm reticulum)**

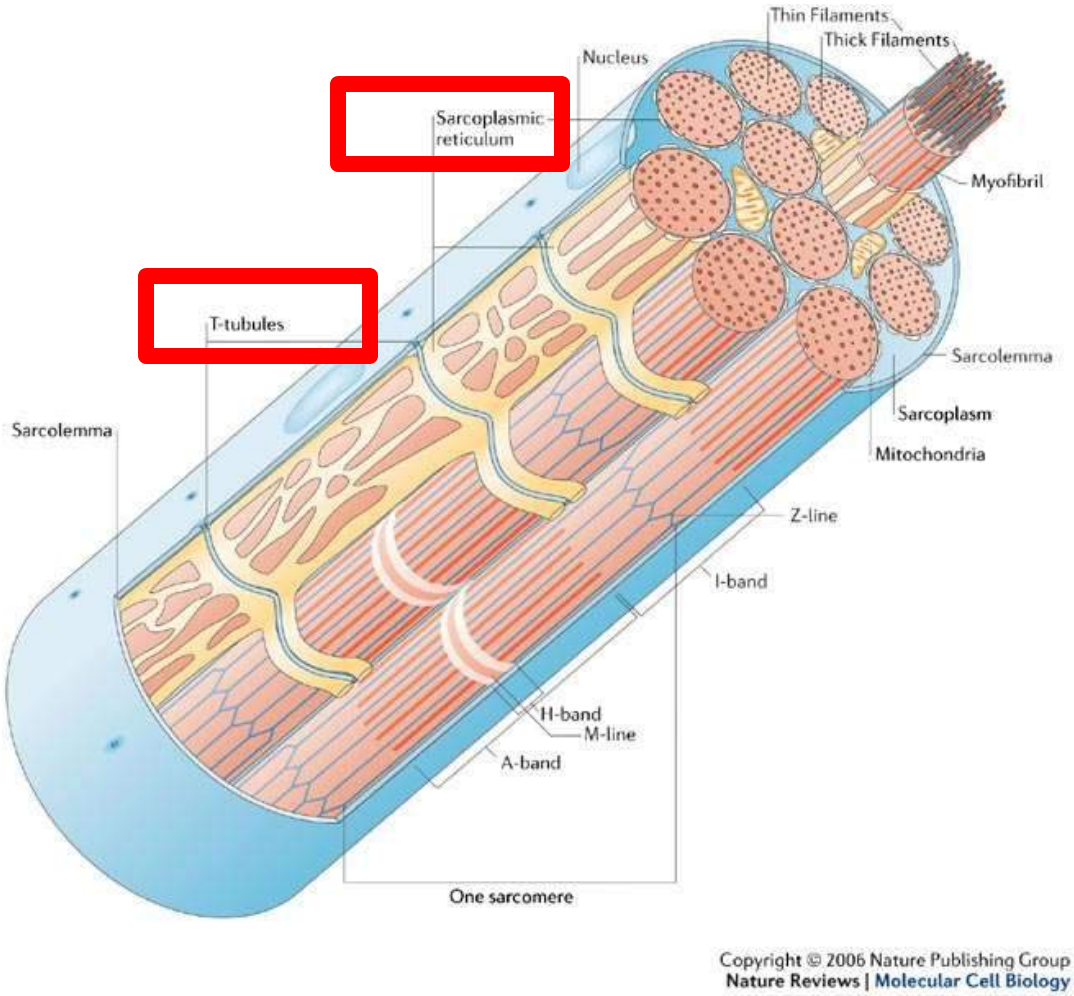
That is similar to endoplasmic reticulum it is reservoir for calcium ions needed to initiate muscle contraction

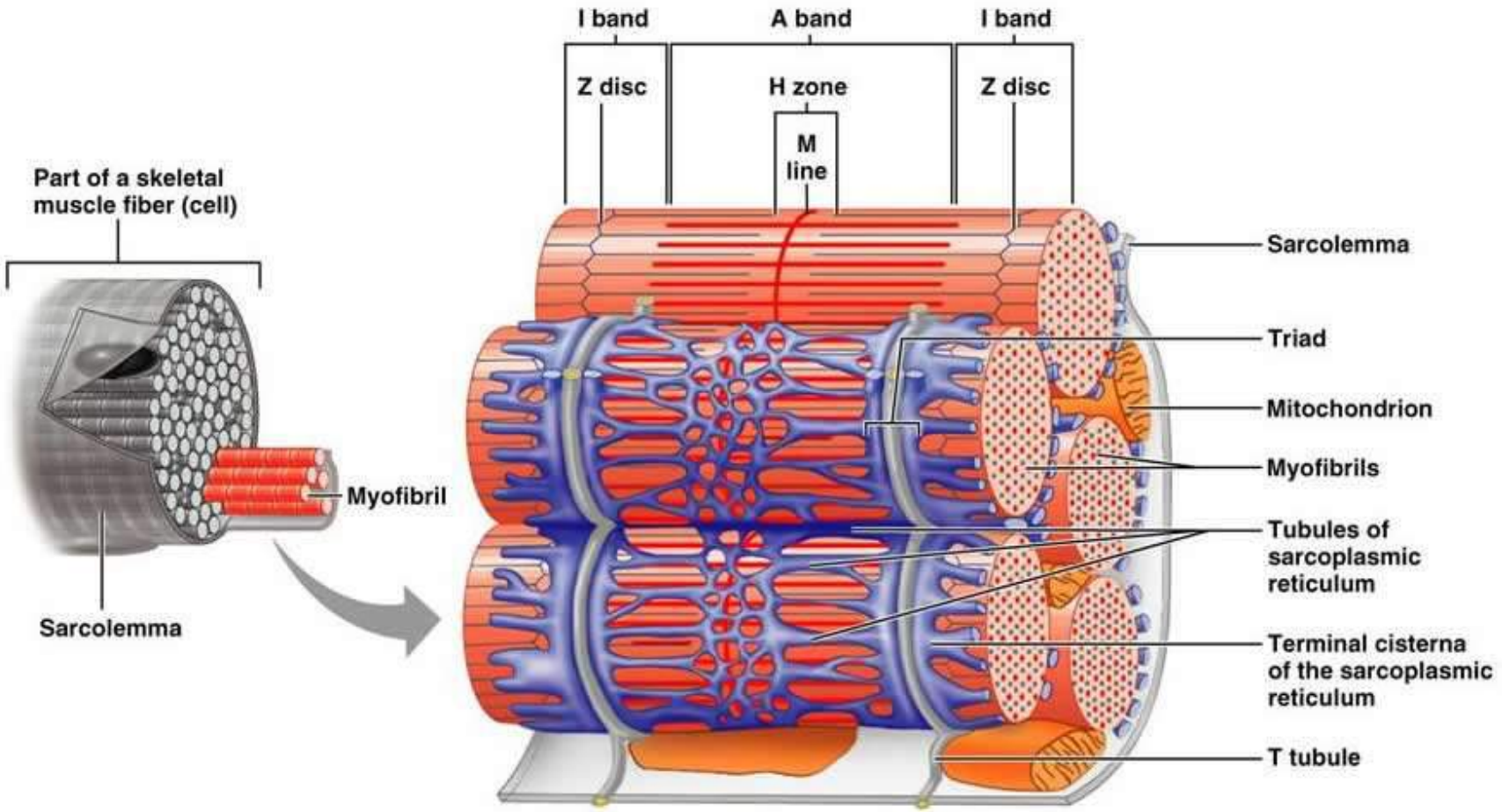
❖ **Terminal cisterna**

Blind sac of SR perpendicular to the fibers length they are reservoir for ca+ ions

- **Triad**

Its structure of tow terminal cisternae and the centrally placed T-tubule



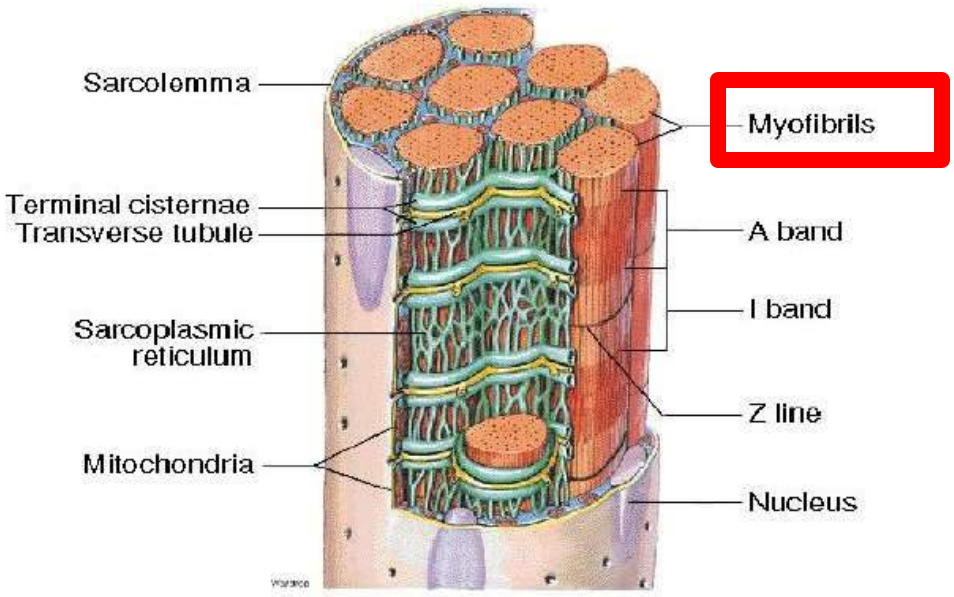

I band
A band
I band
Z disc
H zone
Z disc
M line
Part of a skeletal muscle fiber (cell)
Myofibril
Sarcolemma
Sarcolemma
Triad
Mitochondrion
Myofibrils
Tubules of sarcoplasmic reticulum
Terminal cisterna of the sarcoplasmic reticulum
T tubule

Myofibrils and myofilments

- **Myofibrils**

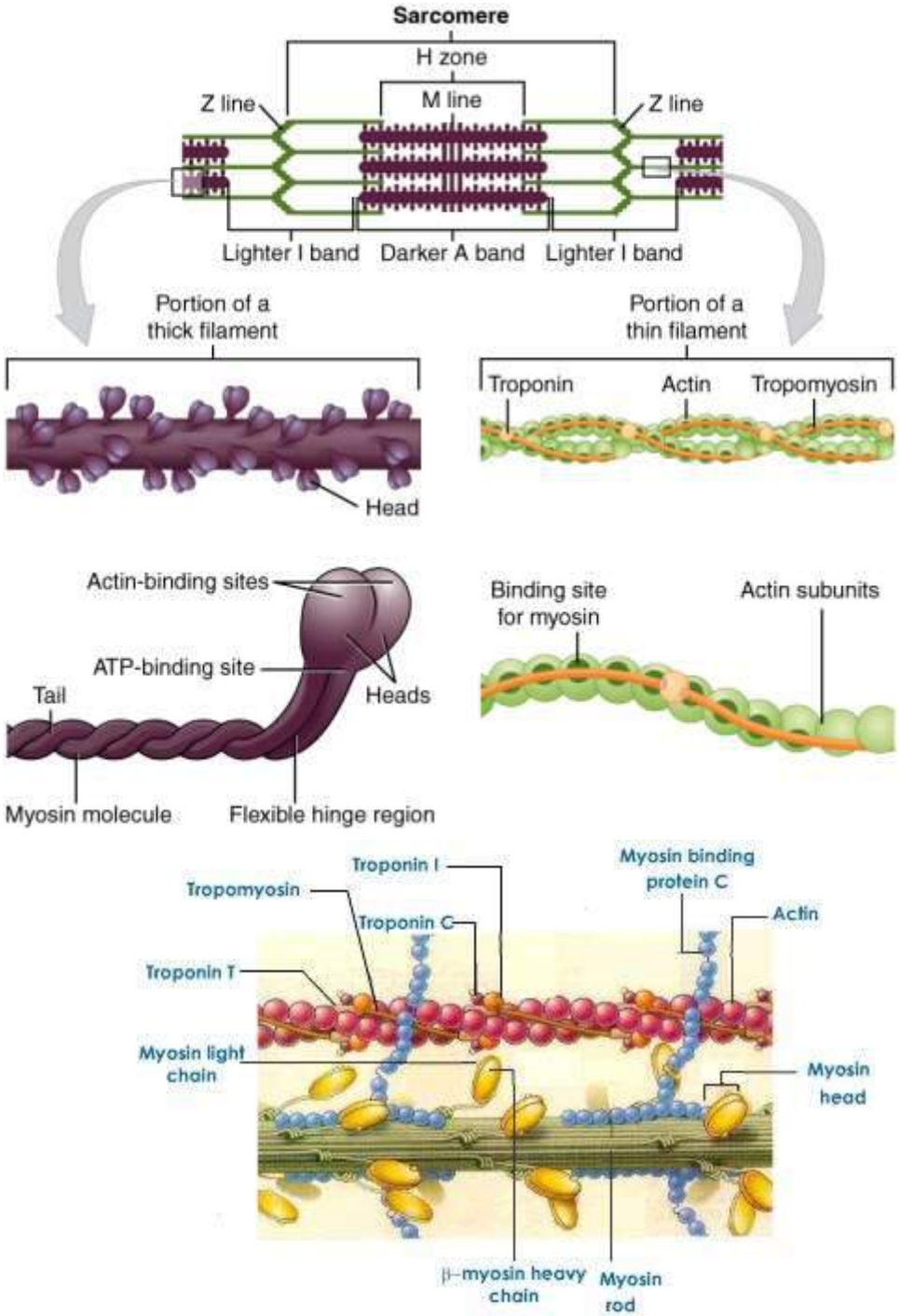
sarcoplasm of skeletal fiber that contain hundreds to thousands of long, cylindrical of structure

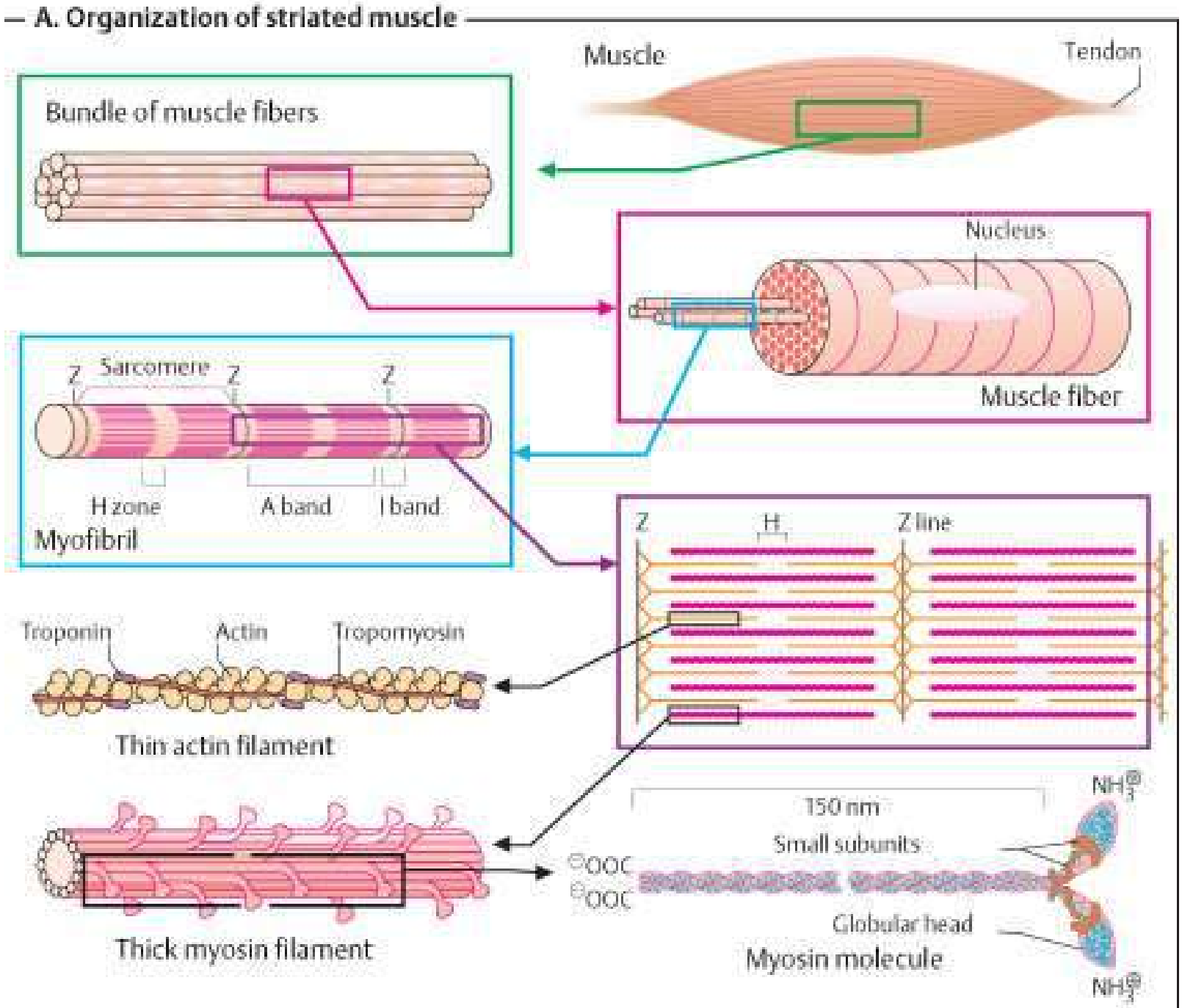
- Myofibrils consist of bundle of short **Myofilments**



Thin and thick filaments

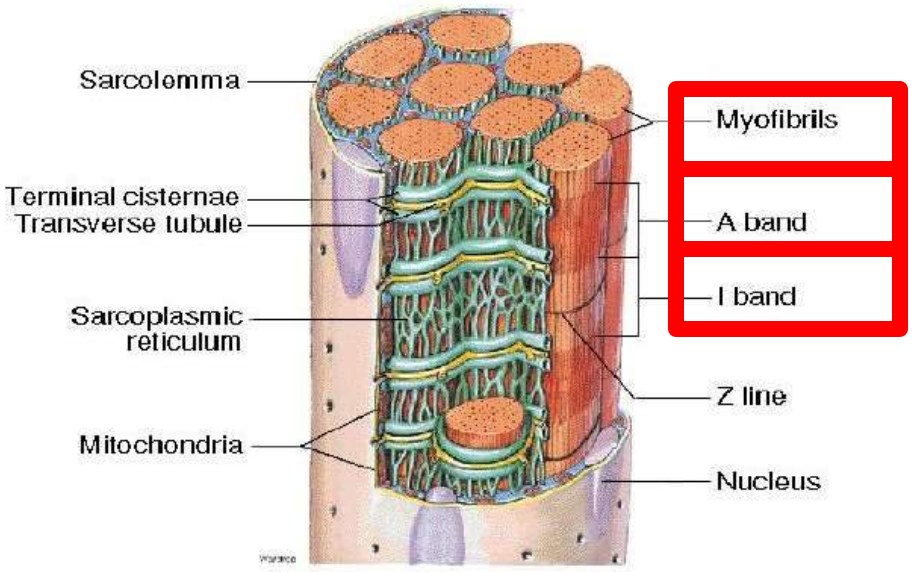
Thin filament	Thick filament
About 5-6 nm	About 11 nm
Composed of 2 strand of protein actin twisted around each other form helical shape	Bundle of protein myocin consist of two strand : free globular head and attached elongated tail
In helical strand many small spherical molecules as long filament resembling string of beads	Myocin head are referred as crossbridges
Have tow regulatory protein tropomyosin resemble short thinner twisted filament cover small section of actin strand While troponin tow function, attaching actin to anchor the troponin in place and attach tropomyocin to hold it in place over the surface of the actin	Myocin head are referred to crossbridge because during contraction they bind thick filament to thin filament thus forming bridge between them


Sarcomere
H zone
M line
Z line
Z line
Lighter I band
Darker A band
Lighter I band
Portion of a thick filament
Head
Portion of a thin filament
Troponin
Actin
Tropomyosin
Actin-binding sites
ATP-binding site
Tail
Heads
Myosin molecule
Flexible hinge region
Binding site for myosin
Actin subunits
Troponin I
Tropomyosin
Troponin C
Troponin T
Myosin binding protein C
Actin
Myosin light chain
Myosin head
β-myosin heavy chain
Myosin rod


A. Organization of striated muscle
Muscle
Tendon
Bundle of muscle fibers
Nucleus
Muscle fiber
Z
Sarcomere
Z
Z
H zone
A band
I band
Myofibril
Z
H
Z line
Troponin
Actin
Tropomyosin
Thin actin filament
150 nm
Small subunits
Globular head
Myosin molecule
Thick myosin filament

Myofibrils and striation

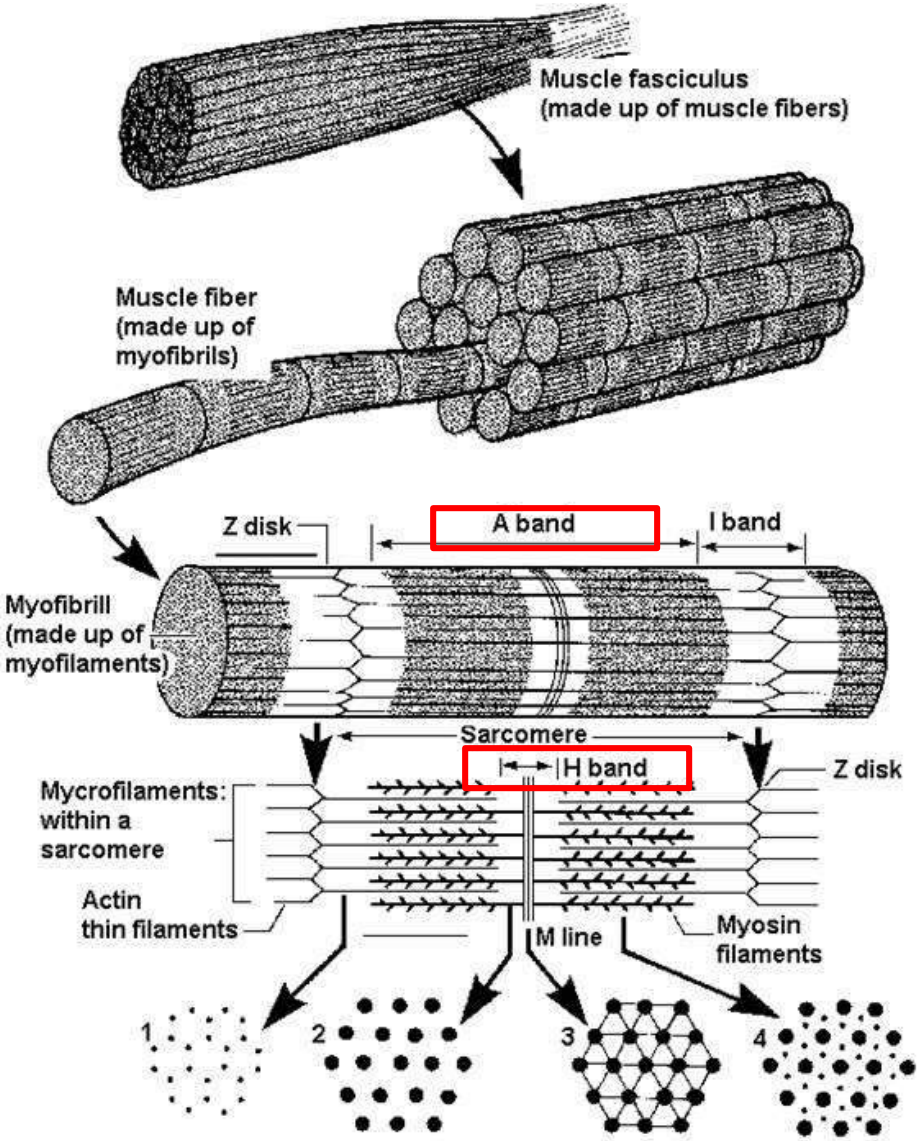
Anisotropic, A bands	Isotropic, I bands
The area appears dark when viewed under polarized light	The area appears light when viewed under polarized light
Contain thick filaments	Contain thin filaments
Its dark area	Lighter than A bands



Important structure in A bands and I bands

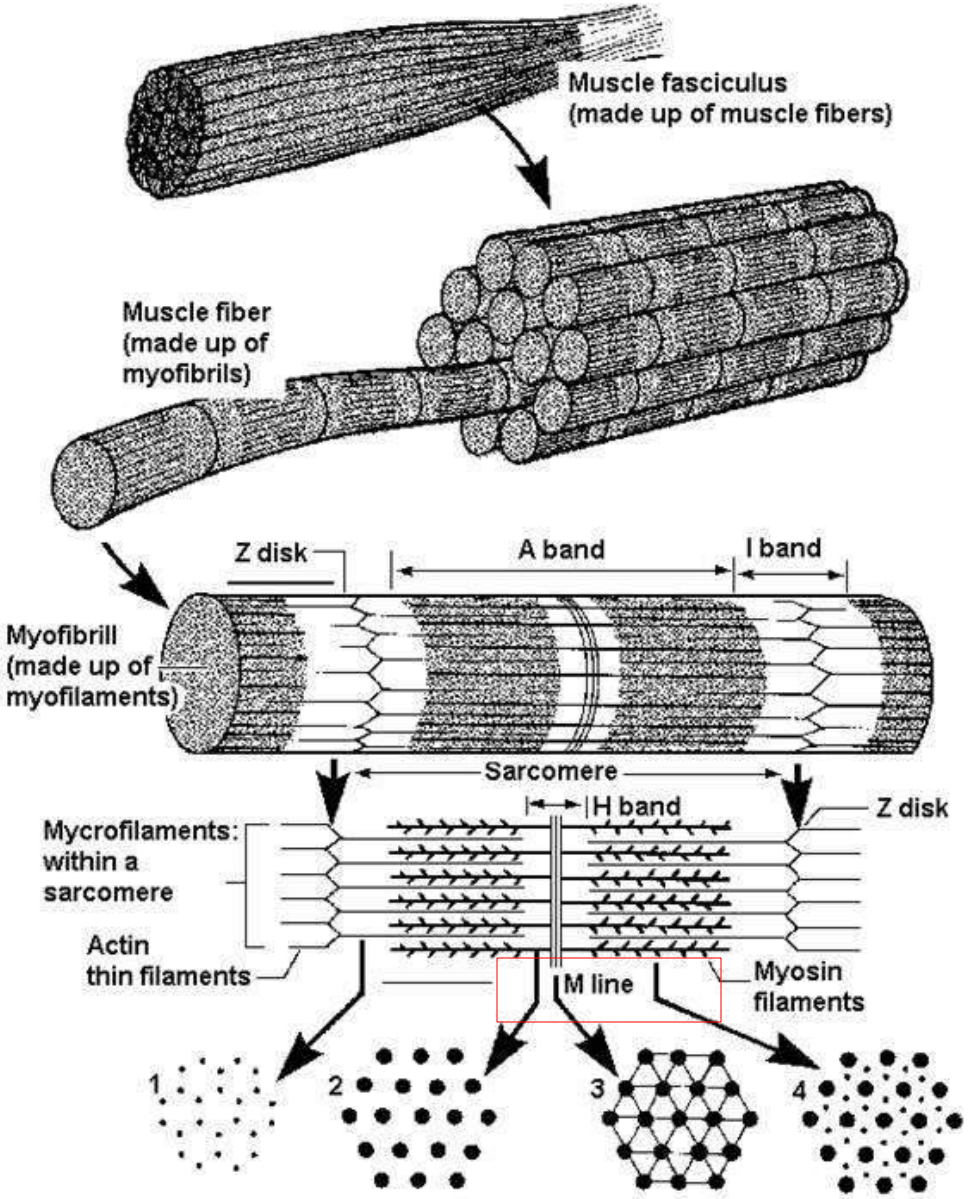
1. H zone

- Is light, central region in the **A band**.
- It is lighter shaded because only thick filaments are present so there are no thin filaments in **H zone** of a relaxed muscle fiber.
- At maximal contraction, the thin filaments are pulled into this zone, and the **H zone** disappear.



2. M line

- Is thin protein meshwork structure in the center of the **H zone** of a relaxed fiber.
- It serves an attachment site for the thick filaments and keeps the thick filament aligned contraction and relaxation events

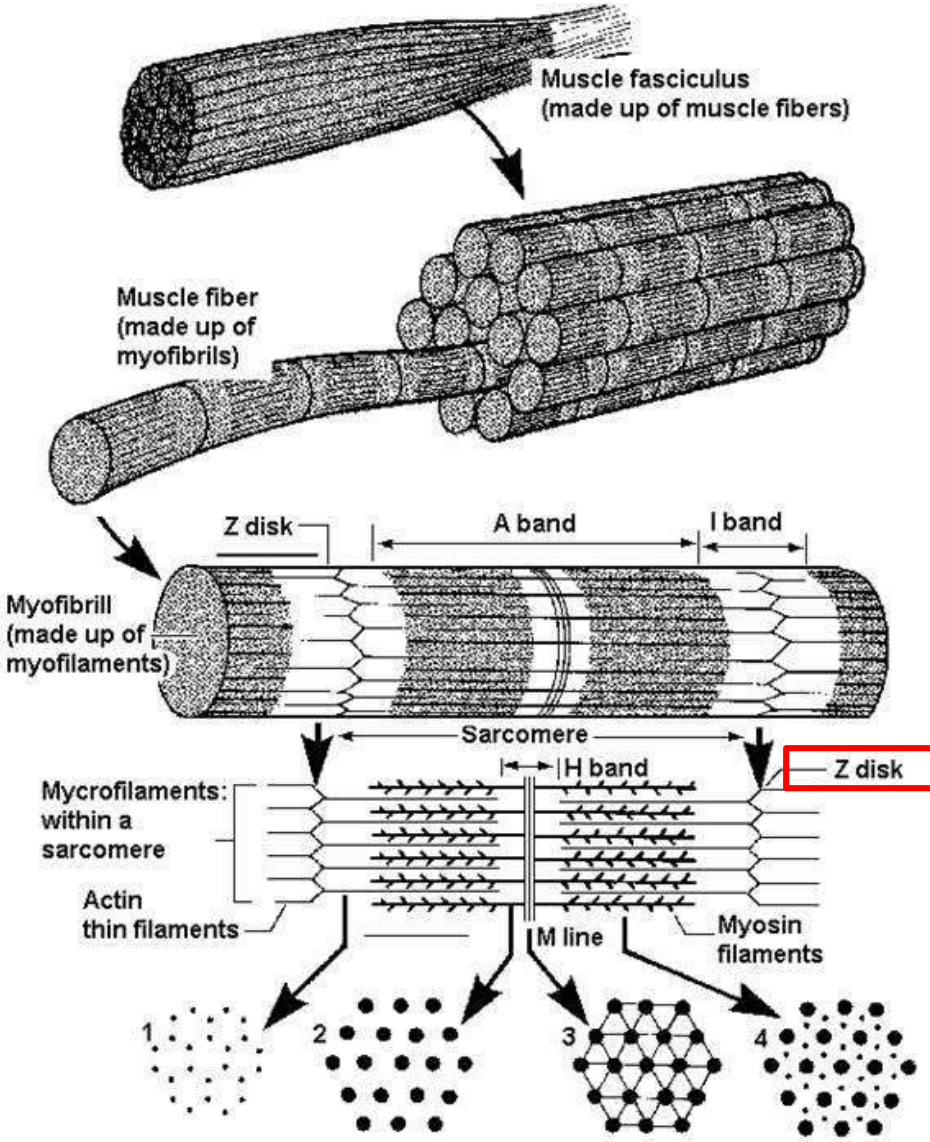


3. Z disk

Is thin protein structure in center of **I band** serves as an attachment site for thin filament ends. Although the **Z disk** is circular

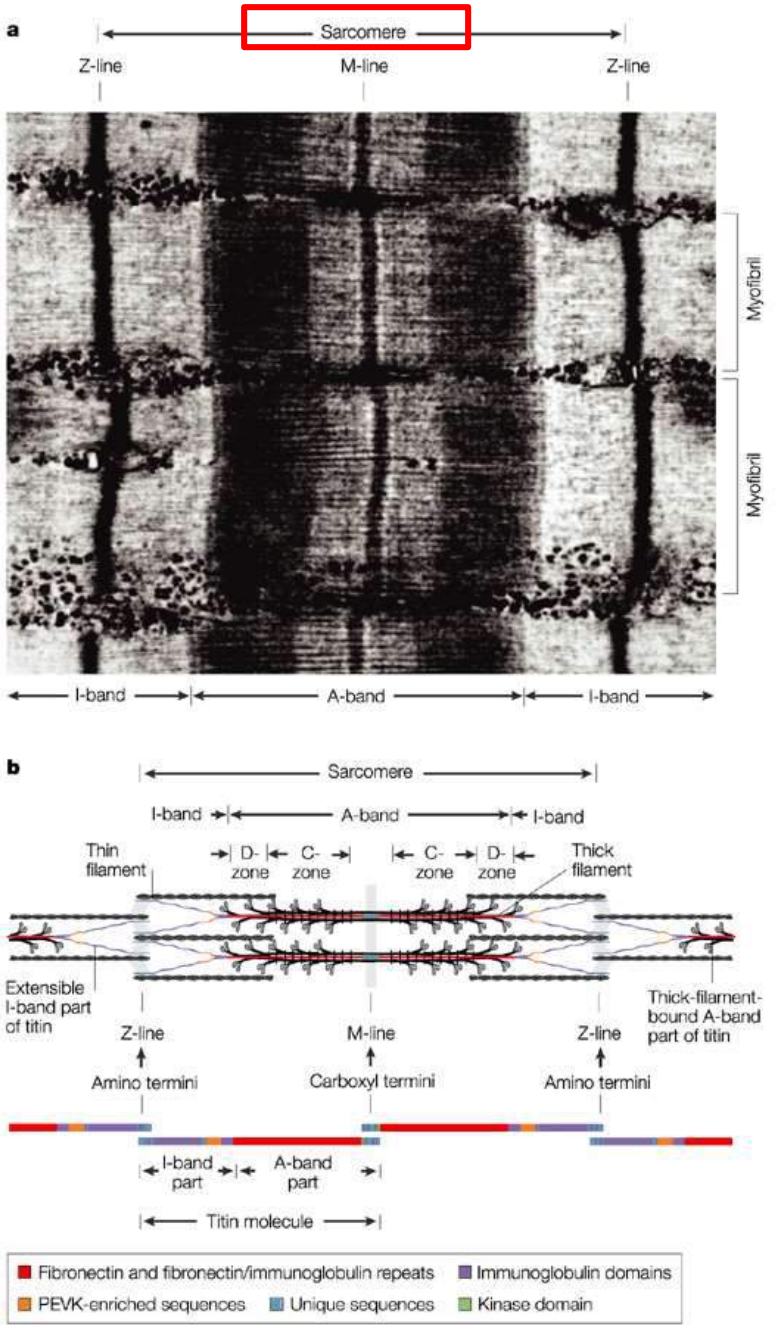
- **Titin**

Elastic proteins attach **thin filament**, **thick filaments** and **M line protein** to the **Z disk** to maintain their organization and order



Sarcomere

- **Is the functional contractile unit of skeletal muscle so its distance from one Z disk to the next Z disk**



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Sliding filament theory

- When muscle contracts thick and thin filaments slide past each other and sarcomere shorten
- **The change during contraction**

1. Width of **A band** remain constant but **H zone** disappear
2. The **Z disks** in one sarcomere move closer together
3. The **sarcomere** narrows
4. The **I band** narrows

Muscle contraction

Nerve impulse → stimulate impulse of muscle fiber → muscle fiber controlled by one motor neuron → motor neuron transmits the effect of nerve impulse to muscle fiber (neuromuscular junction)

- **Neuromuscular junction**

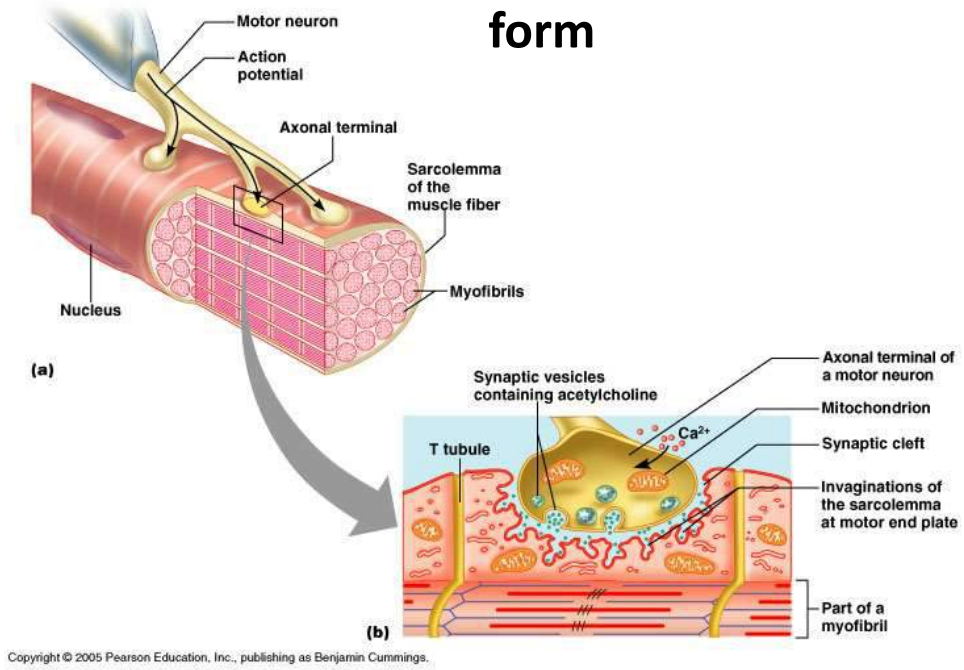
Point where motor neuron meets a skeletal muscle fiber

Neuromuscular junction component

1. Synaptic knob of the neuron
2. Synaptic knob cytoplasm
3. Motor end plate
4. Synaptic cleft
5. Ach receptors in the motor end plate
6. Enzyme acetylcholinesterase (AChE)

Mechanism of sliding

After Myocin heads bind to thin filaments myofilament sliding begins



Crossbridges form → **Myocin head pivot toward the center of sarcomere**

↓

The actin pulls thin filament toward sarcomere center

↓

Z disk move closer together

↓

When myocin head complete pivoting the crossbridge detaches and returns to its original ready to repeat cycle

Type of muscle fiber

Fast fibers

- Large in diameter
- Contain large glycogen reserves
- Densely packed myofibrils
- Few mitochondria
- Called **white fibers** because pale in color due to lack of myoglobin (**a globular, O2 binding, reddish-appearing protein**)
- They are fast in contractions because contain large number of sarcomeres, but fatigue rapidly

Intermediate fibers

- Between fast and slow fiber in properties
- Contract faster than slow fiber and slower than fast fiber
- Histologically resemble fast fibers
- Have greater resistant fatigue

Slow fiber

- Half diameter of fast fiber
- Contract more slowly than fast fiber
- Tow or three time longer contract after stimulation
- Vascular supply more extensive
- Called **red fibers** because contain red pigment myoglobin
- Have large number mitochondria
- Produce greater amount ATP than fast fiber

Cardiac muscle

- **Are individual muscle fibers arranged in thick bundles with in the heart wall**

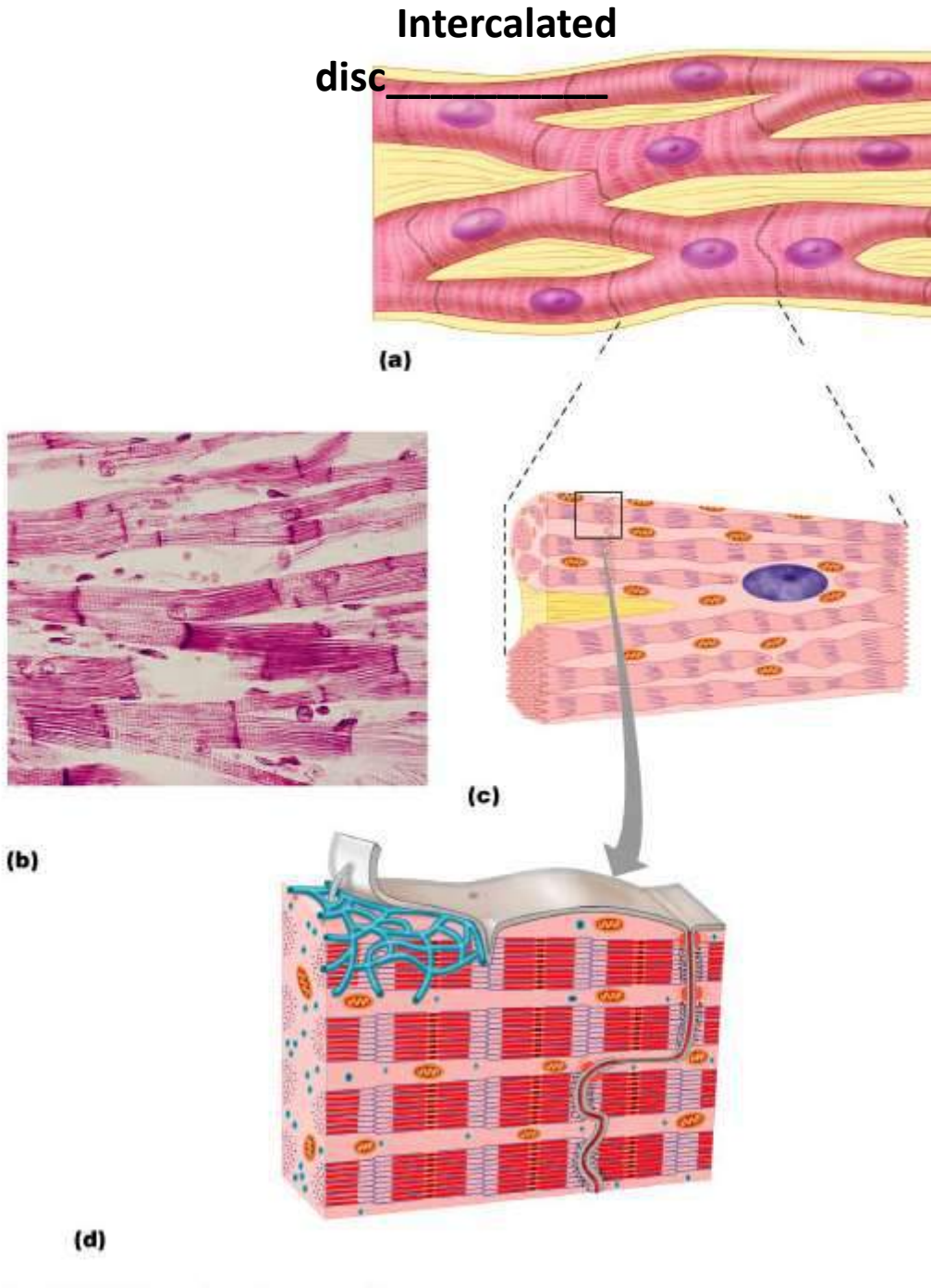
Cardiac muscle	Skeletal muscle
Cell are short and branching	Cell are long and cylindrical
1 or 2 centrally located nuclei in the cell	Multiple nuclei at the periphery of the cell
Cell joined by intercalated discs	Cells don't have specialized intercellular junctions
Function contractile unit is the sarcomere	Function contractile unit is the sarcomere
T- tubule present but of a simpler form than skeletal muscle	T- tubule present
Composed of thick and thin filaments	Composed of thick and thin filaments
Contain sarcoplasmic reticulum but less than in skeletal muscle	Contain sarcoplasmic reticulum
More mitochondria	Fewer mitochondria

Cardiac and skeletal differs in

1. The **SR** less extensive and not organized in cardiac muscle
2. cardiac muscle has **no terminal cisternae**
3. A tight association of smooth **ER** and **T-tubule** is lacking in cardiac muscle
4. **T- tubule** overlie **Z disks** (cardiac muscle) instead of junctions of **A bands** and **I bands** (as seen in skeletal muscle)

Intercalated discs

Are electrically and mechanically link the fibers together and permit the immediate passage of muscle impulses.

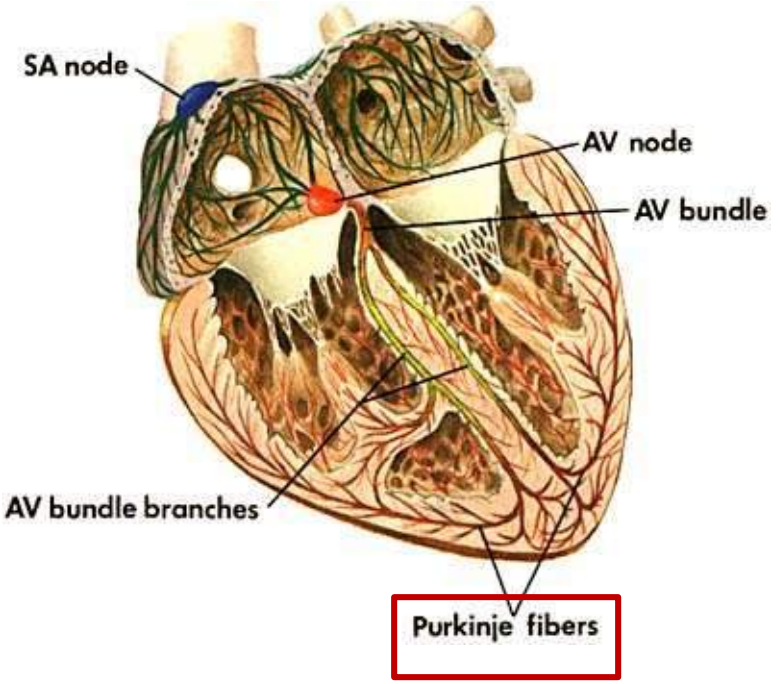


Purkinji fibers

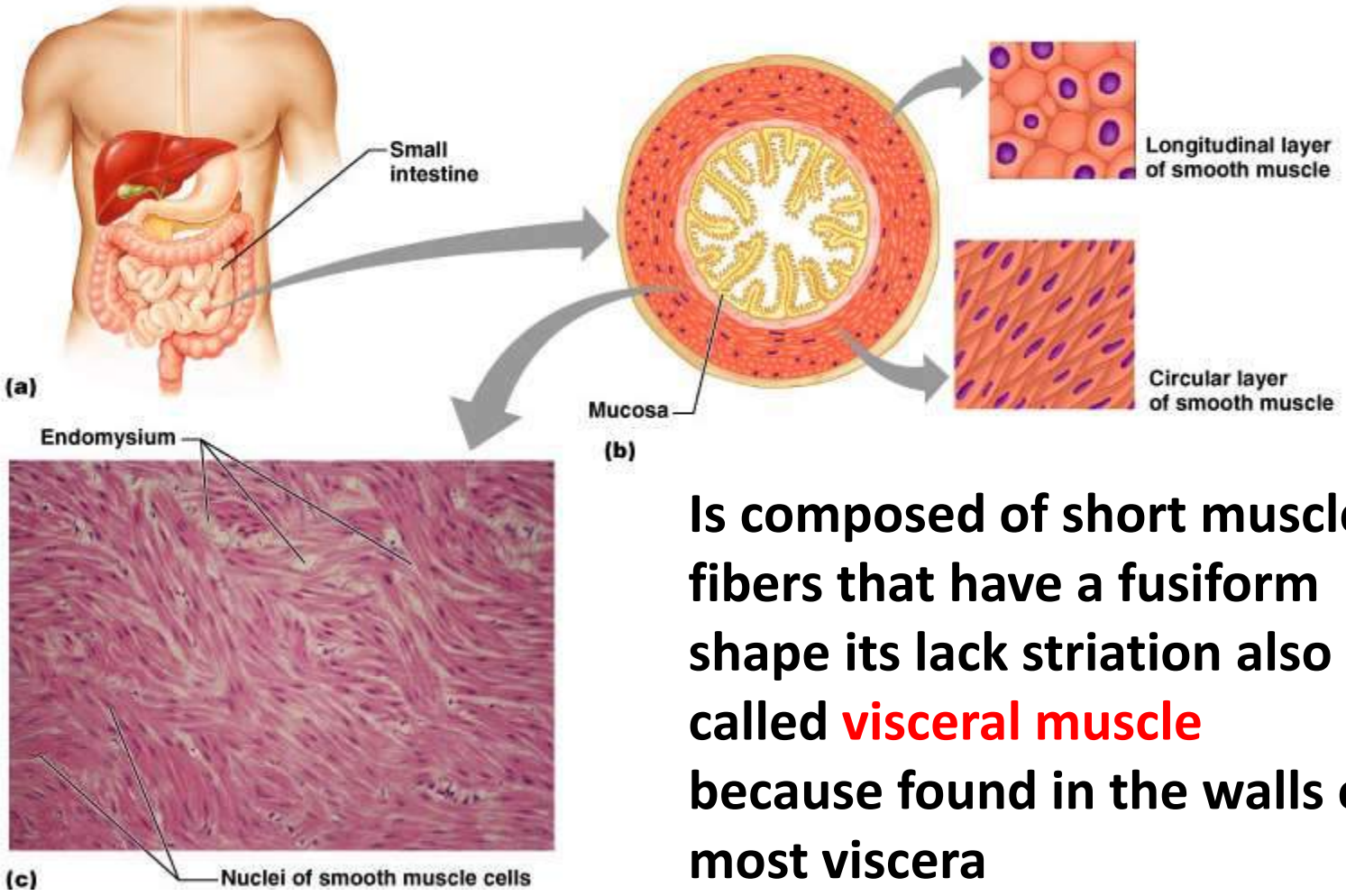
- Are conduction fibers that begin within the apex of the heart and extend through the walls of ventricles.

Purkinji fiber is:

- Larger.
- Thicker.
- More palely staining.
- Abundant central sarcoplasm.
- Relatively few myofibrils which usually peripheral position.
- Contain large quantity of glycogen.
- Intercalated disk are present but not seen commonly.
- Muscle contraction is rapid, consisted with large sized of the cells.



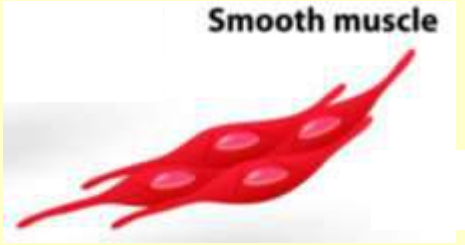
Smooth muscle



Is composed of short muscle fibers that have a fusiform shape its lack striation also called visceral muscle because found in the walls of most viscera

Characteristics of smooth muscle

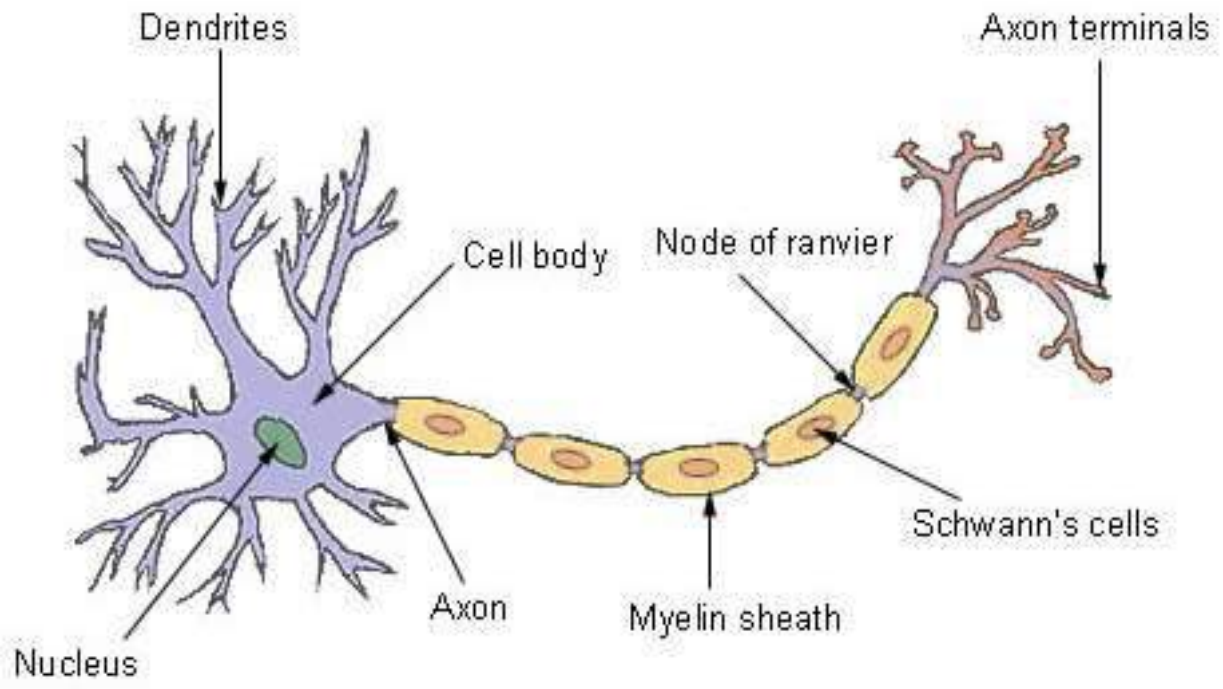
- Have single centrally located nucleus
- Have both thick and thin filaments
- Not precisely aligned so visible striation and sarcomeres are present
- Z disks are absent from smooth muscle fibers instead, thin filaments are attached to dense bodies by elements of the cytoskeleton
- Dense bodies are small concentration of protein scattered throughout the sarcoplasm



- SR is spares
- T- tubules are absent
- The Ca+ needed to activate smooth muscle contraction originates in the interstitial fluid around the cell
- Smooth muscle contraction is slow, resistant to fatigue
- Smooth muscle take longer than skeletal to contract and relax
- Contraction under involuntary control


Thank you

Neurons tissue

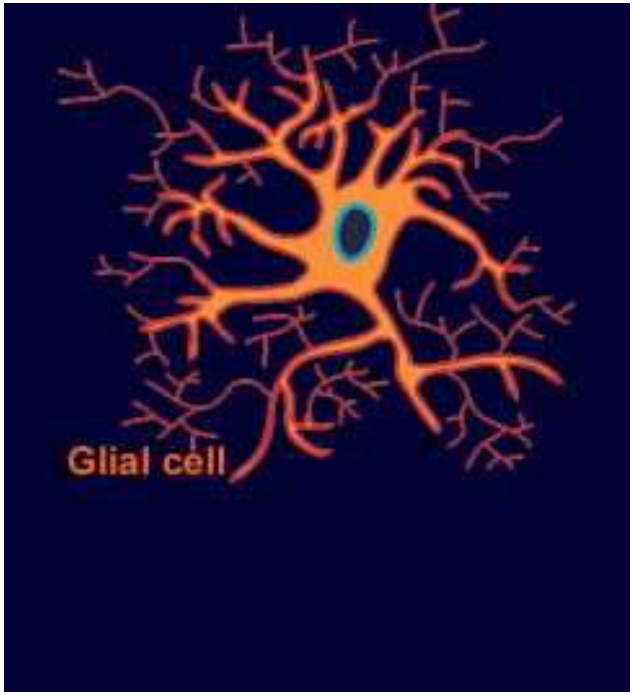


Lec.Dr.Ruwaidah F. Khaleel

Neuron

- **The nervous tissue**

is consists of cell called (neurons) or (nerve cell) these cell are specialized cell to receive integrate and transmit electeochemical massage and supporting cell are called neurogelia or glial cell



- **Their function include:**

1. **Structural and nutritional support of neurons**
2. **Electrical insulation**
3. **Enhancement of impales conduction velocity**

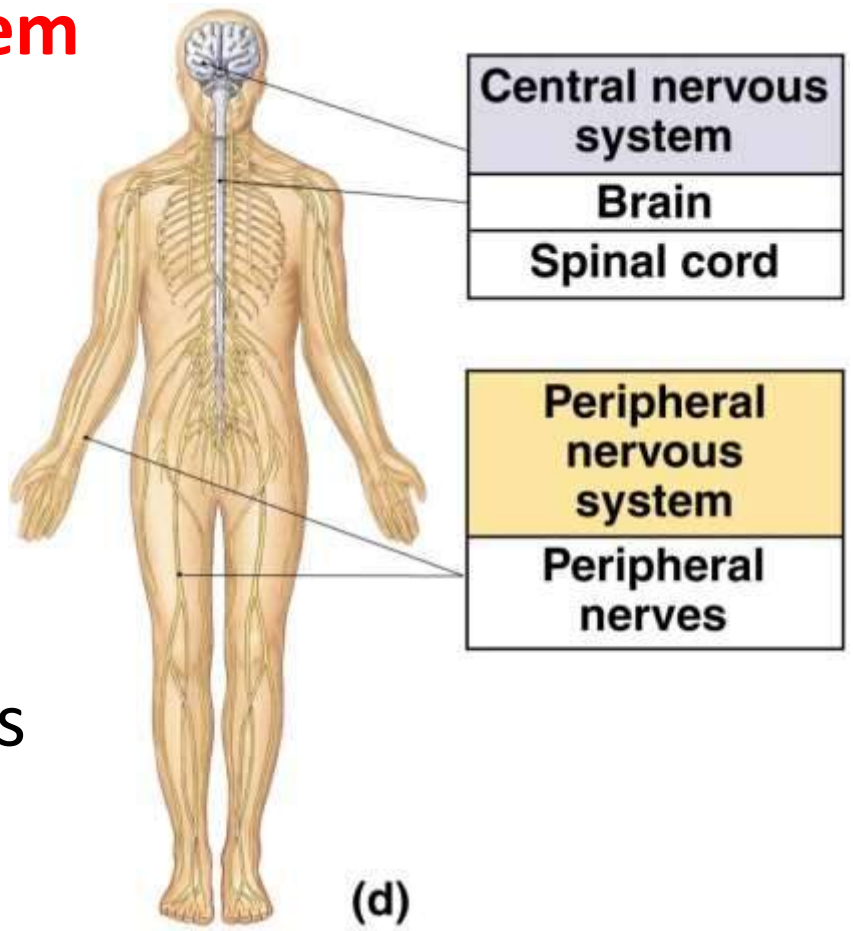
Anatomically the nervous system

1. **The central nervous system (CNS):** Included the **brain and spinal cord**
2. **The peripheral nervous system (PNS):**Include

A. cranial nerve (nerve that extend from the brain)

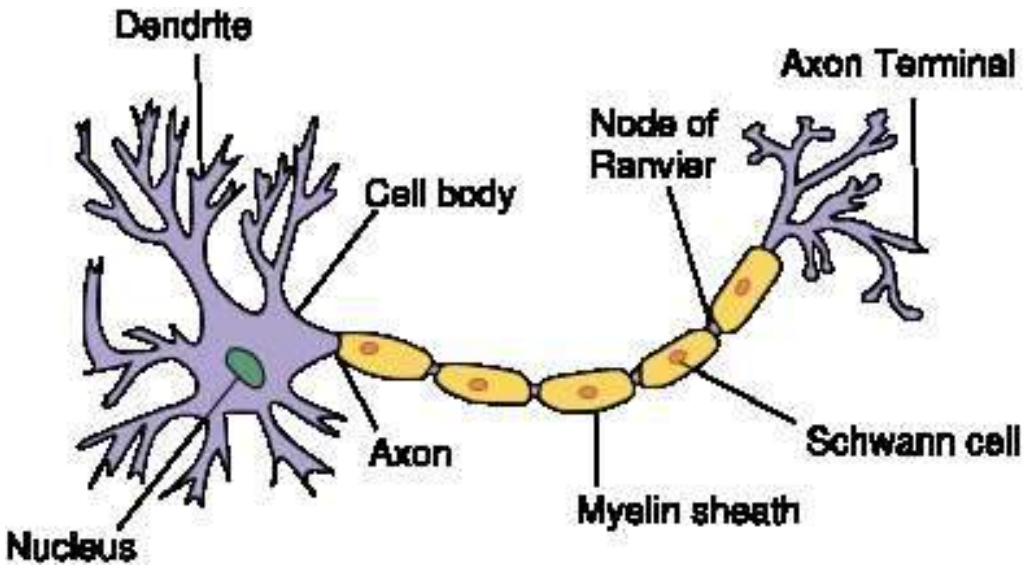
B. Spinal nerve

C. **Ganglia** which are clusters of neuron cell bodies located outside the CNS



Functionally, nervous system divided into

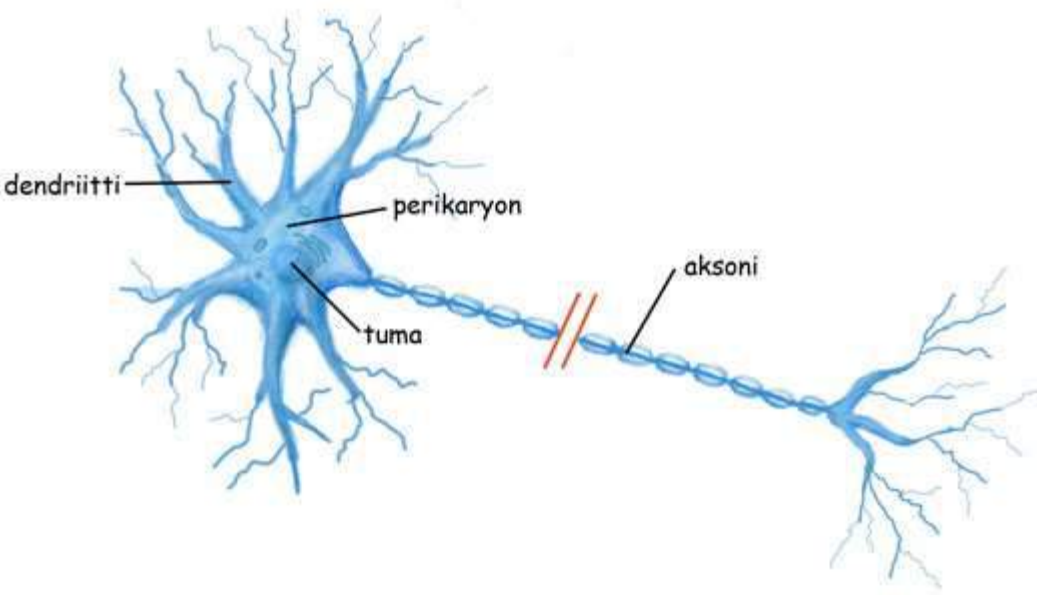
1. **The autonomic nervous system (ANS)** Controls involuntary visceral function (eg. Glandular secretion, smooth and cardiac muscle contraction
2. **The somatic nervous system:** include all nerve tissue except that of ANS
3. **Neurons:** the basic structural unit of the nervous system



Neurons consists of

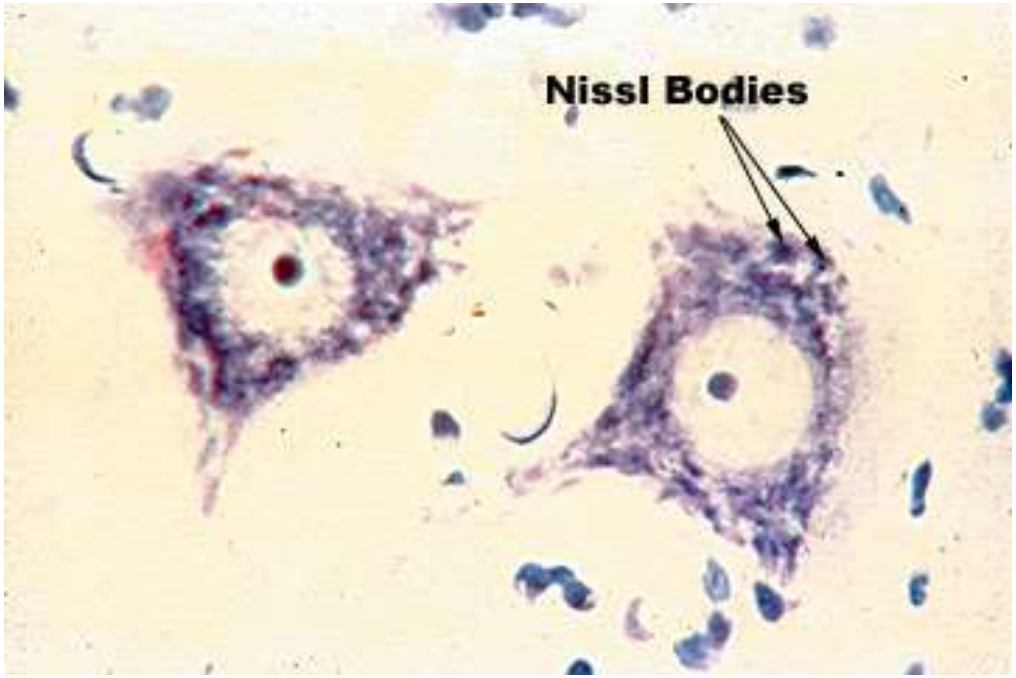
1. **The cell body, also called (perikaryon) or (soma)**

- Part of neuron that contains the nucleus and surrounding cytoplasm, it is atrophic center and is also receptive to stimuli.
- The nucleus spherical, large and contains a prominent nucleolus, the nucleus is located in the center of the cell body



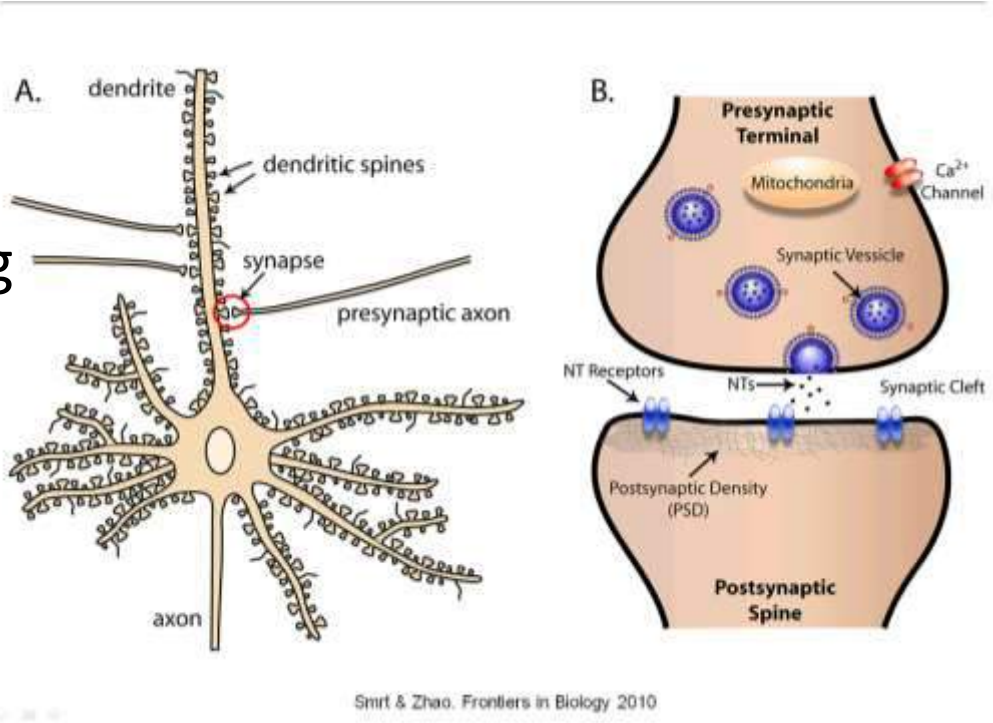
The cytoplasm of the soma contains many organelles including

1. **Mitochondria**
2. **Lysosomes**
3. **Golgi complex**
4. **The abundant free and RER** associated polyribosomes appear as clumps of basophilic material collectively called **Nissl bodies**



2. Dendrites

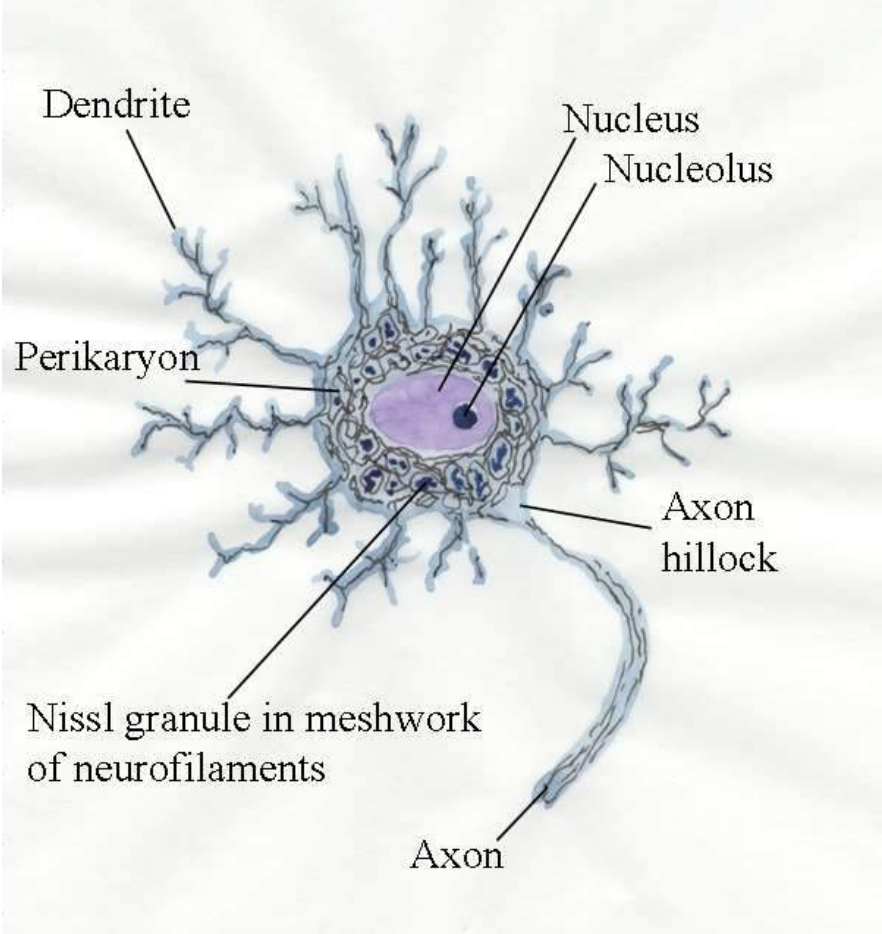
- These extension of the soma increase available for incoming signal.
- The farther they are from the soma, the thinner they are owing to successive branching much of their surface often is covered with synaptic contacts, and some have sharp projection, termed **(dendritic spines),** or **(gemmules)** that act as synaptic sites.
- **Dendrites lack Golgi complex but contain small amounts of other organelles found in perikarya**



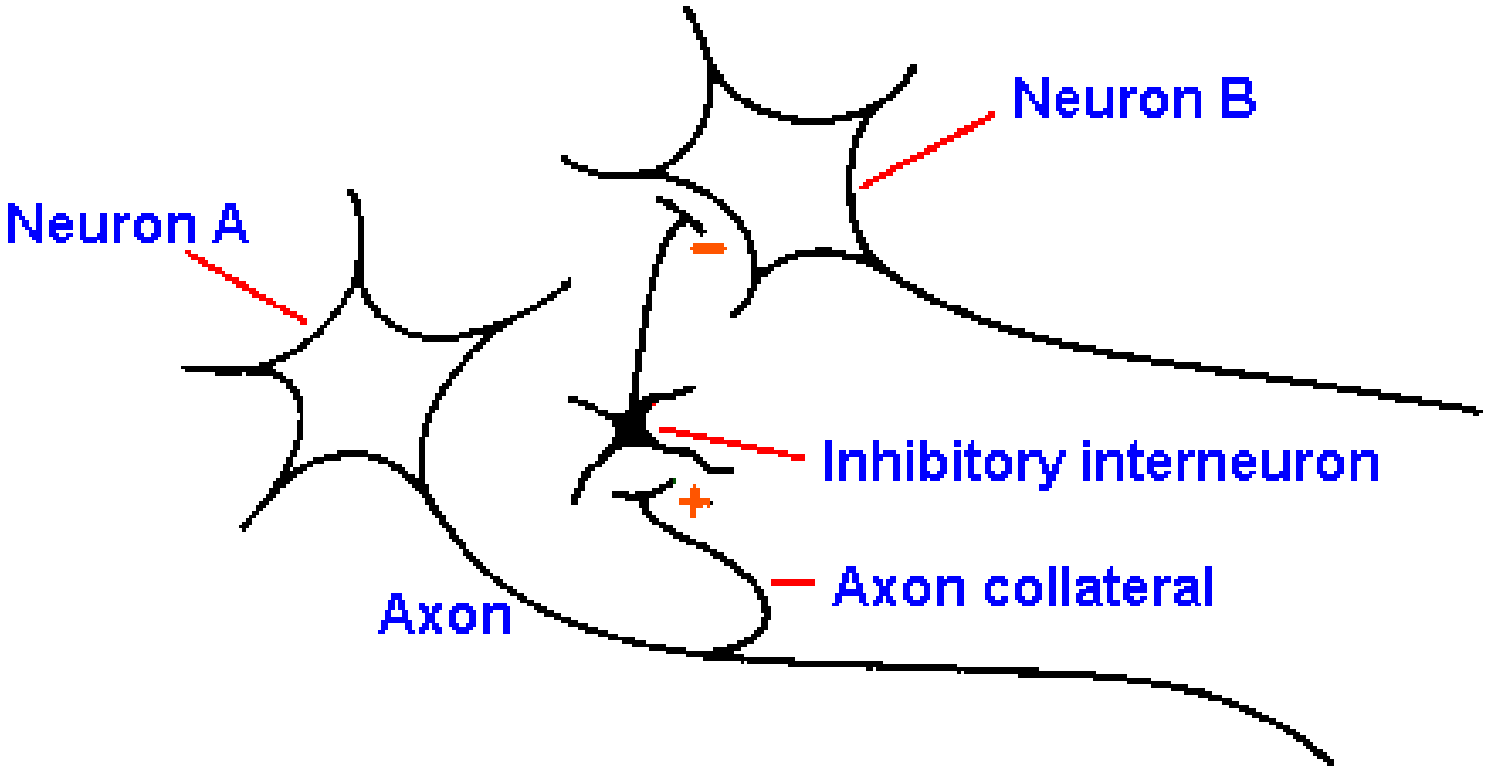
3. Axon

- Each neuron has one axon, a complex cell process that carries impulses away from the soma
- **Axon divide into several region**

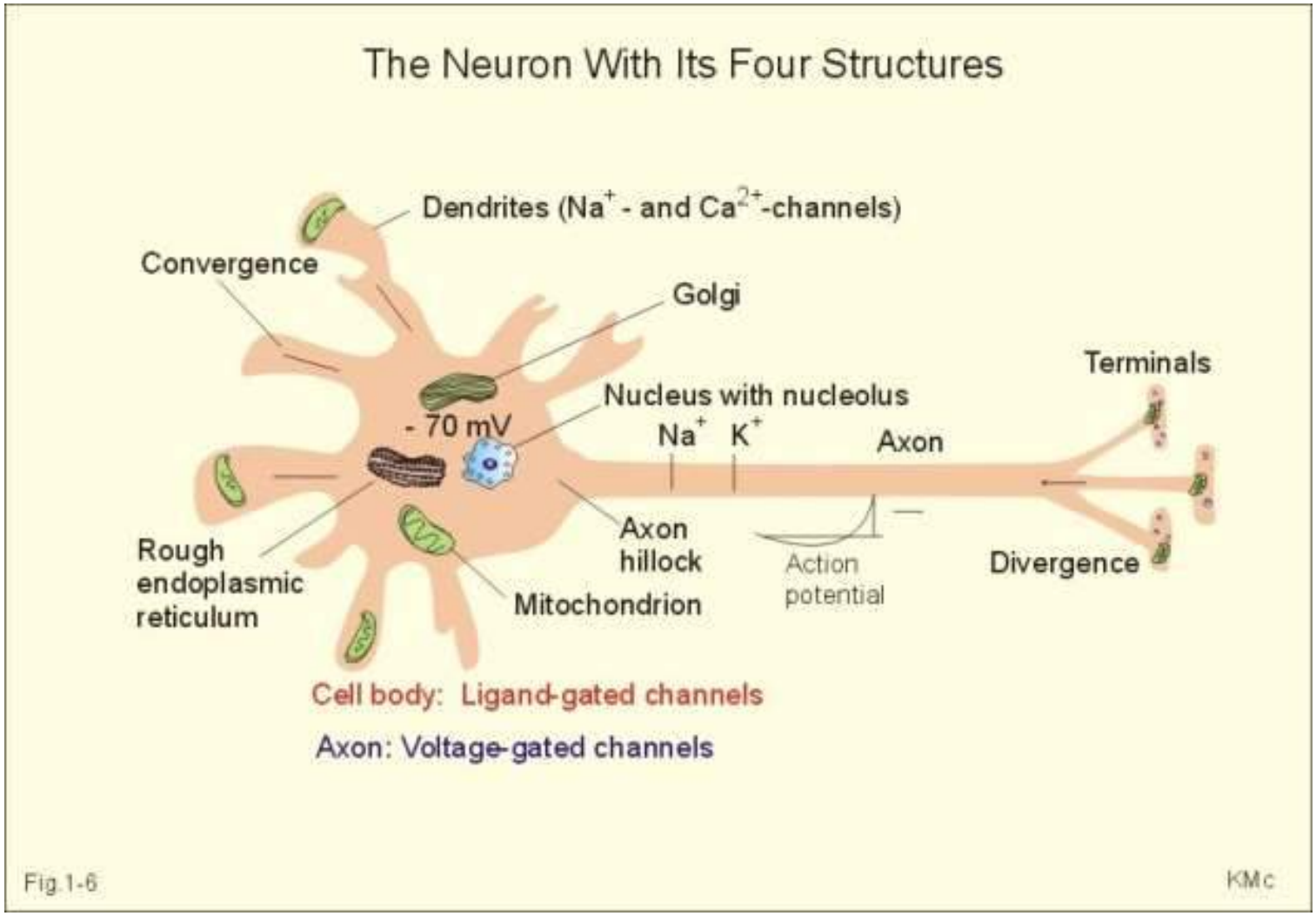
1. **Axon hillock:** the part of soma leading into axon differs from, differs from the rest of the cell body in that lacks **Nissl bodies**



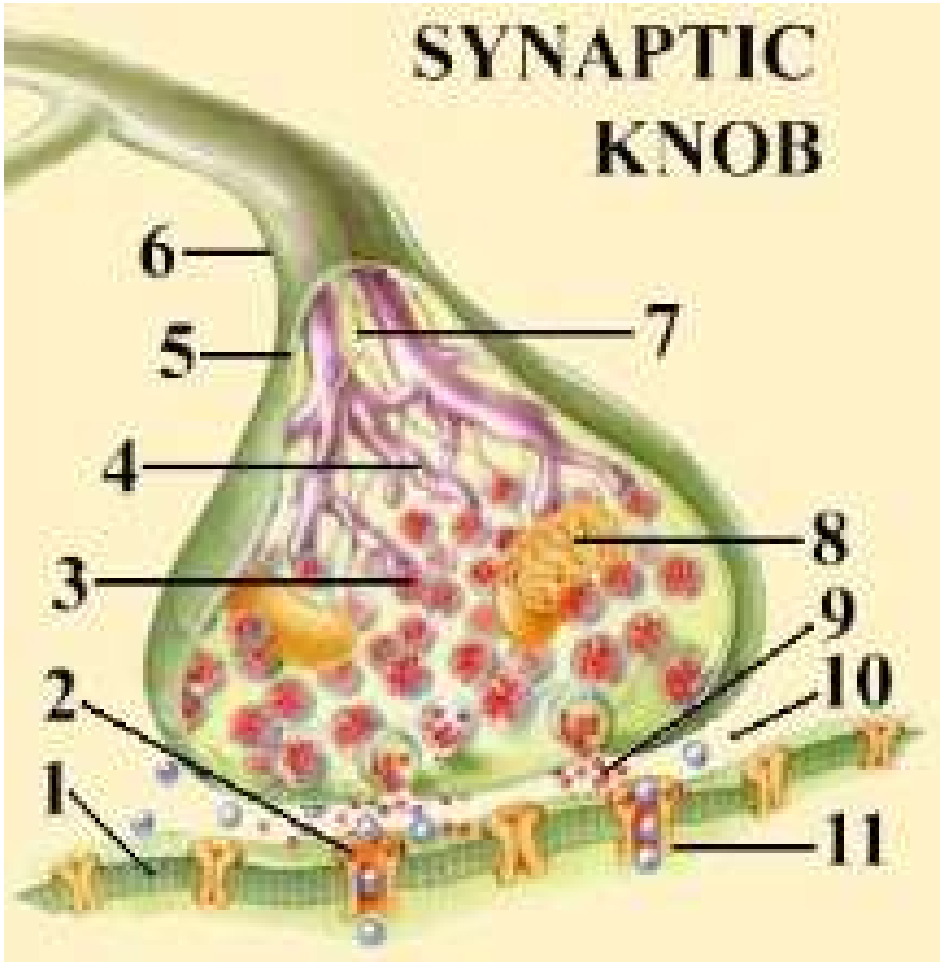
2. Axon collaterals: in some axon branches which many contact axon neuron



3. Axon terminals (telodendria): many axons undergo branching near their termination



Synaptic knobs: the extreme tips of the fine extension of telodendria are slightly expanded region



1.Target cell membrane

2.Receptor sites

3.Synaptic vesicles

4.Microtubules

5.Cell membrane

6.Axon terminal fiber

7.Neurofilaments

8.Mitochondrion

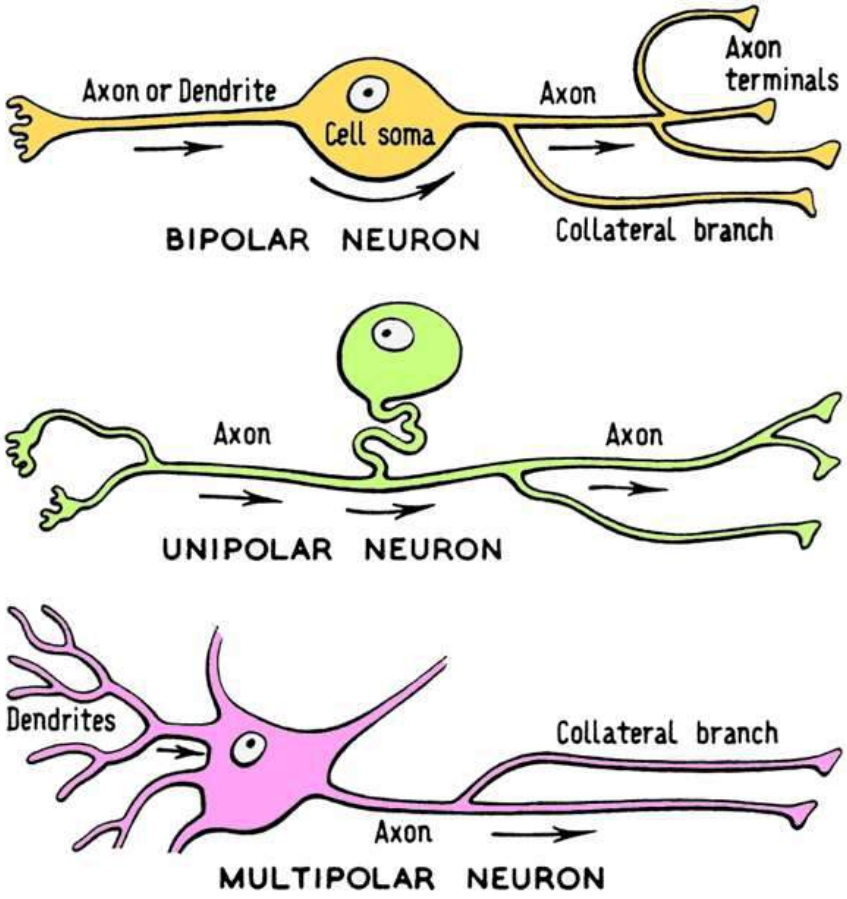
9.Neurotransmitter molecules

10.Synaptic cleft

11.Membrane channels

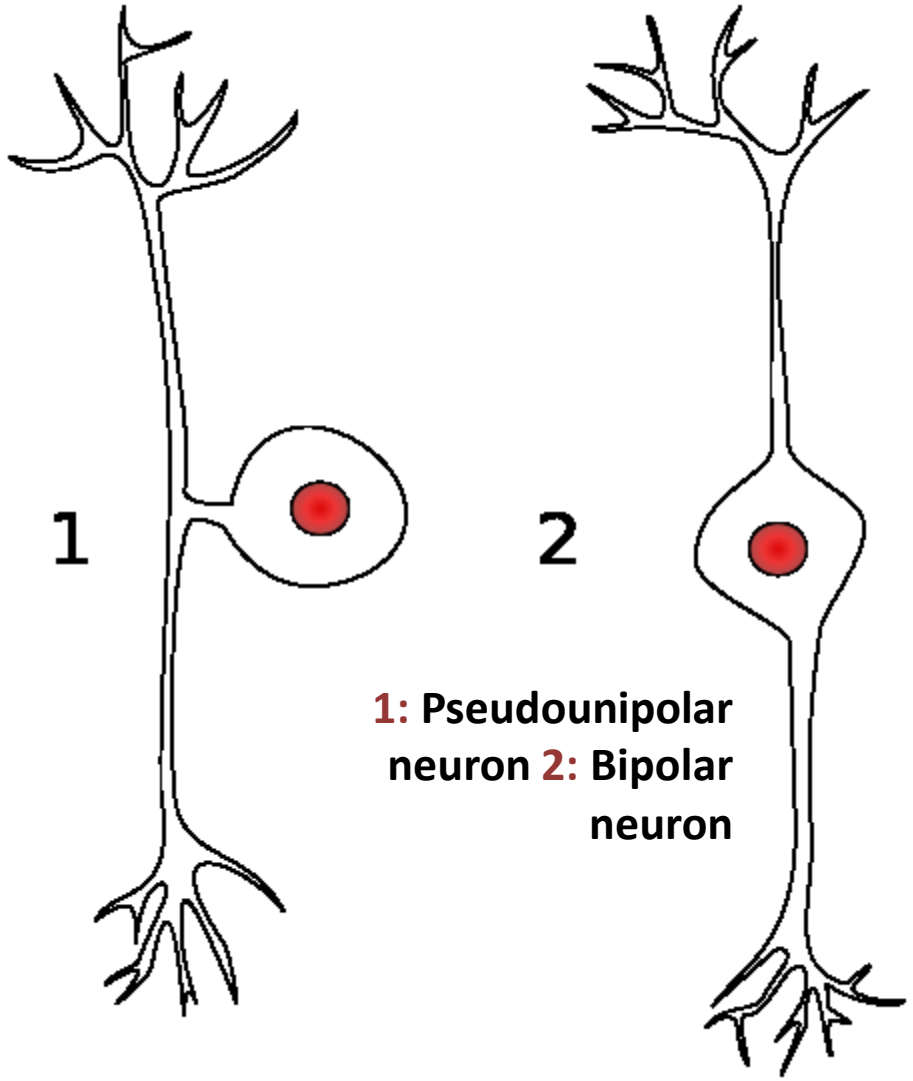
Classification of neuroses

- **Unipolar neurons:** have single, short neuron process from the cell body, some function for reception as dendrite, other being axonal.
- **Bipolar neurons:** have two neuron processes that extend from the cell body, one axon and one dendrites, these neurons are relatively un common in humans and primary limited in some of the special senses ex. Retina, olfactory mucosa and vestibular ganglia of inner ear.
- **Multipolar neurons:** most abundant multiple neuron processes many two or more dendrites and a signal axon extend from the cell body.



Pseudounipolar neuro

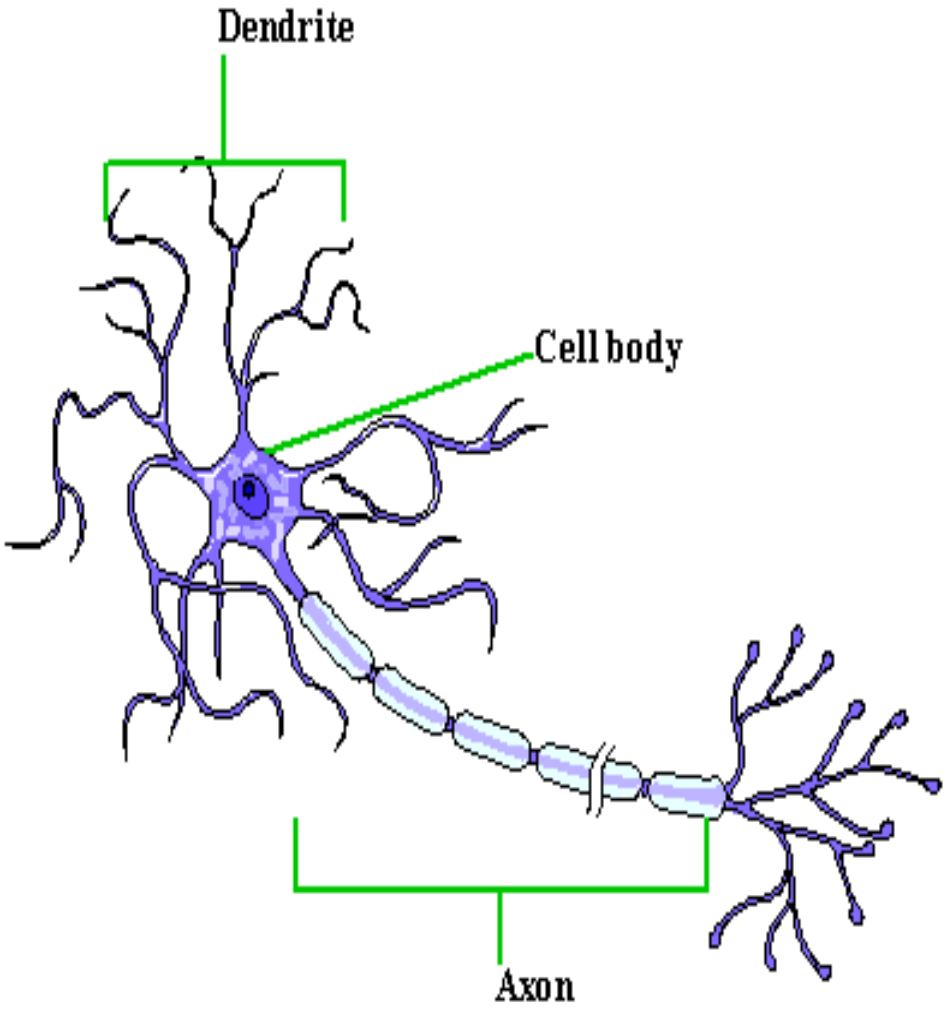
start out as bipolar neurons during development but their two processes into a single process, this process then bifurcates one branch passing periphery and functior a dendrite, the other passing centrally as an axon to the CNS.



Functional classification

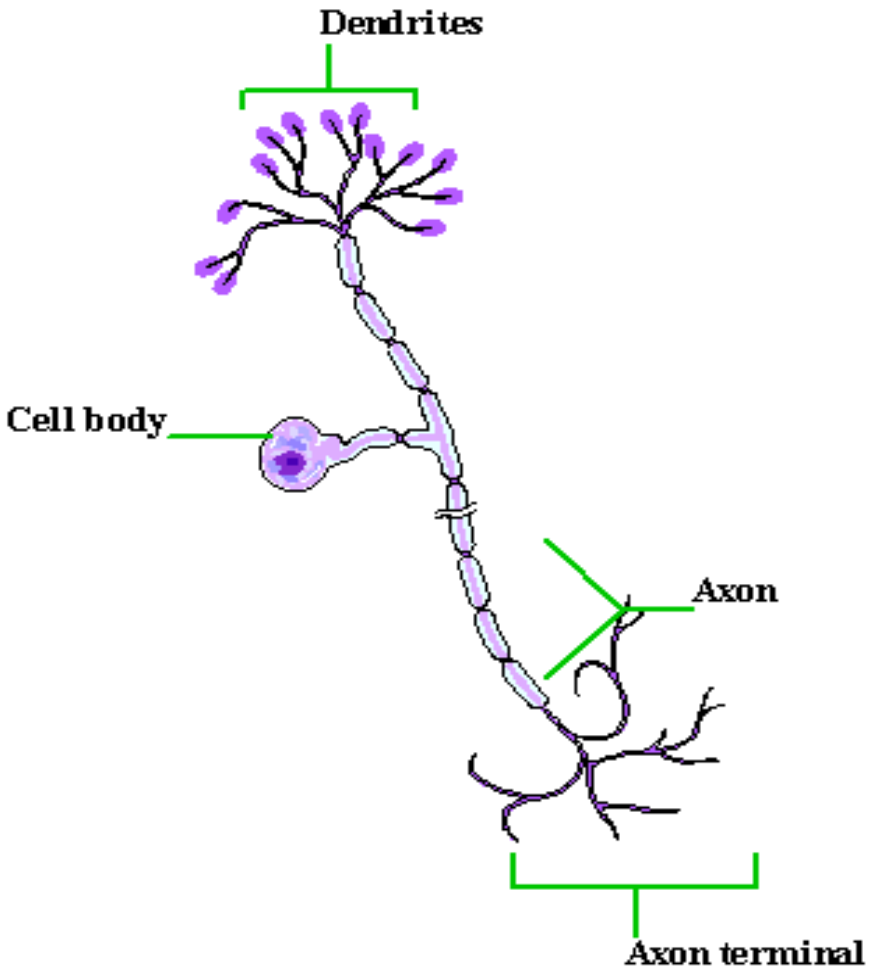
Motor neurons or efferent neurons

- Transmit nerve impulses from the CNS to muscle and gland.
- All motor neurons are multi polar



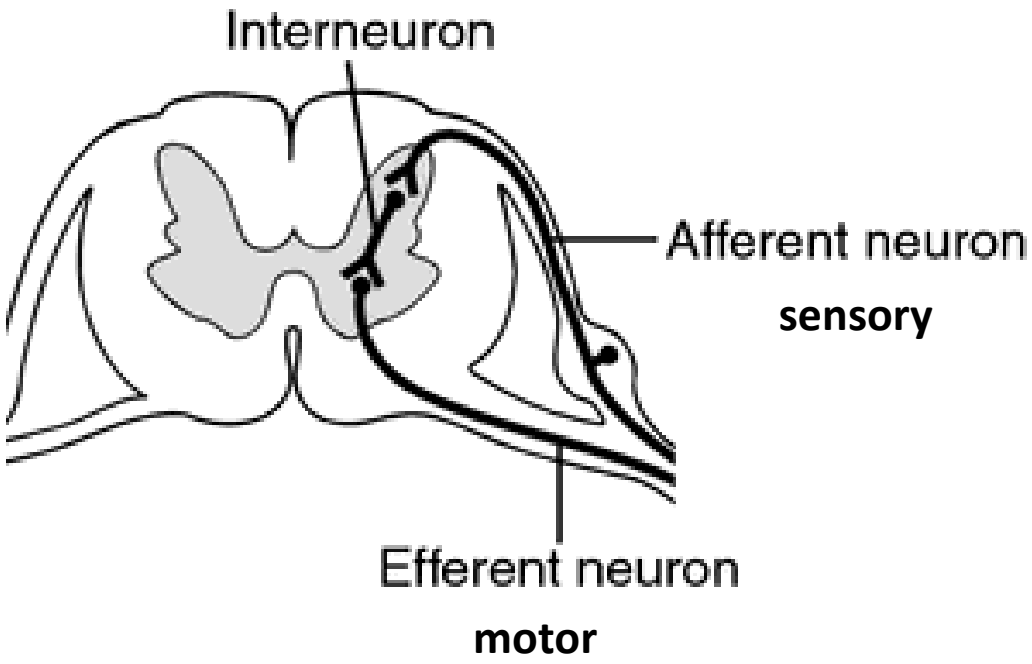
Sensory neurons or afferent neurons

- Transmit never impulses from sensory receptors to CNS.
- Most sensory neurons are unipolar



Interneurons or association neurons

- Lie entirely with the CNS and are multi polar structure.
- The interneurons facilitate communication between sensory and motor neurons

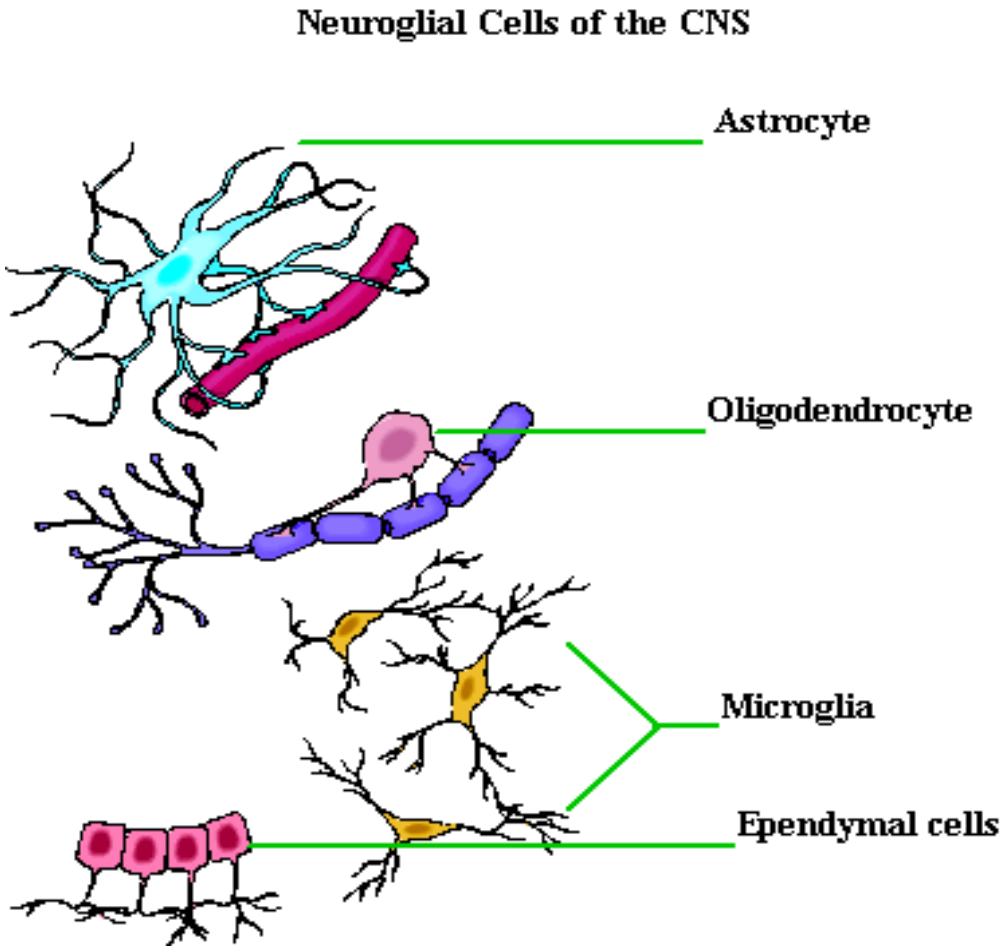


Neuroglia (glial cell)

Are cell that outnumber neurons and take up more than half the volume of brain, and its smaller than neurons

Primary function of neuroglia

Support and nourish neurons



Glial cell of the CNS

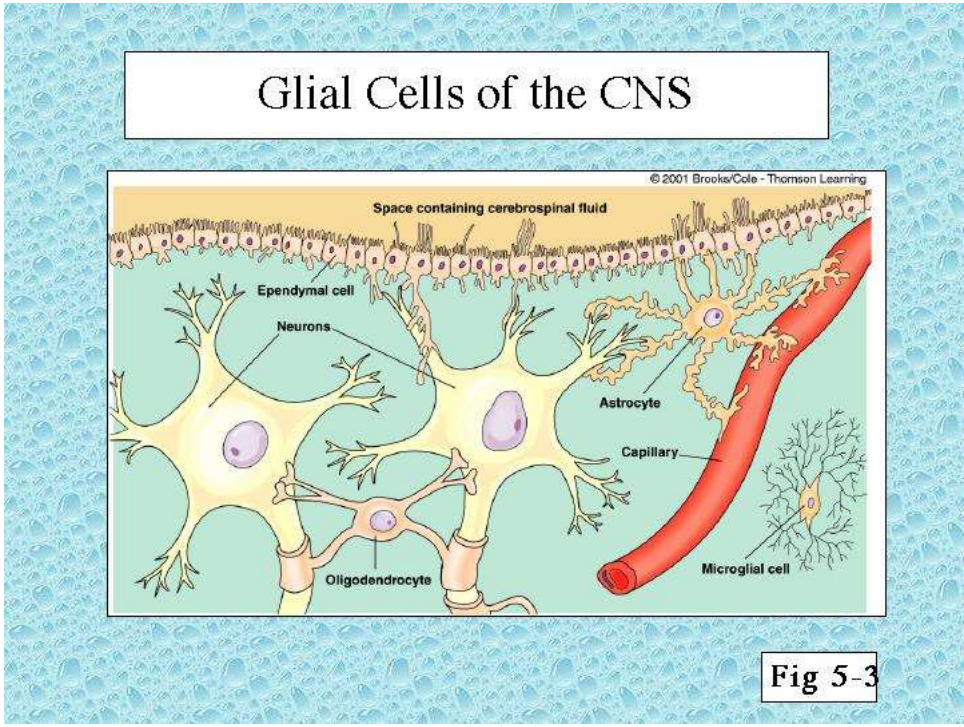
Type of glial cell

1. **Macroglia (astrocytes and oligodendrocytes)**

❖ **Astrocytes:** are largest cell, large nuclei, irregular, spherical, pale staining

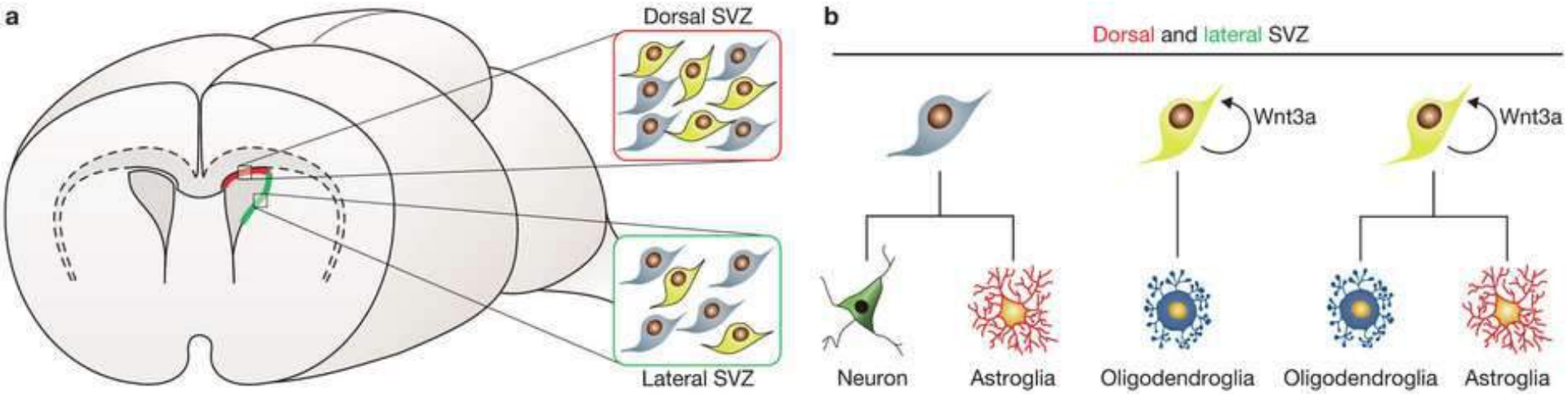
There are two type:

1. **Protoplasmic astrocyte**: located in gray matter have granular cytoplasm and short, thick, highly branched processes.
2. **fibrous astrocyte**: located in white matter. Long, thin processes are less branched than those of protoplasmic astrocyte



Oligodendroglia (oligodendrocytes)

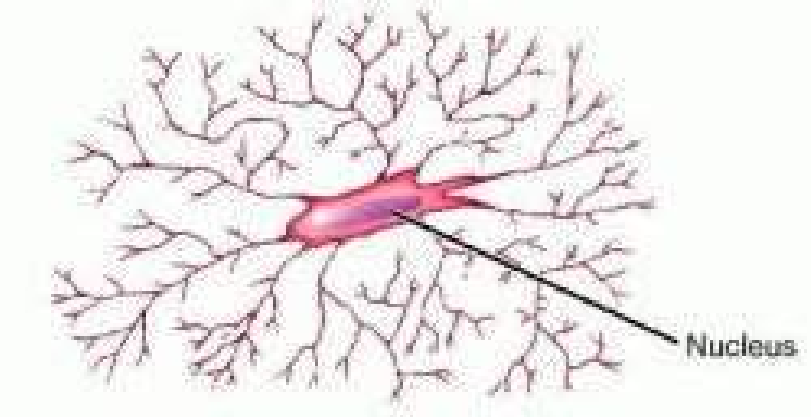
In both gray and white matter, spherical nuclei range between of astrocyte and those of microglia in size and staining intensity. Like schwann cell of the PNS. **Oligodendrocyte responsible for myelin formation.**



3. Microglia

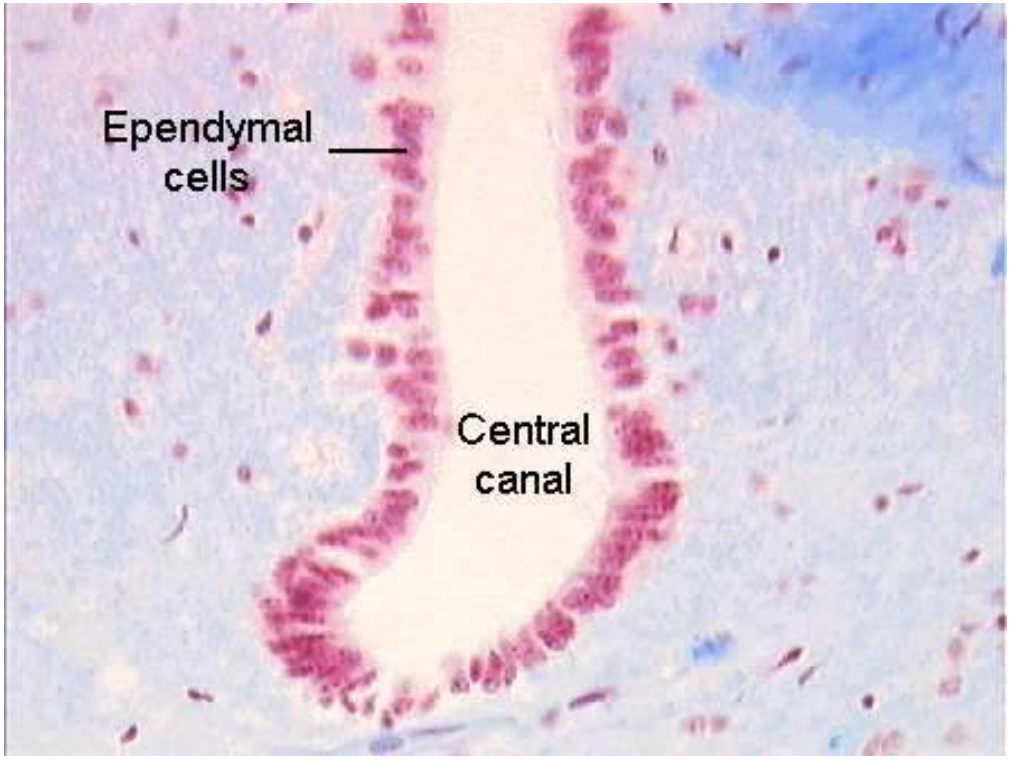
Microglia: **Smallest and few number**

A. **Processes shorter than astrocyte**
B. **Cover with spiny branched**
C. **Microglia cell drive from mesoderm**
D. **Are component of mononuclear phagocytes system and have phagocytes capabilities**
E. **Occur in both gray and white matter**



4. Ependymal cells

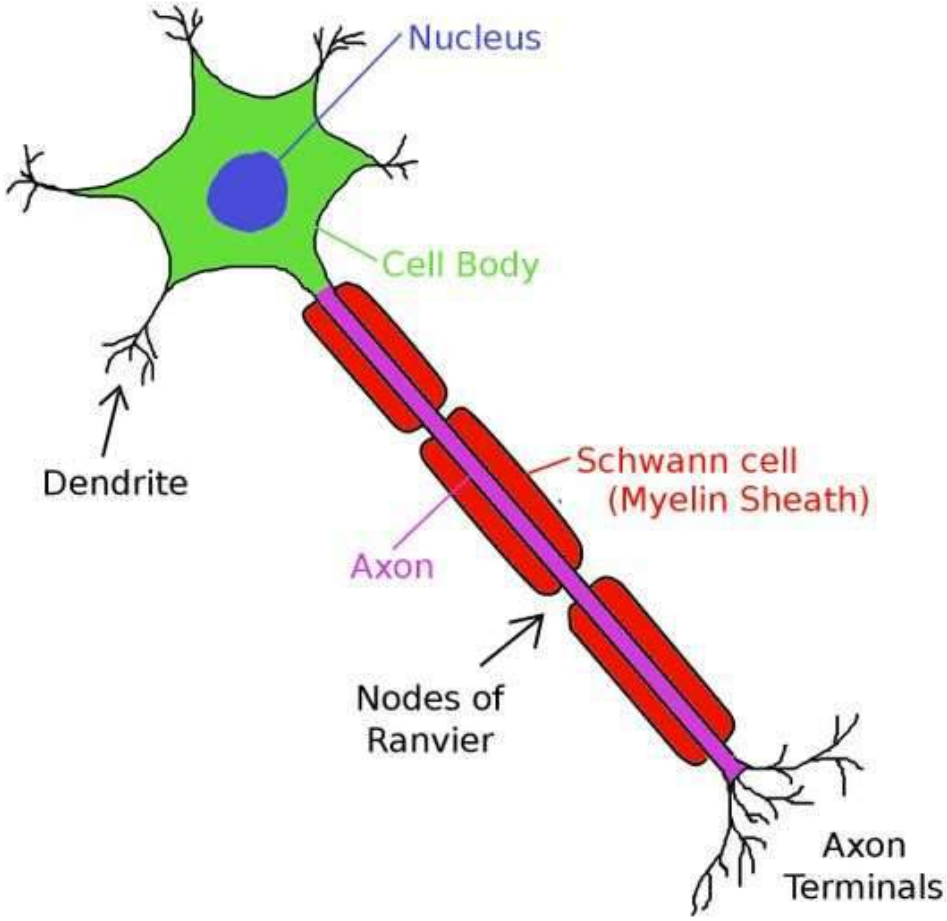
Are cuboidal epithelial cell that line internal cavities of brain and the central of canal the spinal cord.



Glial cell of PNS

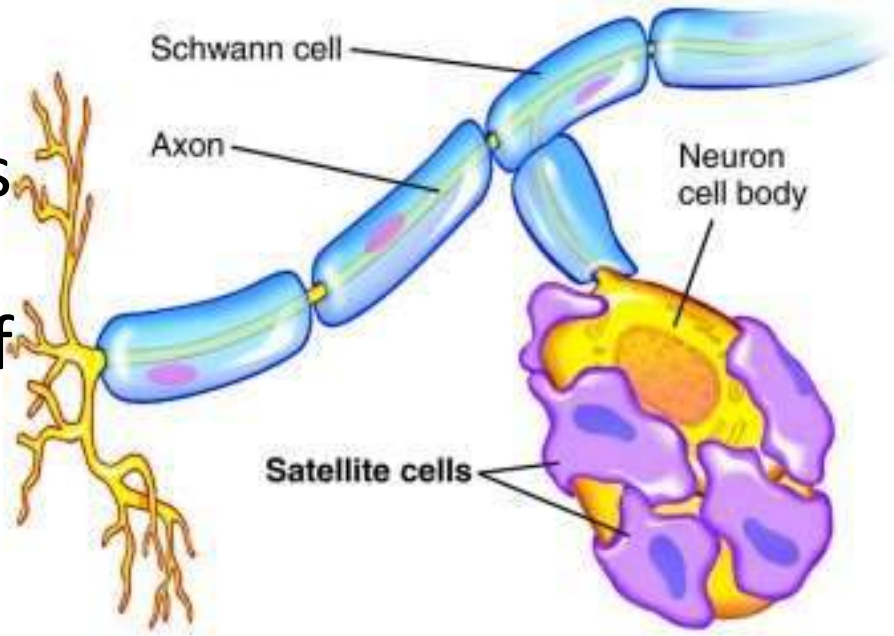
1. **Schwann cell:** are supporting cells of peripheral nerves schwann cell have envelop segment of several un maylinated axons, each maylinated axon segment is surrounded by multiple layers of a schwann cell

- Gaps between the myelin sheath segment are the **nodes of Ranvier**



2. Satellite cells

- Flatted cell around cell bodies in ganglia
- **Function**
- Regulate the continuous exchange on nutrients
- **Notes:** the cell bodies of neuron are found in the CNS and ganglia
- The ganglia are collection of cell bodies with in the PNS



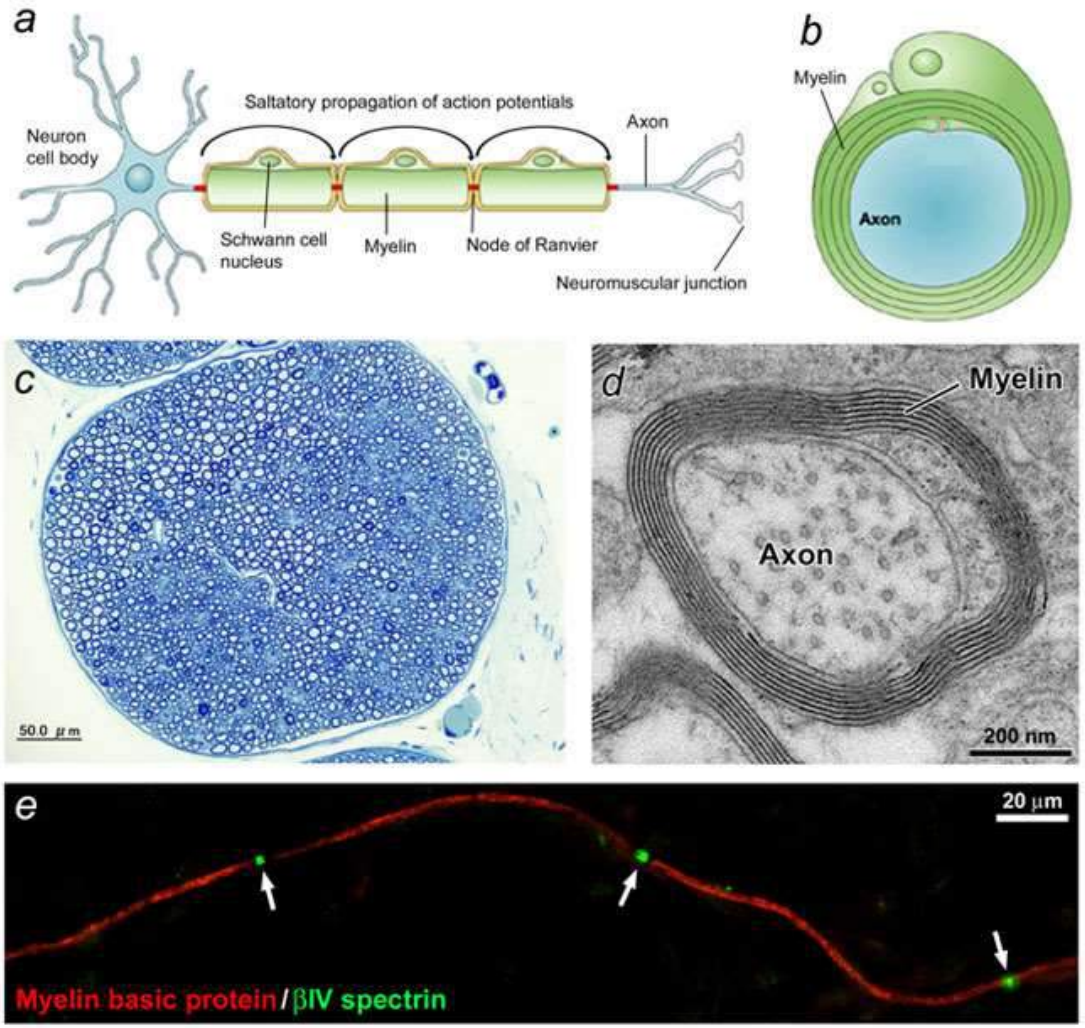
Nerve fibers

1. **Unmyelinated common in the CNS and PNS**
2. **myelinated in the PNS**

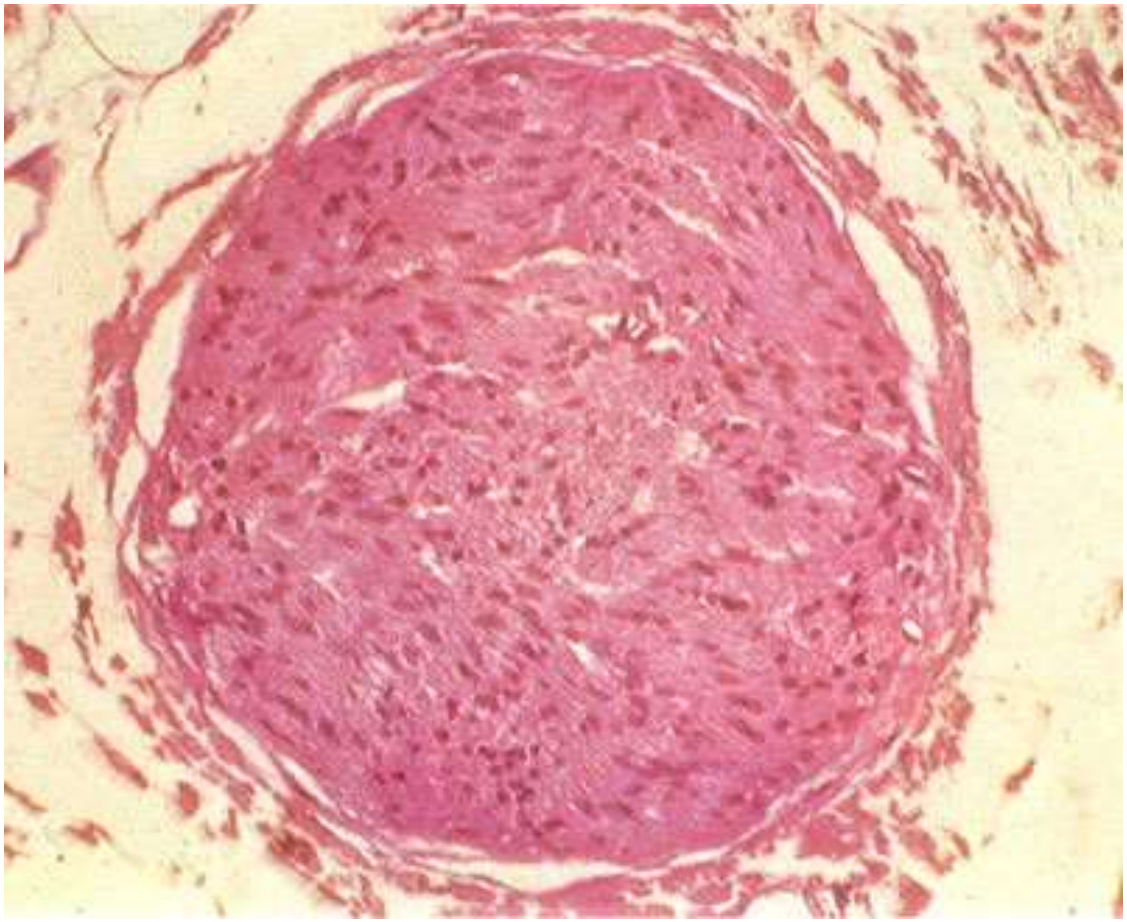
Peripheral nerves contain

1. Unmyelinated and myelinated axon
2. Schwann cell

But lack neuron cell bodies



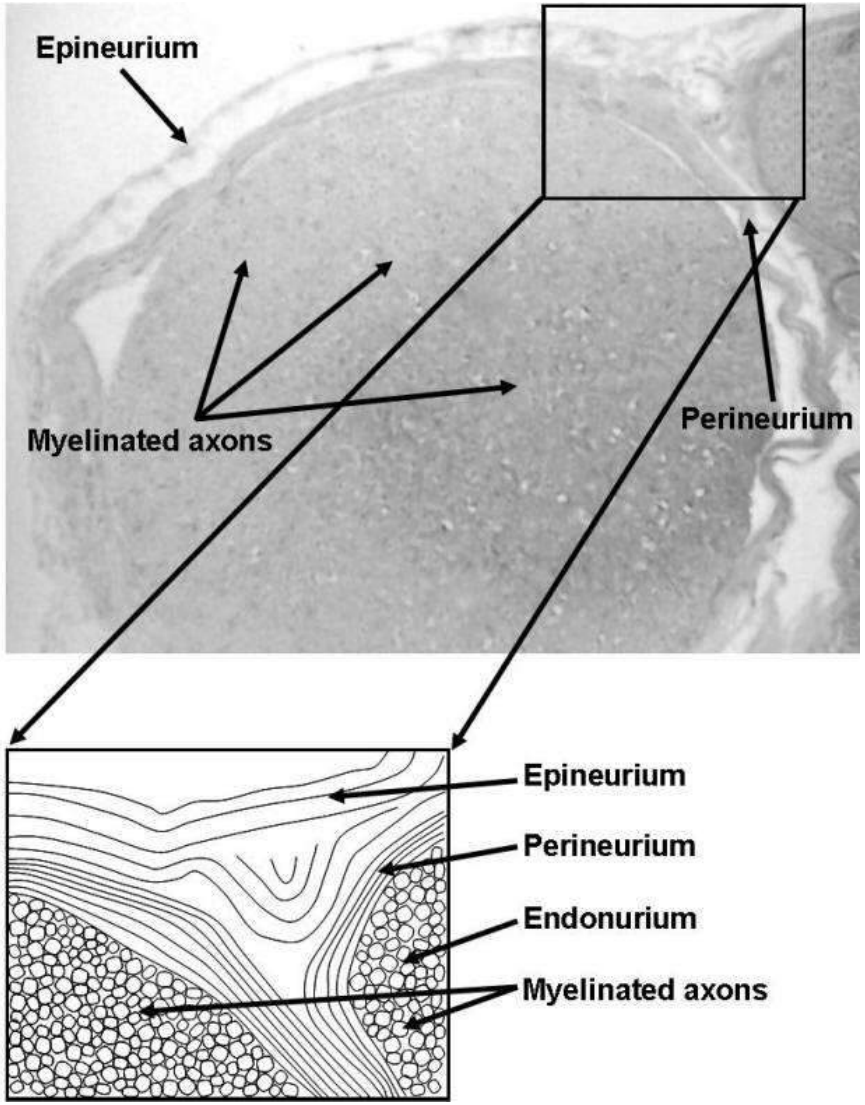
myelinated



unmyelinated

Peripheral nerve surround by

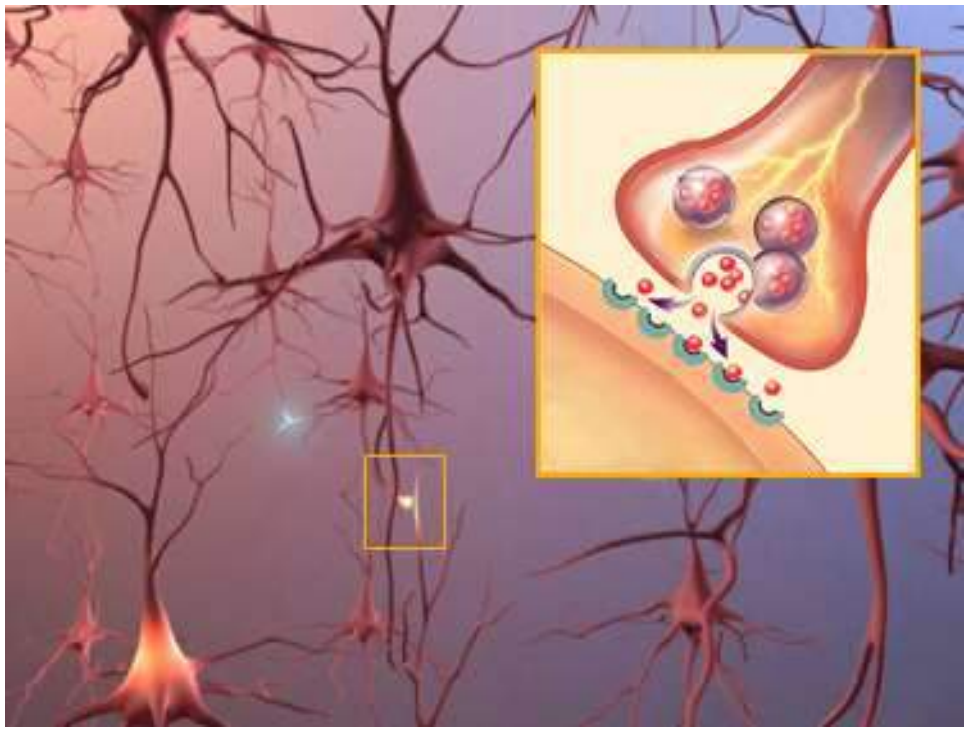
- **Epineurium:** dense C.T
- **perineurium:** sheath surrounding nerve fiber bundle
- **endoneurium:** fine slips of reticular C.T from the perineurium penetrate the bundles to surround each nerve fiber



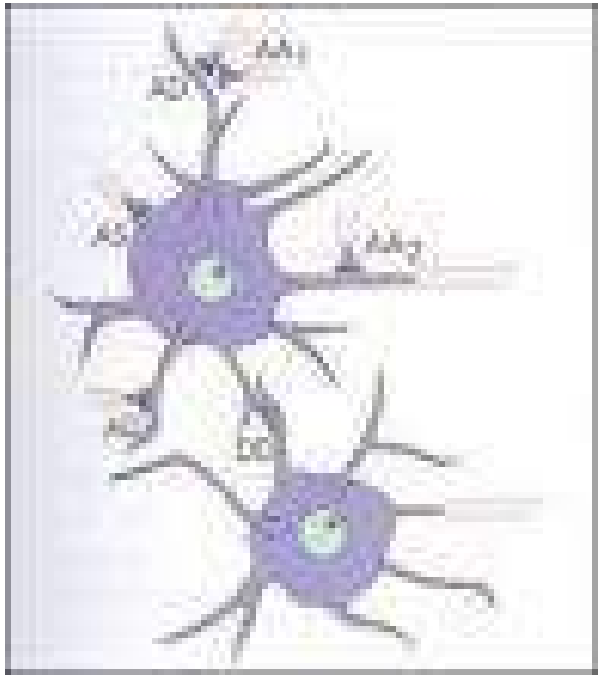
Synapses

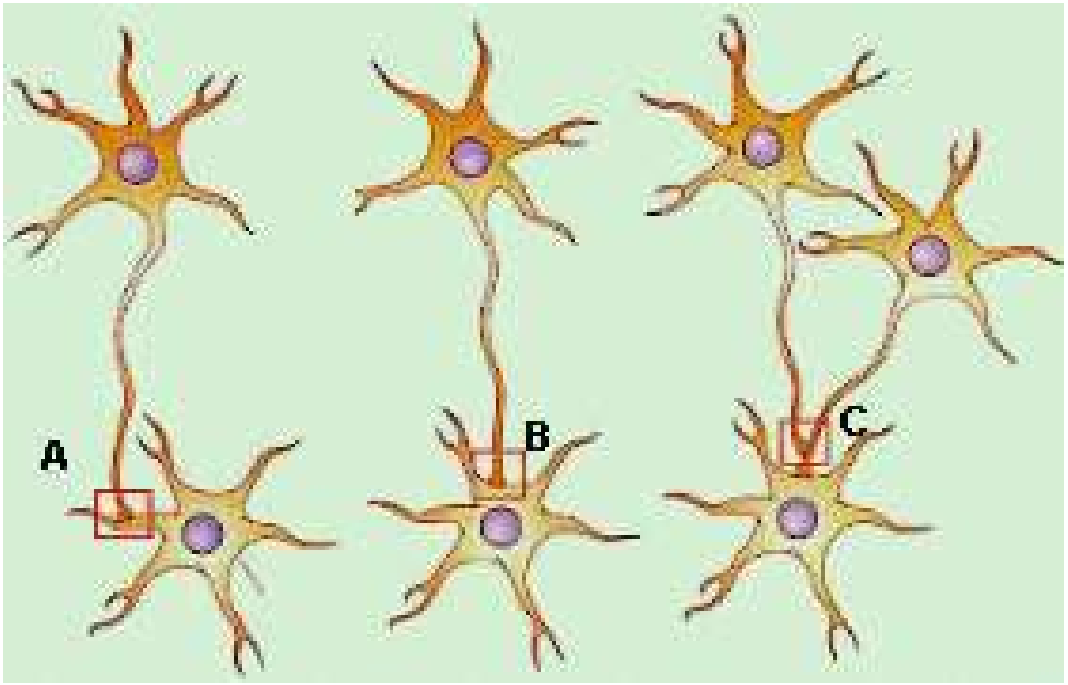
Are specialized junctions by means of which stimuli are transmitted from a neuron to its target cell

Synapses are named according to the structure they connect **eg. Axodendtritic, axosomatic, axoaxonic and dendrodentritic**



- Axodendtritic, axosomatic, axoaxonic and dendrodentritic





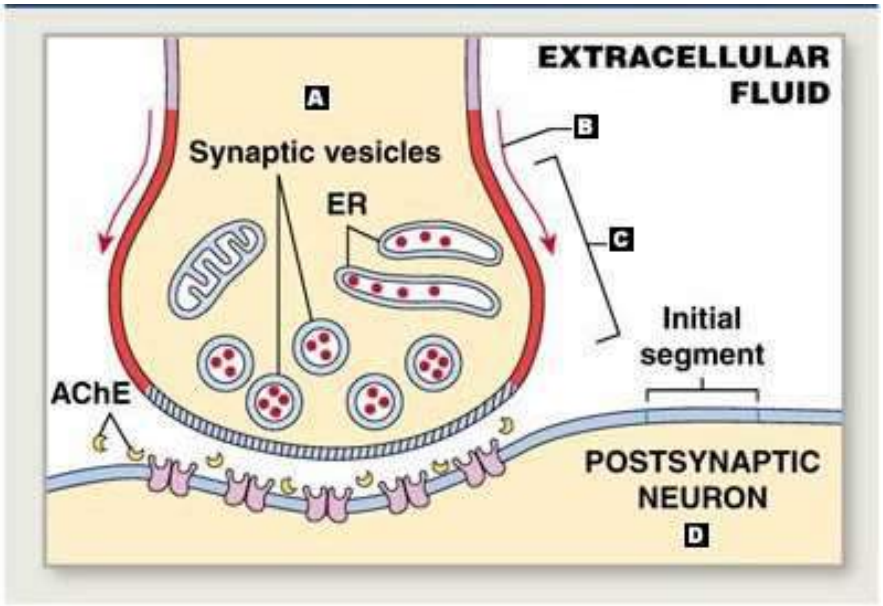
Synaptic arranjements in the CNS. **A.** An axodendritic synapse, **B.** an axosomatic synapse. **C.** An axoxonic synapse

Major structural components of each synapse

A. **Presynaptic membrane:** transmit nerve impulses along their axonal membrane toward synapse

B. **Postsynaptic membrane:** conduct nerve impulses through their dendritic and cell body membranes away from the synapses

C. **Synaptic cleft (synaptic Gap):** this is a fluid filled space, generally **20nm** wide, between the presynaptic and postsynaptic membranes.




Thank you
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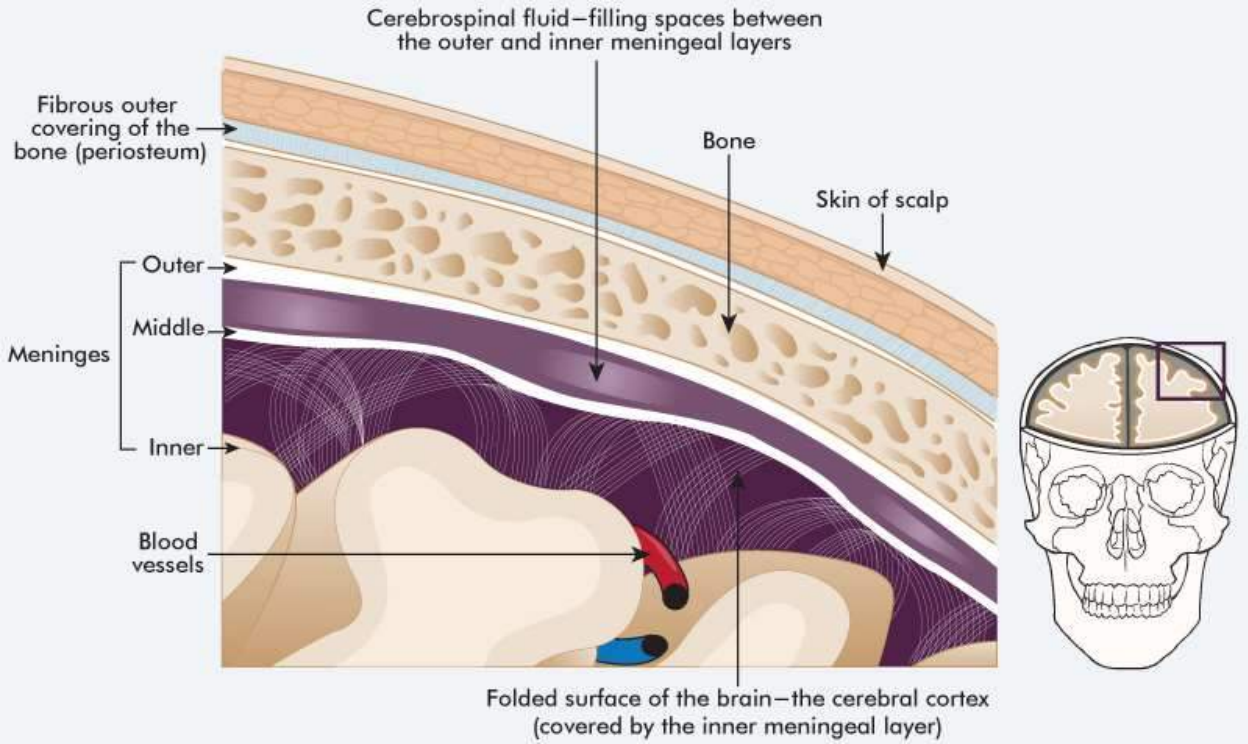
Membranes of the CNS



Lec.Dr.Ruwaidah F. Khaleel

Membranes of the CNS

It consists brain and spinal cord

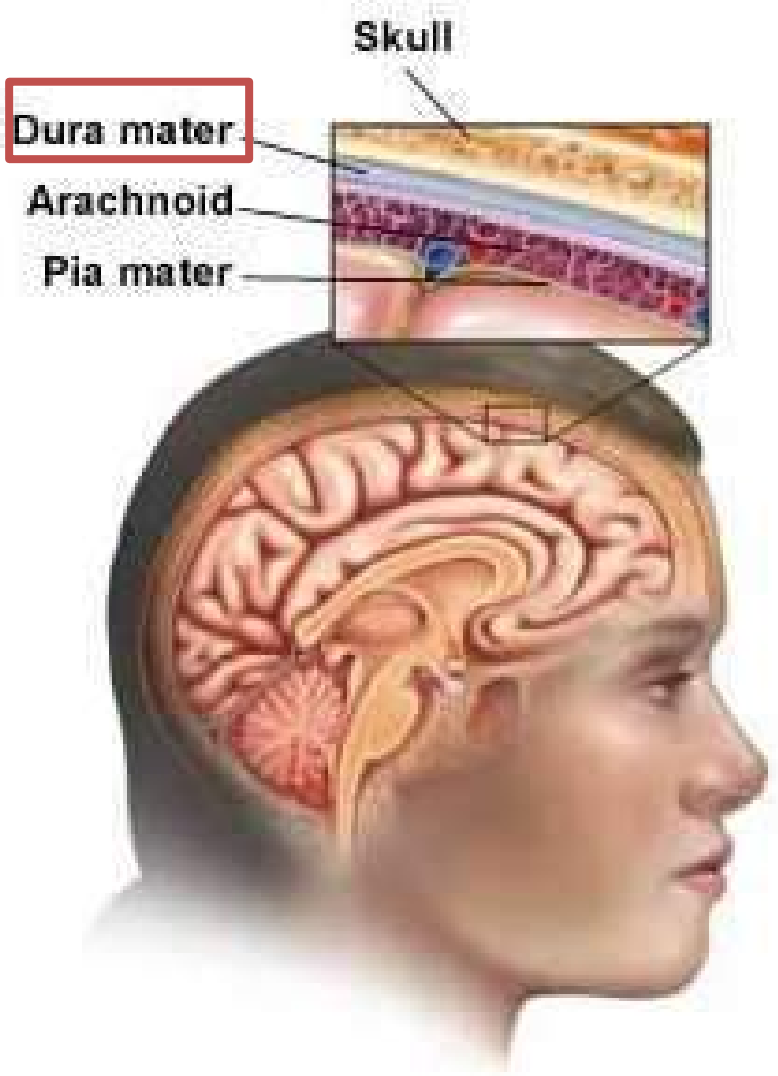
Meninges: that are located between bone and the soft tissue of nerve system

The meninges have three layers:

1. **Dura mater**

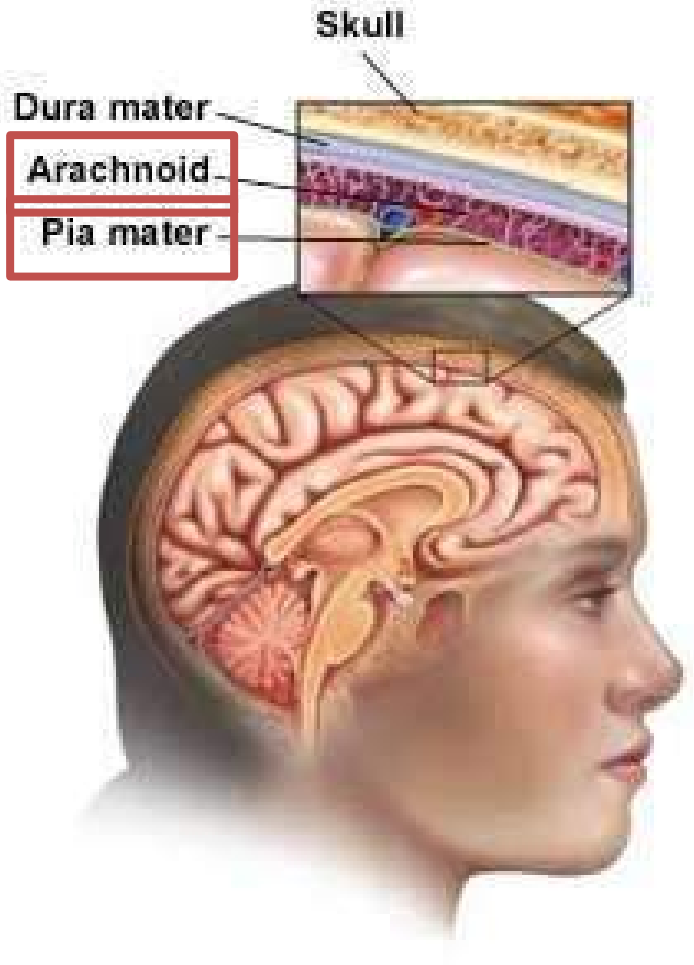
Outer layer: composed of **white fibrous tissue**, its attached to the inside of cranial cavity and from the endosteum of surrounding skull bone

Inner surface: lined by a **membrane of simple squamous epithelium** and separate from arachnoid by subdural space which contain fluid



2. Arachnoid mater:
consists of a **thin layer of C.T**, both external and internal surface lined by **simple layer of flattened cell.**

3. Pia mater: it is the **inner most layer of the meninges**. It is **very delicate membrane of the bone and spinal cord** and convey small blood vessels down into their substance from their surface.



Blood brain barrier

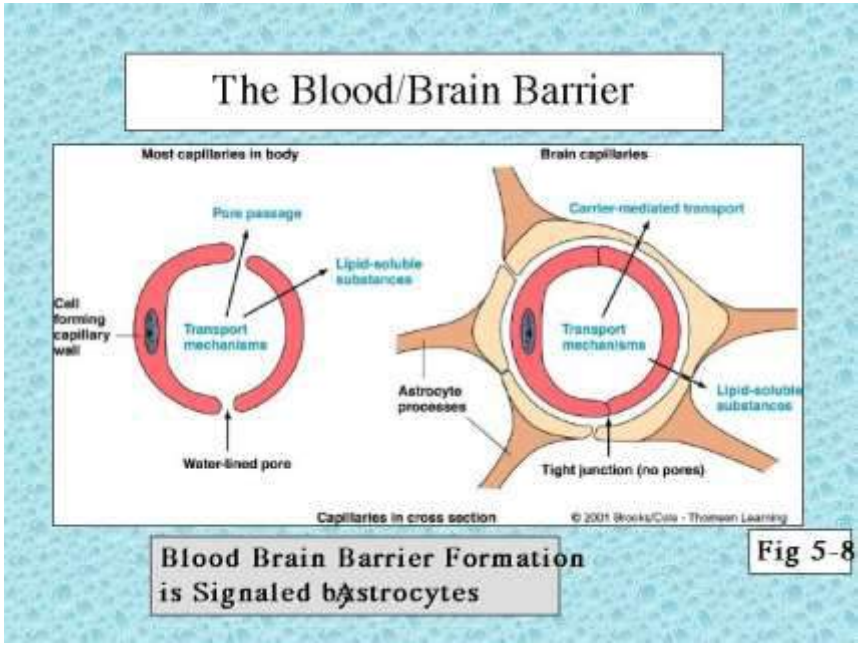
CNS receiver O2 and materials from capillaries in the pia matter

These capillaries are relatively impermeable

1. Because their endothelial cells lack fenestration
2. Are joined at their borders by tight junctions
3. They are partly surround by the cytoplasmic processes of neuroglia called **structural and functional barrier** that:

A. Protects CNS neurons from many extraneous influences

B. Prevent certain antibiotics and chemotherapeutic agents from reaching the CNS



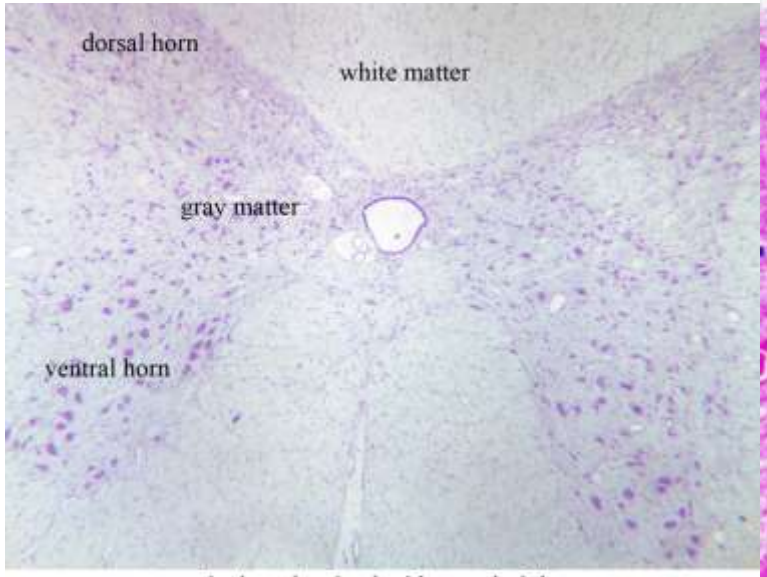
المخcerebrum
المخيخcerebellum

يكون **المخ** القسم الأكبر و الأهم من الدماغ حيث يتشكل من نصفي كرة مخيتين منفصلتين يرتبطان بجسر عصبي يدعى الجسم الثفني . **و يهتم المخ بشكل عام بالوظائف الإدراكية و الحسية و العقلية ووظائف اللغة .**

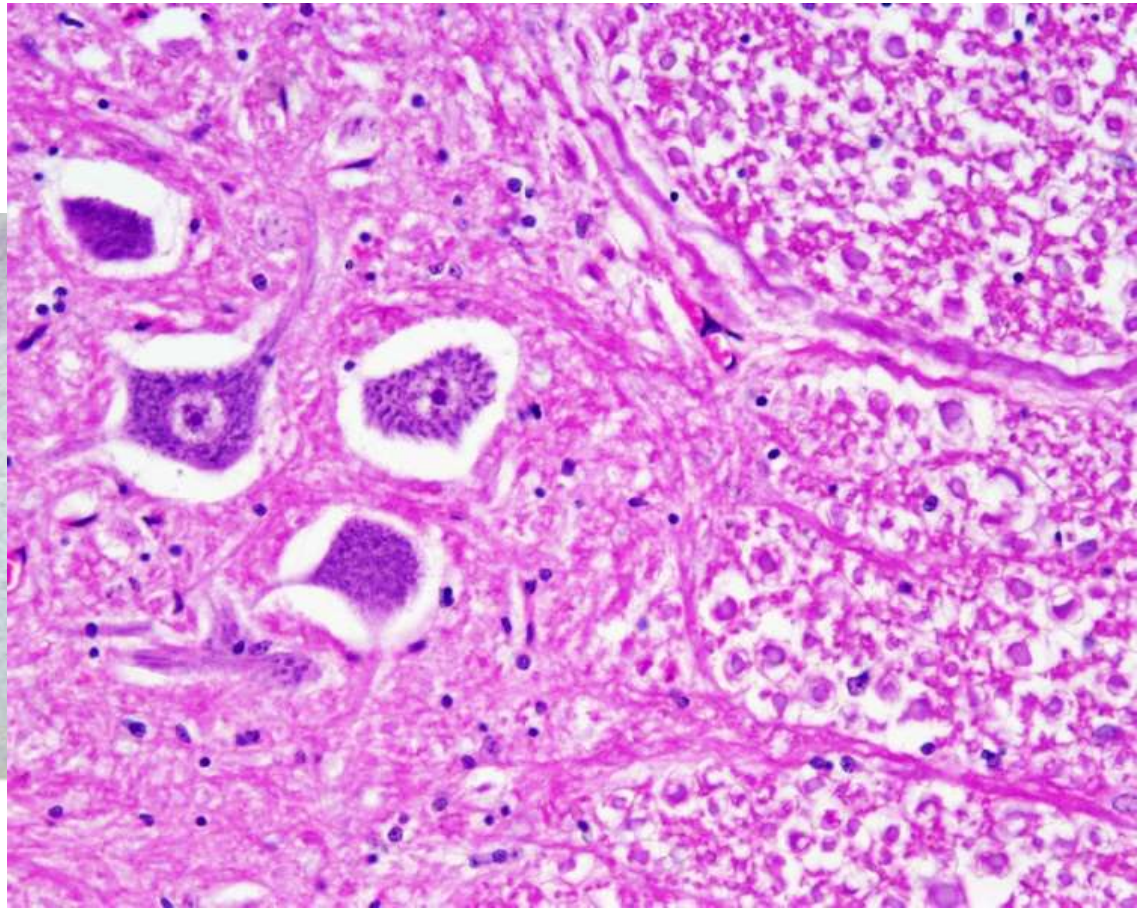
المخيخ هو القسم الكروي الأصغر الذي يقع أسفل نصفي الكرة المخيتين في الدماغ ، **يهتم المخيخ بشكل أساسي بوظائف التوازن و تنظيم الوظائف الحركية**

Type of neurons in CNS

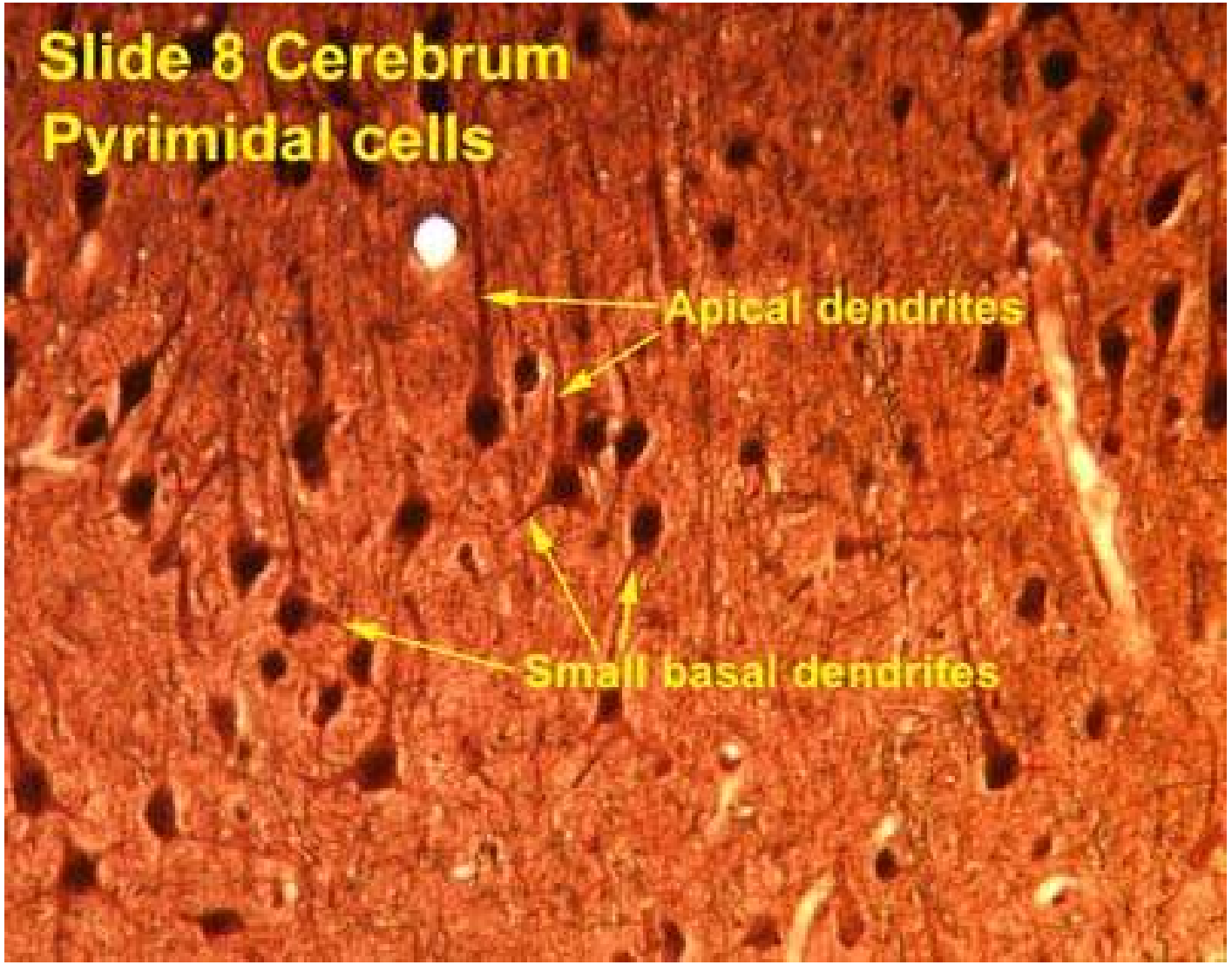
1. **Motor neurons:** found in the ventral horn of spinal cord



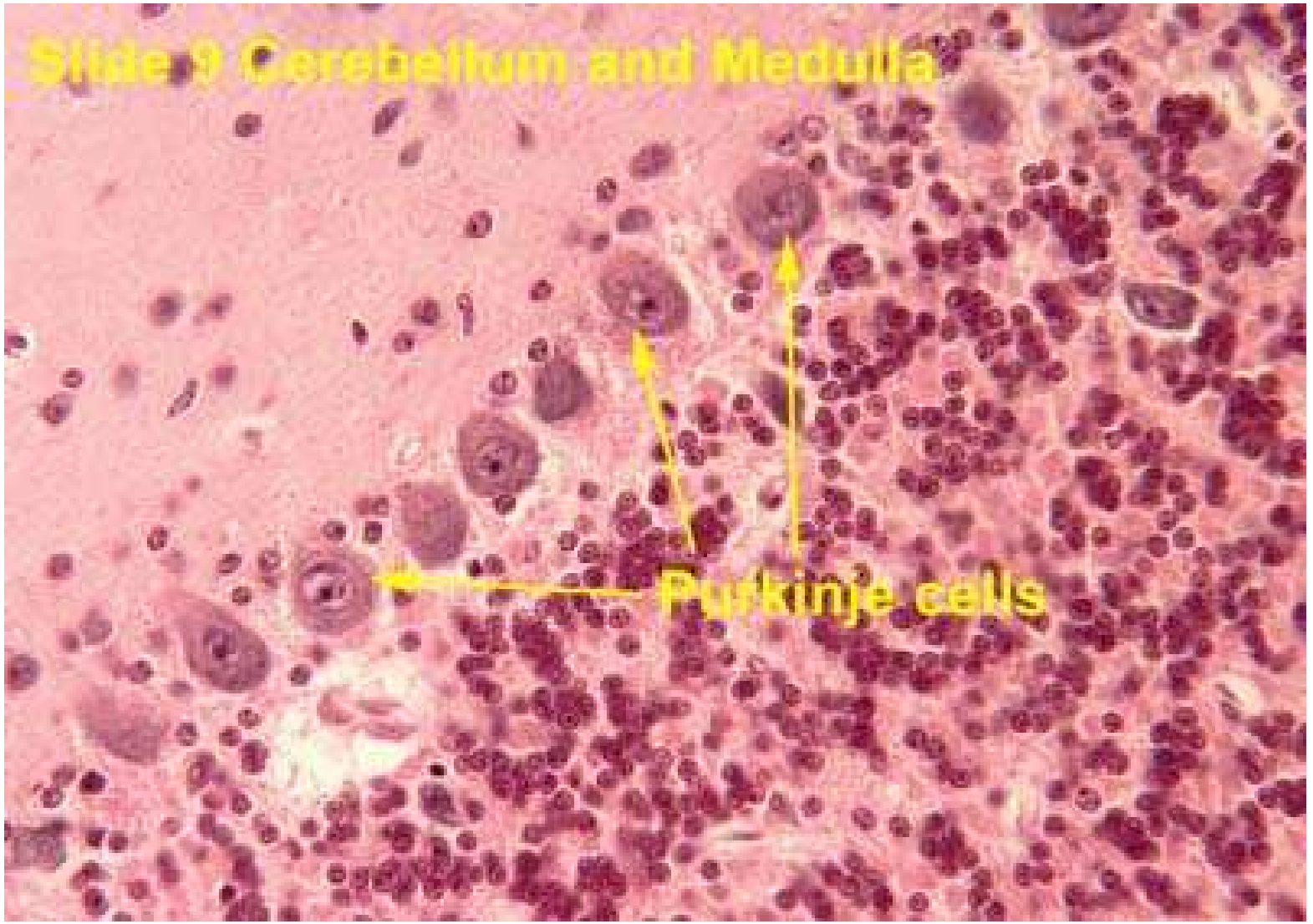
spinal cord stained with cresyl violet



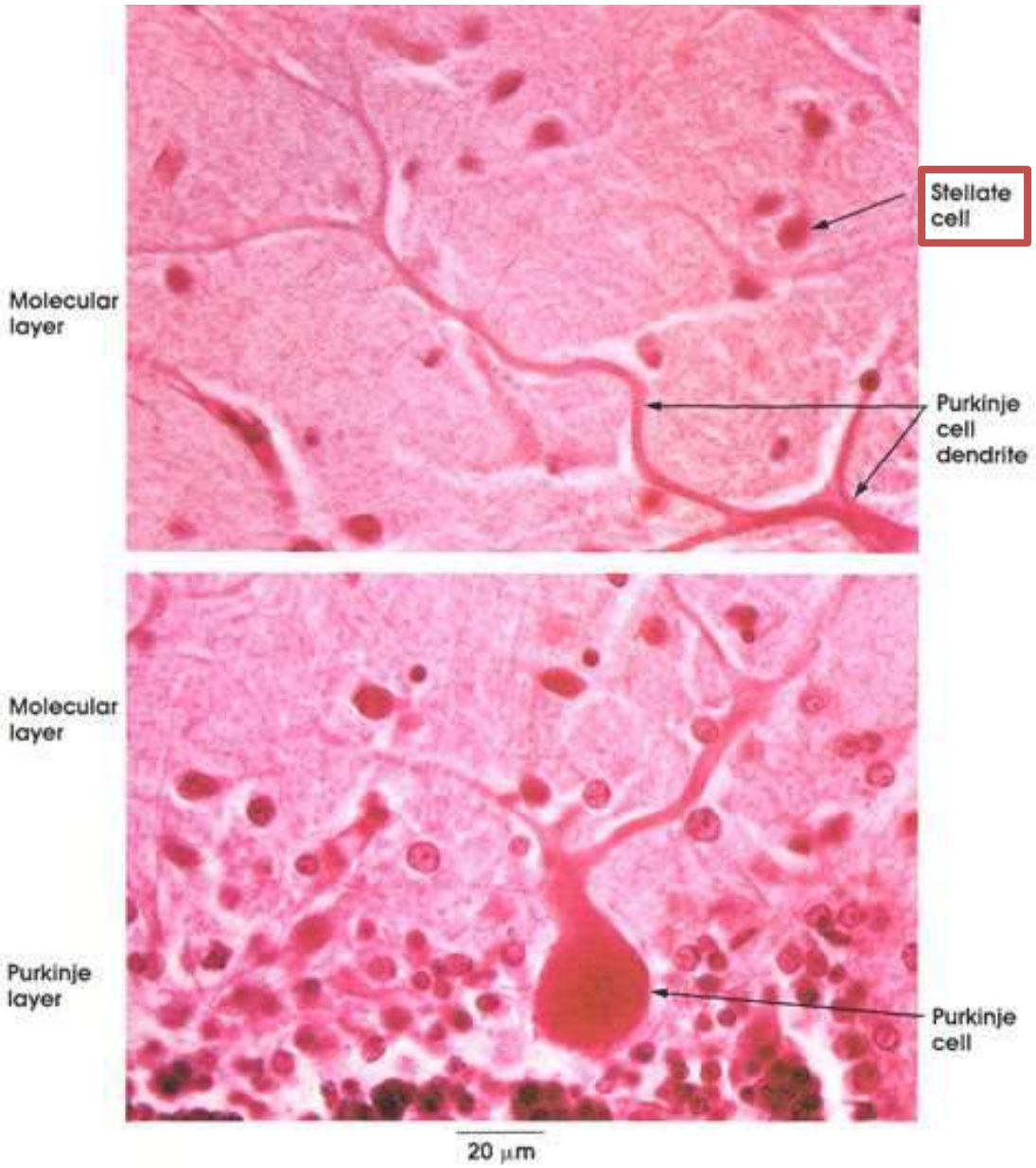
2. Pyramidal cells: found in the cerebral cortex



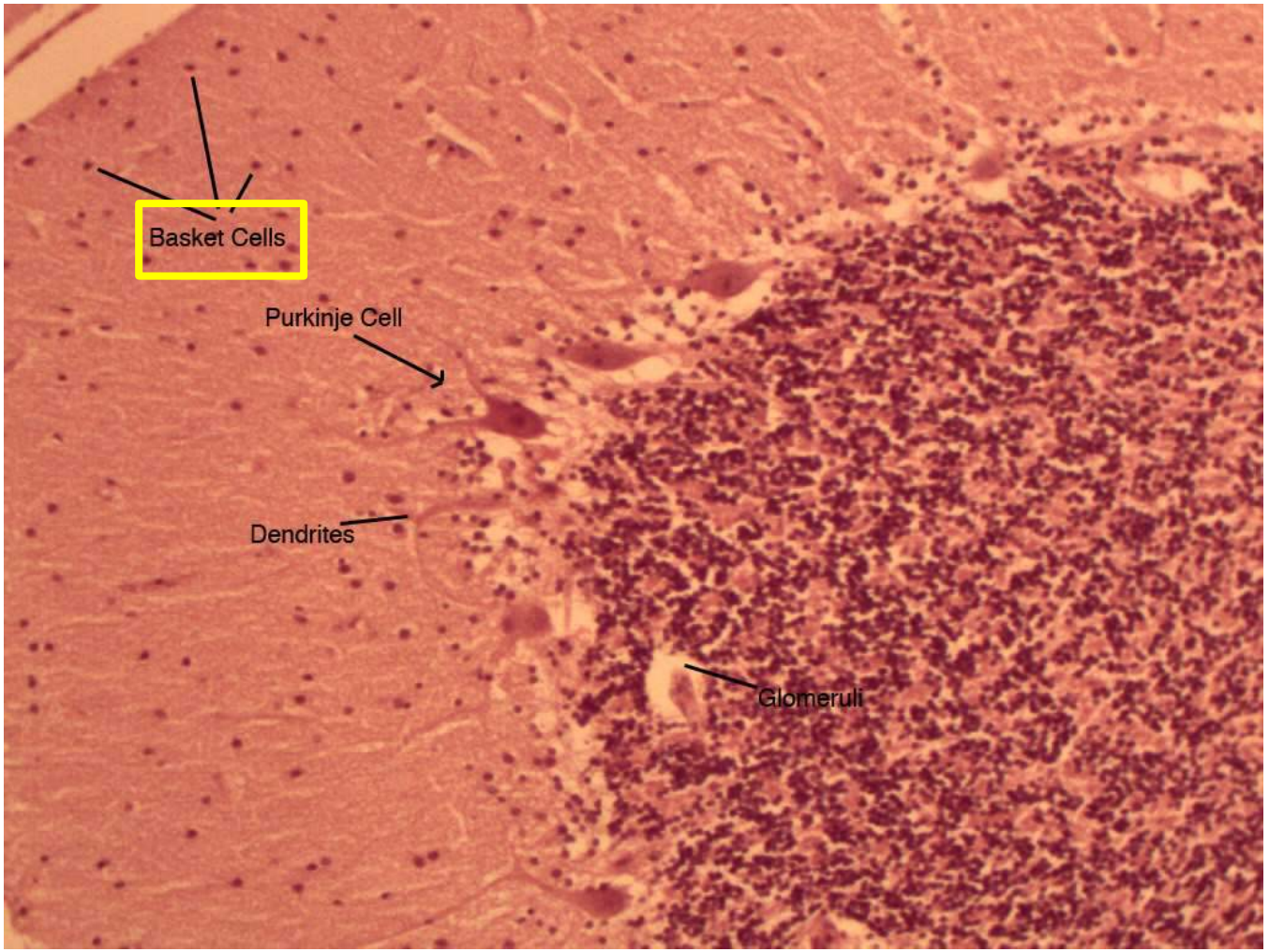
3. Purkingi cells: found in the cerebral cortex



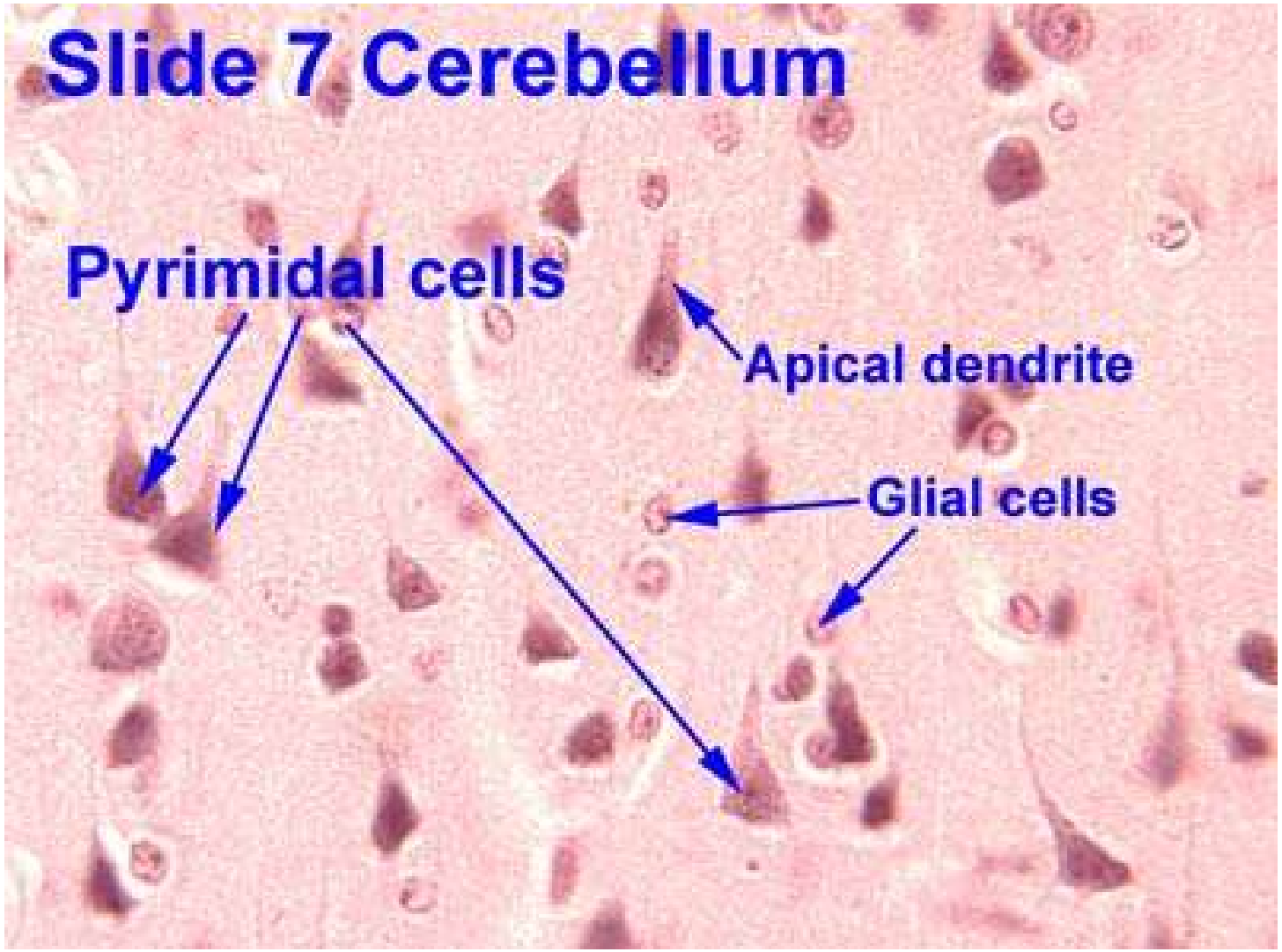
4. Stellate cells: found in cerebellum



5. Basket cells: found in cerebellum



6. Pyramidal cells: found in cerebellum cortex

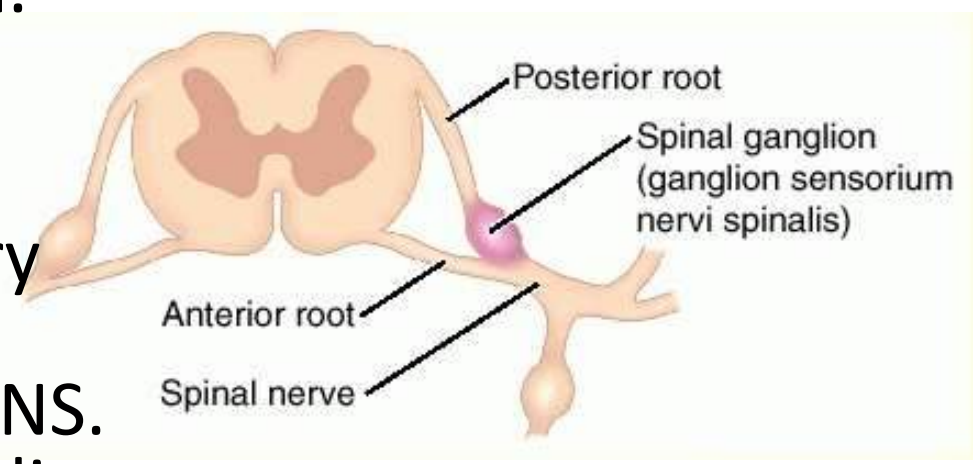


Ganglia

Peripheral clusters of neuron cell bodies, called ganglia.

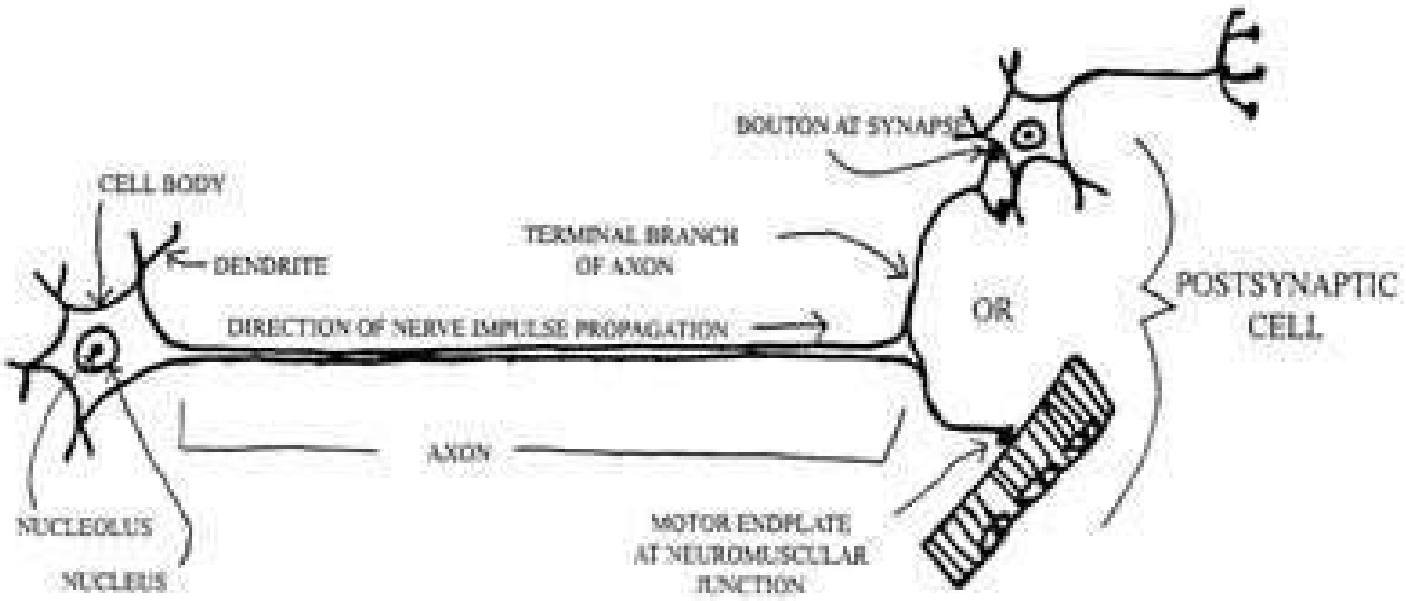
Are two major type

A. Craniospinal group (sensory ganglia): sensory ganglia receive afferent impulses that go to the CNS. Tow type of sensory ganglia are exist, some are associated with **cranial nerve**, other are associated with dorsal root of **spinal nerve** called spinal ganglia



B. Autonomic ganglia

Appear as bulbous dilatation in autonomic nerve some are located within certain organ especially **in the wall of digestive tract.**

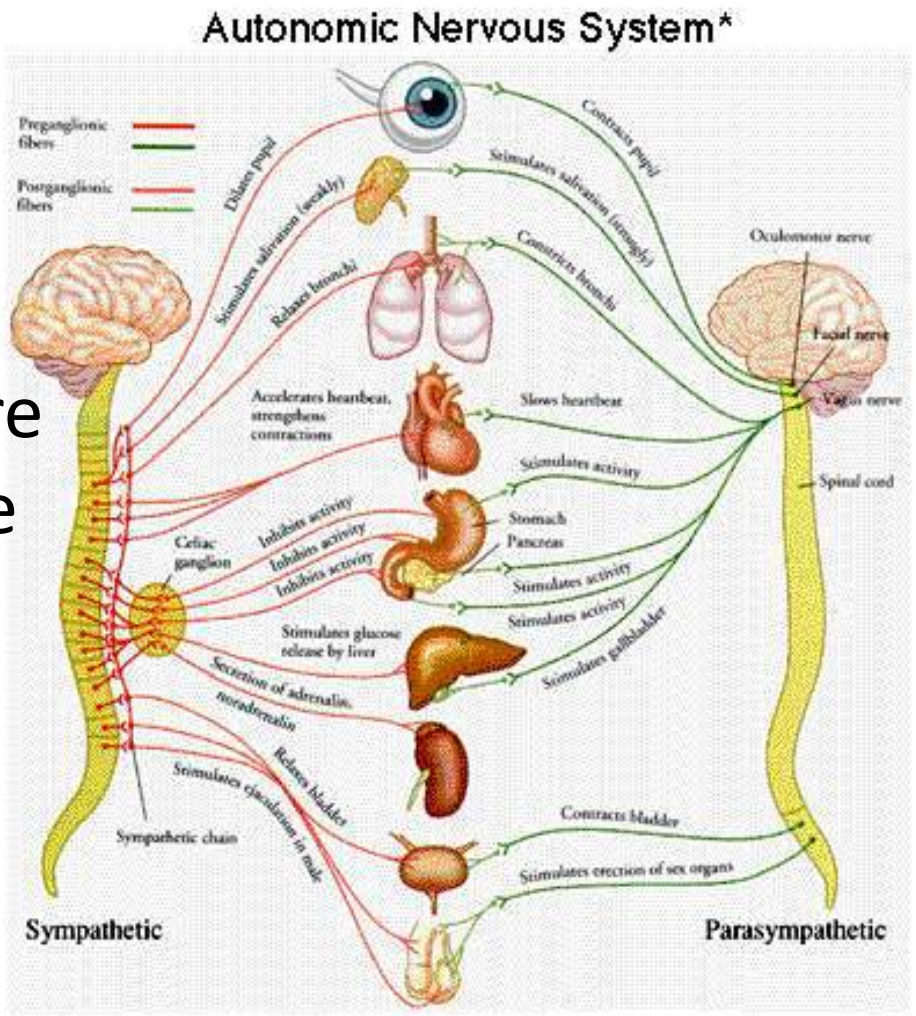


Autonomic nervous system (ANS)

It is the portion of neurons system

Function:

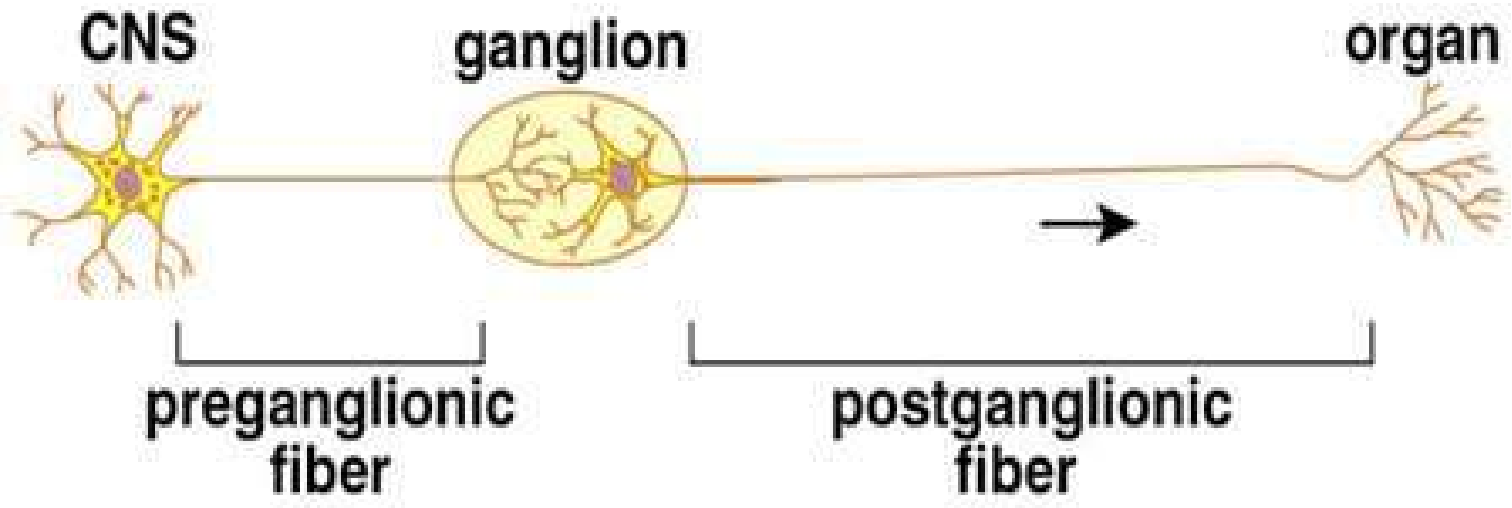
1. Regulating heart beat
2. Regulating Blood pressure
3. Regulating breathing rate
4. Regulating blood temperature
5. Visceral function that maintenance of homeostasis



ANS composed of two section

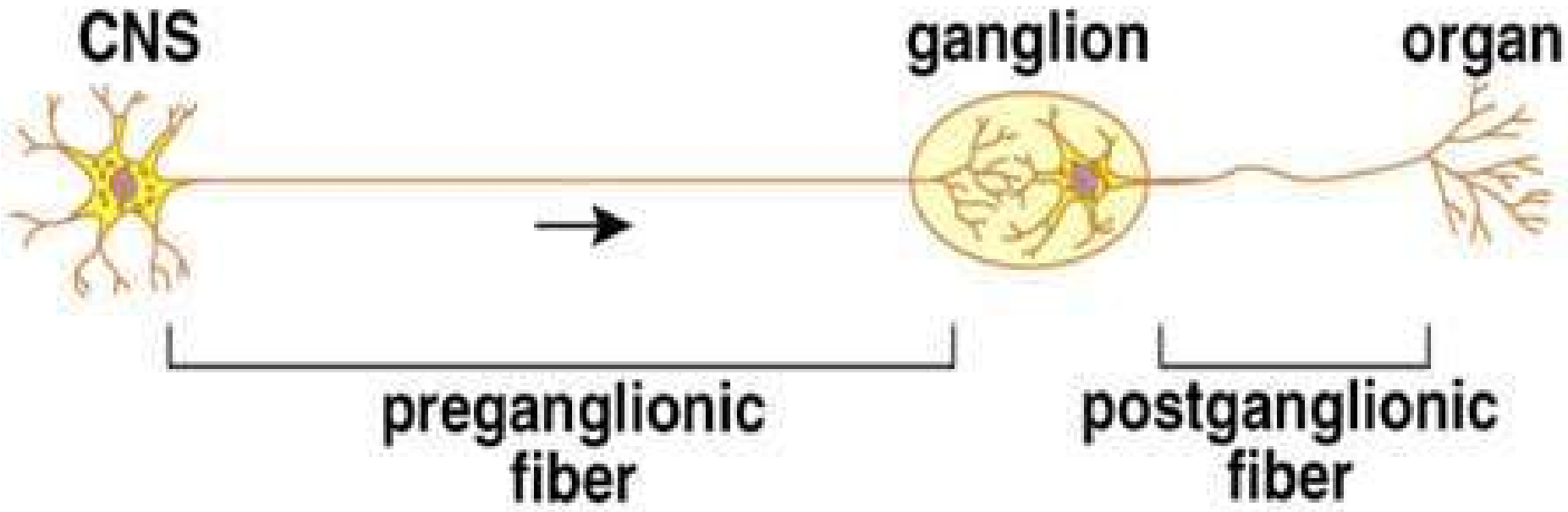
1. Sympathetic:

The preganglionic fiber is short but **postganglionic fiber** that makes contact with fiber **is long**



2. Parasympathetic:

The **preganglionic fiber is long** and **postganglionic fiber is short** because the ganglia lie near or within the organ




Thank you