DAW KHIN HTAY AUNG

LECTURER

DEPARTMENT OF ZOOLOGY

CHAPTER II
STRUCTURAL ORGANIZATION
(tissue histology)

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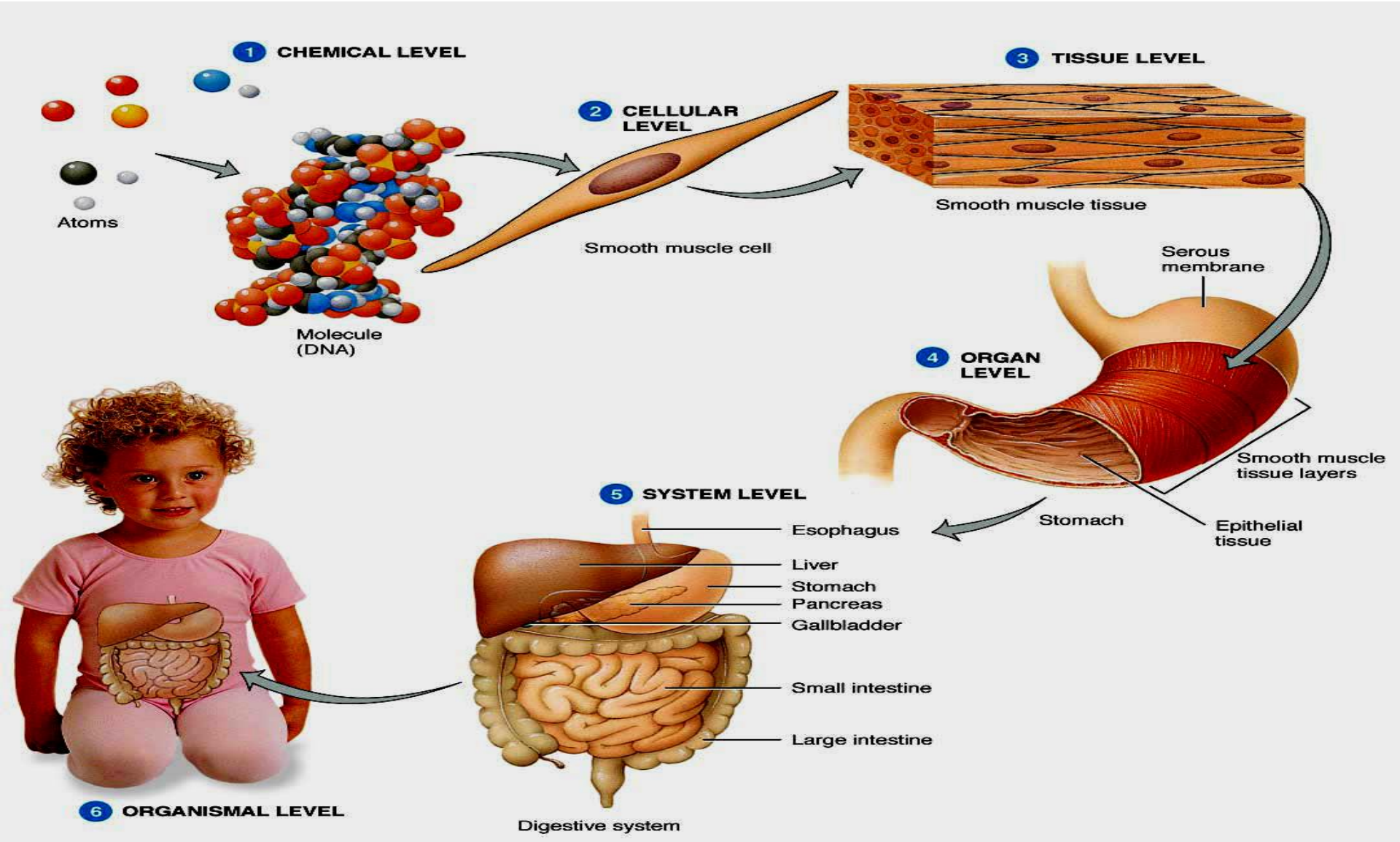
(tissue histology)

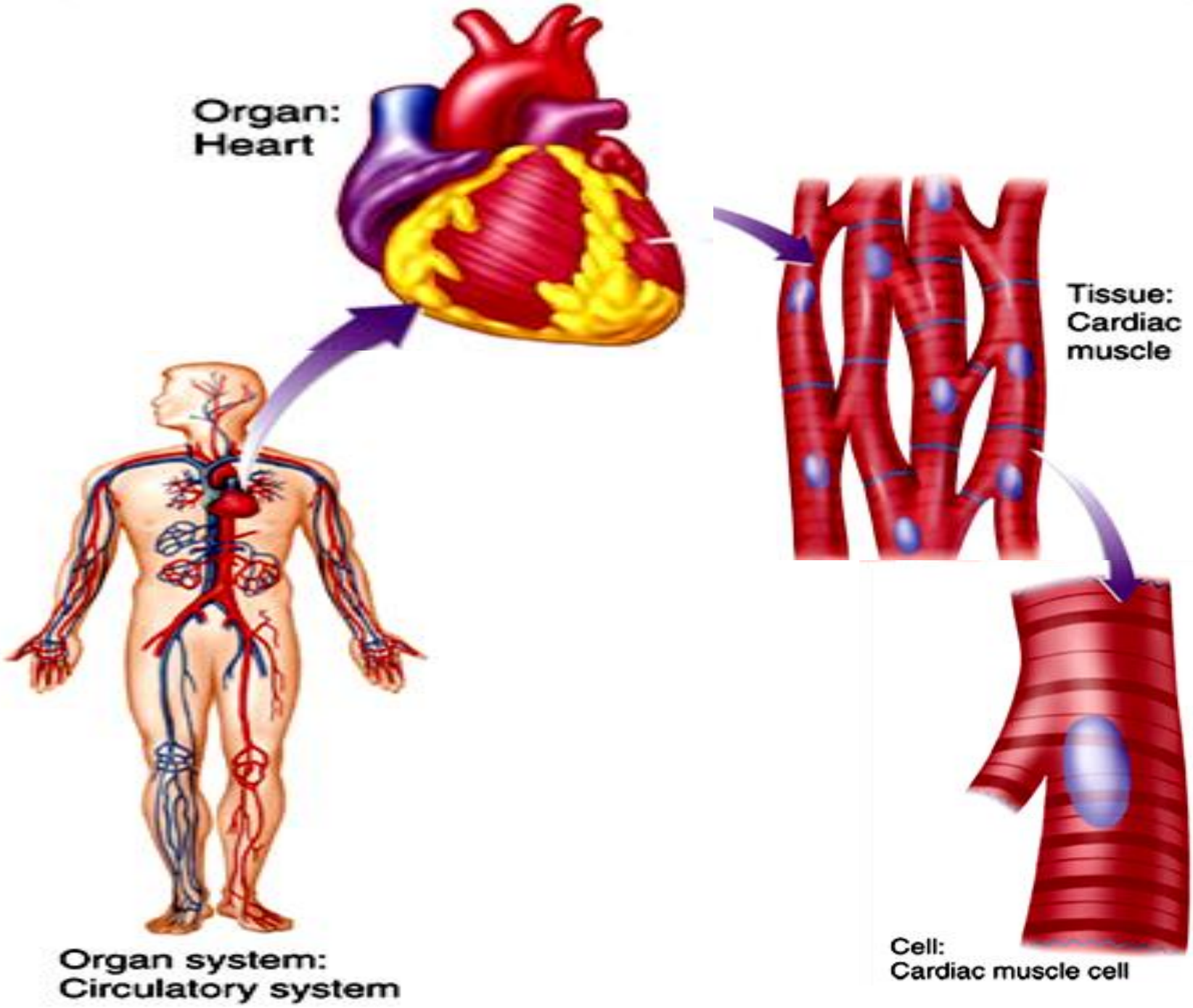


Tissue → collections of similar cells that perform a common function.

- **The various types of tissues are established during early embryonic development.**

- **As the embryo grows,**

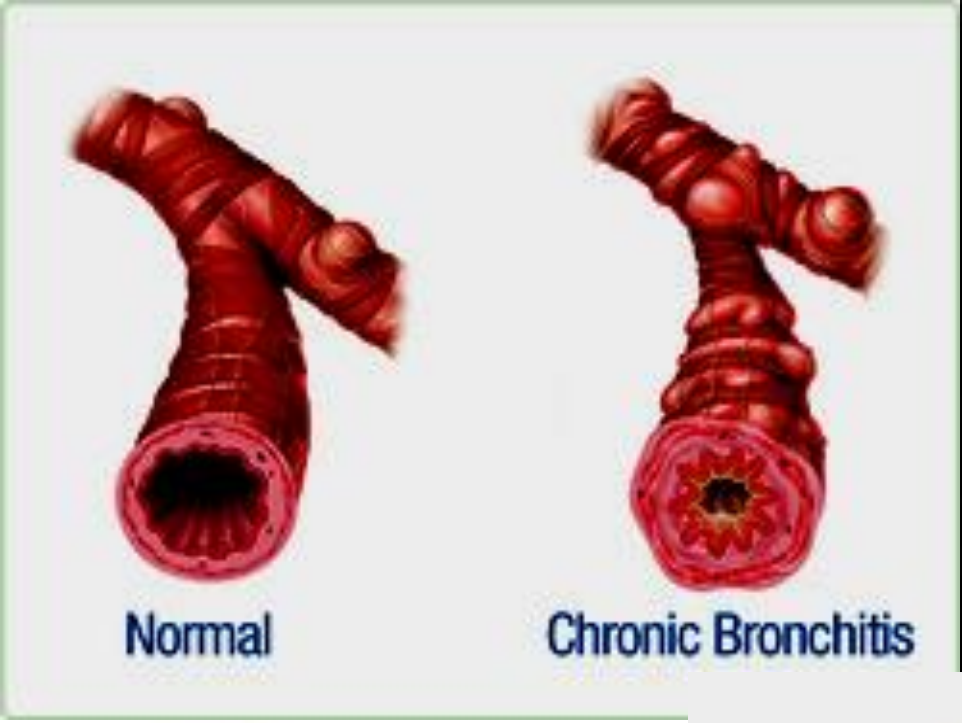
- organs form → from specific arrangements of tissues.

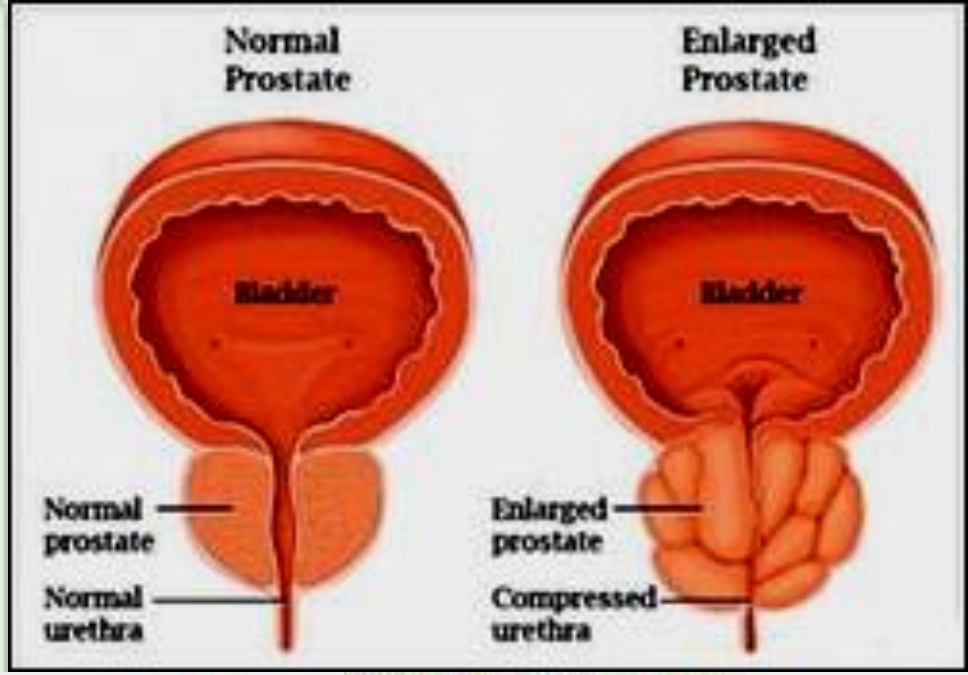

Organ:
Heart
Tissue:
Cardiac
muscle
Cell:
Cardiac muscle cell
Organ system:
Circulatory system

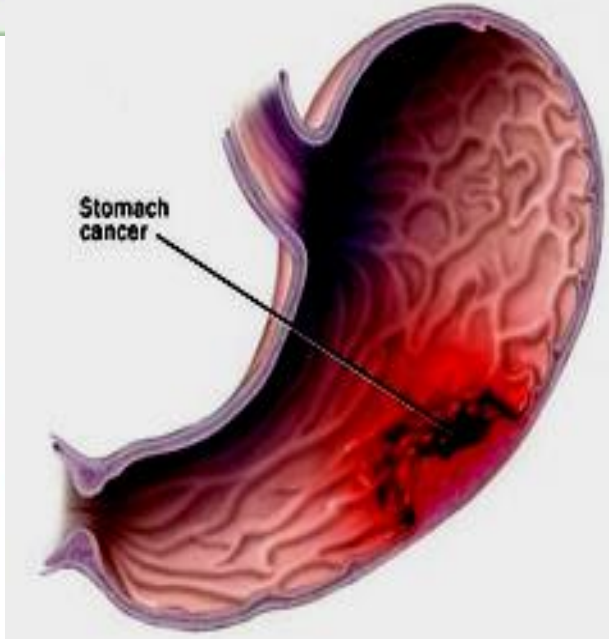
- **Pathology is the study of abnormal tissues in diseased organs.**

- **By knowing the normal tissues structure, a medical practitioner can recognize the abnormal.**

- **Histology in most medical schools is followed by a course in pathology.**


Normal
Chronic Bronchitis


Normal Prostate
Enlarged Prostate
Bladder
Bladder
Normal prostate
Normal urethra
Enlarged prostate
Compressed urethra


Stomach cancer


Normal prostate
Prostate cancer

Body Tissues

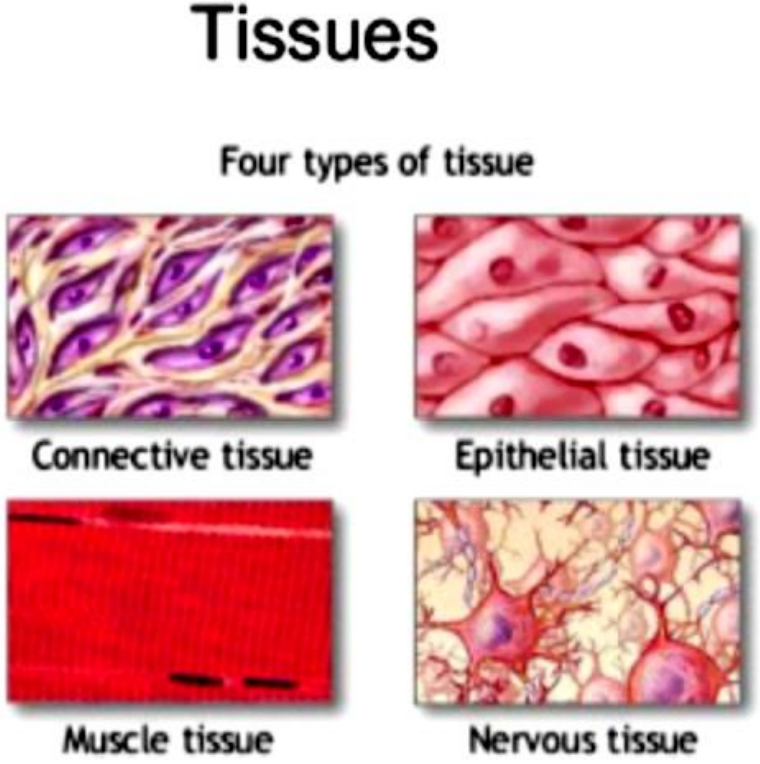
- **Tissues**
  - **Groups of cells with similar structure and function**
  - **Four primary types:**
    1. **Epithelial tissue (epithelium)**
    2. **Connective tissue**
    3. **Muscle tissue**
    4. **Nervous tissue**

➢ **Based on their structure and function,**

- the tissues of the body

- may be classified into four basic categories

- ❖ **Epithelial tissue**
- ❖ **Connective tissue**
- ❖ **Muscular tissue**
- ❖ **Nervous tissue**



1.Epithelial tissue

- covers body and organ surfaces,
- lines the inside walls of the body cavities &organs,
- and forms various glands.

2.Connective tissue

- joins, supports, and protects body parts.

3.Muscle tissue

- contracts to produce movement.

4.Nervous tissue

- produces nerve impulses and

  transmits them from one body part to another.

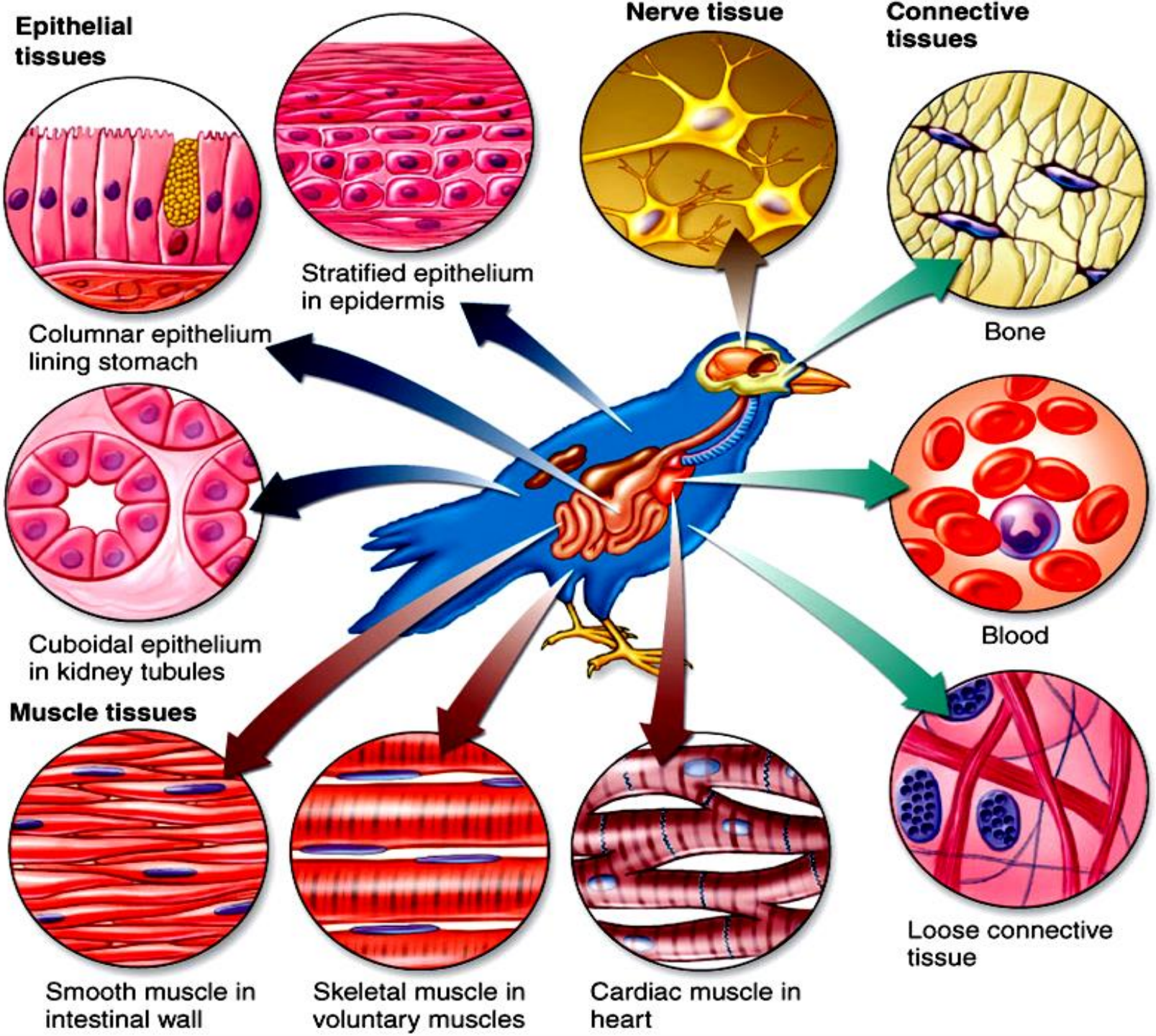
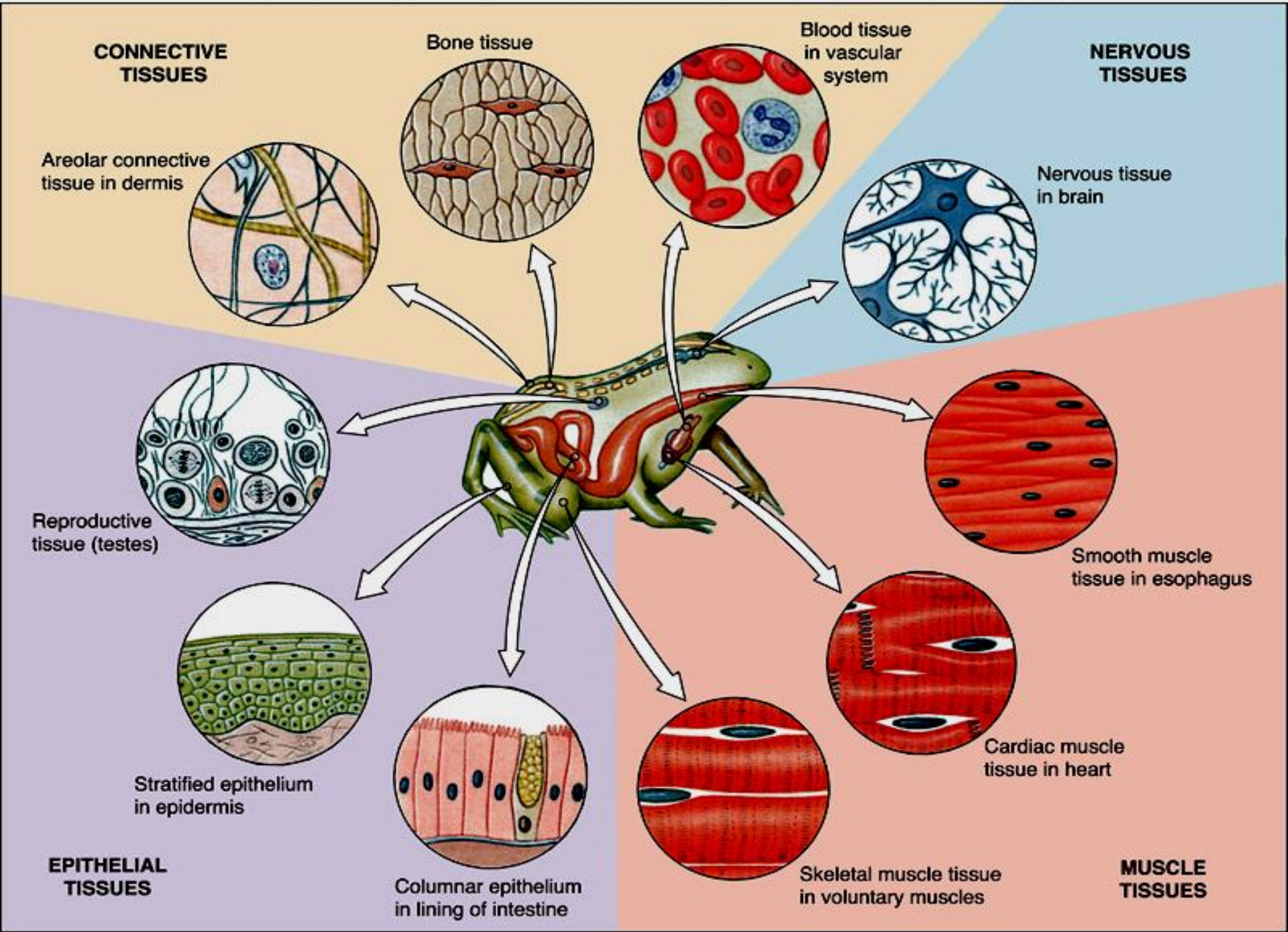


Fig. 24.1
Vertebrate tissue types



Characteristics of Membranous Epithelial Tissues

- **Epithelial tissues or epithelium**

- is located throughout the body &

- forms such structures as

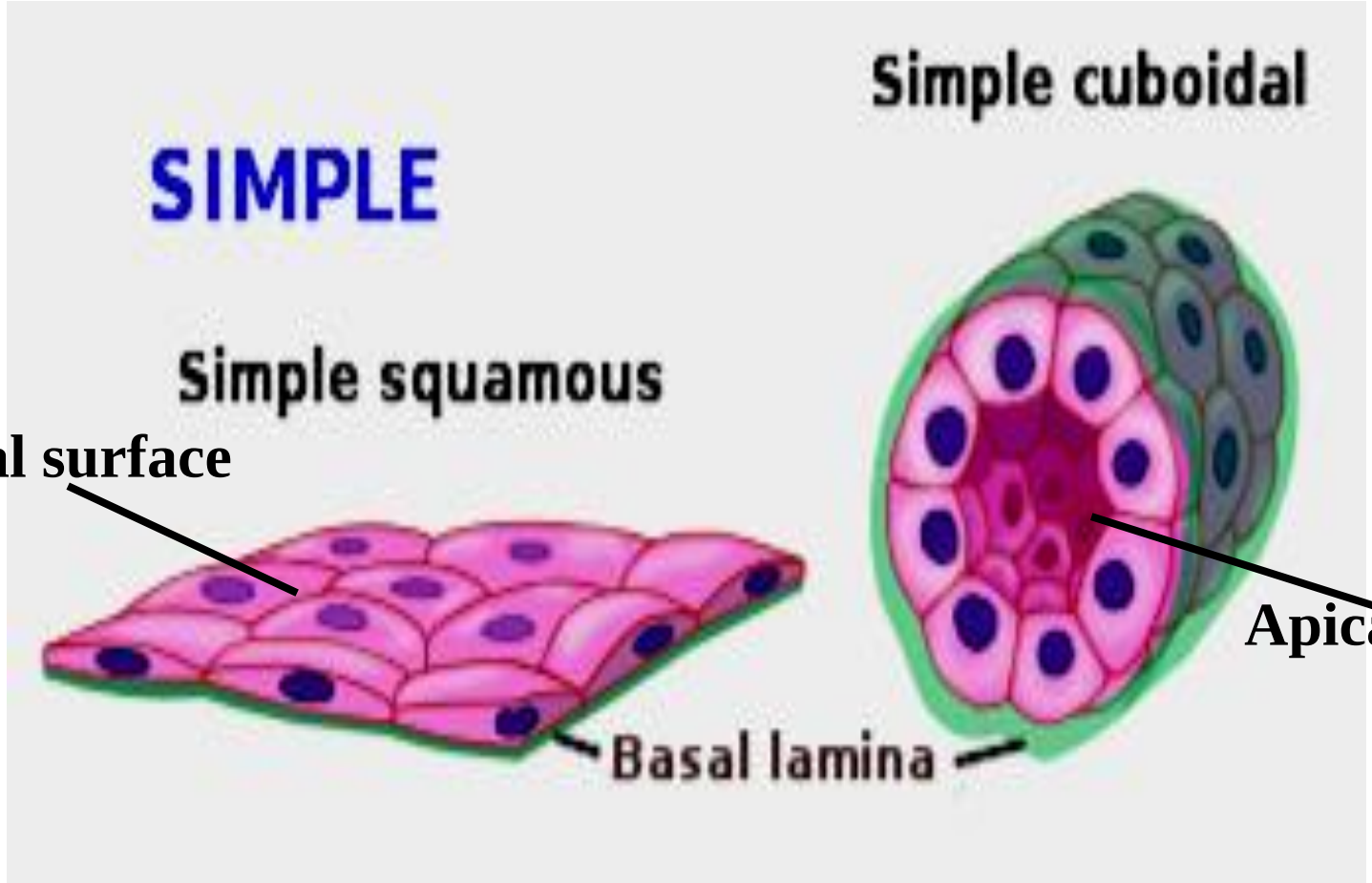
-- the outer layer of the skin,

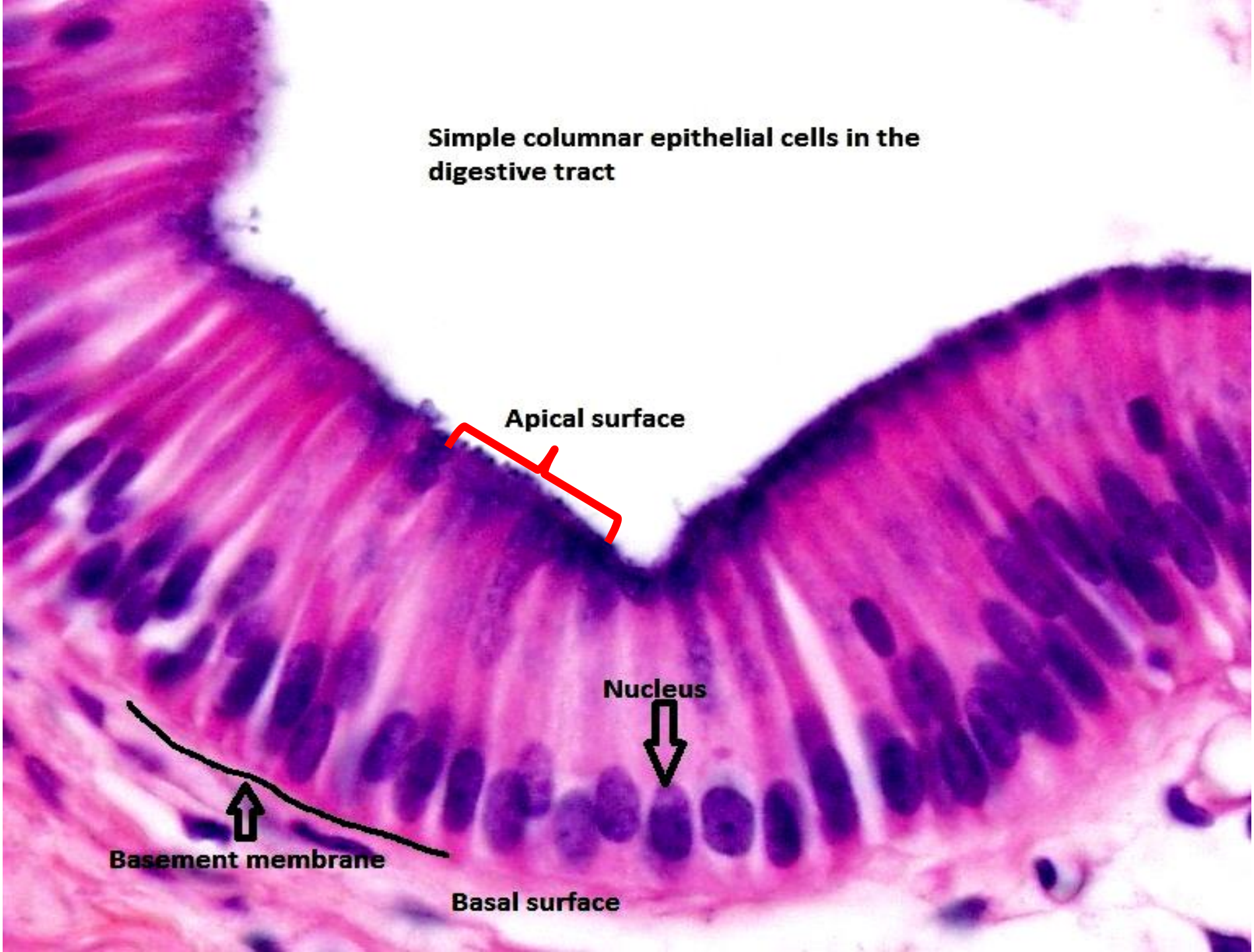
-- the lining of ⟹ the body cavities & vessels ,

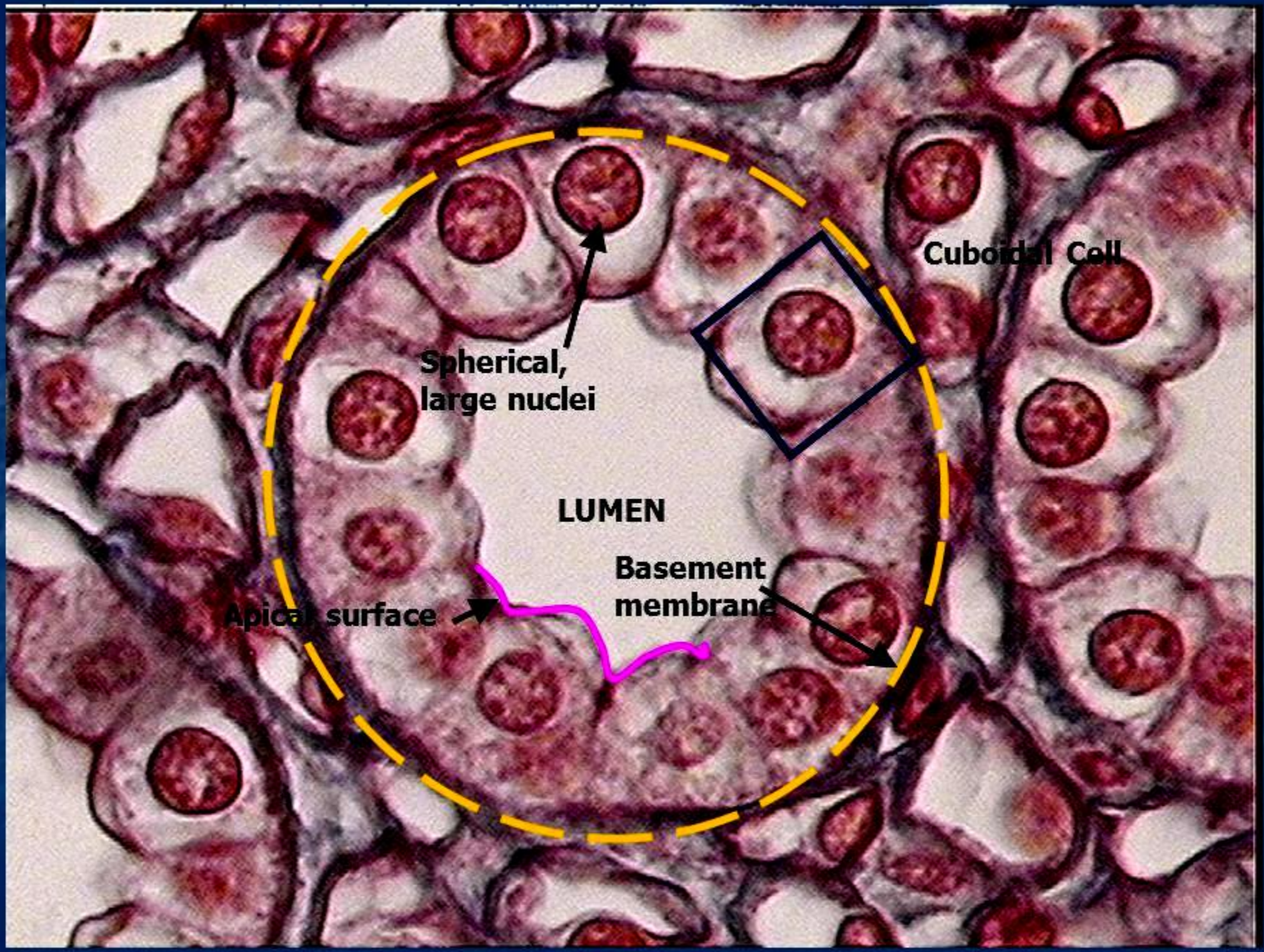
-- the covering of ⟹ viscera , &

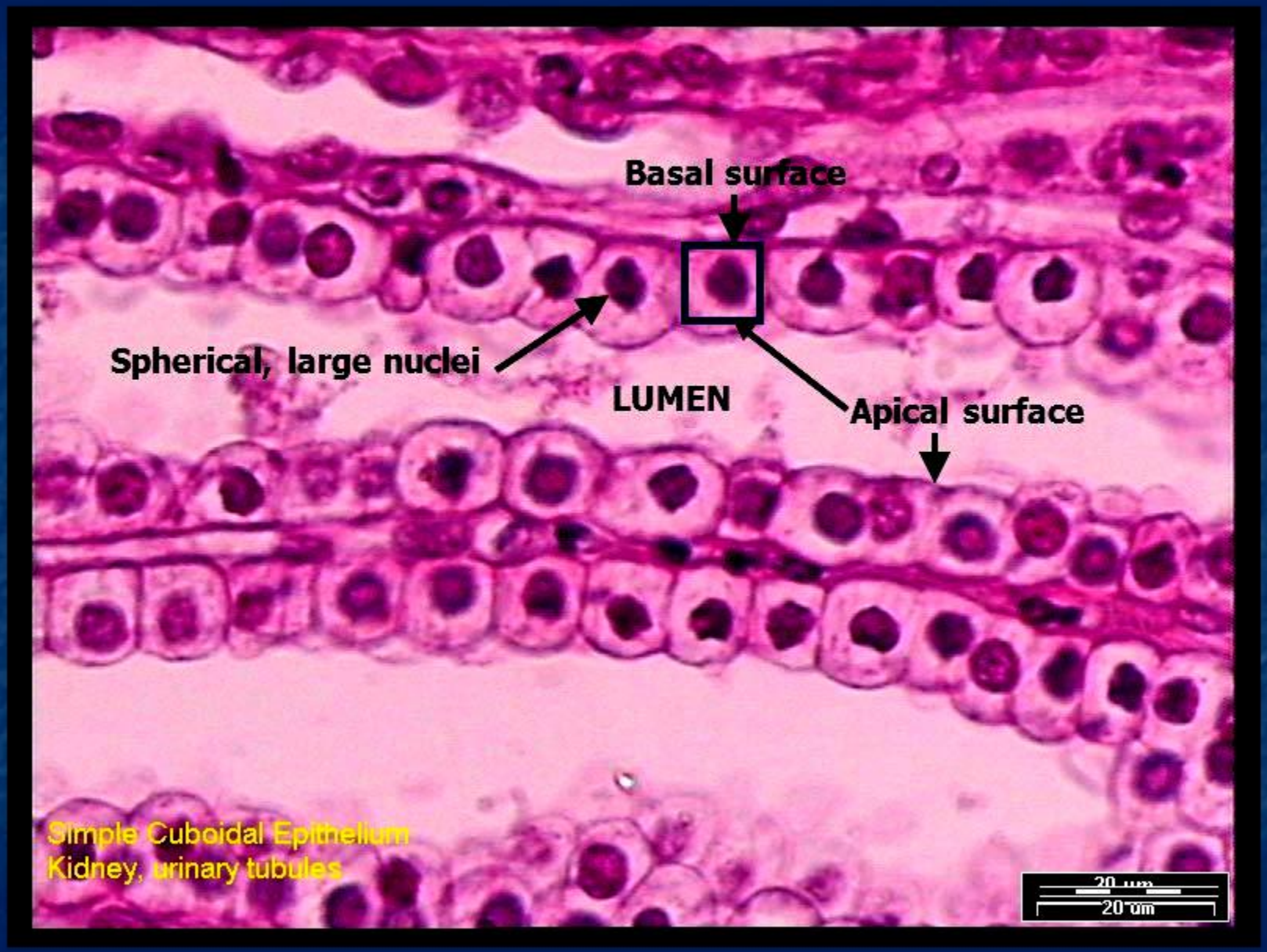
the secretory part of glands.

- **Epithelium always has one free surface (the apical surface) exposed to a body cavity, a lumen (hallow part of a body tube or duct), or to the skin surface.**




Simple columnar epithelial cells in the digestive tract
Apical surface
Nucleus
Basement membrane
Basal surface


Cuboidal Cell
Spherical,
large nuclei
LUMEN
Basement
membrane
Apical surface


Basal surface
Spherical, large nuclei
LUMEN
Apical surface
Simple Cuboidal Epithelium
Kidney, urinary tubules
20 um
20 um

- The deep surface of most epithelial tissues is bound to underlying tissue by a basement membrane.Epithelial tissue may be one layer or several layers thick.

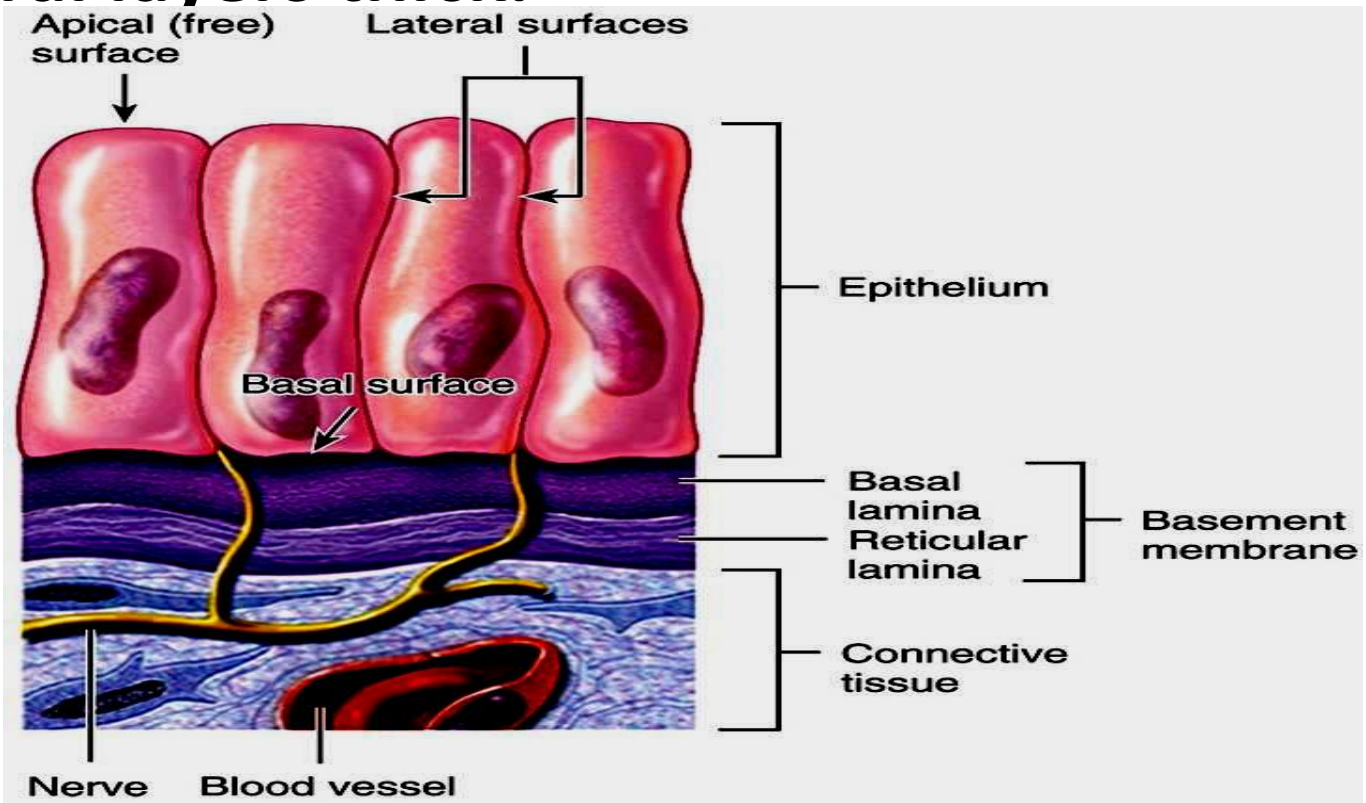


Figure 04.02 Tortora - PAP 12/e

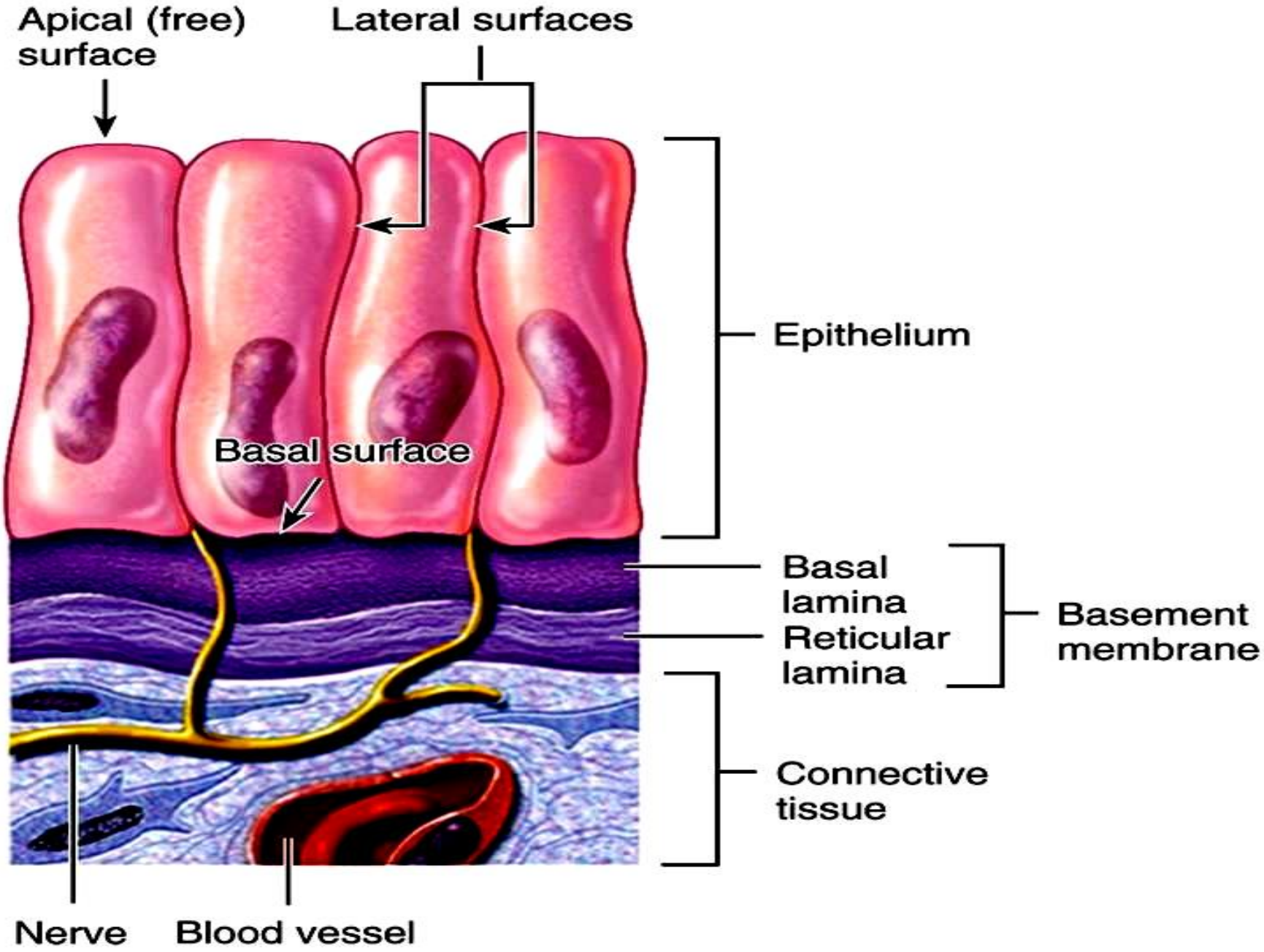
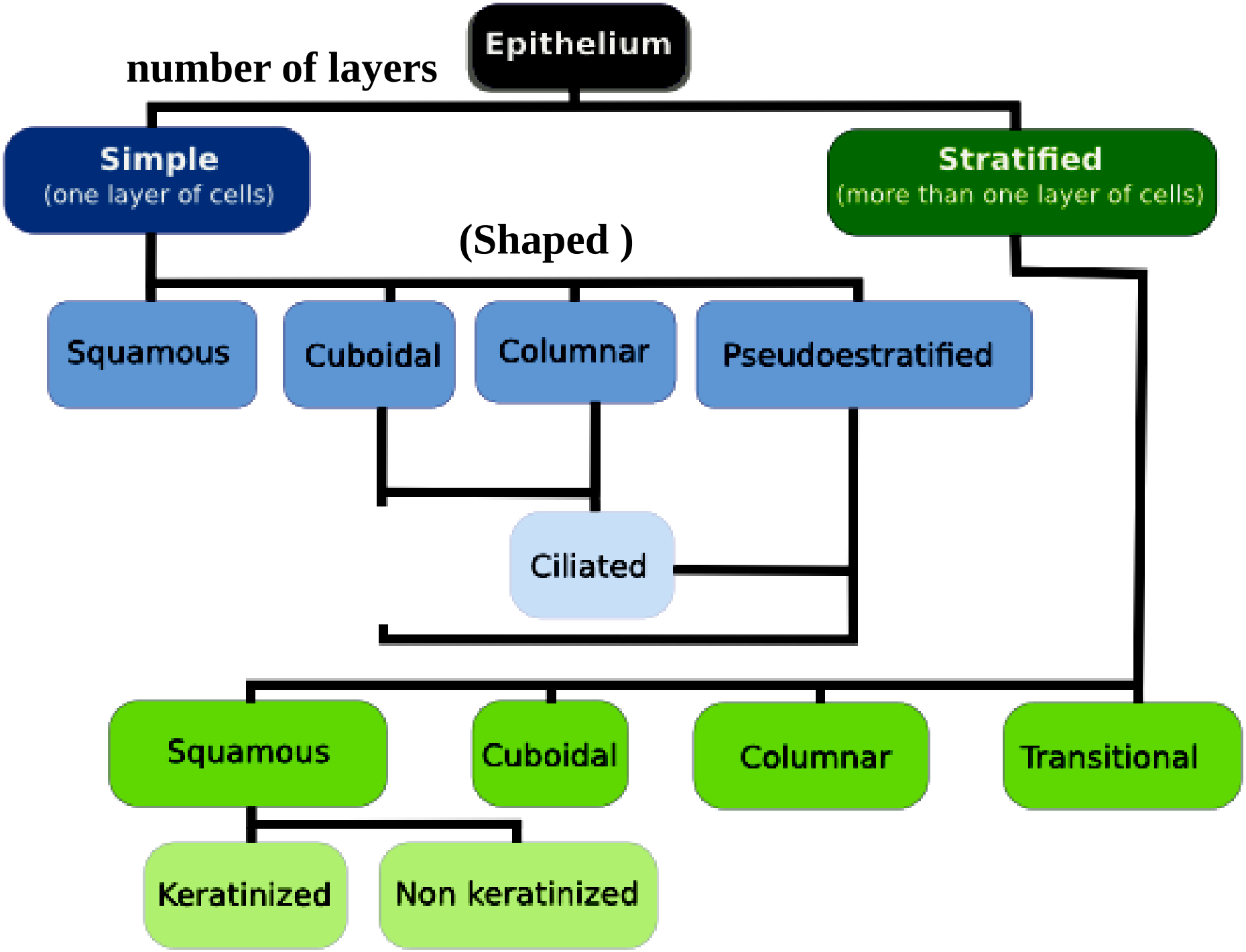
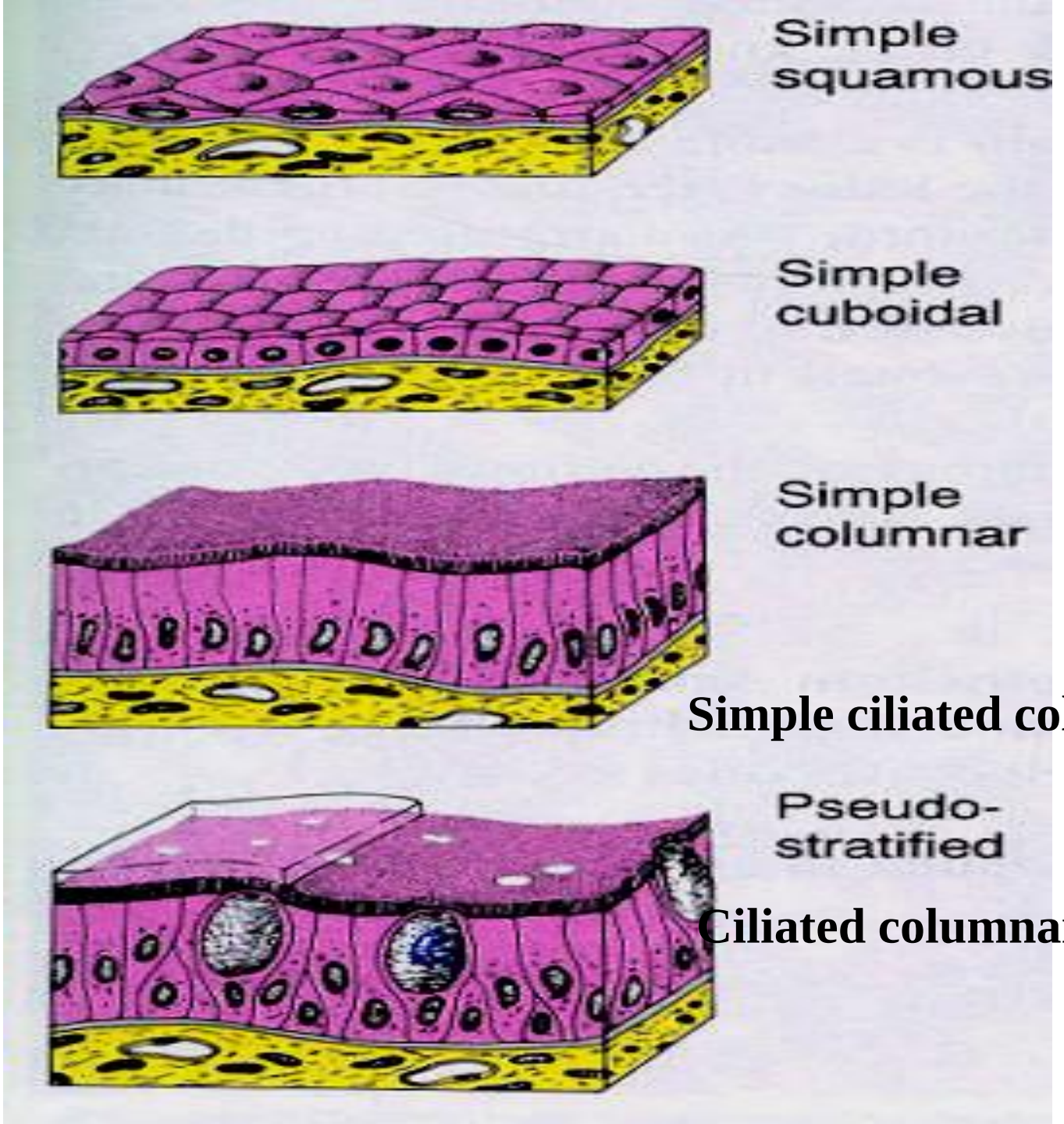


Figure 04.02 Tortora - PAP 12/e

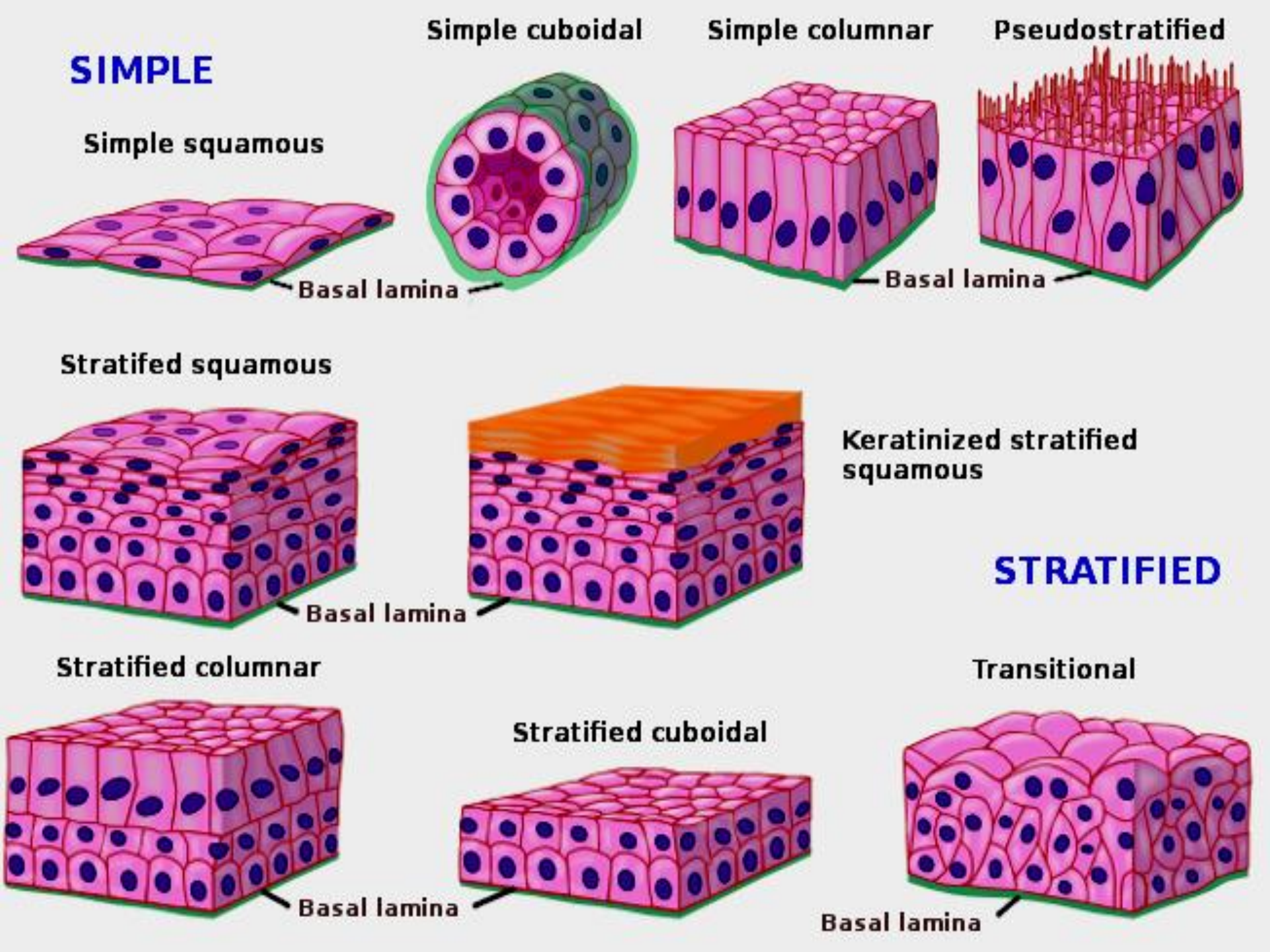

number of layers
Epithelium
Simple
(one layer of cells)
Stratified
(more than one layer of cells)
(Shaped)
Squamous
Cuboidal
Columnar
Pseudoestratified
Ciliated
Squamous
Cuboidal
Columnar
Transitional
Keratinized
Non keratinized

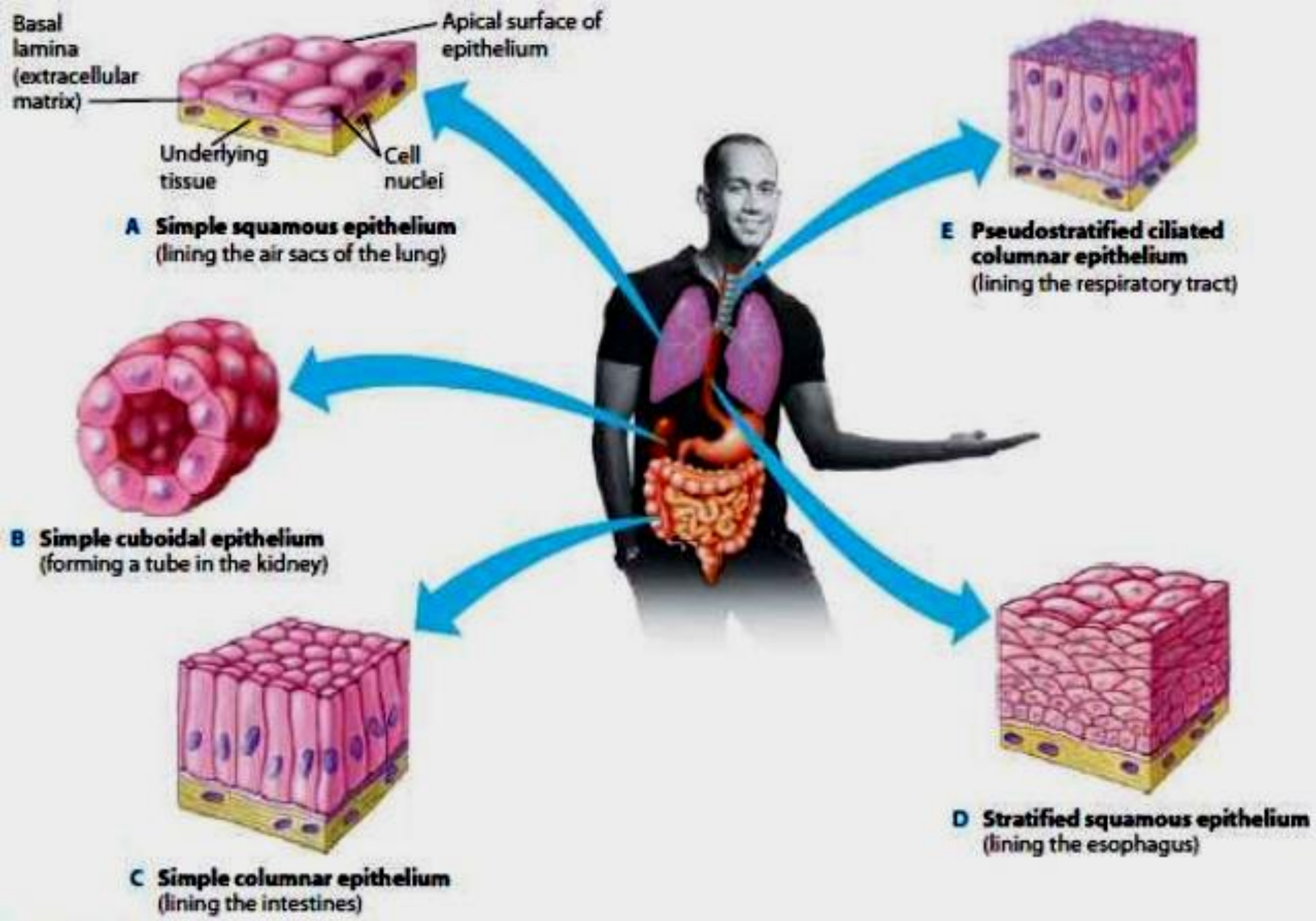
Simpie Epithelium



Simple ciliated columnar

Ciliated columnar


SIMPLE
Simple cuboidal
Simple columnar
Pseudostratified
Simple squamous
Basal lamina
Basal lamina
Stratifed squamous
Keratinized stratified squamous
STRATIFIED
Basal lamina
Stratified columnar
Stratified cuboidal
Transitional
Basal lamina
Basal lamina



▲ **Figure 20.4** Types of epithelial tissue

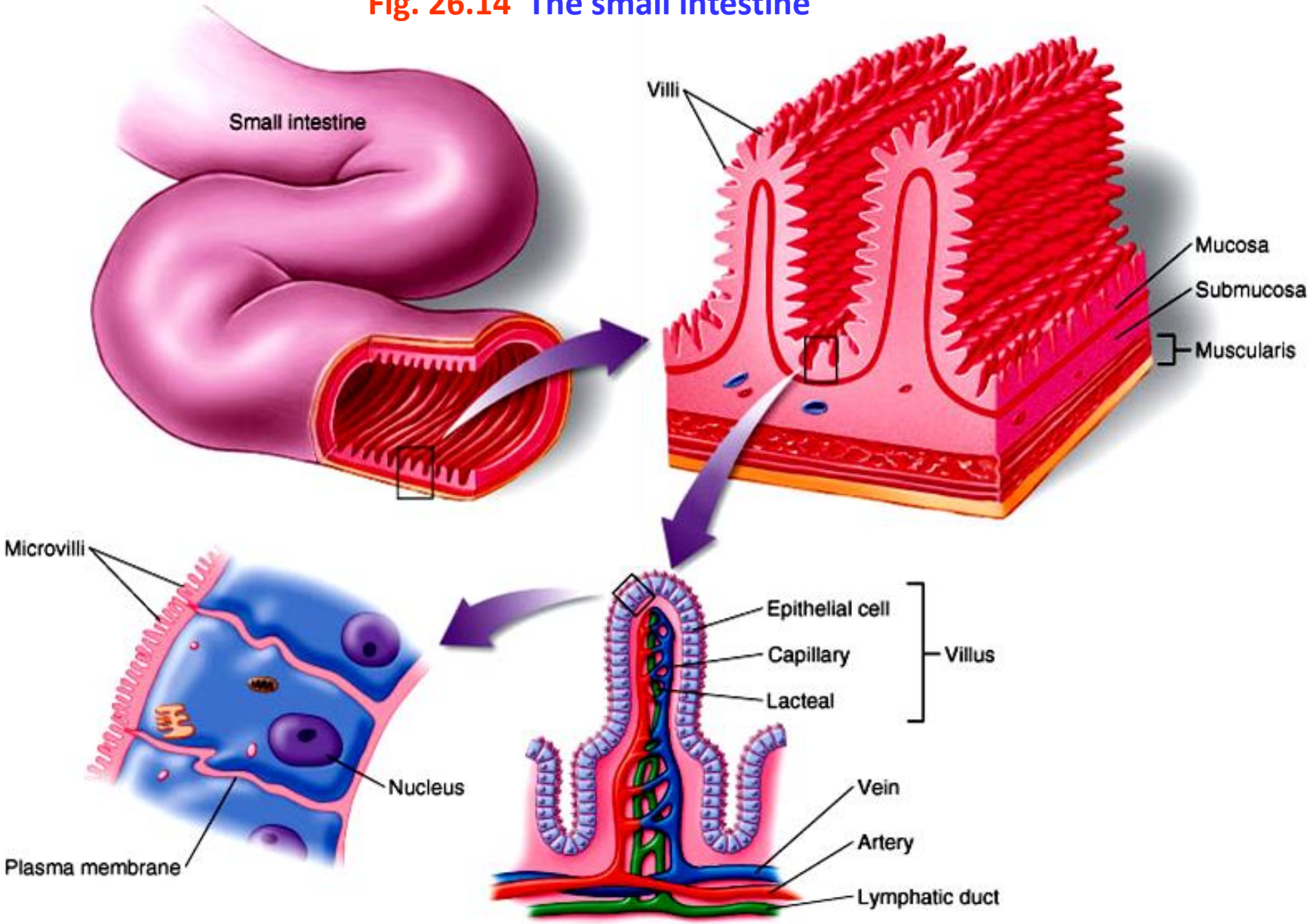
Simple Epitehlial Tissues

- **Single cell layer.**
- **is located where diffusion, filtration,**
- **secretion are principle function.**
- **range in size and shape**

  from thin, flattened cells to tall, columnar cells.
- **Some have cilia**

  for the movement of materials across cell surfaces.
- **Other have microvilli that increase the surface area for absorption.**

Fig. 26.14 The small intestine



➢**Other have microvilli that increase the surface area for absorption.**

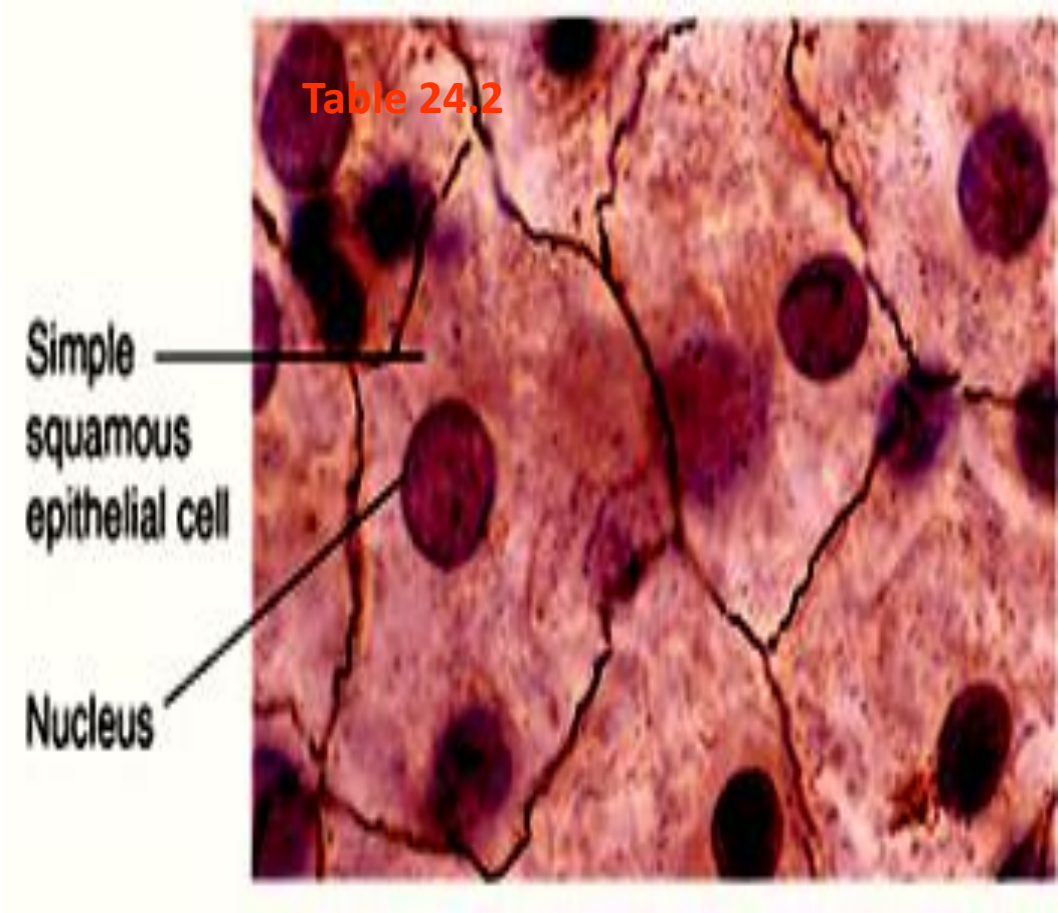
Simple Squamous Epithelium

- Composed of flattened, irregularly shaped cells

- that are tightly bound together

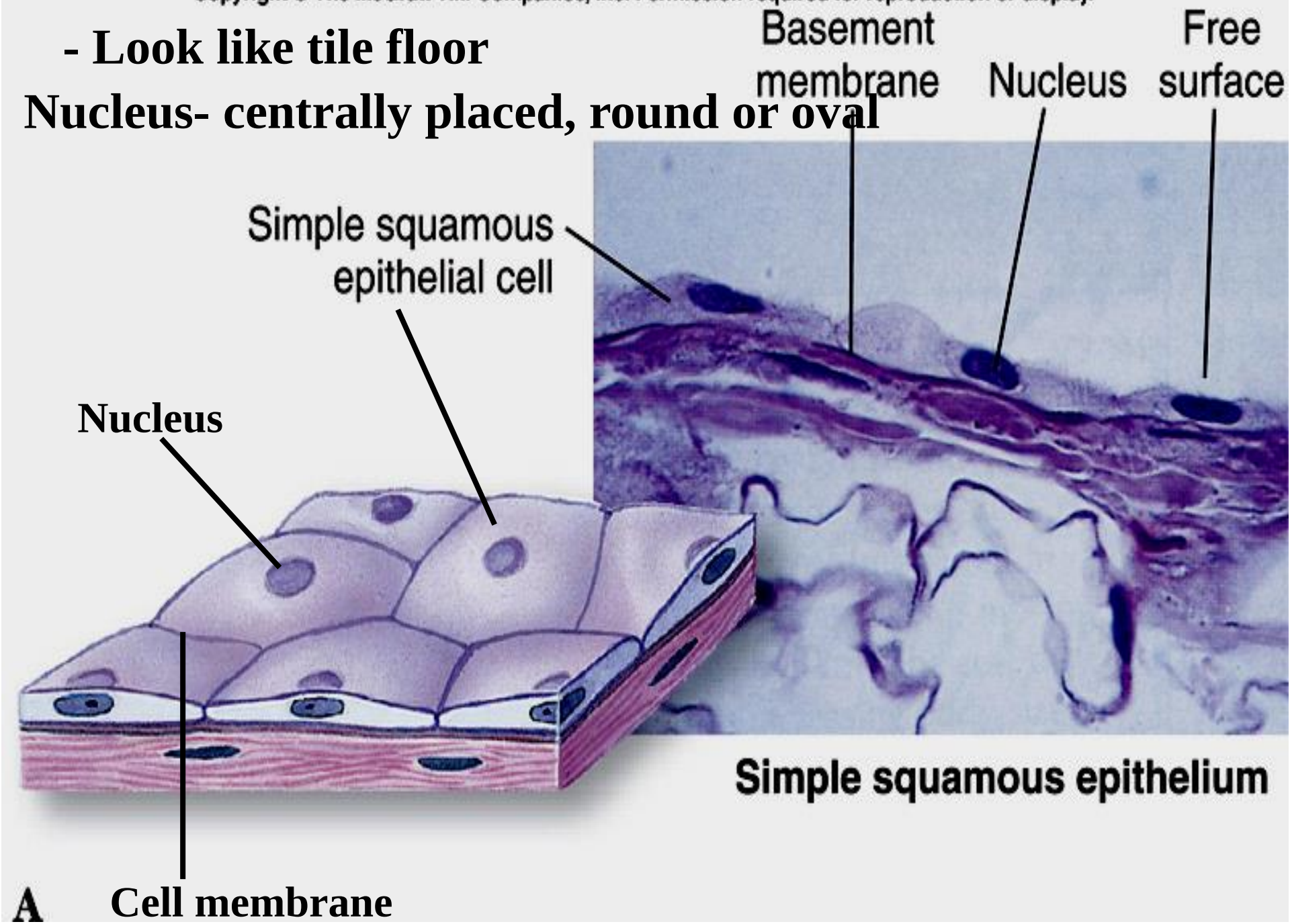
- adapted for diffusion

- and filtrations.

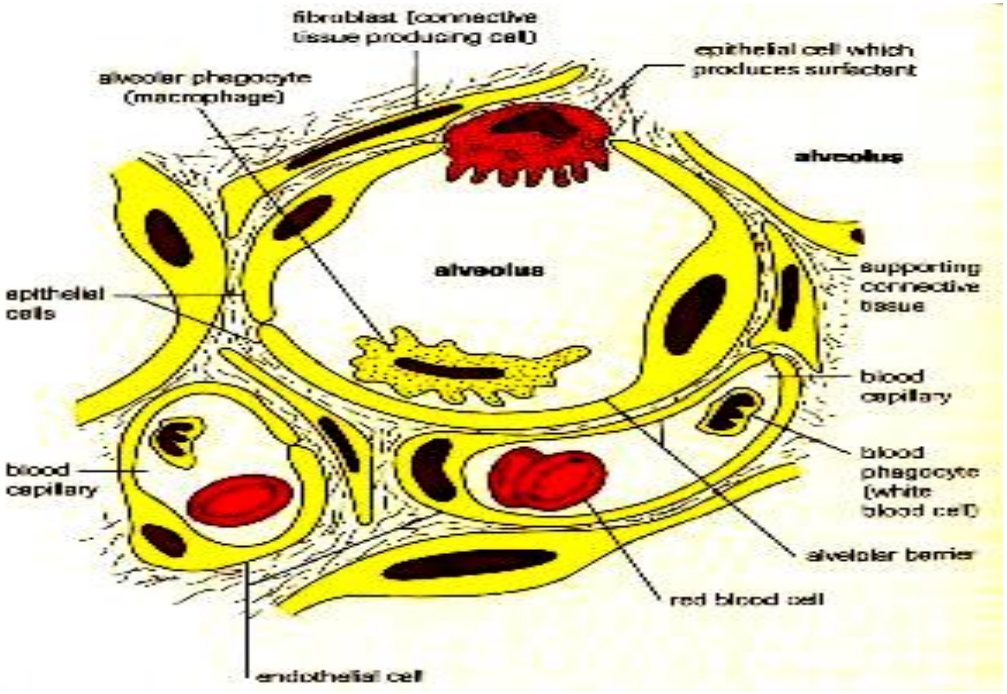


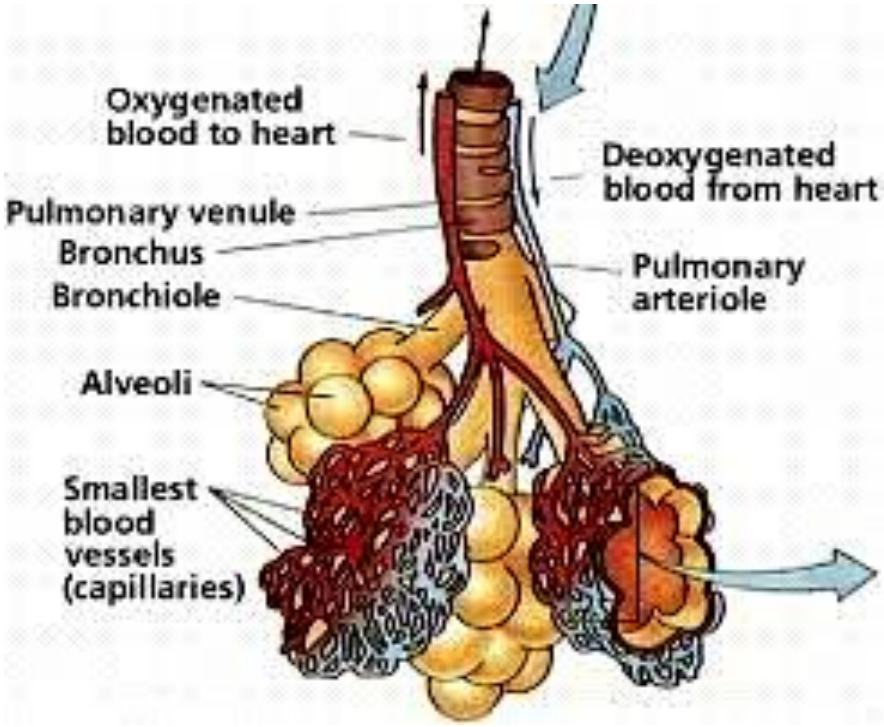
- Look like tile floor

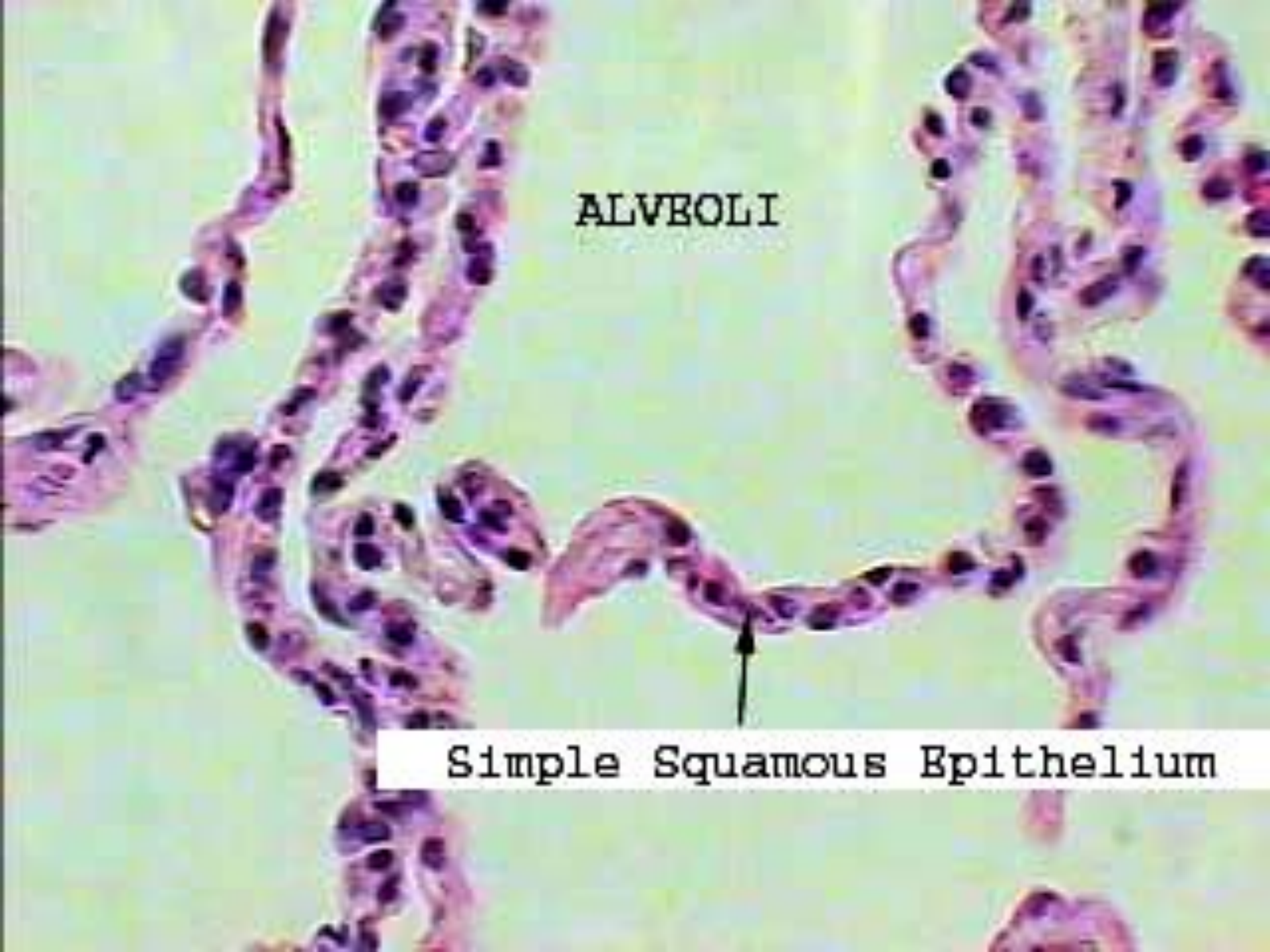
Nucleus- centrally placed, round or oval

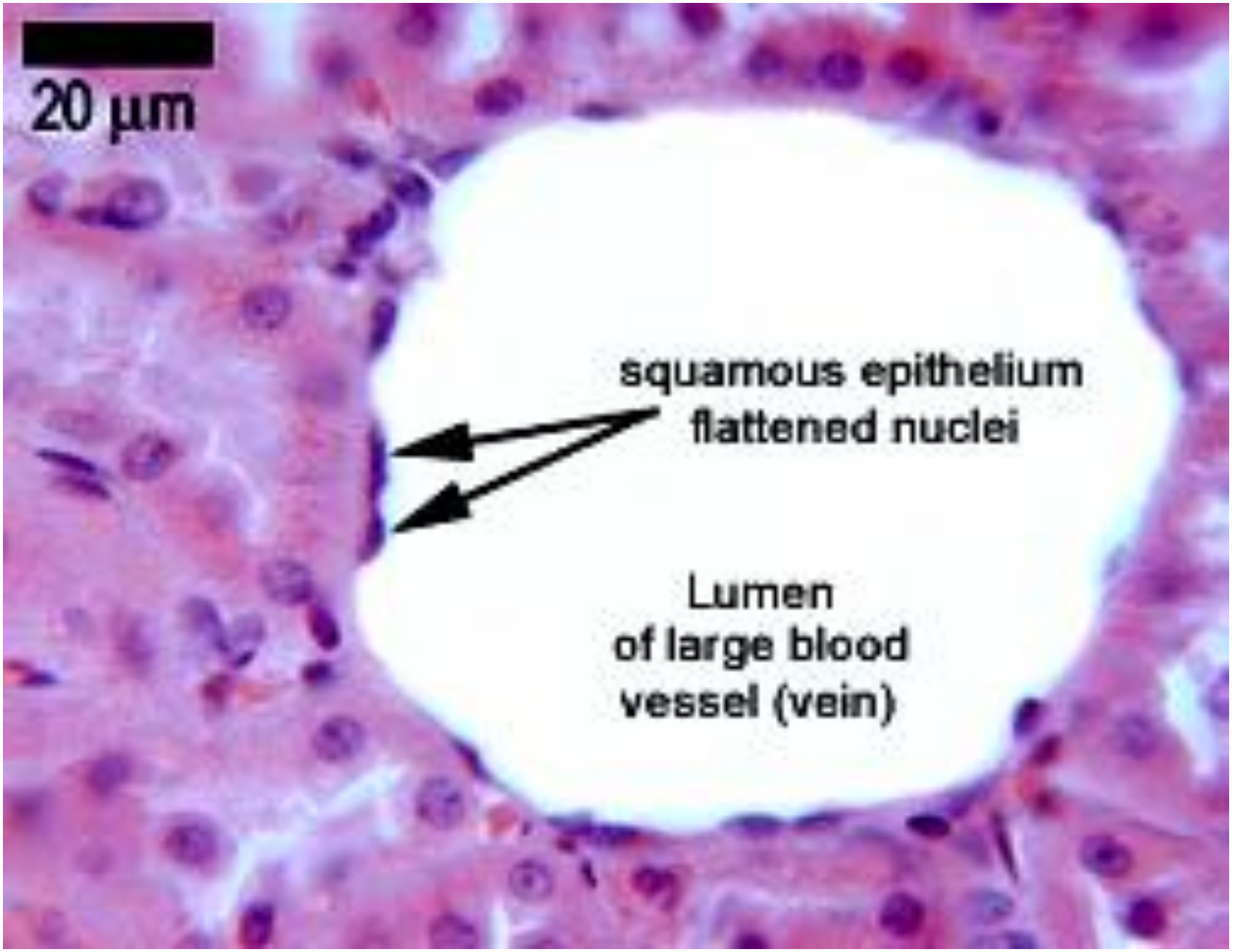


- **It occurs**
  - **the lining of air sacs within the lungs (where gaseous exchange occurs),**
  - **in the kidney(where blood is filtered),**
  - **walls of blood vessels, the lining of body cavities and covering of the viscera.**

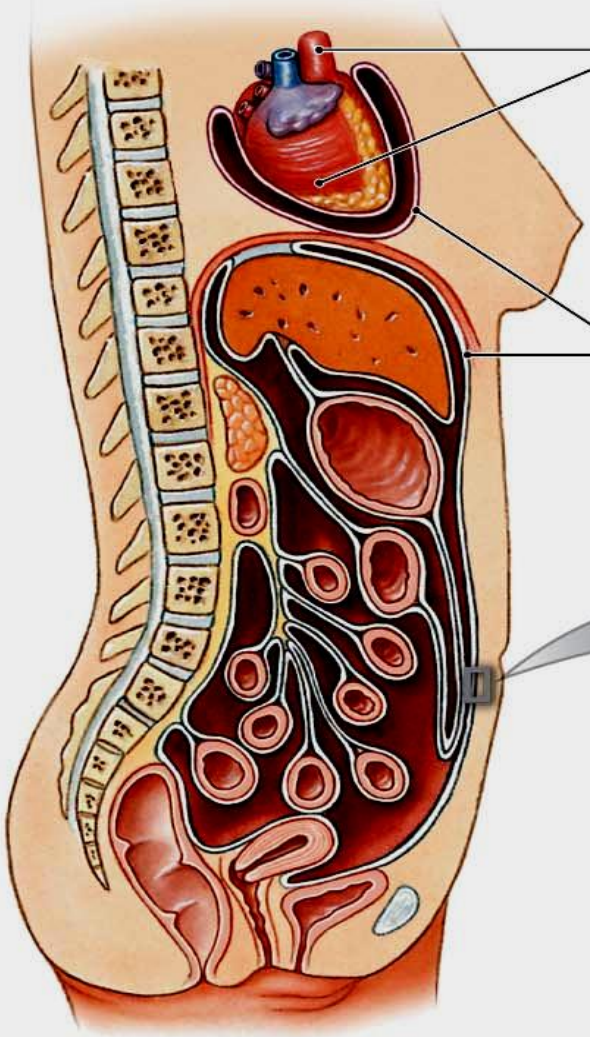





ALVEOLI
Simple Squamous Epithelium

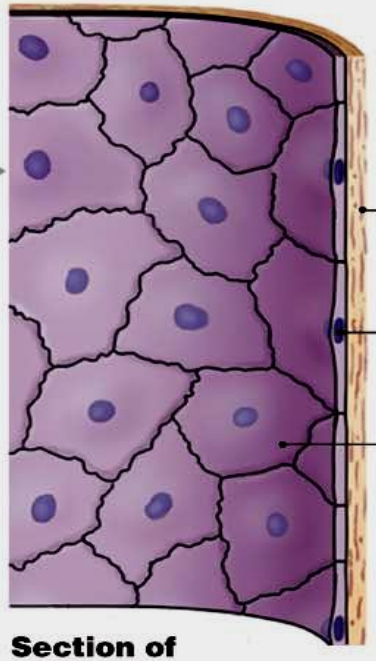

20 µm
squamous epithelium
flattened nuclei
Lumen
of large blood
vessel (vein)

Simple squamous epithelia, which include the specially named endothelium and mesothelium



Endothelium lining the inside of the heart and blood vessels

Mesothelium lining the pericardial cavity and the peritoneal cavity

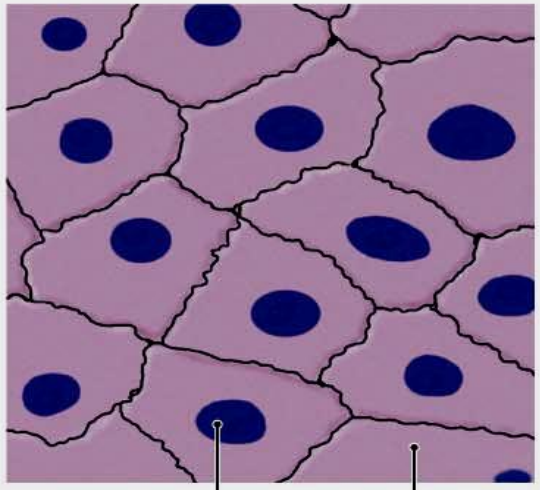


Connective tissue

Sectioned epithelial cell

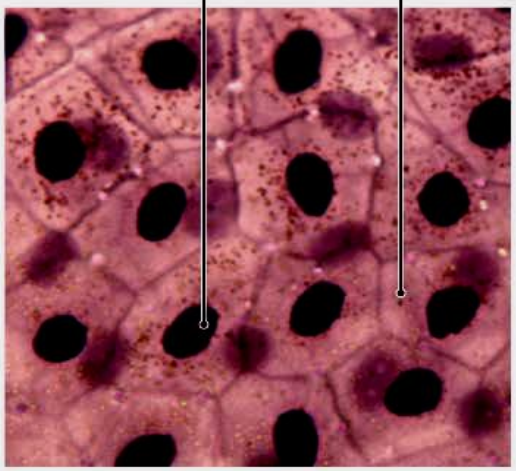
The surface of a simple squamous epithelium

Section of peritoneum

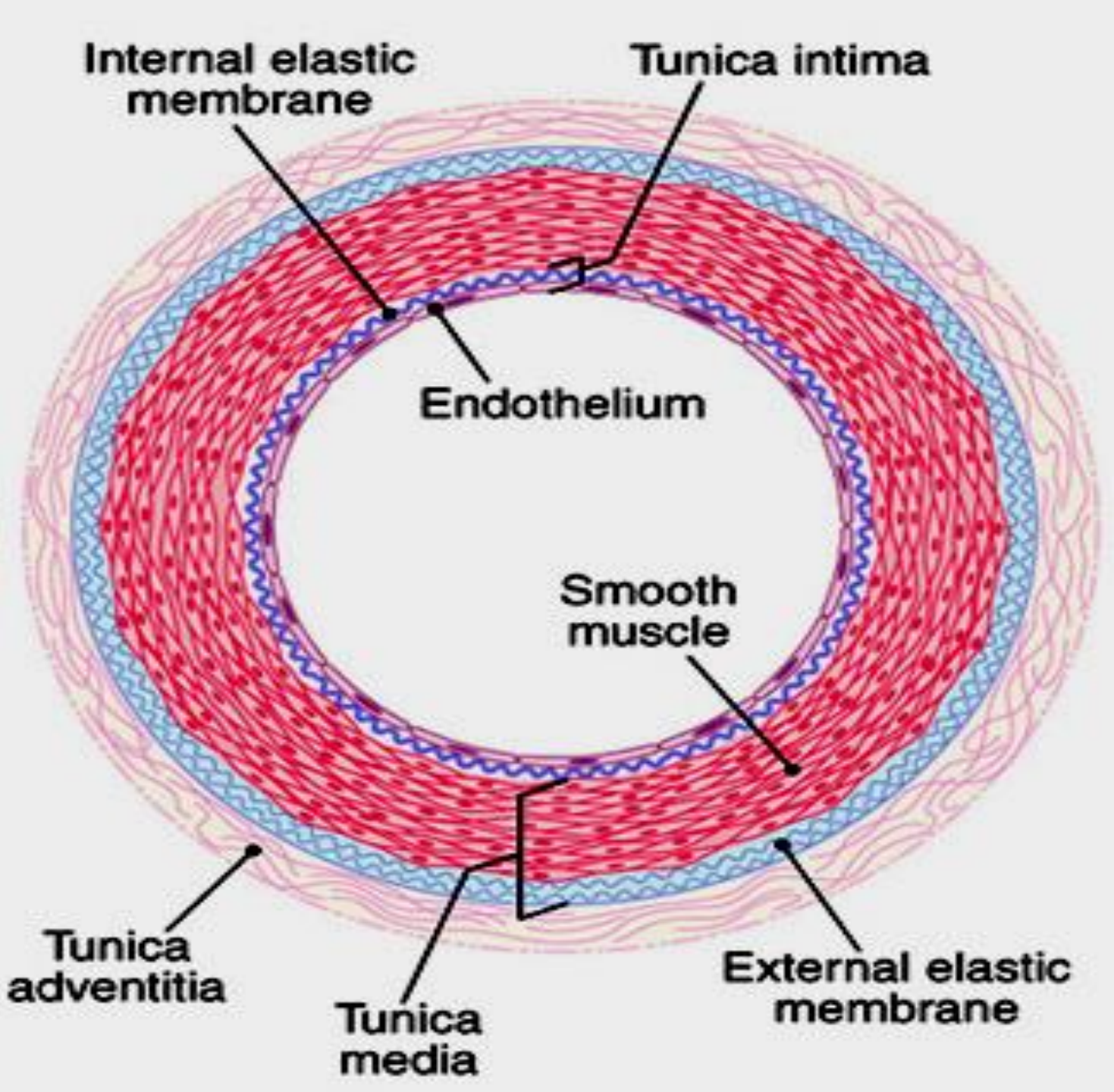


Nucleus

Cytoplasm



Simple squamous epithelium LM× 270

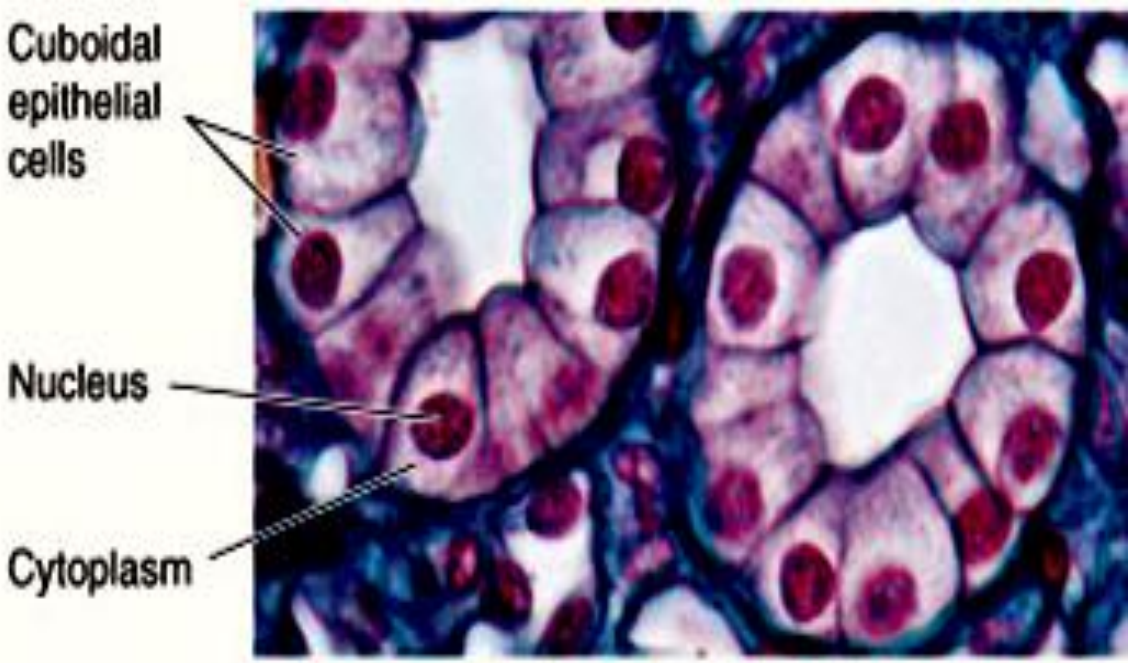

Internal elastic membrane
Tunica intima
Endothelium
Smooth muscle
Tunica adventitia
Tunica media
External elastic membrane

Simple Cuboidal Epithelium

- **Composed of a single layer**

- of tightly fitted cube shaped cells,

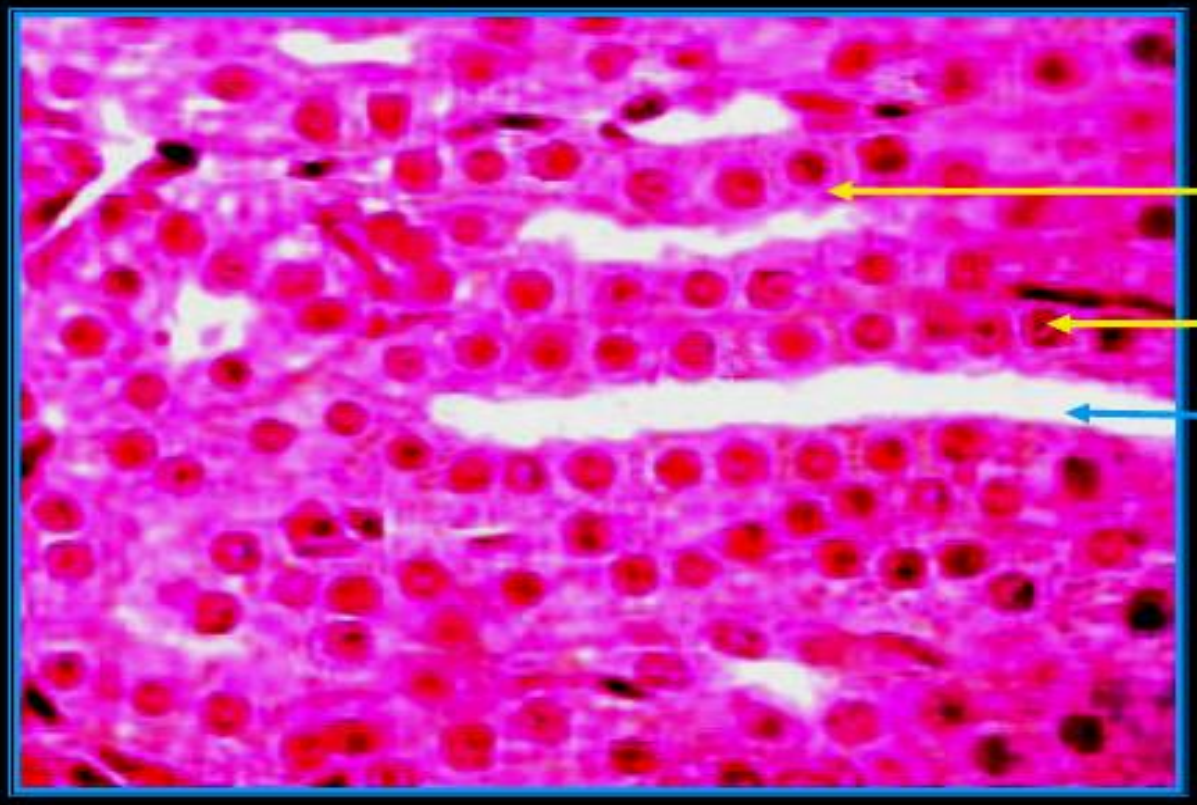
- found linings small ducts and tubules that have excretory, secretory,or absorptive functions.

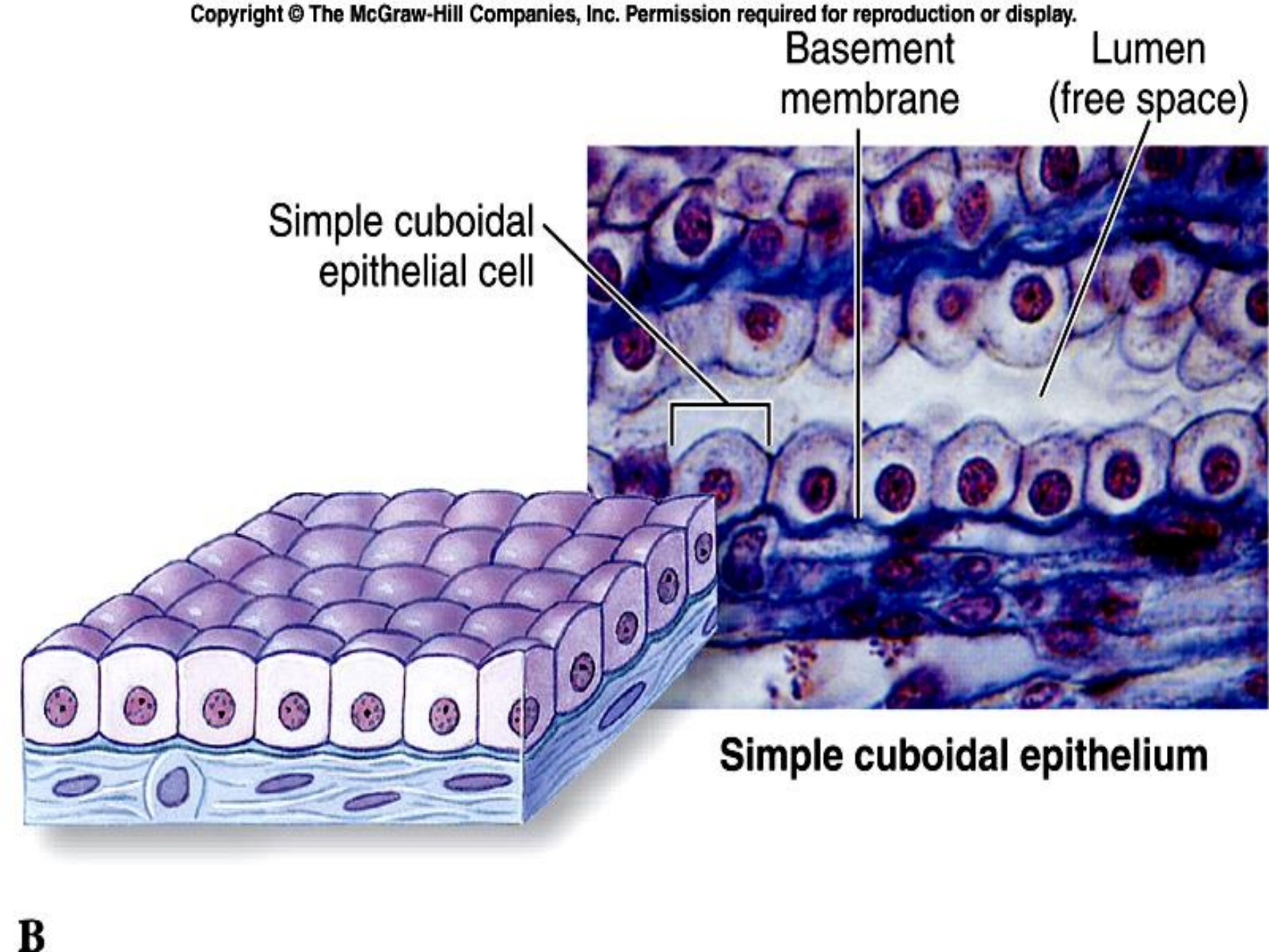


It occurs on the surface of the ovaries, portion of the kidneys, ducts of the salivary glands and pancreas.

Simple Cuboidal epithelium

Kidney tubules L.S.





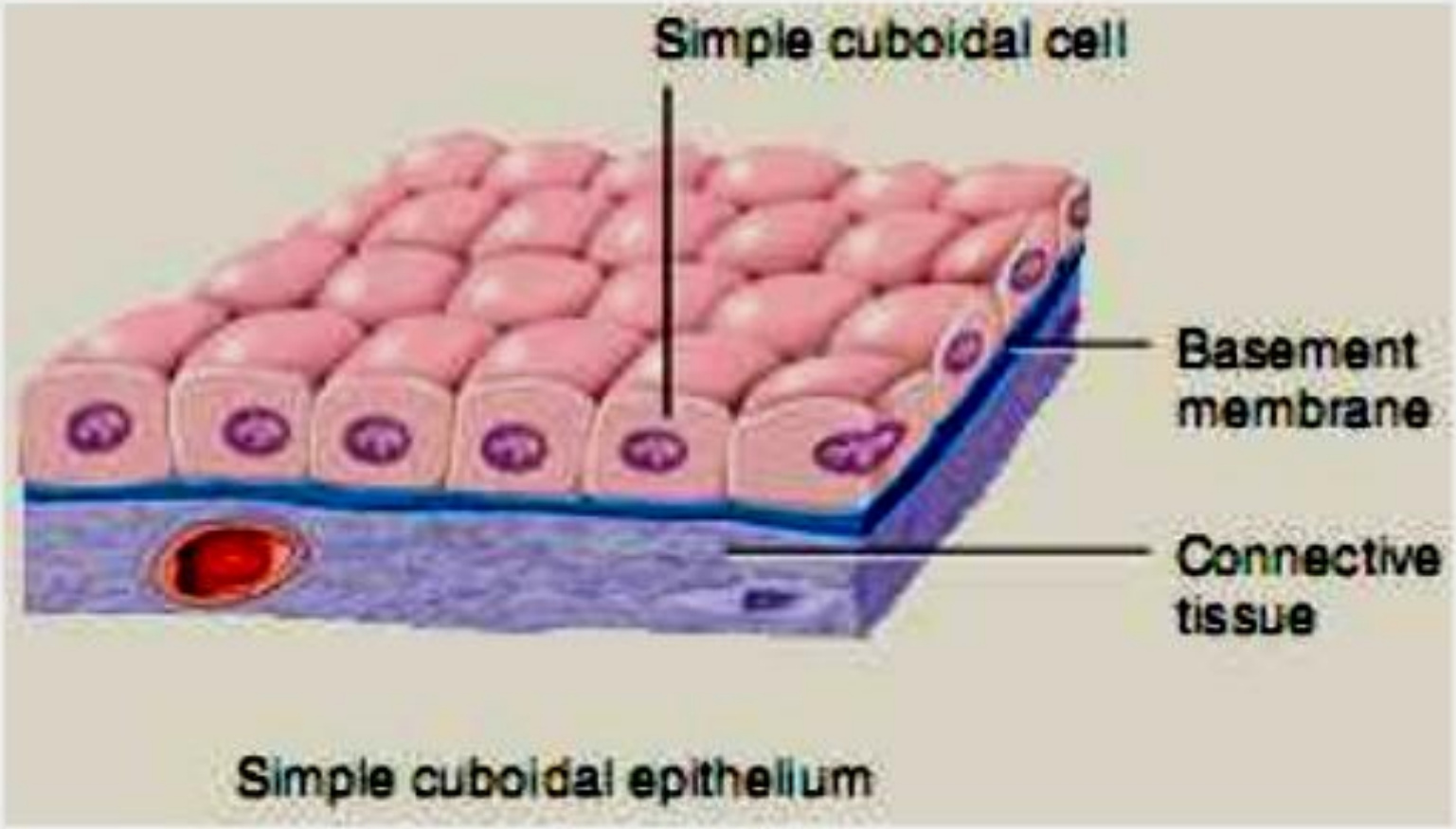
B

B) Simple Cuboidal epithelium

Description: It contains Single layer of cube-shaped cells; centrally located nucleus.

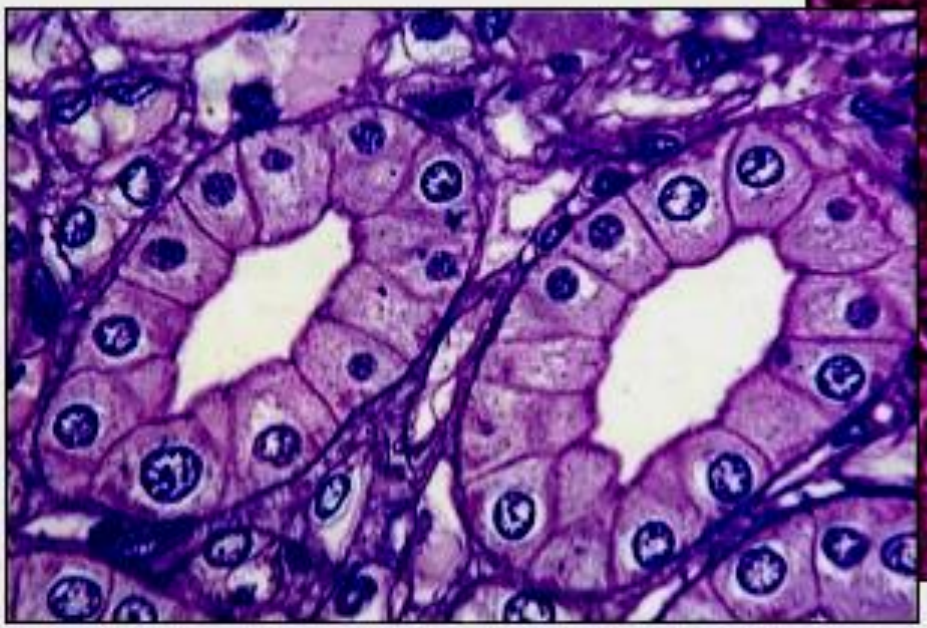
Location: It is found in organelles such as **thyroid gland** and **kidneys**. It also covers the surface of **ovaries** and posterior surface of **Eye**.

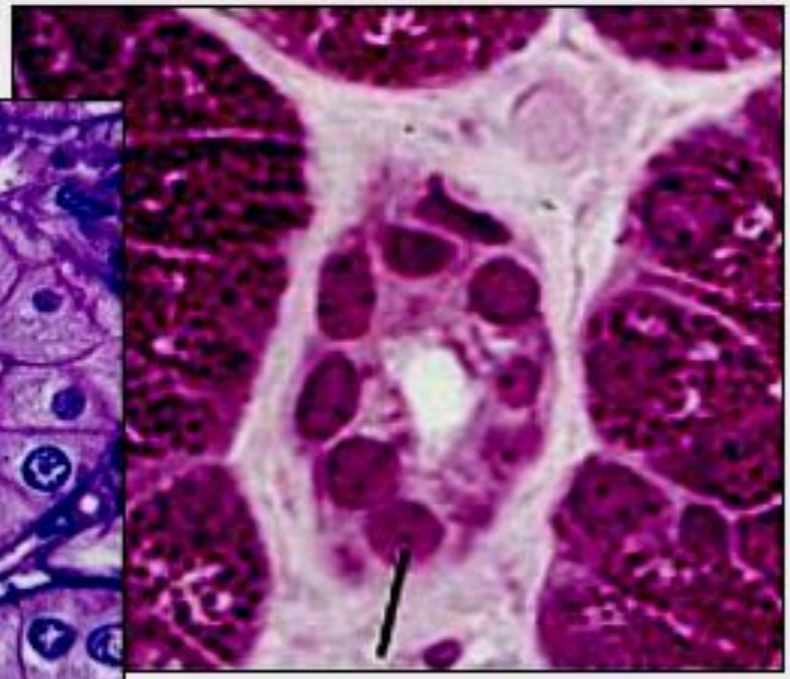
Functions: Secretion and Absorption.



Simple cuboidal epithelium

- gland ducts ⇒



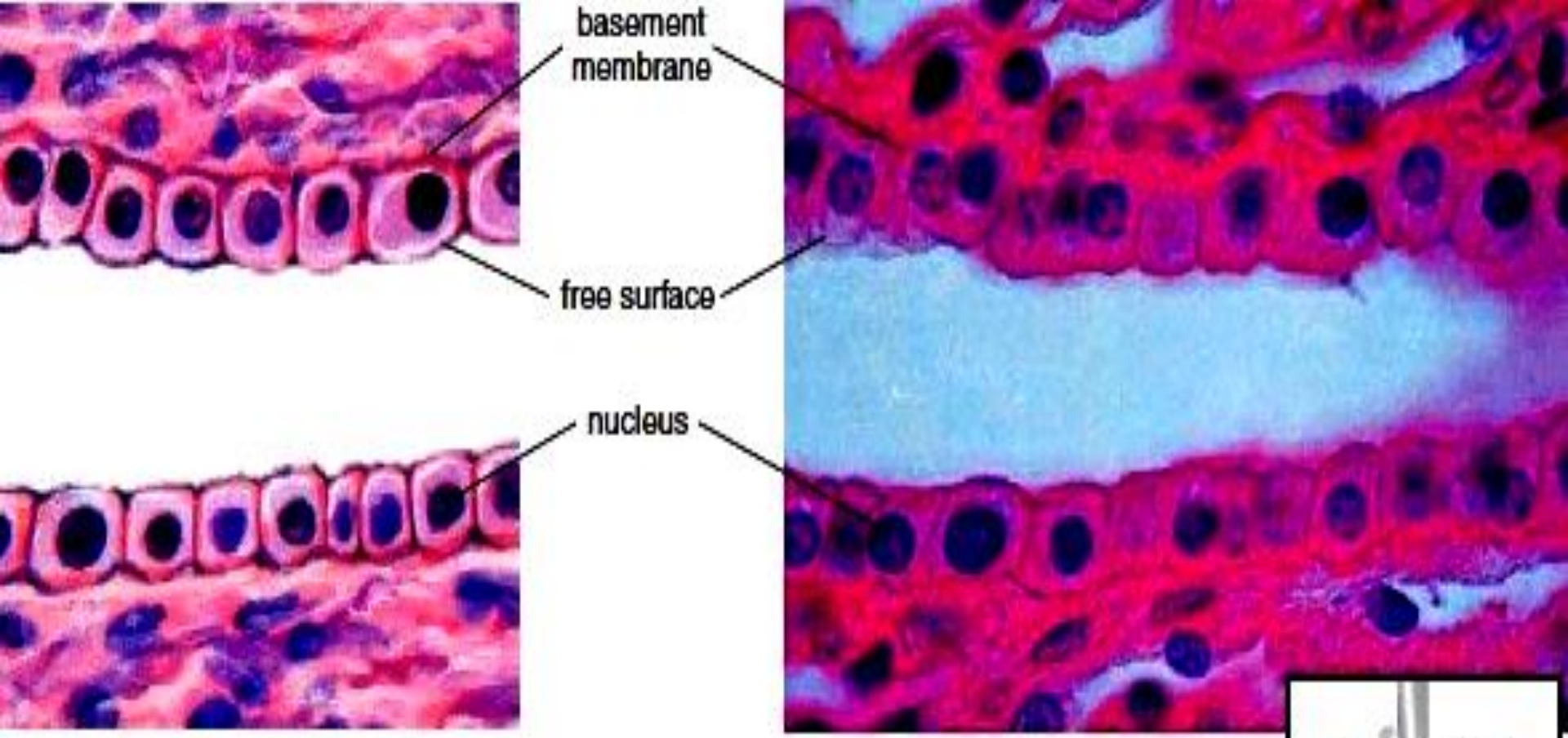


parotid gland striated duct

- kidney tubules ⇑

Functions

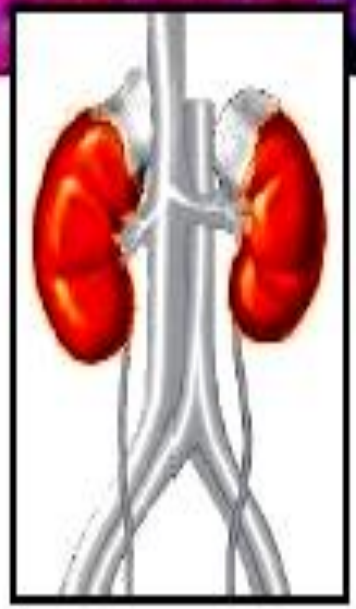
- transport water and ions



Simple Cuboidal Epithelium

Location:
Lines kidney tubules; ducts of many glands; covers surface of ovaries

Function:
Secretion; absorption



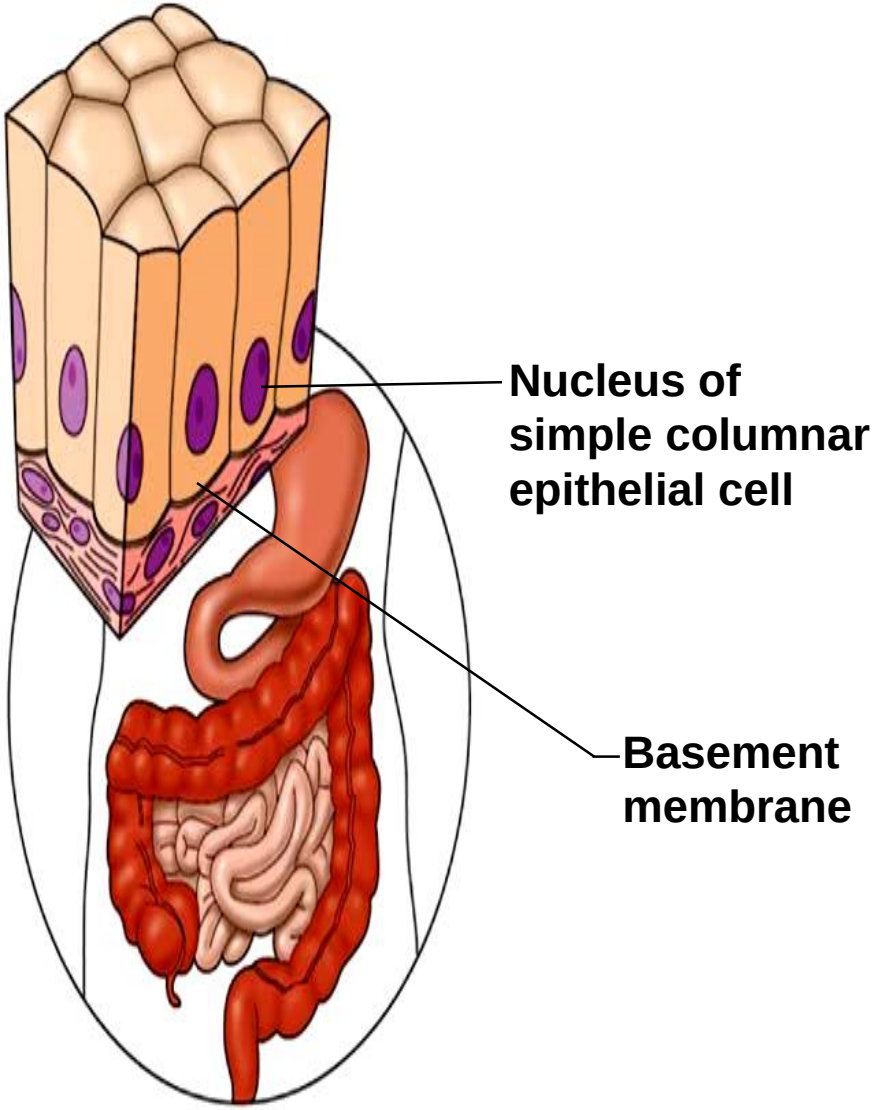
Simple columnar Epithelium

- **Tall , narrows cells.**
- **Specialized goblet cells**

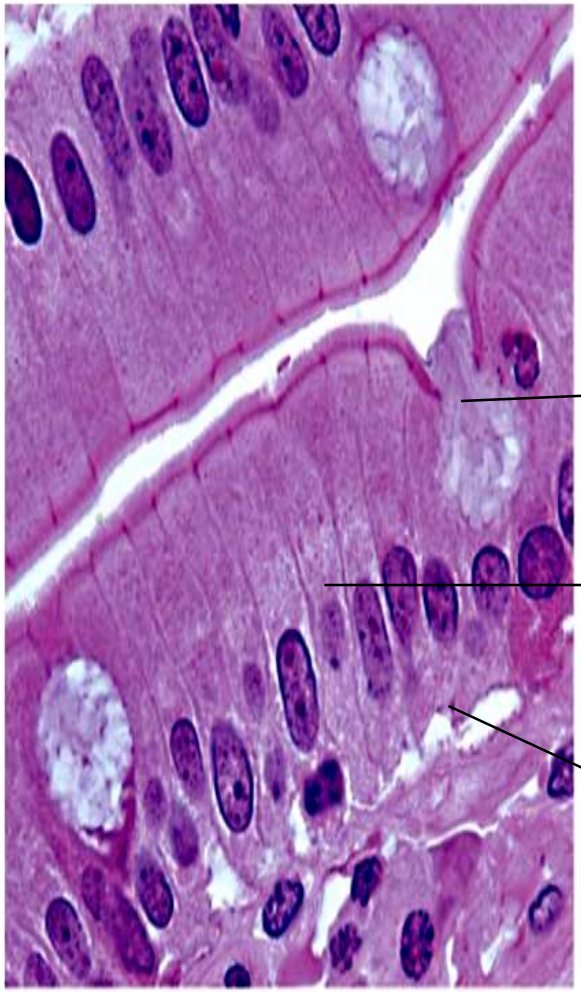
  - are scattered through tissue.
- **Goblet cells**

  - secrete a lubricative & protective mucus along surface of the tissue.

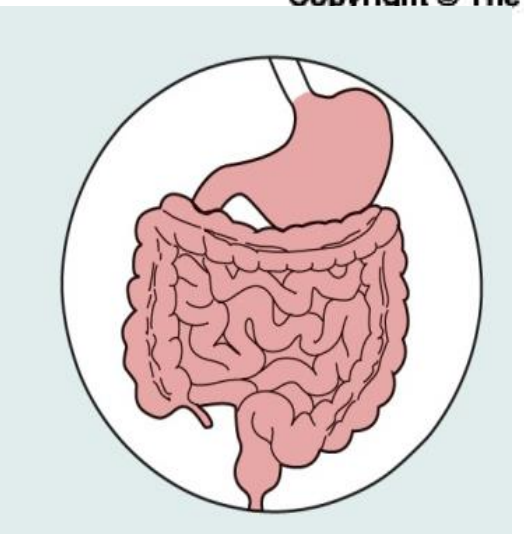
Figure 3.18c Types of epithelia and their common locations in the body.

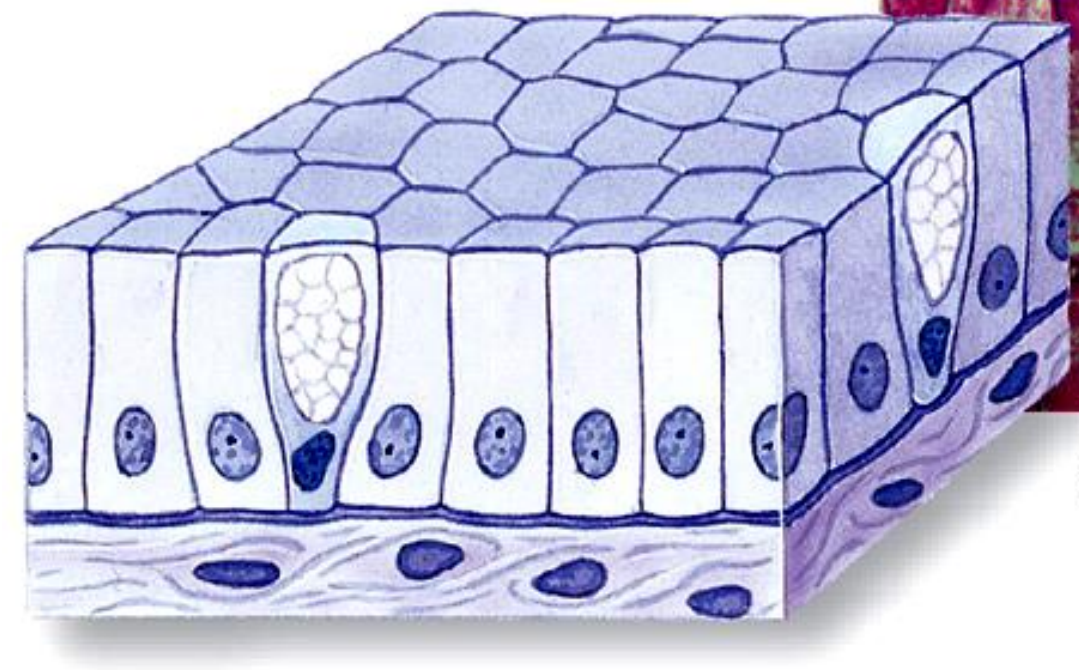


(c) **Diagram:** Simple columnar



Photomicrograph: Simple columnar epithelium of the small intestine (575×).





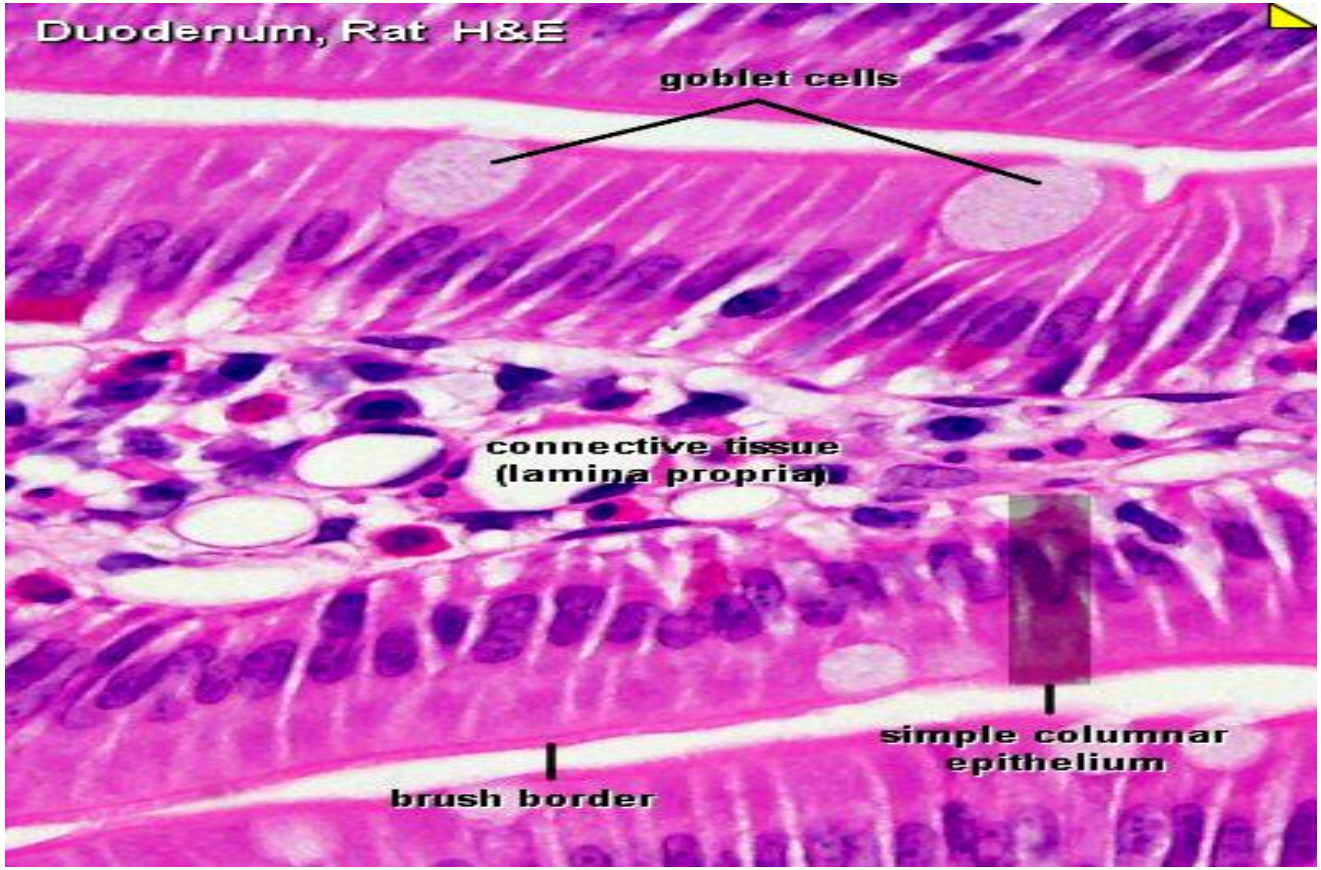
Simple columnar epithelium

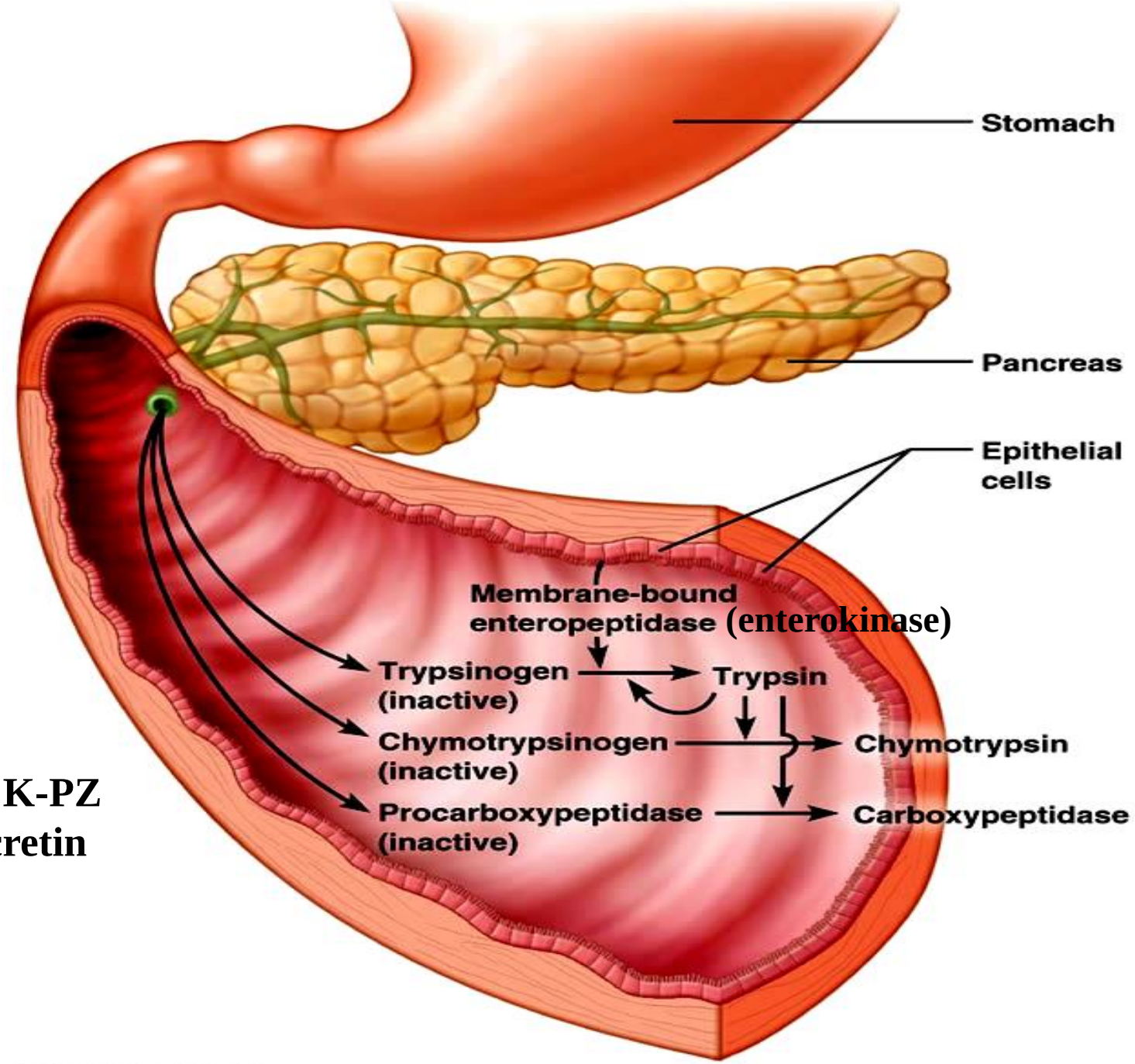
C

- **Simple columnar epithelium is found**

- lining ➡ inside walls of the stomach & small intestine,

- **where it forms a highly absorptive surface & also secretes certain digestive chemicals.**





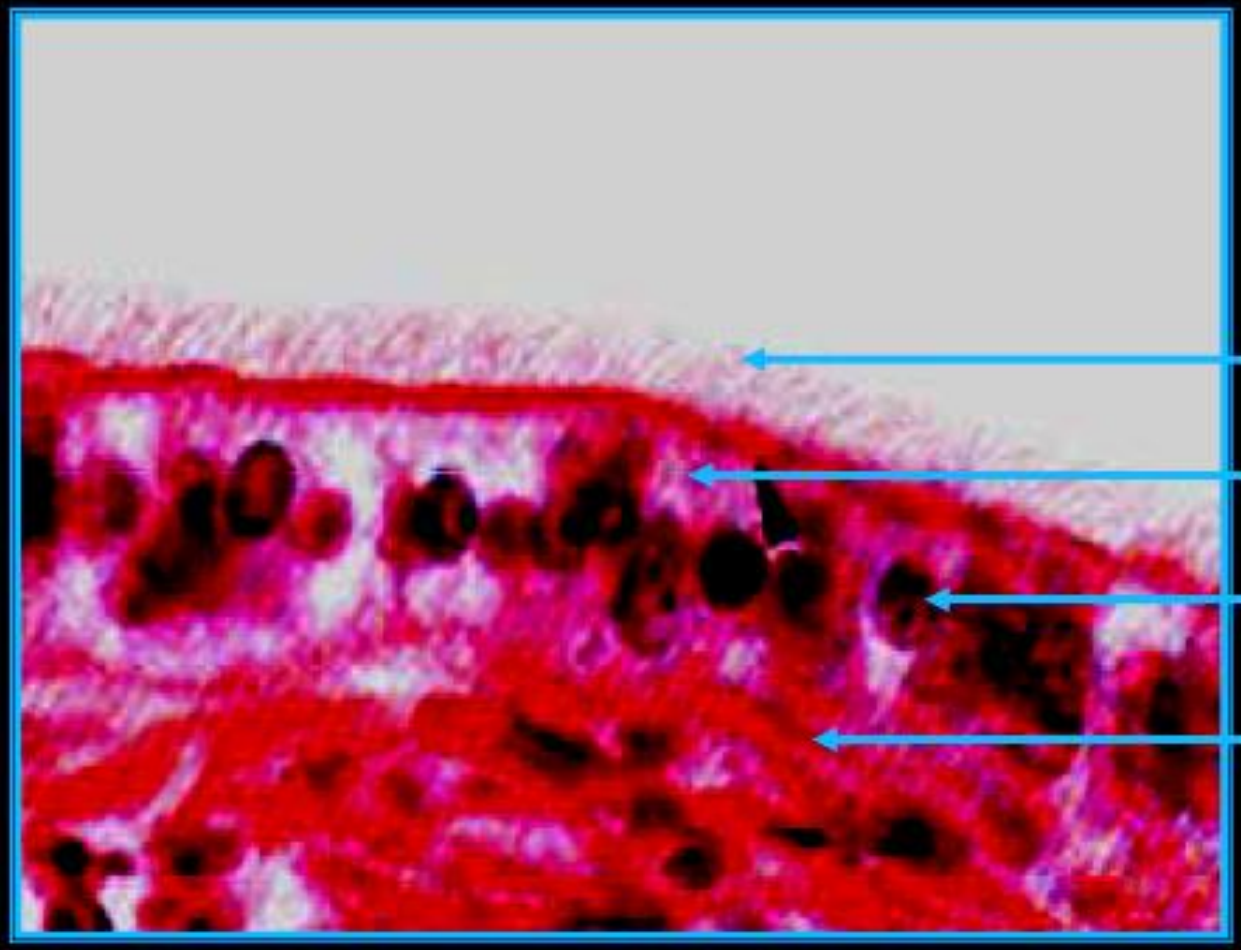
CCK-PZ
Secretin

Simple Ciliated Columnar Epithelium

- **Presence of cilia along the free surfaces.**
- **Cilia produce wavelike movements that transport materials through tubes or passageways.**
- **It occurs in the female uterine tubes.**

Ciliated columnar epithelium

Uterine tube ~ urethra



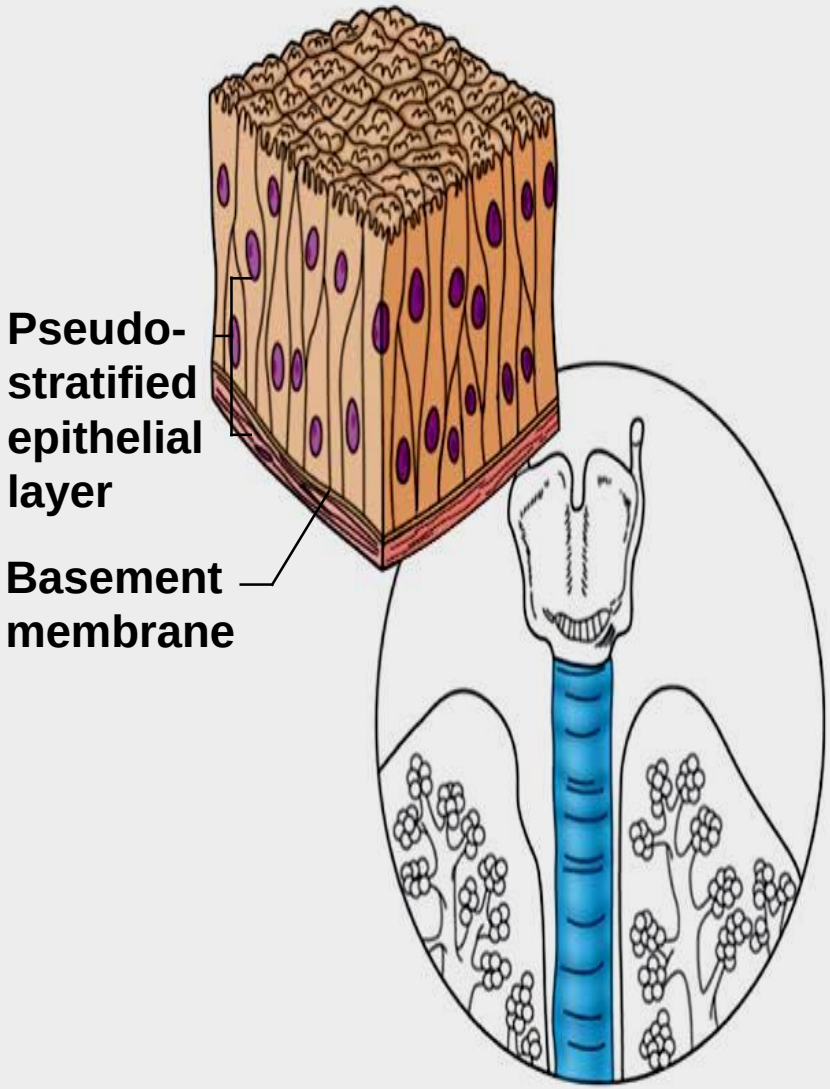
Pseudostratified Ciliated Columnar Epithelium

- **Epithelium appears to be stratified,**

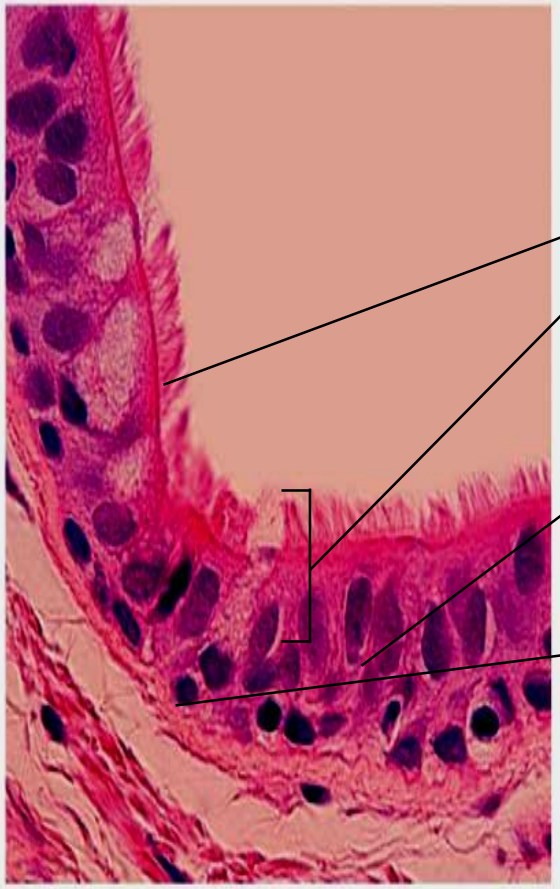
  - because of nuclei of the cells are located at different levels.

- **Numerous globet cells and a ciliated exposed surface are characteristic of this epithelium.**
- **The trachea and the bronchial tubes frequently called respiratory epithelium.**

Figure 3.18d Types of epithelia and their common locations in the body.

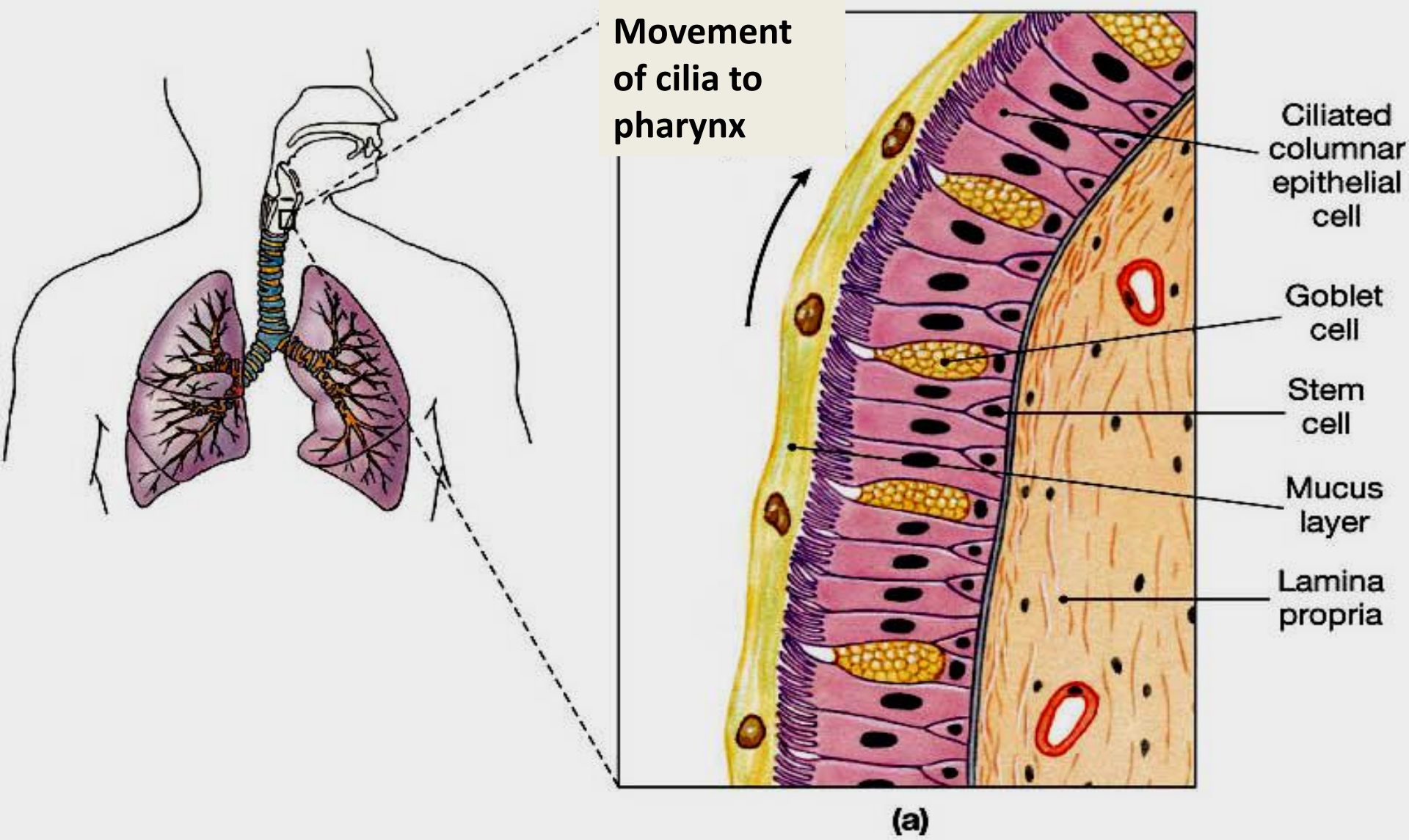


(d) **Diagram:** Pseudostratified (ciliated) columnar



Photomicrograph: Pseudostratified ciliated columnar epithelium lining the human trachea (560×).

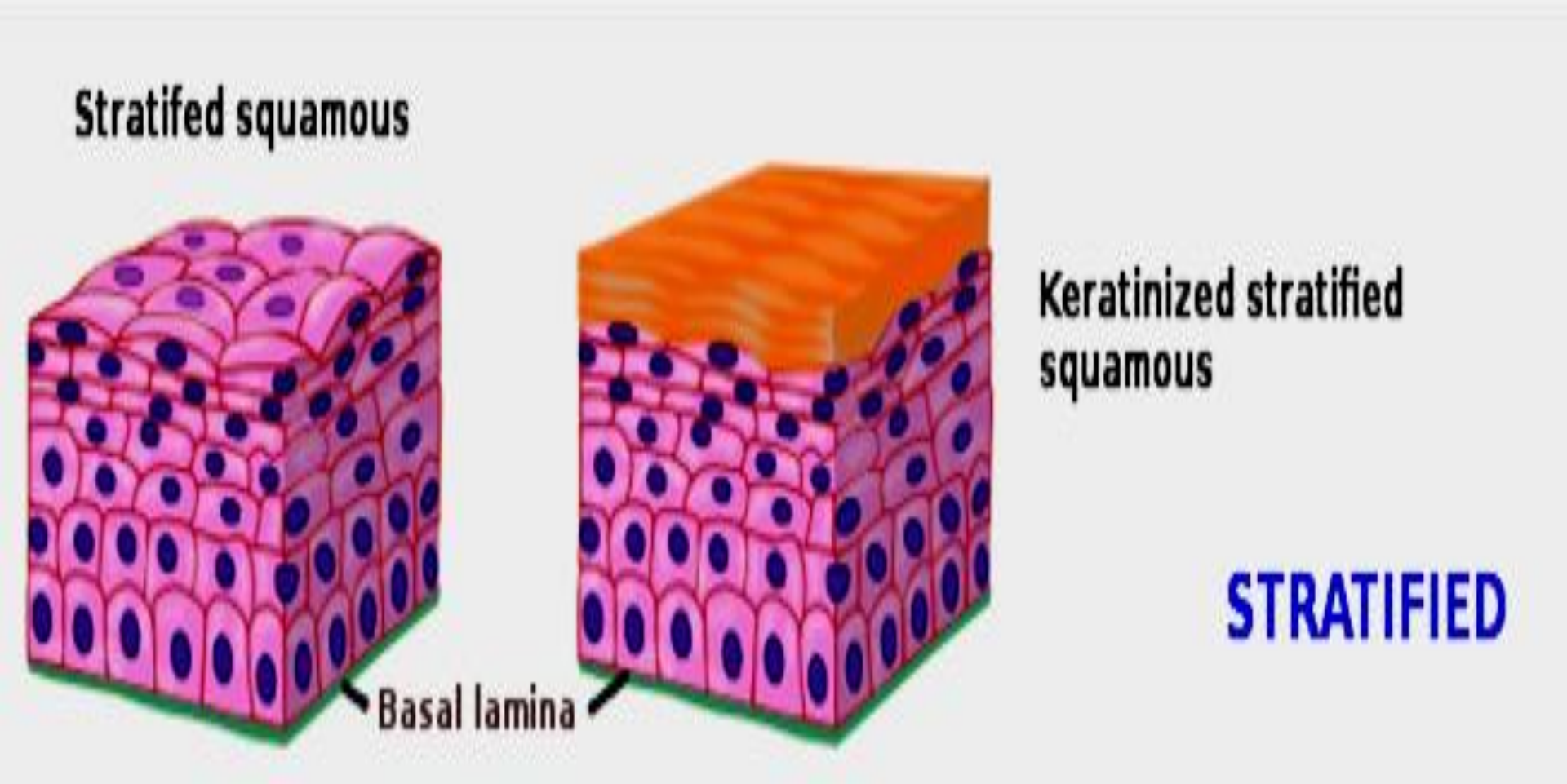
Function is to remove dust and bacteria trapped in mucus.



Stratified Squmaous Epithelium

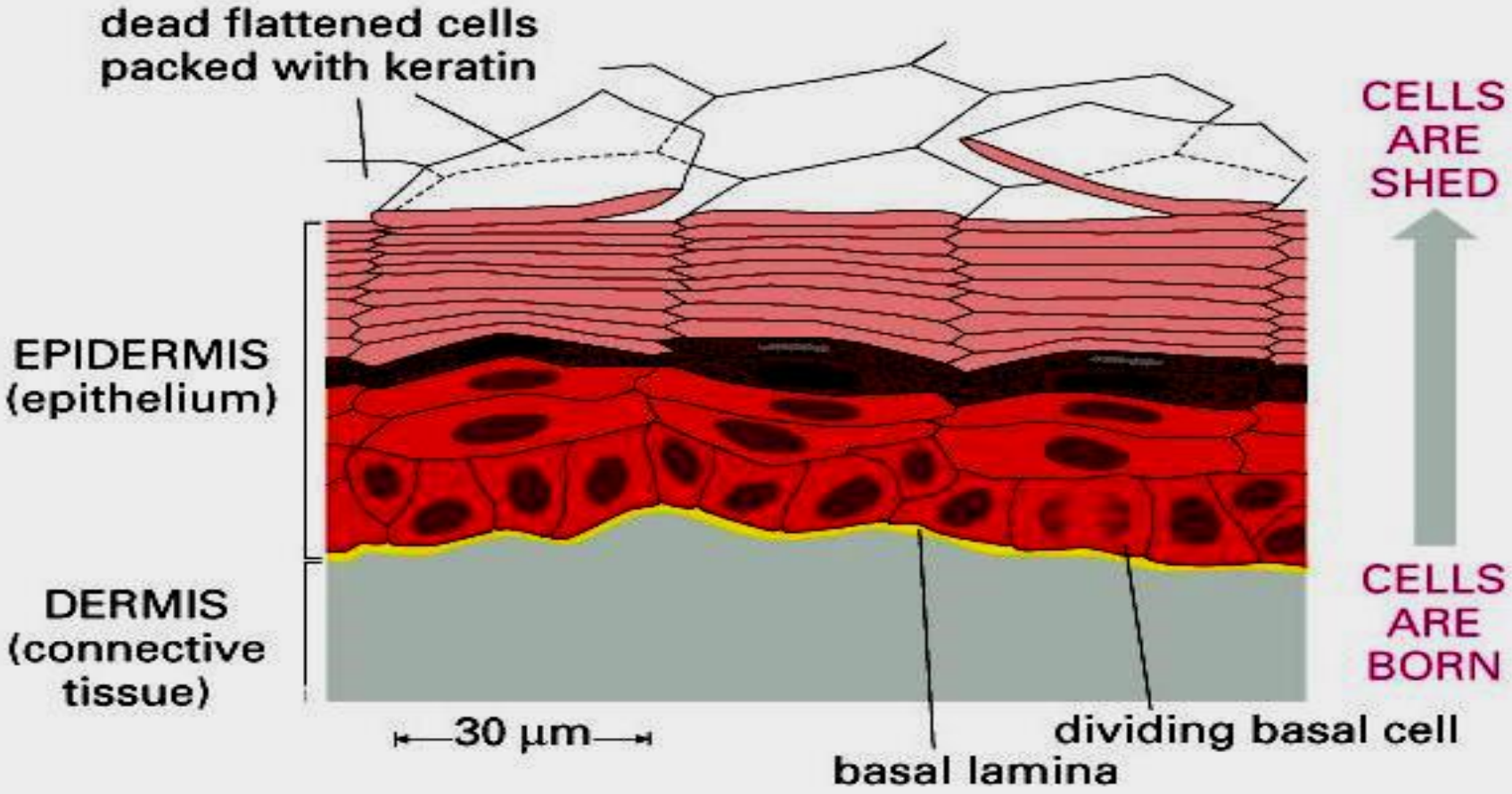
- is composed of a number of cell layers

- that are flattest at the surface.

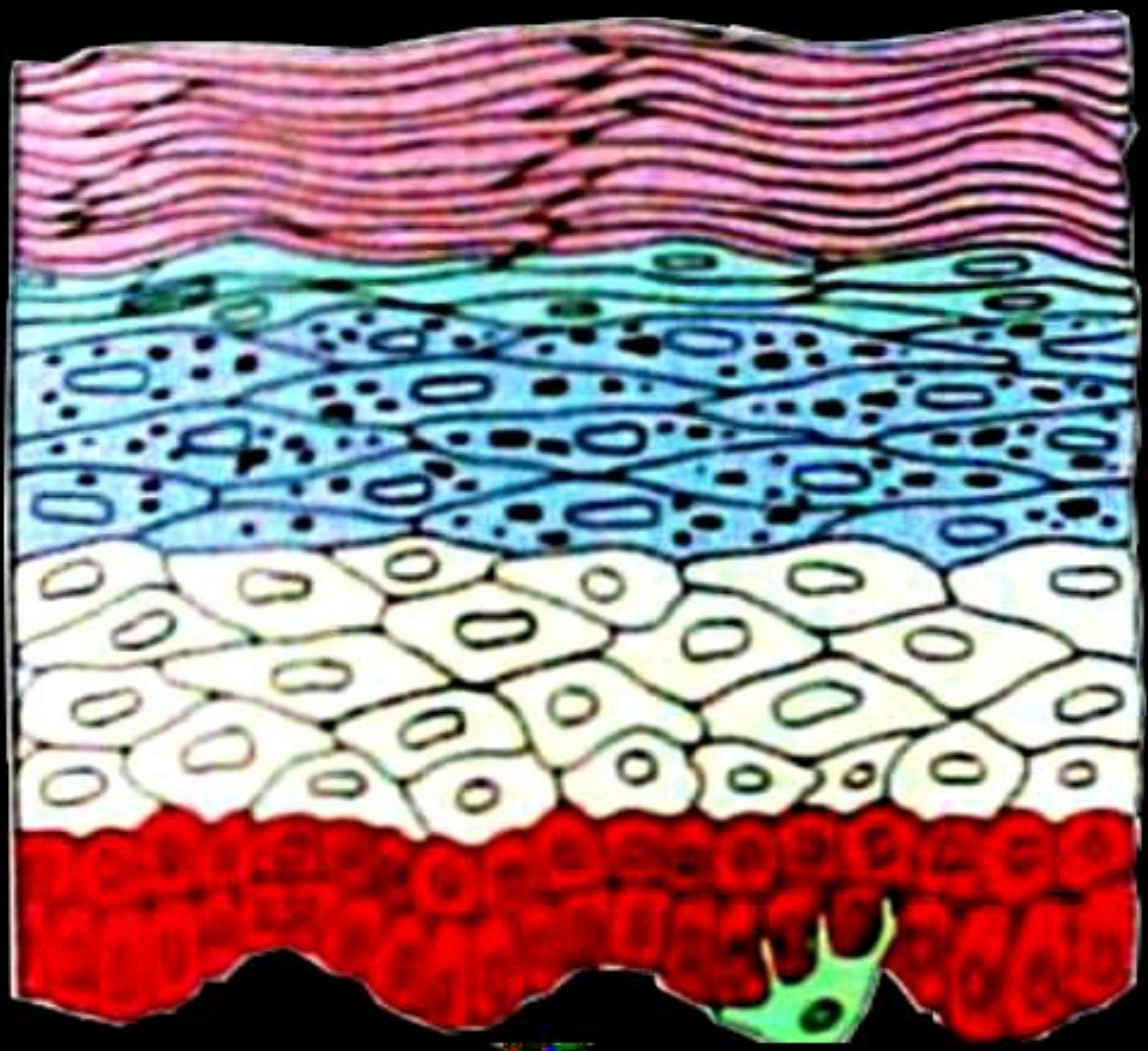


- **Cell divisions occur only**

- **within the deepest layer (the stratum basale)**



EPIDERMIS


Stratum corneum
Startum lucidum
Stratum granulosum
Stratum spinosum
Stratum germinativum
Stratum basale

- **As the newly produced cells grow in size**

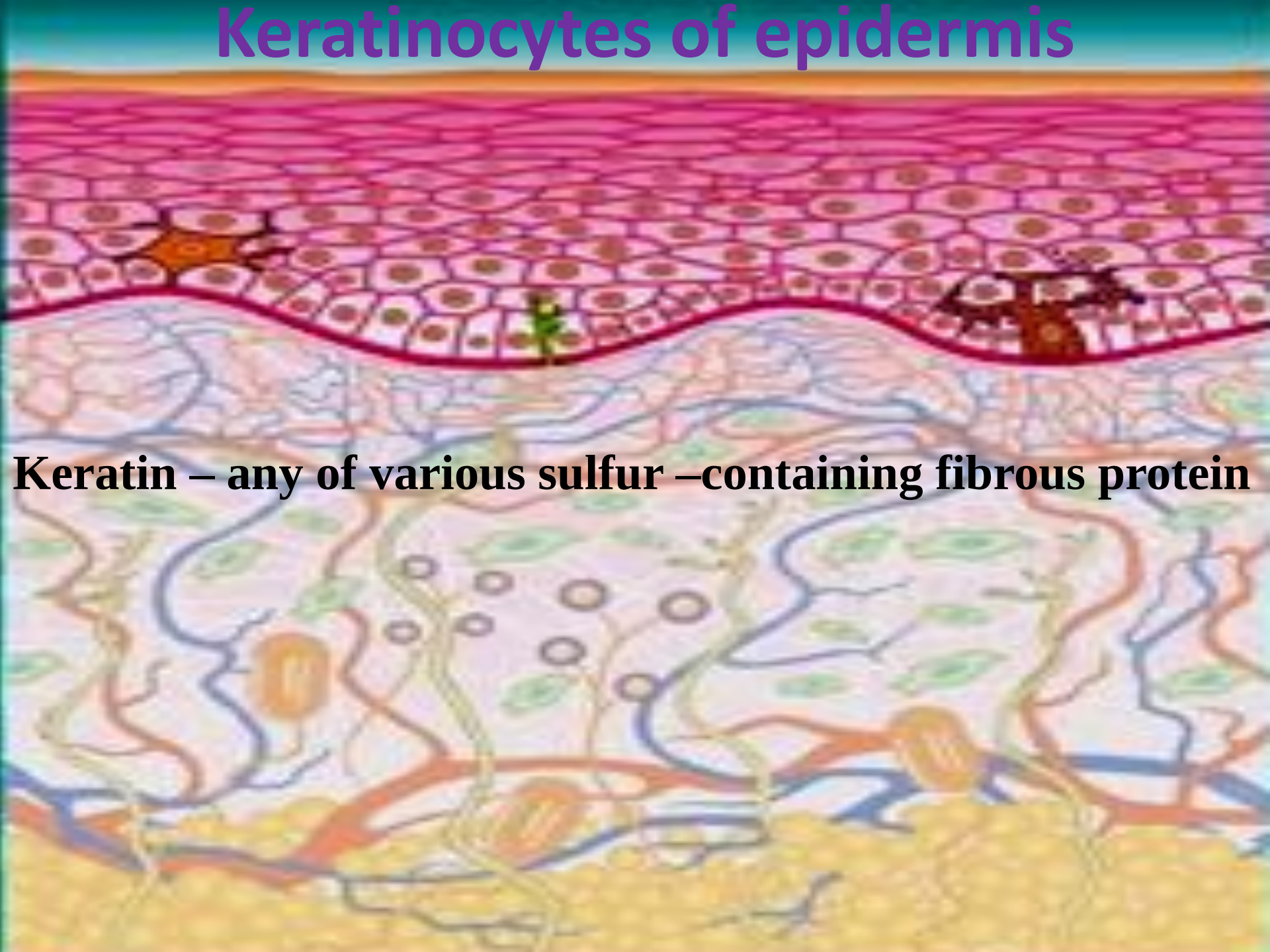
  - they are pushed toward the surface

  - where they will replace the cells

  - that are sloughed off.

- **Movement of the epithelial cells away from the supportive basement membrane is accompanied by the production of keratin, progressive dehydration, and flattening.**

Keratinocytes of epidermis



Keratin – any of various sulfur –containing fibrous protein

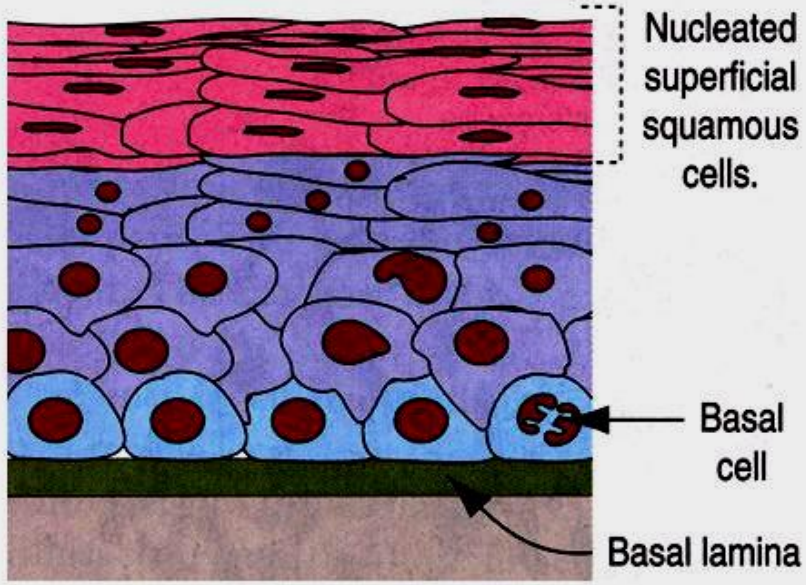
Stratified squamous epithelial tissues:

- **Two types**
  - **Keratinized**
  - **nonkeratinized.**

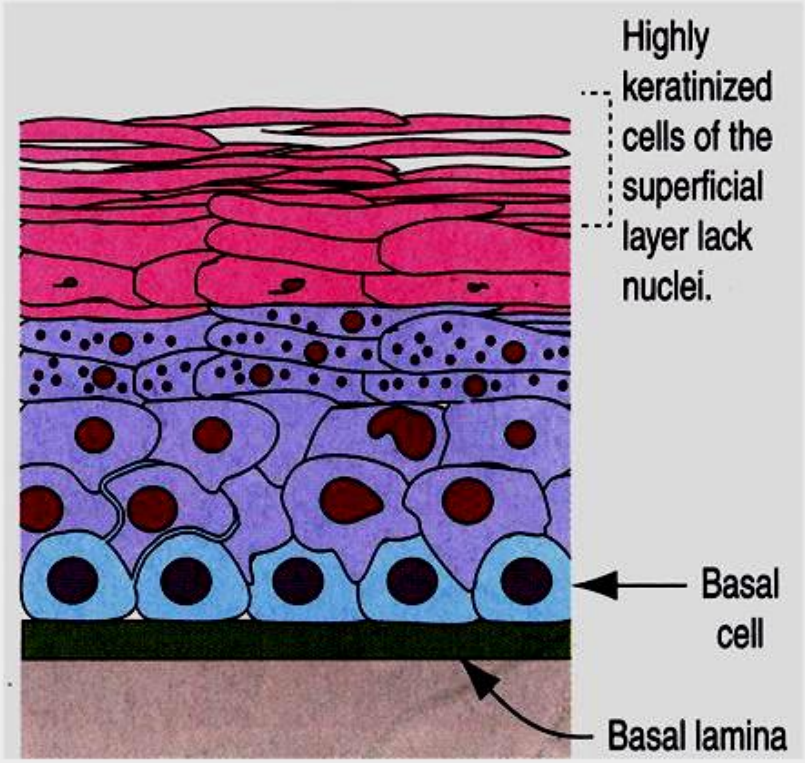
- Location
  - Keratinized – forms epidermis
  - Non-keratinized – forms lining of esophagus, mouth, and vagina

Stratified Squamous Epithelium

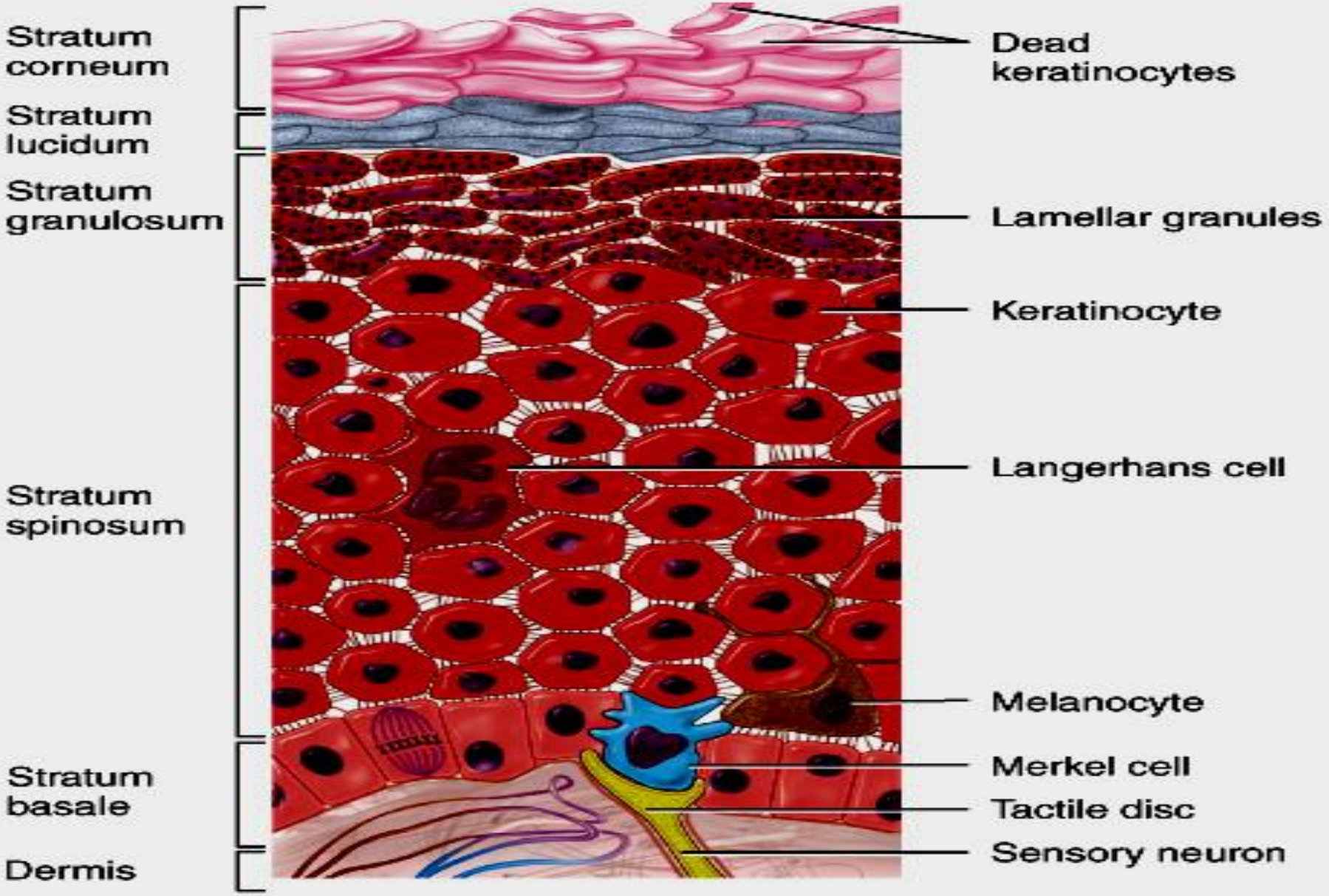
non-keratinized



keratinized



Kierszenbaum pg 5



(a) Four principal cell types in epidermis

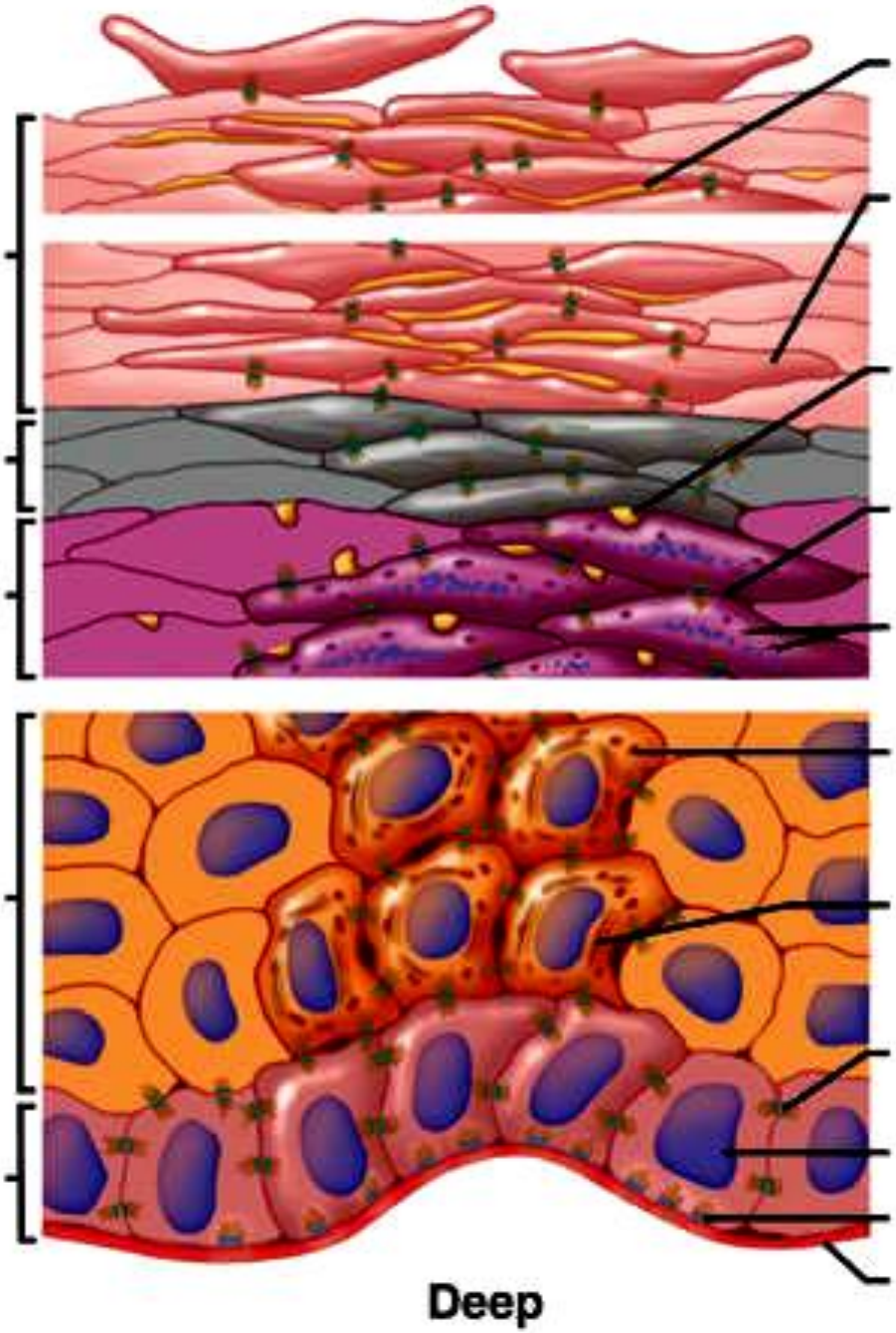
5. Stratum corneum
Dead cells with a hard protein envelope; the cells contain keratin and are surrounded by lipids.

4. Stratum lucidum
Dead cells containing dispersed keratohyalin.

3. Stratum granulosum
Keratohyalin and a hard protein envelope form; lamellar bodies release lipids; cells die.

2. Stratum spinosum
Keratin fibers and lamellar bodies accumulate.

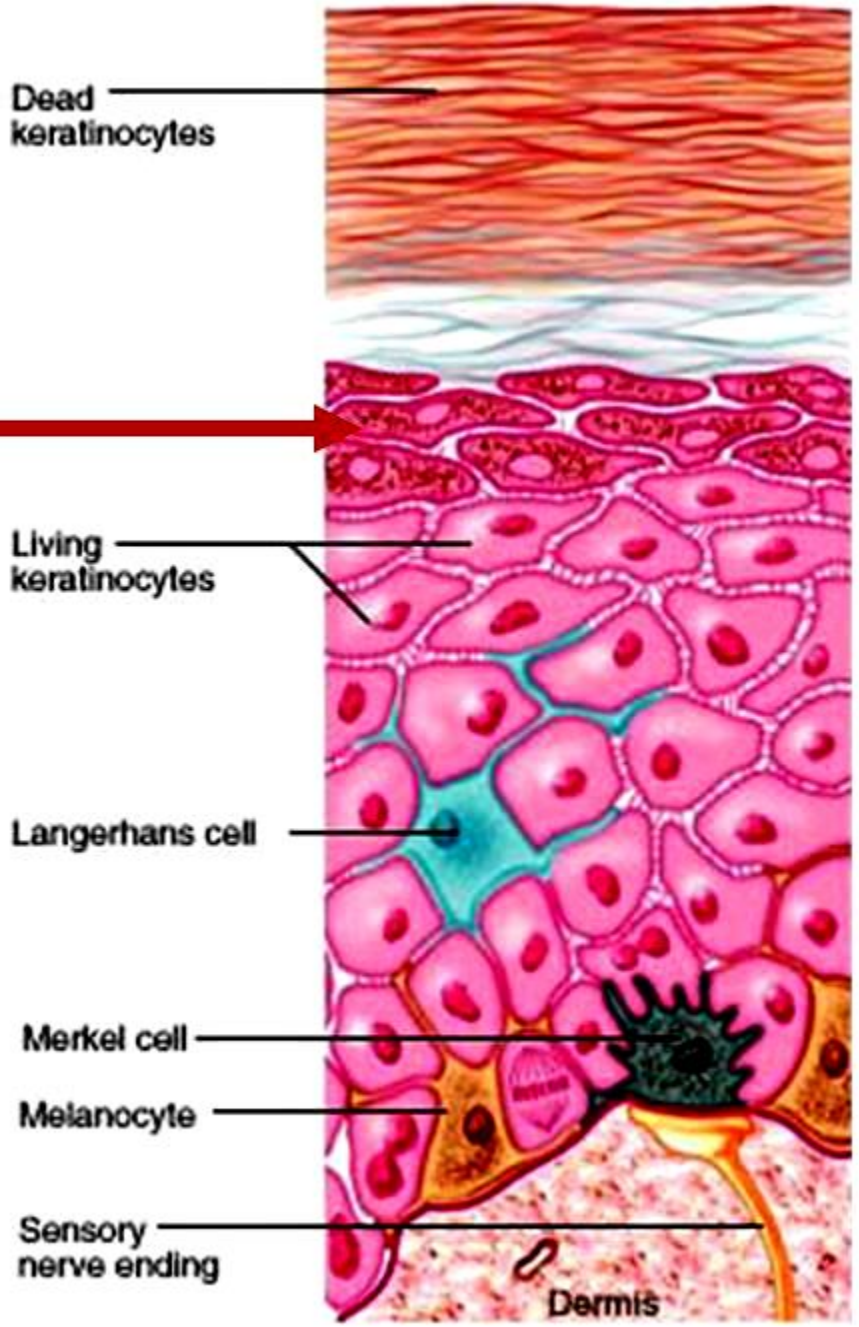
1. Stratum basale
Cells divide by mitosis and some of the newly formed cells become the cells of the more superficial strata.



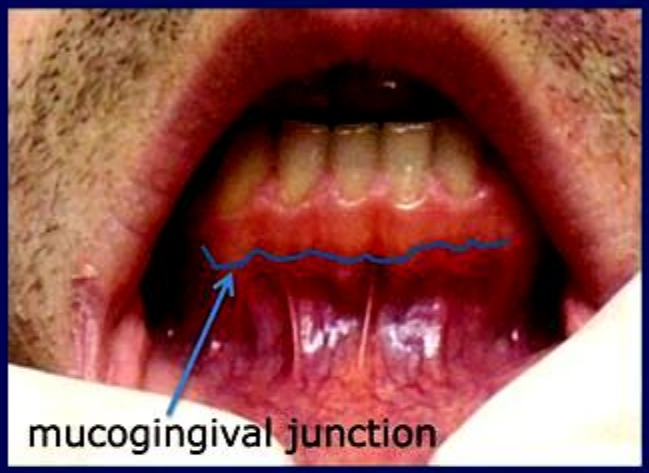
C. Layers

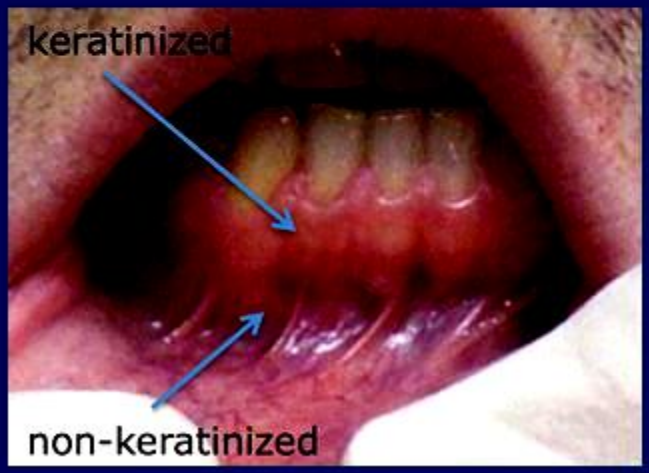
3. Stratum Granulosum

- Granular layer
- Keratinization begins
- Cells begin to die
- Thin layer 3-5 cell layers

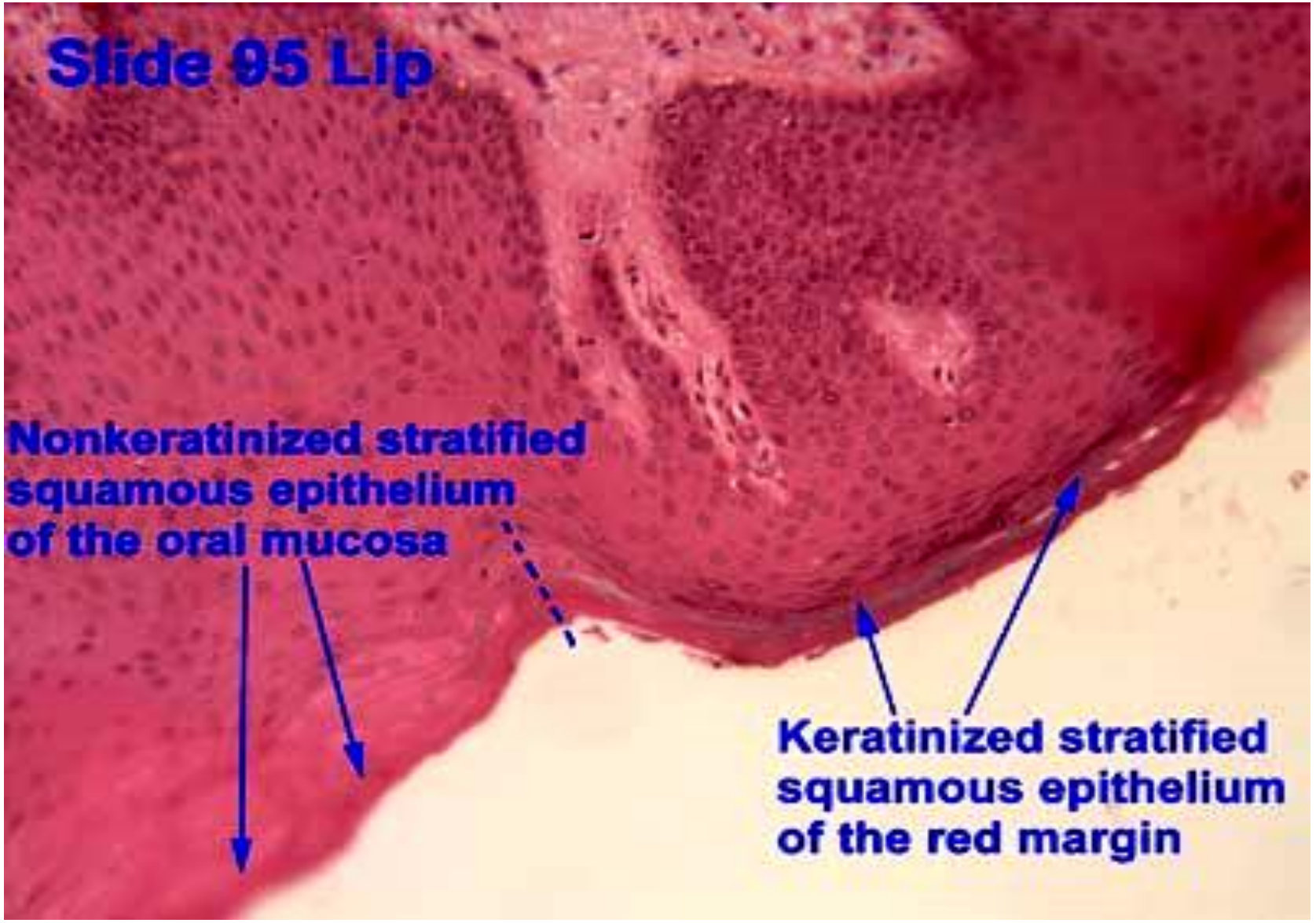


Mucogingival junction





- Keratinized tissue, often "bound" to bone and less vascular in appearance in healthy tissue
  - Gingiva
  - Hard palate
- Non-keratinized tissue, "non-bound" to bone and more vascular in appearance
  - Buccal mucosa
  - Soft palate
  - Floor of mouth


Slide 95 Lip
Nonkeratinized stratified squamous epithelium of the oral mucosa
Keratinized stratified squamous epithelium of the red margin

- **1. Keratinized stratified squamous epithelium --- contain ⇒ keratin,**

  - a protein that strengthens the tissue.

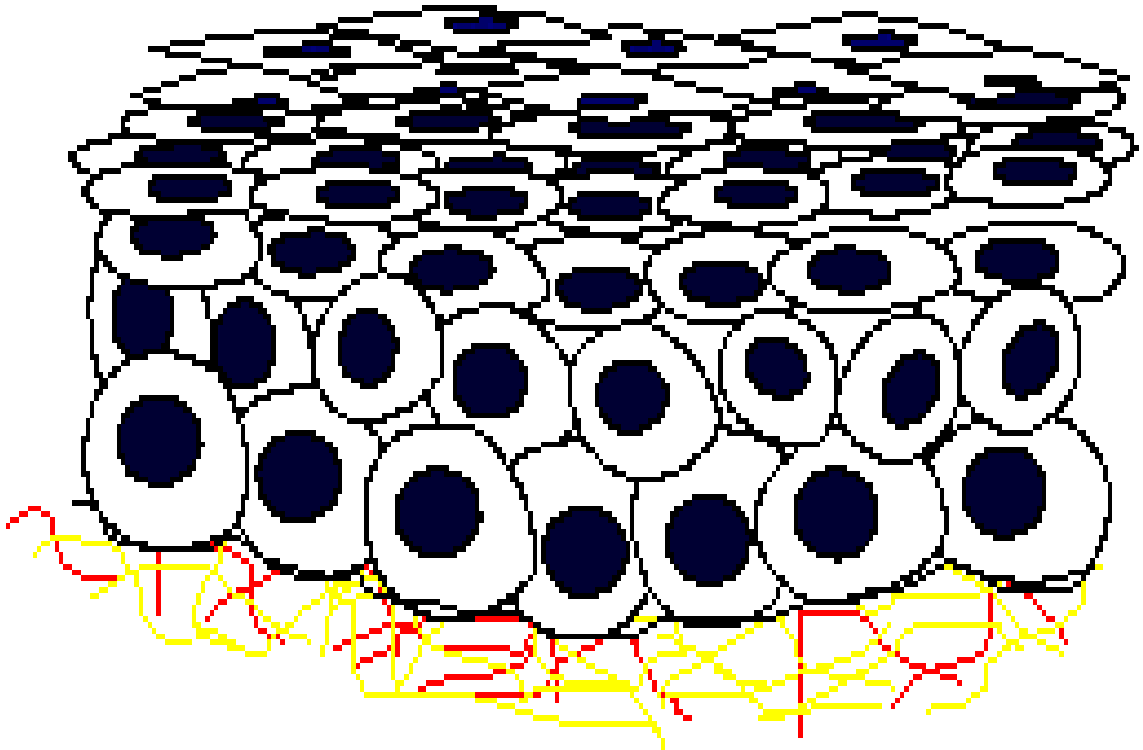
- **Keratin makes the epidermis (outer layer) of the skin somewhat waterproof and protects it from bacterial invasion.**

- **The outer layer of the skin are dead,but glandular secretions keep them soft.**

- **2. Nonkeratinized stratified squamous epithelium lines the mouth and throat, nasal cavity, vagina and anal canal.**
- **This type of epithelium, called mucosa is well adapted to withstand moderate abrasion but not fluid loss.**
- **The cells on the exposed surface of this tissue are alive and are always moistened.**

non-keratinized stratified squamous

living, nucleated cells at surface



cells flatten
toward surface

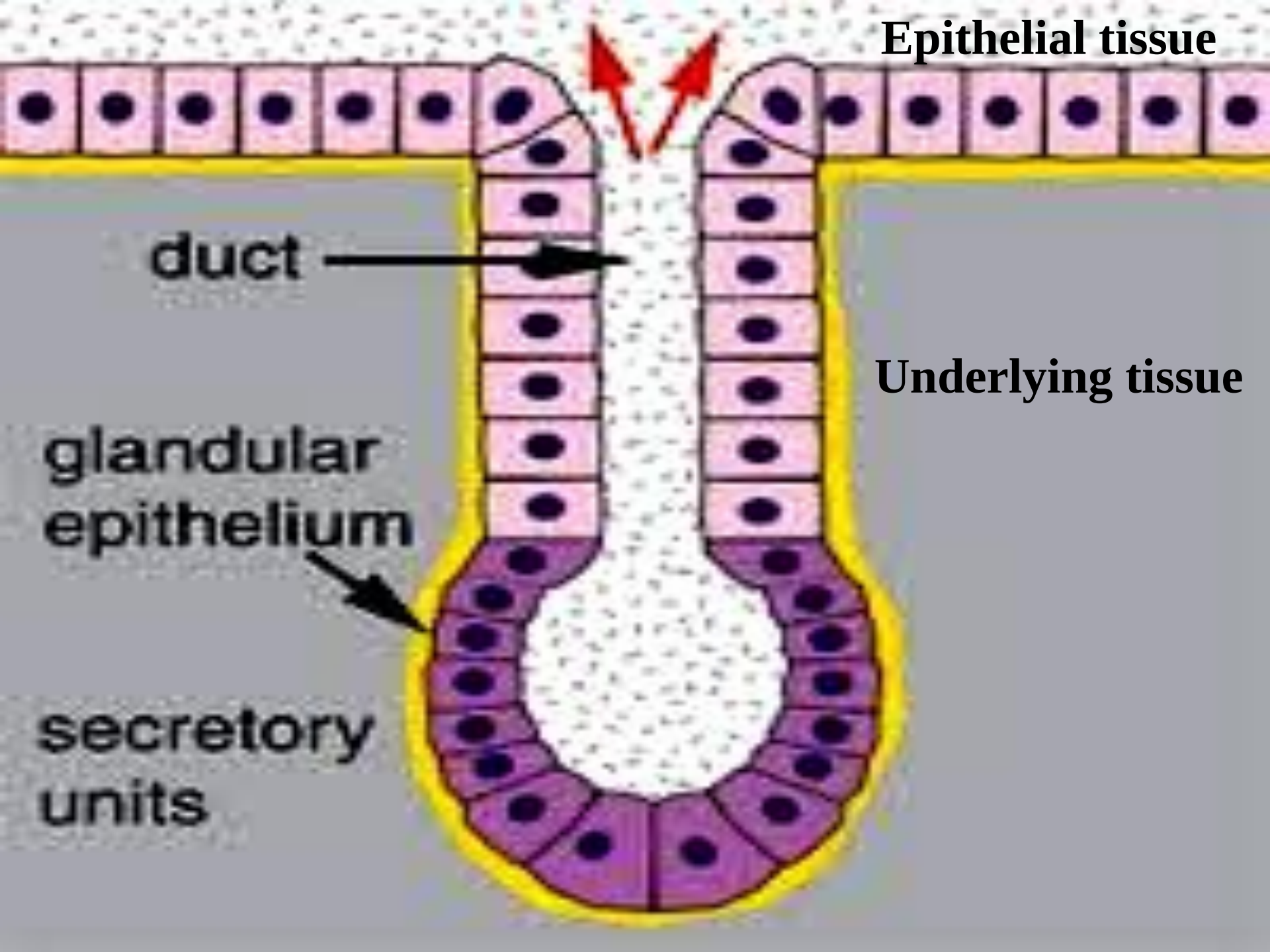
mitotic divisions

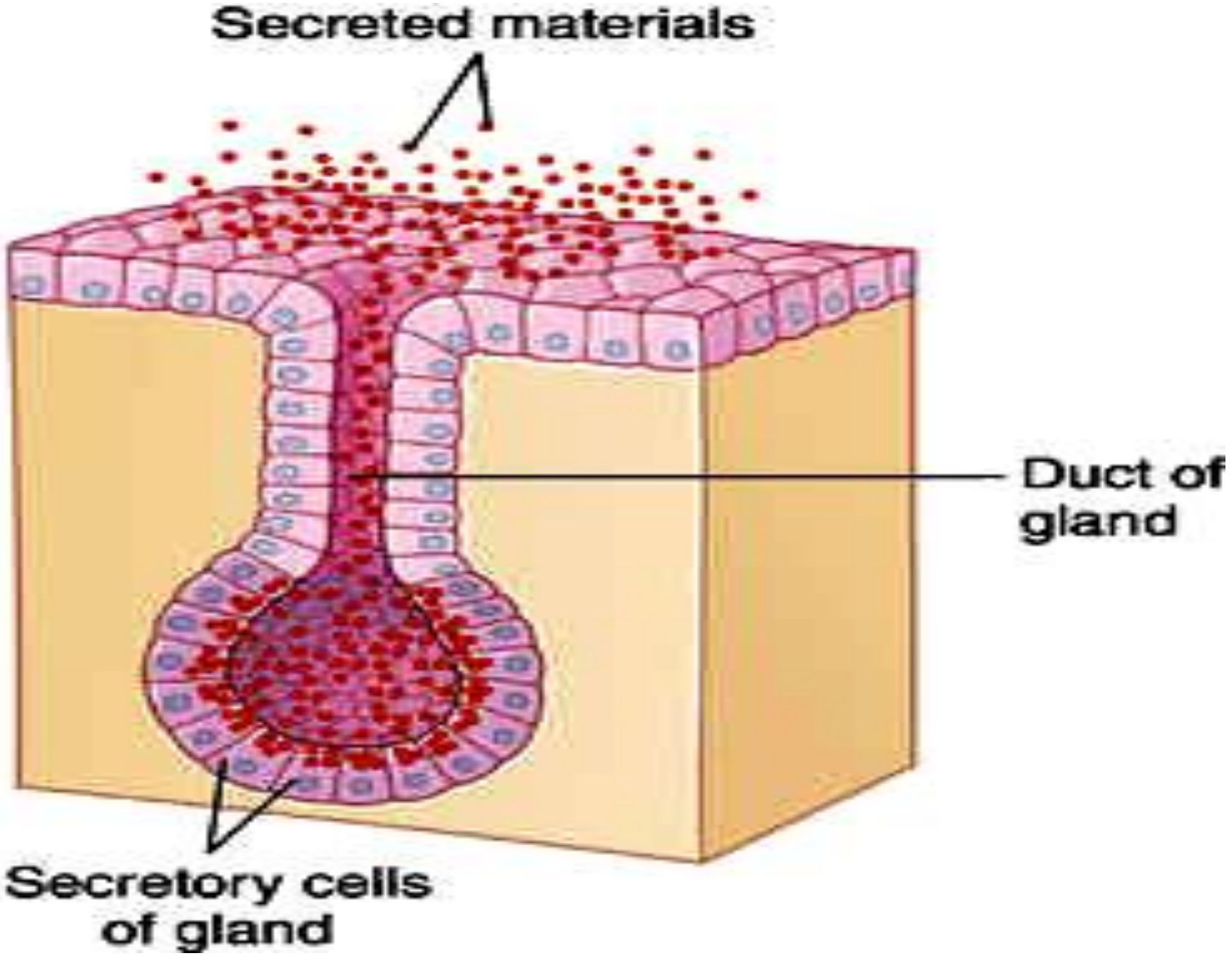
Glandular Epithelium

- ***Exocrine glands***
  - cells that secrete---sweat, ear wax, saliva, digestive enzymes onto free surface of epithelial layer
  - connected to the surface by tubes (ducts)
  - unicellular glands or multicellular glands
- ***Endocrine glands***
  - secrete hormones into the bloodstream
  - hormones help maintain homeostasis

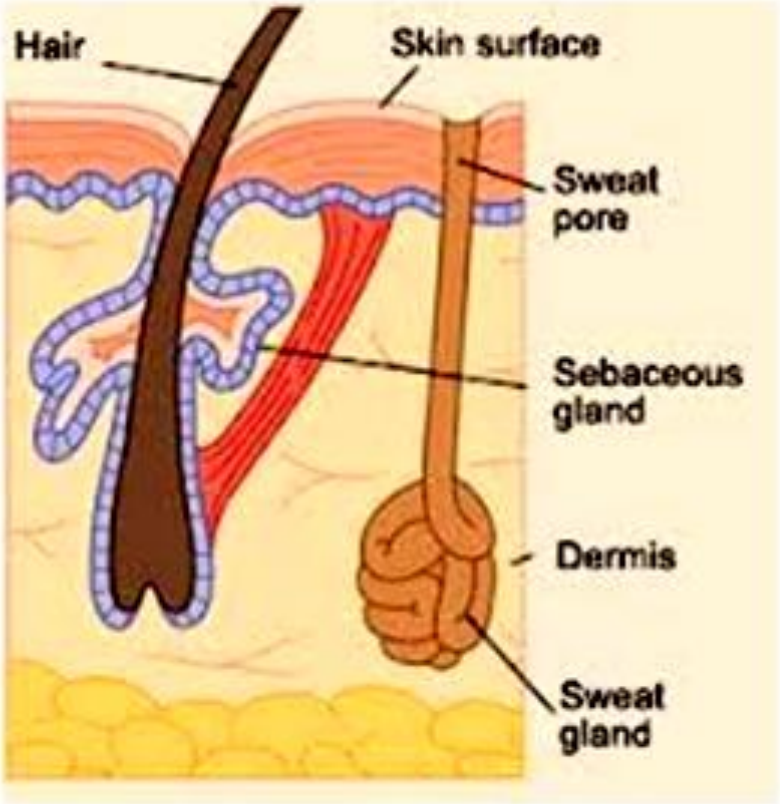
Glandular Epithelial Tissue

- As tissues develop in the embryo,
- certain epithelial cells migrate into the underlying connective tissue,
- forming secretory structures
  - called **exocrine glands**.


Epithelial tissue
duct
Underlying tissue
glandular epithelium
secretory units


Secreted materials
Duct of gland
Secretory cells of gland

Glands of the Skin



Sebaceous Gland

- always attached to the hair follicle
- Produces oil
- 1- 6 glands on each follicle
- Most numerous on forehead, nose, chin and scalp

Source: Google

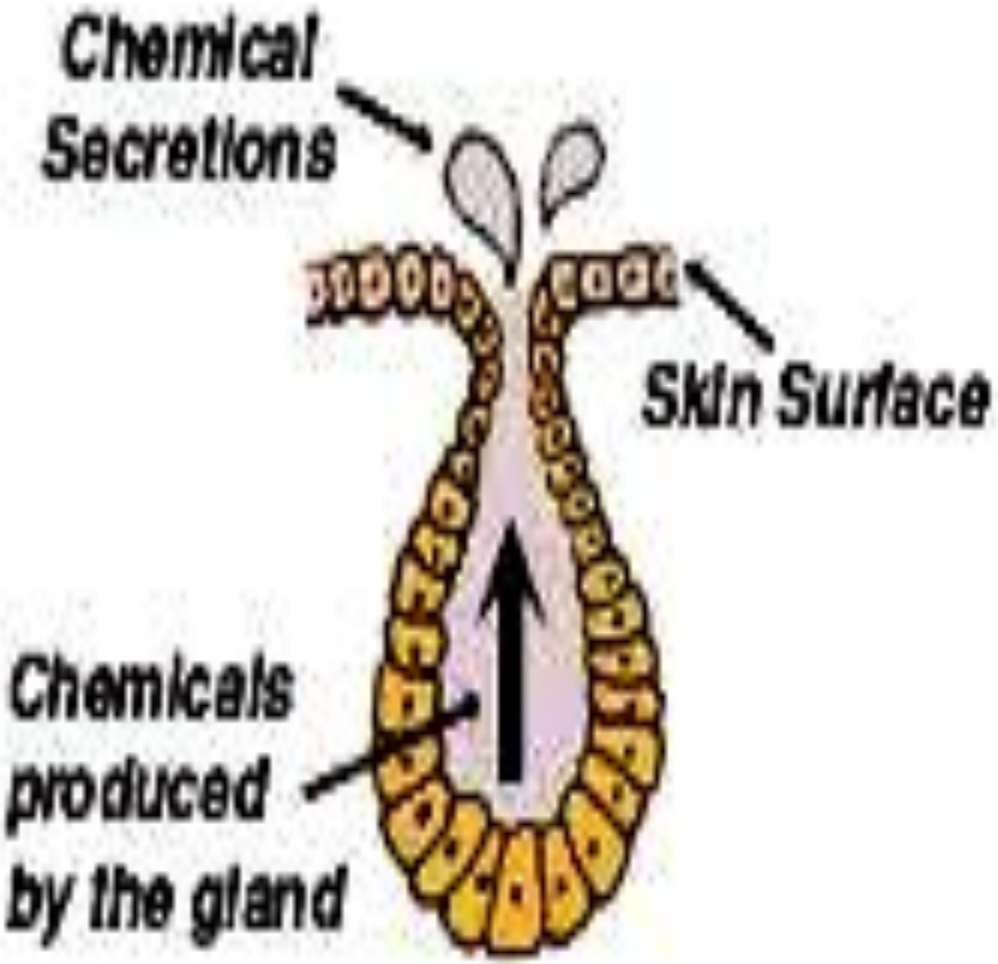
- **The secretions from exocrine glands**
- **pass through ducts → onto body surface**

  or into body cavities.
- **These glands should not be confused with endocrine glands ,**

- which are ductless,

- and which secrete their products (hormones)

- in to the blood or surrounding extracellular fluid.



Exocrene Gland

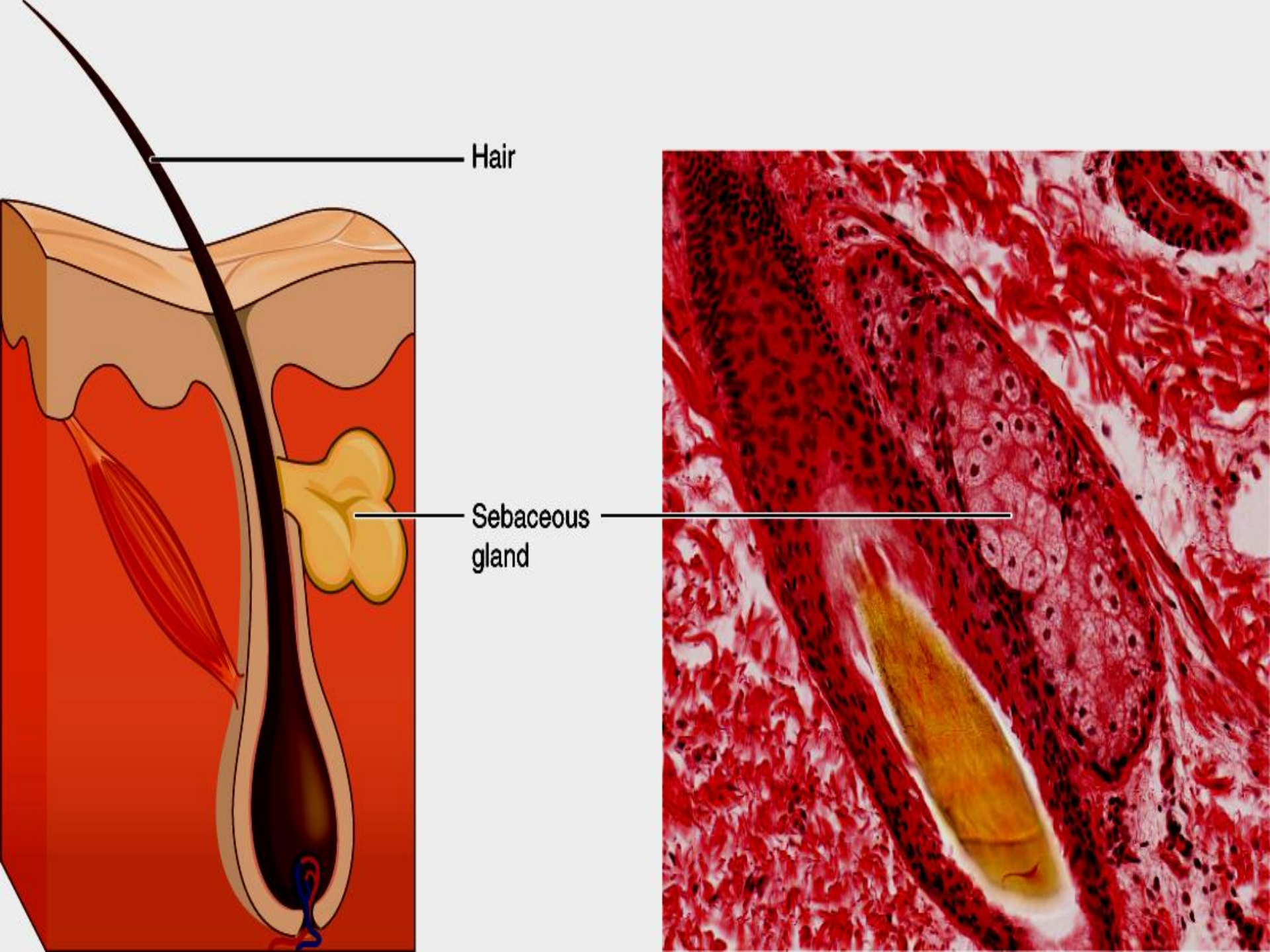
Endocrine Gland

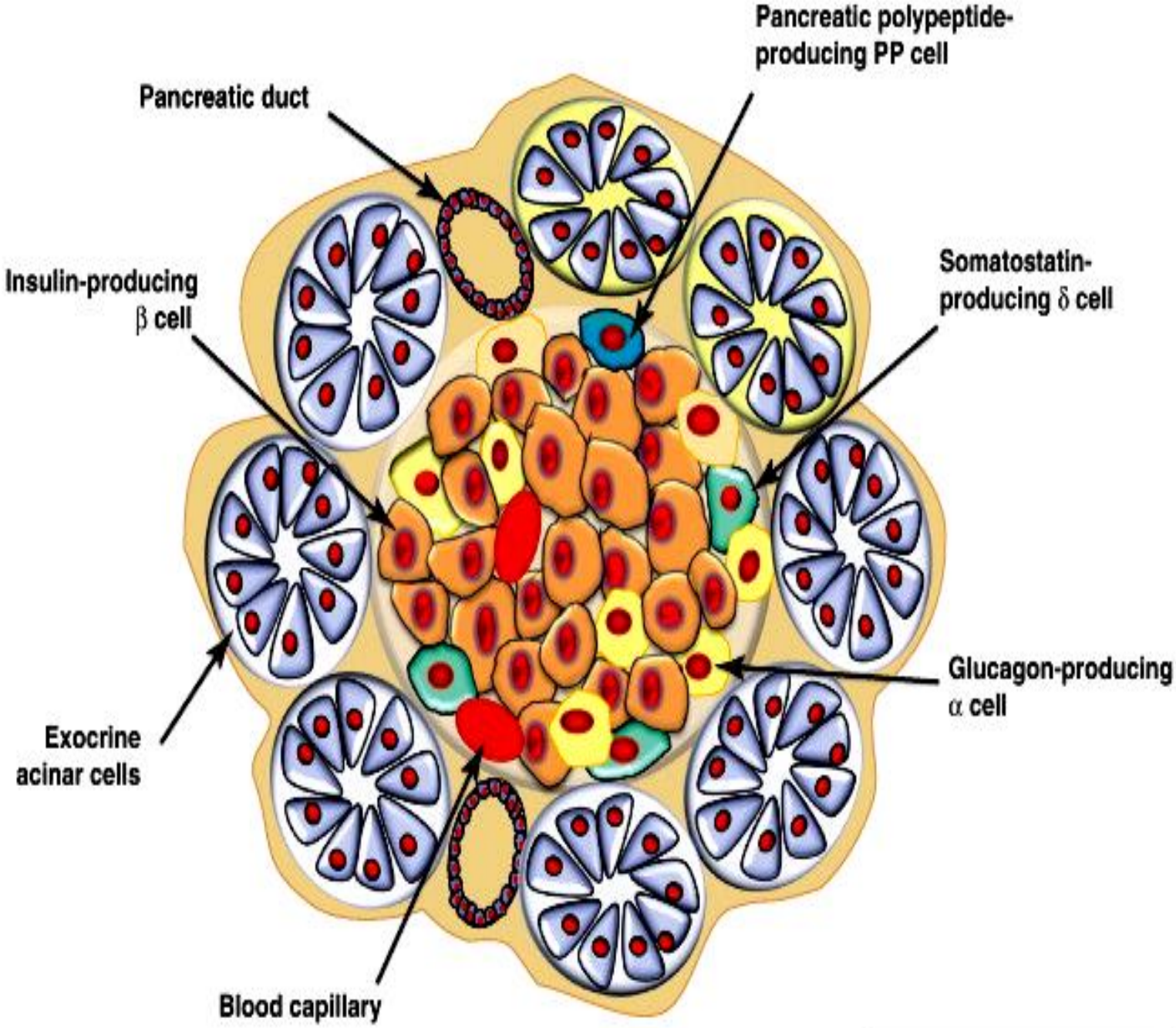
- **Exocrine glands within the skin --**

- include
- **oil (sebaceous) glands,**
- **sweat glands , &**
- **mammary glands.**

- **Exocrine glands within the digestive system**

include
- **the salivary gland &**
- **pancreatic gland.**


Hair
Sebaceous gland


Pancreatic polypeptide-producing PP cell
Pancreatic duct
Insulin-producing β cell
Somatostatin-producing δ cell
Glucagon-producing α cell
Exocrine acinar cells
Blood capillary
TRENDS in Endocrinology & Metabolism

- **Exocrine glands are classified**

- according to their structure &

- how they discharge their products.

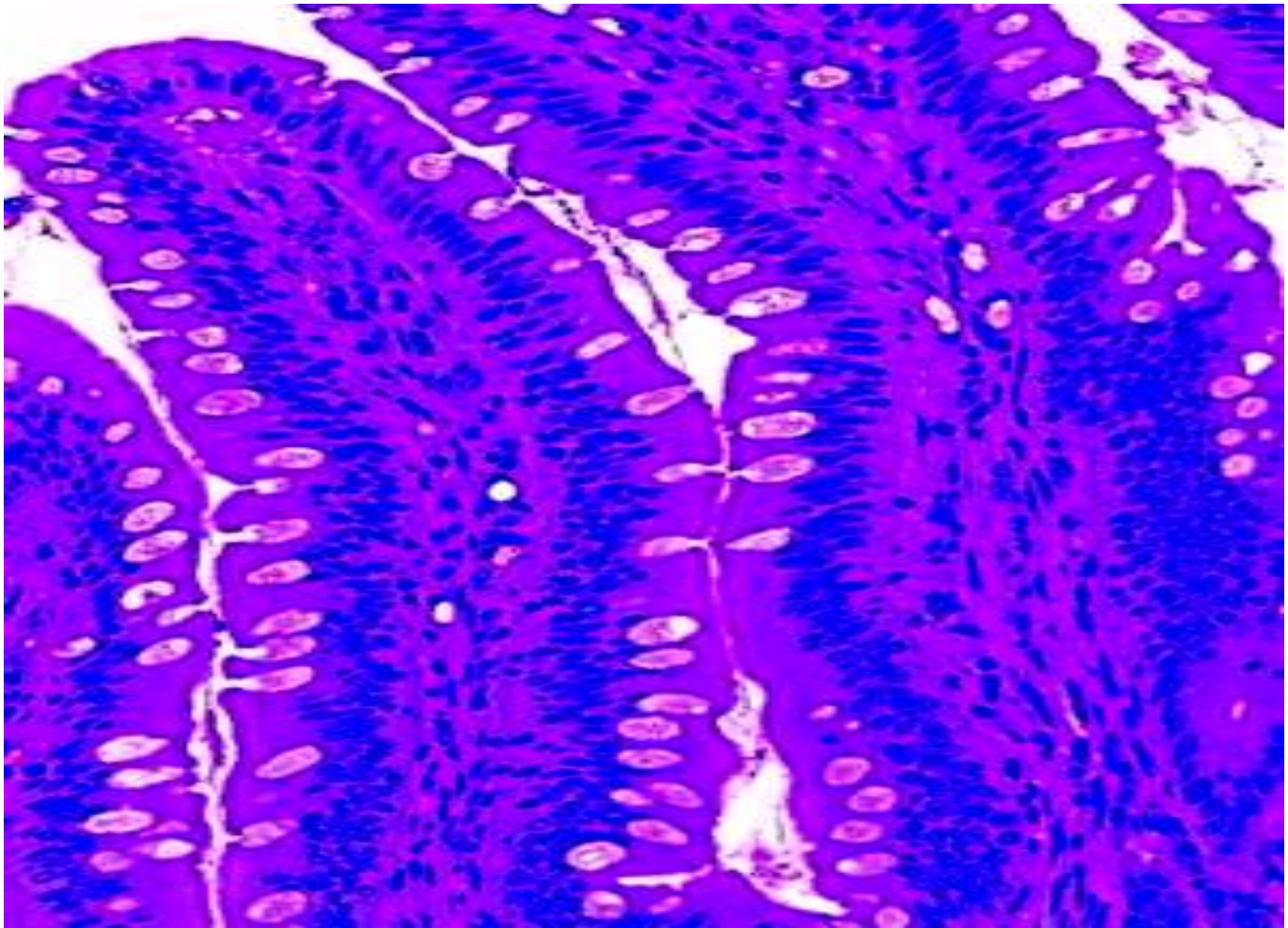
- **Classified according to structure,**

two types
- **unicellular glands**
- **&**
- **multicellular glands.**

- **1.Unicellular glands are**

- **single-celled glands, (goblet cells)**

-interspersed within most columnar epithelial tissues.



- **Goblet cells are found in the epithelial lining of**

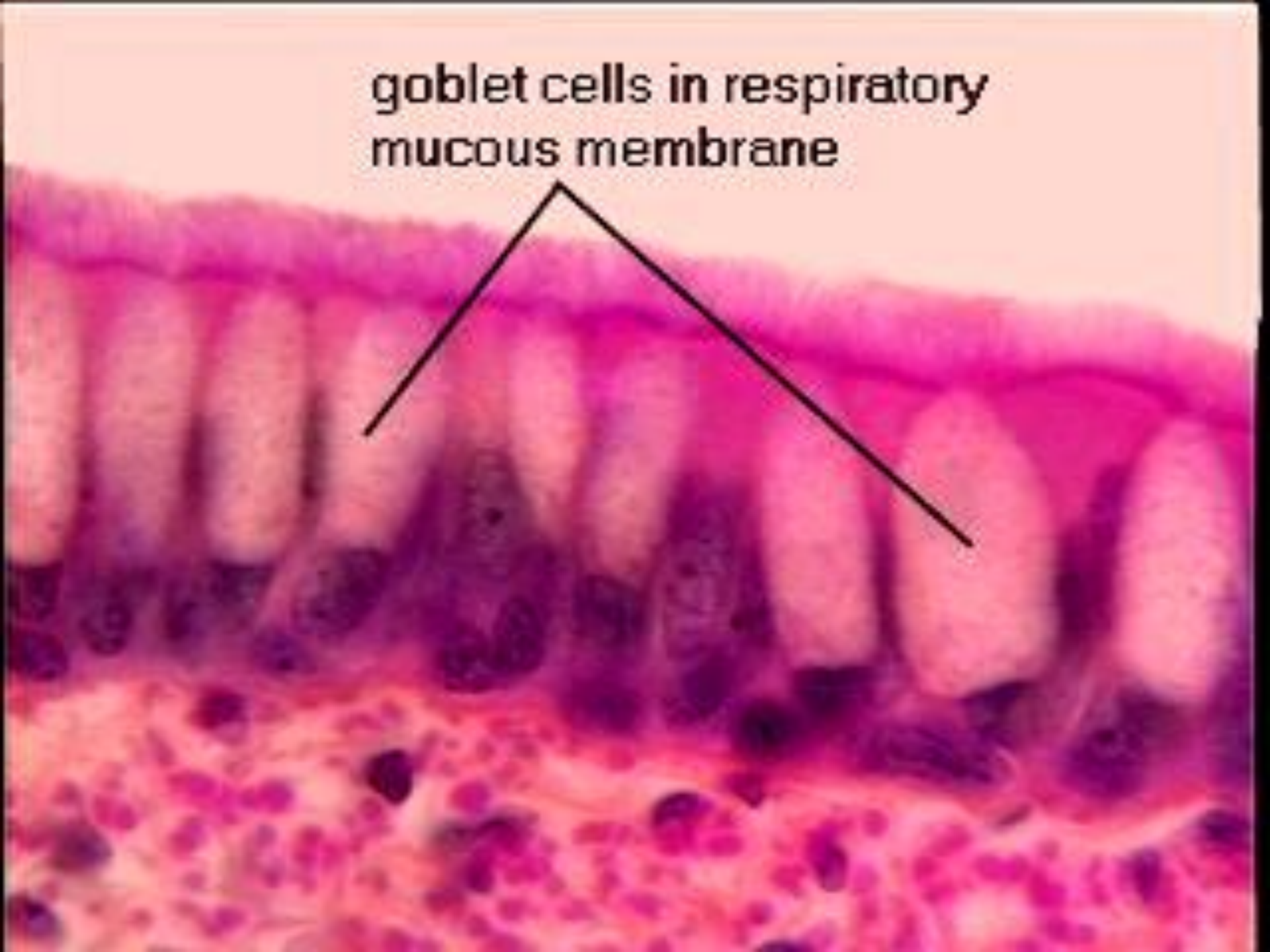
  - the respiratory ,

  - digestive ,

  - urinary &

  - reproductive system.

- **The mucous secretion of these cells lubricates and protects the surface linings.**


goblet cells in respiratory
mucous membrane

2.Multicellular glands,

- as their name implies,

- are composed of **both secretory cells** and **cells**

- **that form the walls of the ducts.**

- **Multicellular glands are classified as**

simple glands or **compound glands.**

- **The ducts of the simple glands do not branch ,**

whereas those of the compound type do.

Multicellular glands are also classified

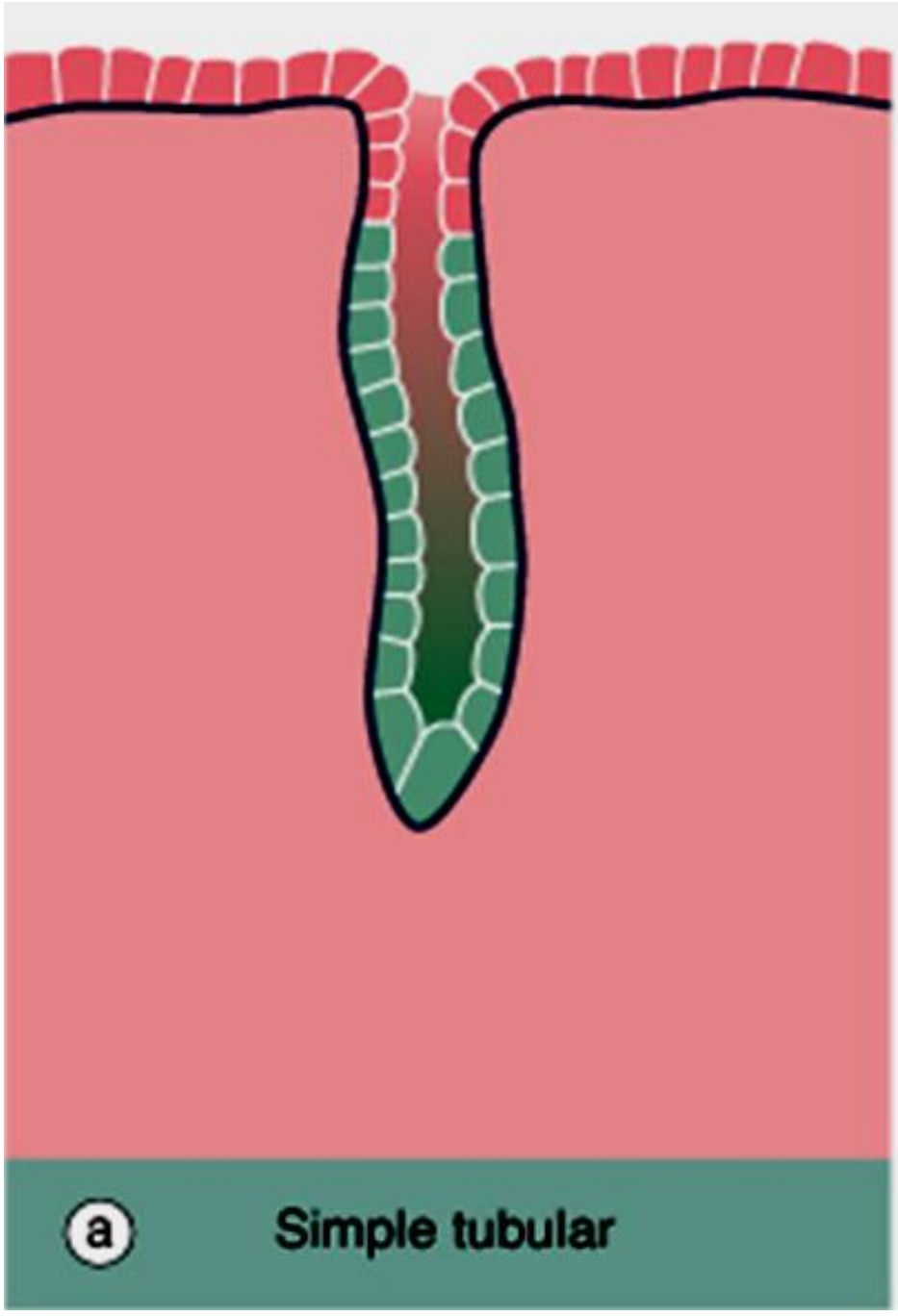
- according to the shape of their secretory portion.

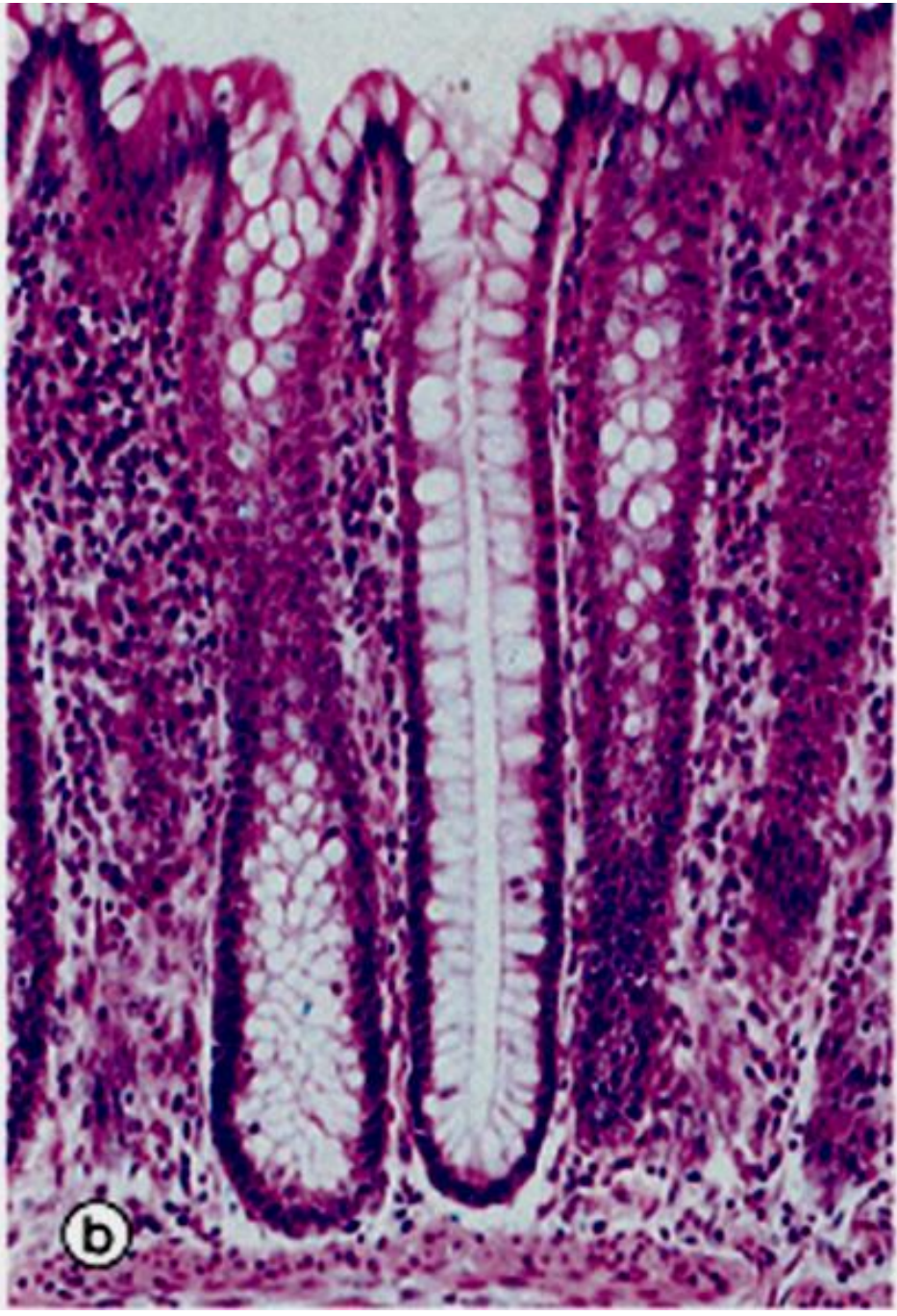
- **They are identified**
  - **tubular glads**
  - **acinar glands**
  - **tubulo-acinar glands**
- **as tubular glands**

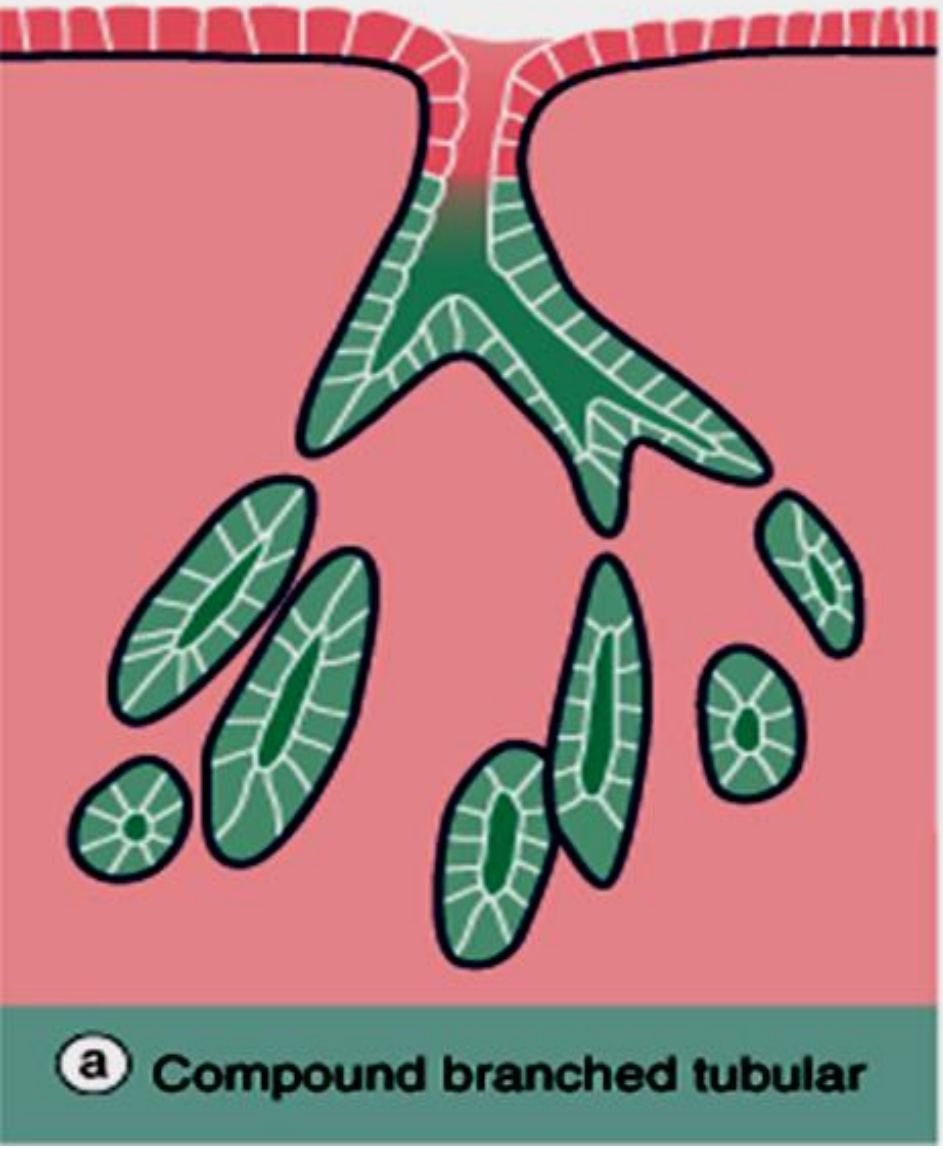
- if the secretory portion resembles = a tube &

- **as acinar glands**

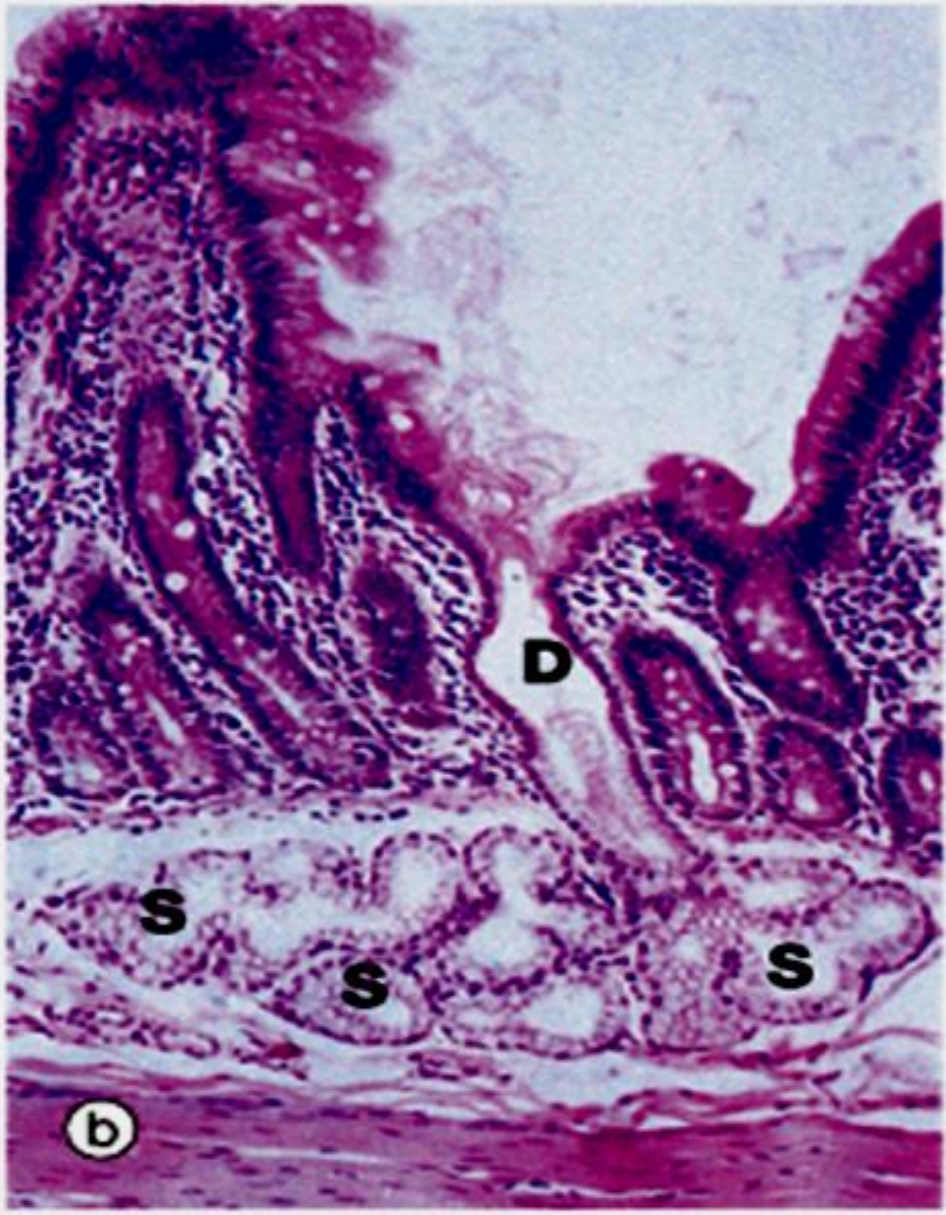
- if the secretory portion resembles =a flask.

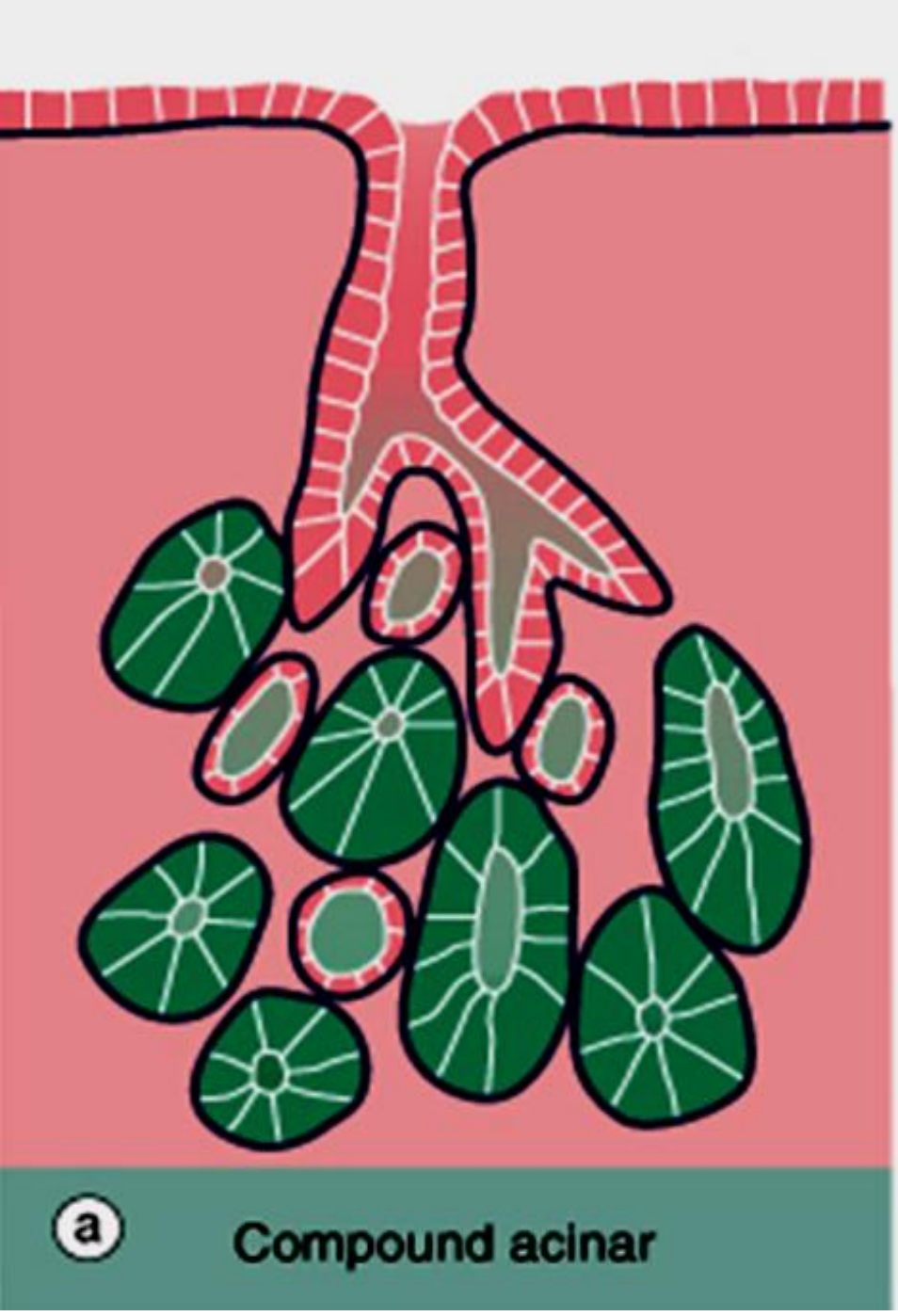

a
Simple tubular

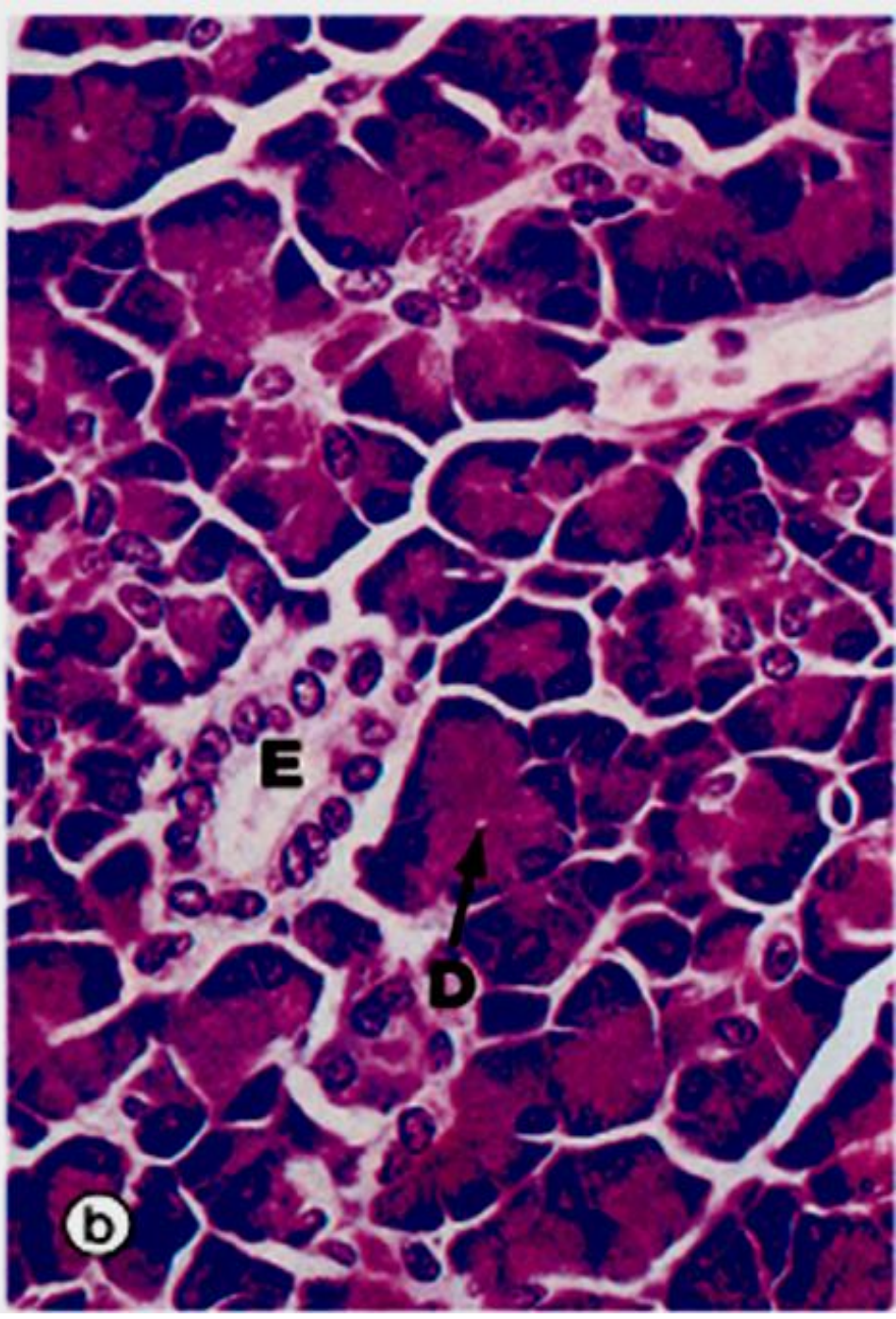

b



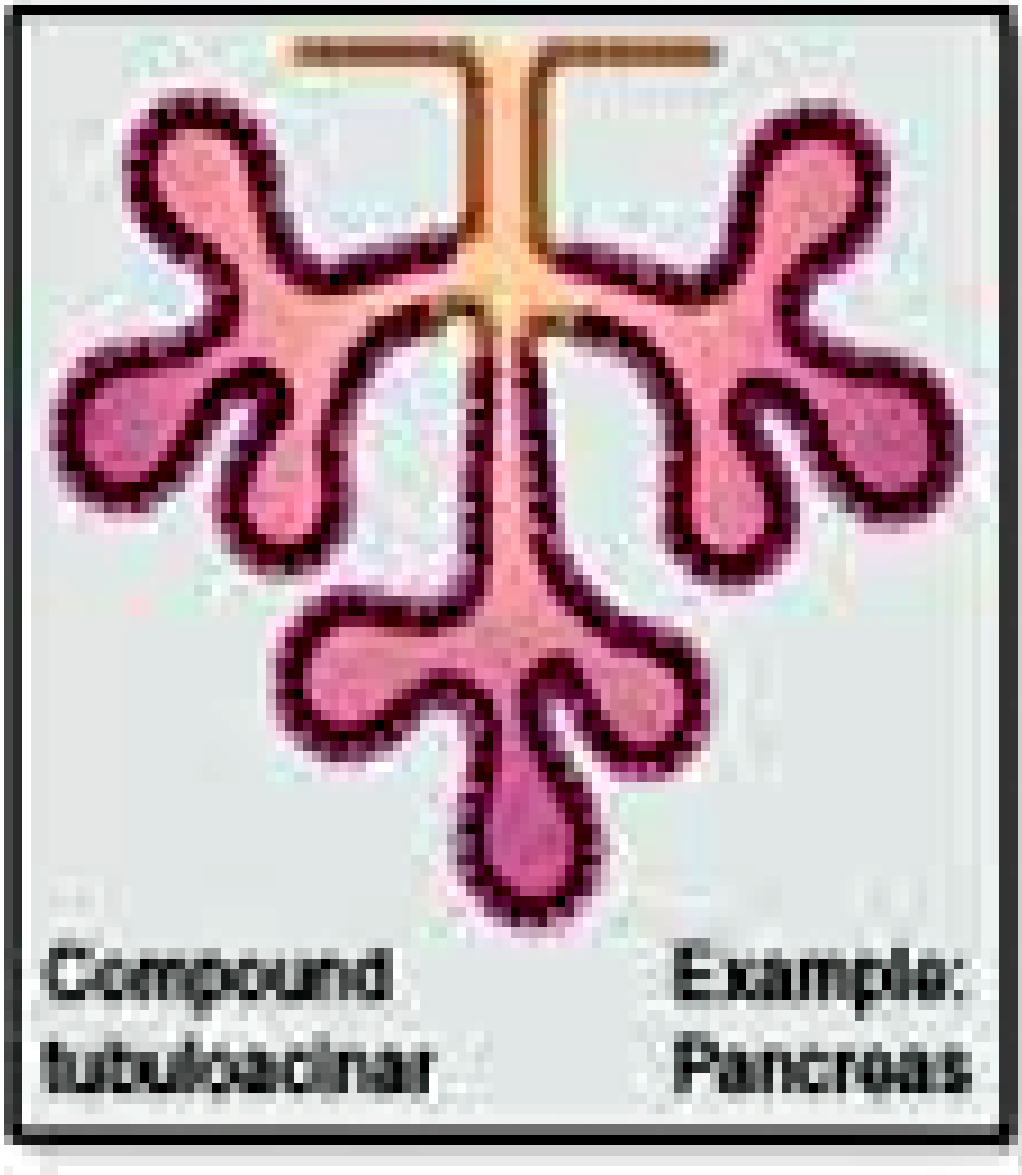
(a) Compound branched tubular

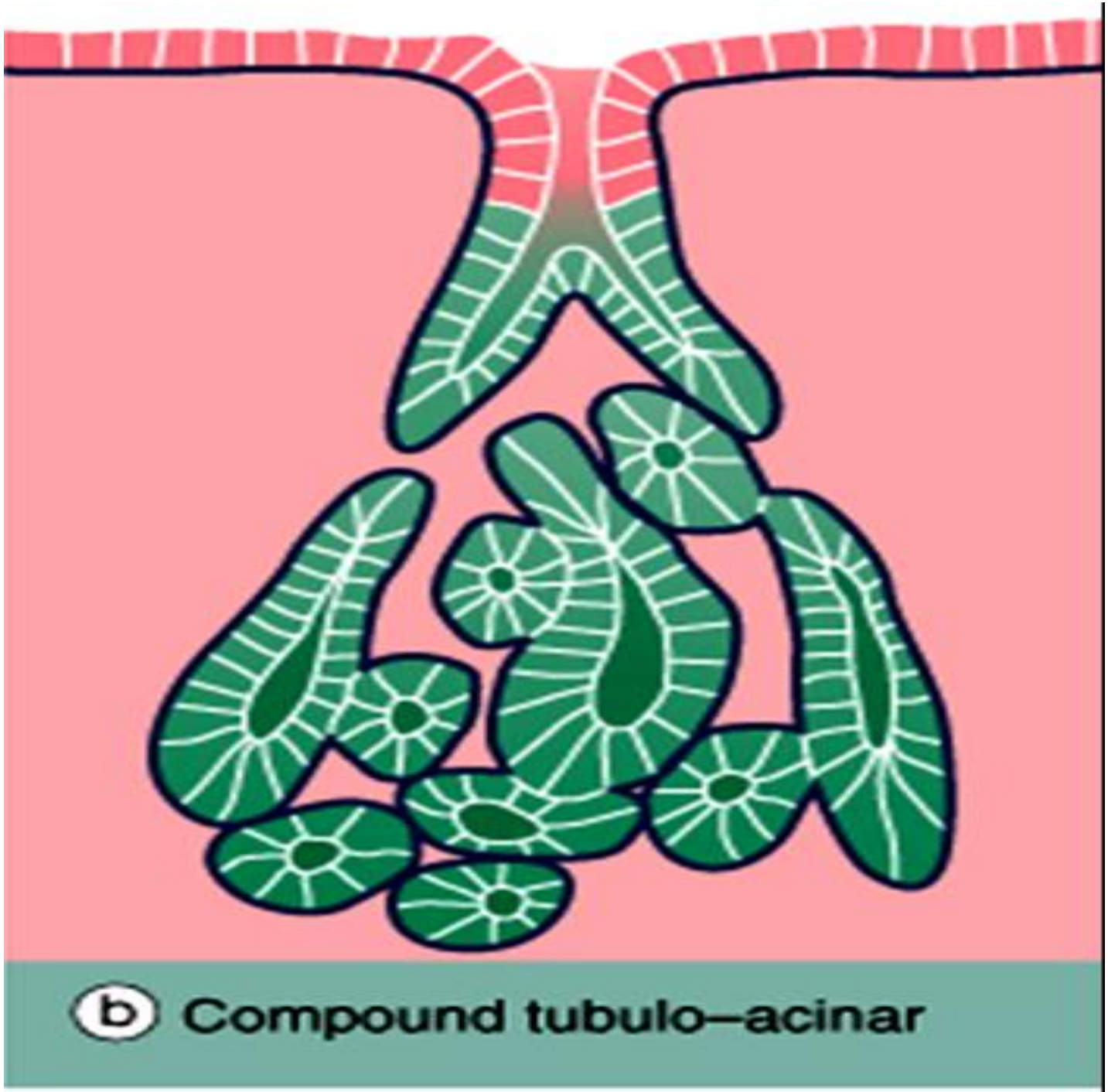



a
Compound acinar


E
D
b

➢**Multicellular glands with secretory portion that resembles both a tube and a flask are termed tubuloacinar glands**




b Compound tubulo–acinar

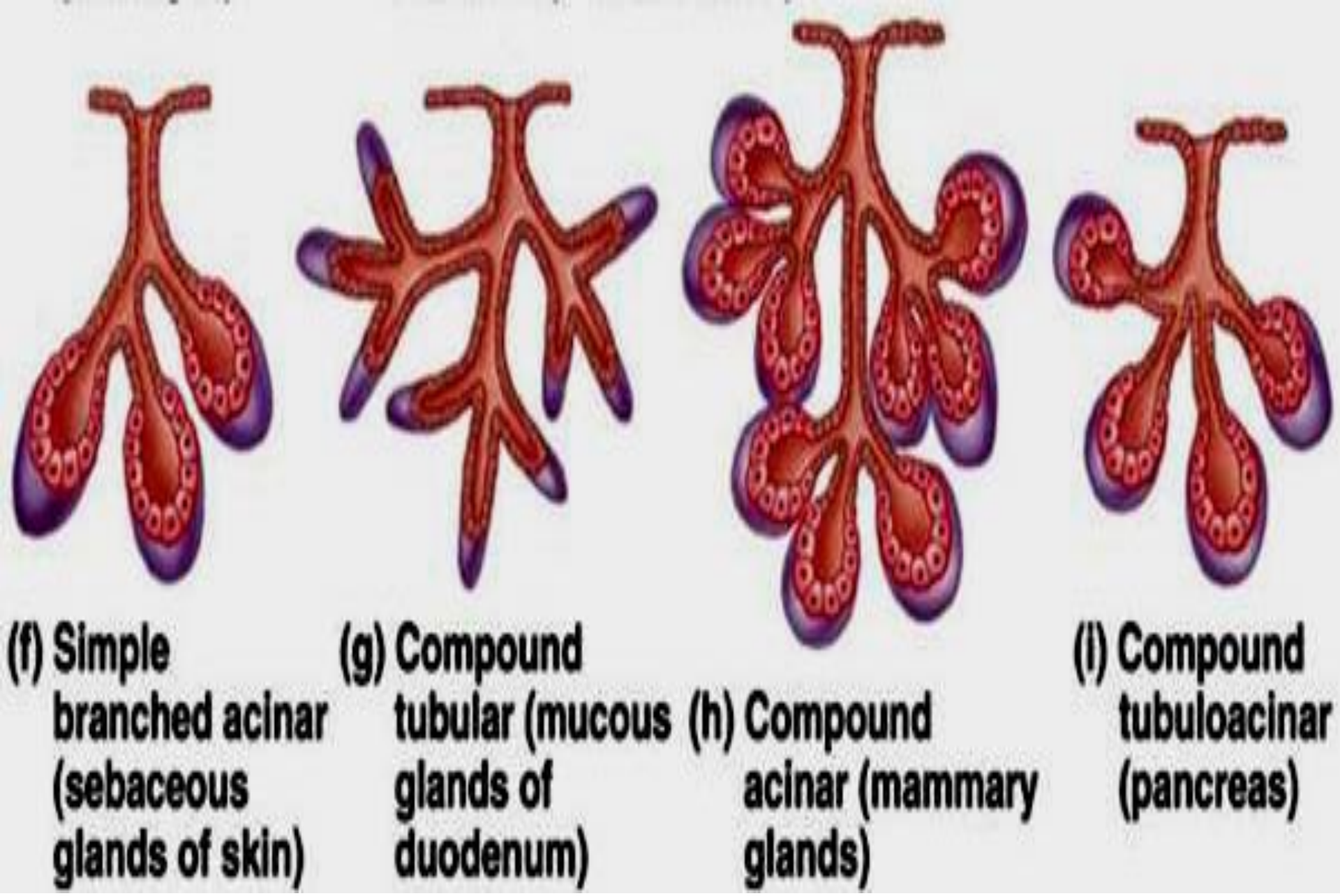
(a) Unicellular (goblet cells in large and small intestine and respiratory passages)

(b) Simple straight tubular (glands in stomach and colon)

(c) Simple branched tubular (glands in lower portion of stomach)

(d) Simple coiled tubular (lower portion of stomach and small intestine)

(e) Simple acinar (sebaceous glands of skin)



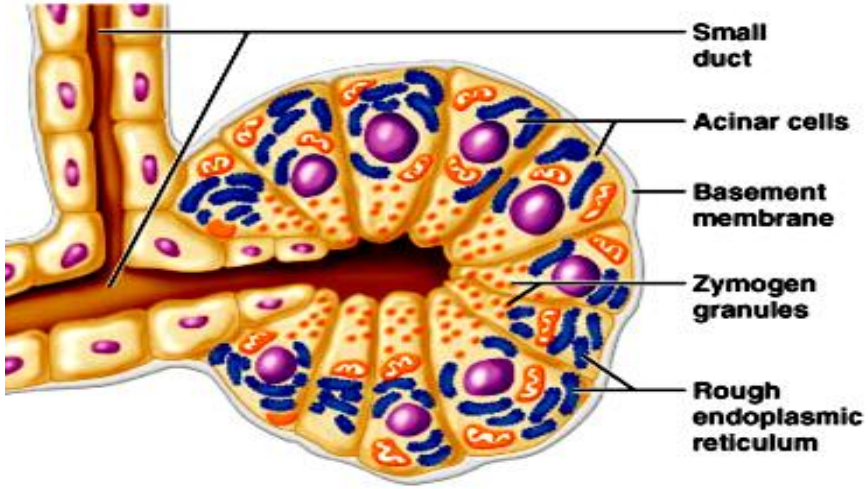
(f) Simple branched acinar (sebaceous glands of skin)

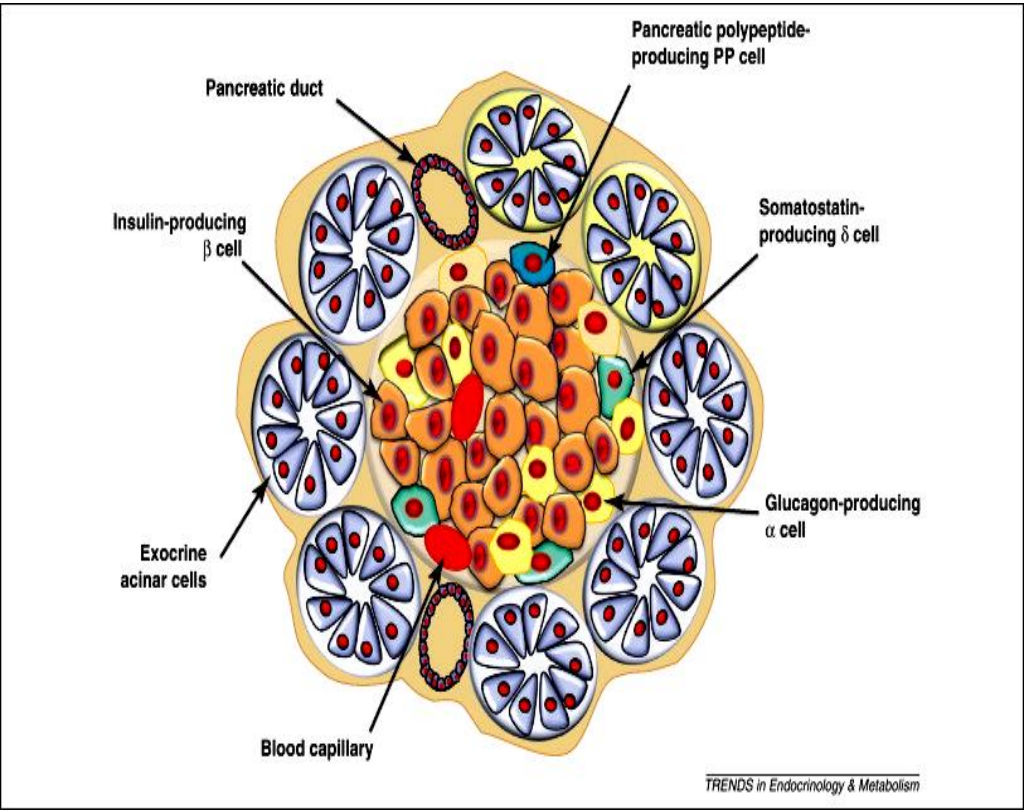
(g) Compound tubular (mucous glands of duodenum)

(h) Compound acinar (mammary glands)

(i) Compound tubuloacinar (pancreas)

one acinus





Pancreatic *exocrine* function

- Compound *acinar* (sac-like) glands opening into large ducts (therefore exocrine)
- *Acinar* cells make 22 kinds of enzymes
  - Stored in zymogen granules
  - Grape-like arrangement
- Enzymes to duodenum, where activated

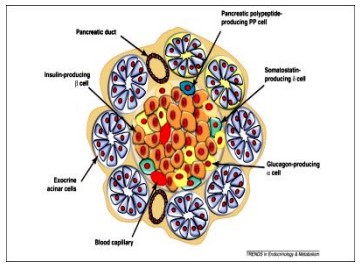
Pancreatic acinar cells (exocrine)

Endocrine cells:

α (glucagon-producing) cells

β (insulin-producing) cells

Pancreatic islet (of Langerhans)



- **Multicellular glands are also classified**

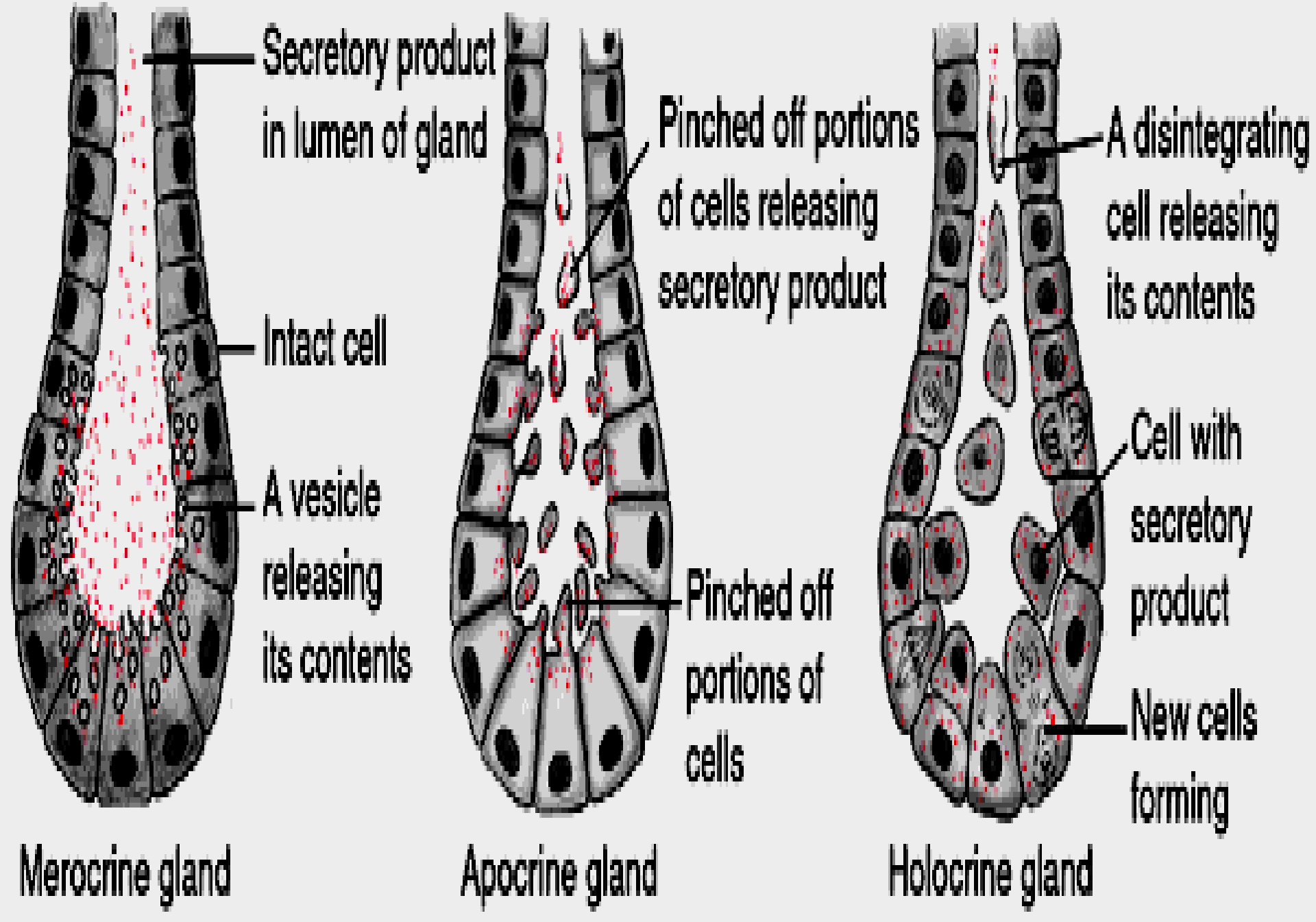
  -according to the means by which they release their product.

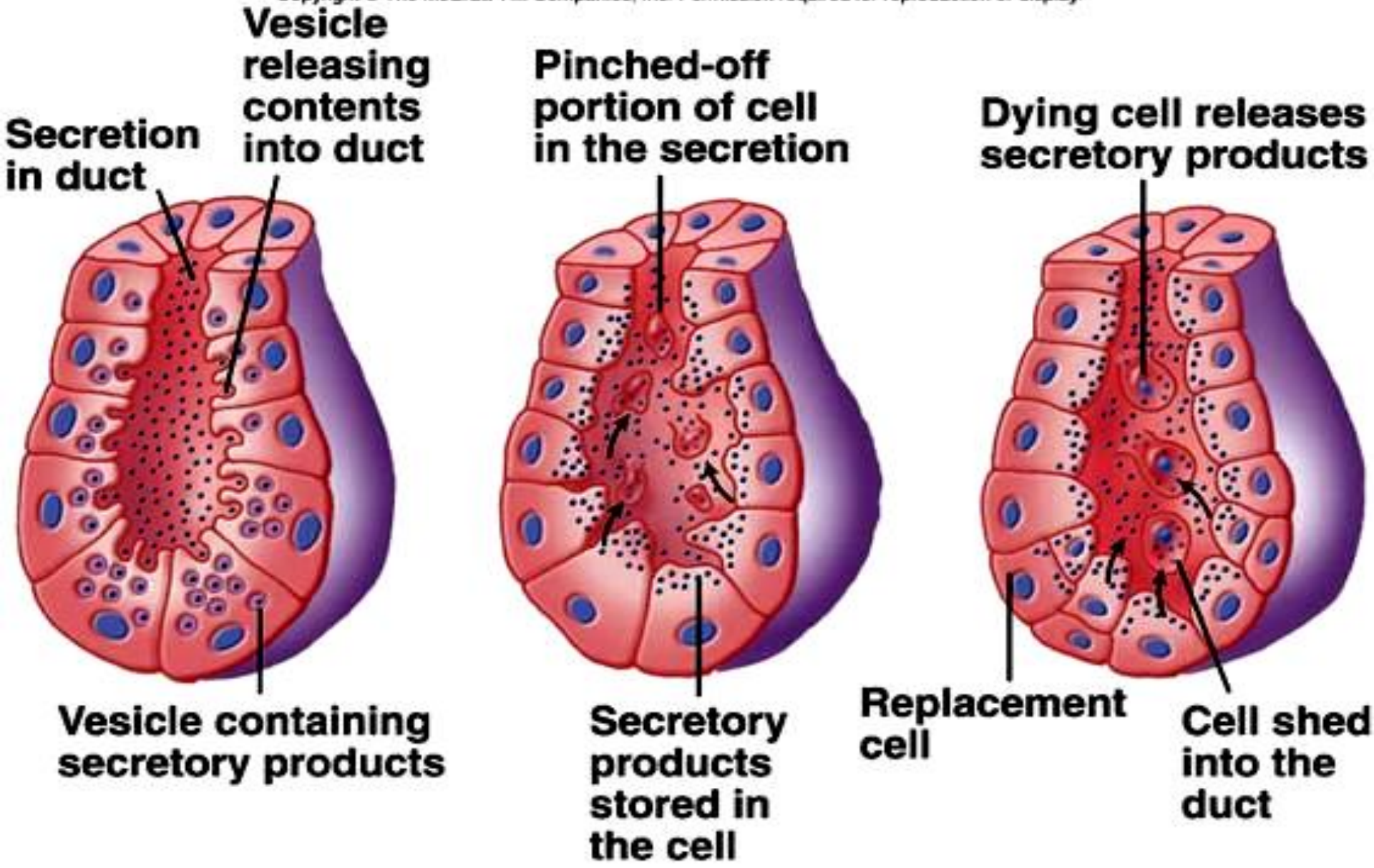
- **They are**

  - Merocrine glands,

  - Apocrine glands,

  - holocrine glands.

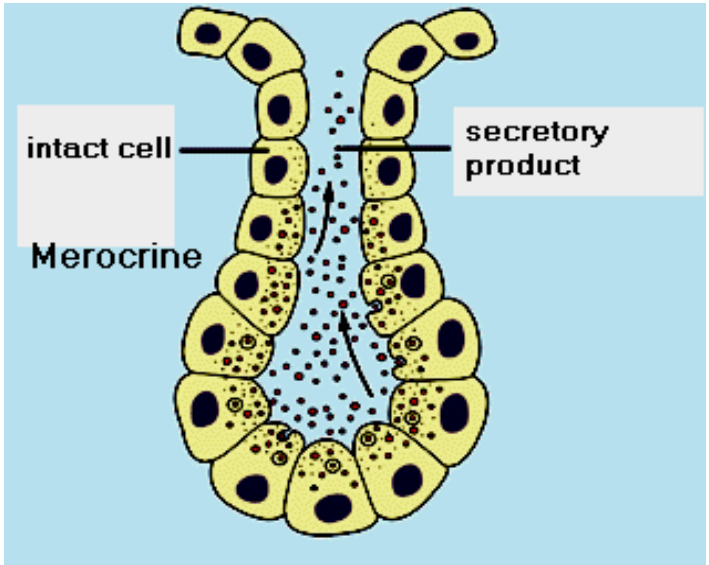

Secretory product in lumen of gland
Intact cell
A vesicle releasing its contents
Merocrine gland
Pinched off portions of cells releasing secretory product
Pinched off portions of cells
Apocrine gland
A disintegrating cell releasing its contents
Cell with secretory product
New cells forming
Holocrine gland

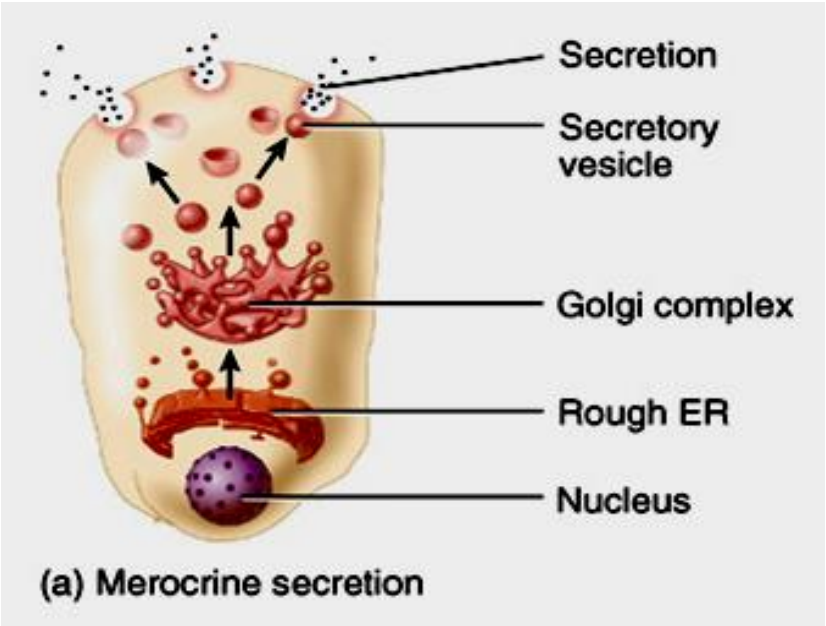


1.Merocrine glands

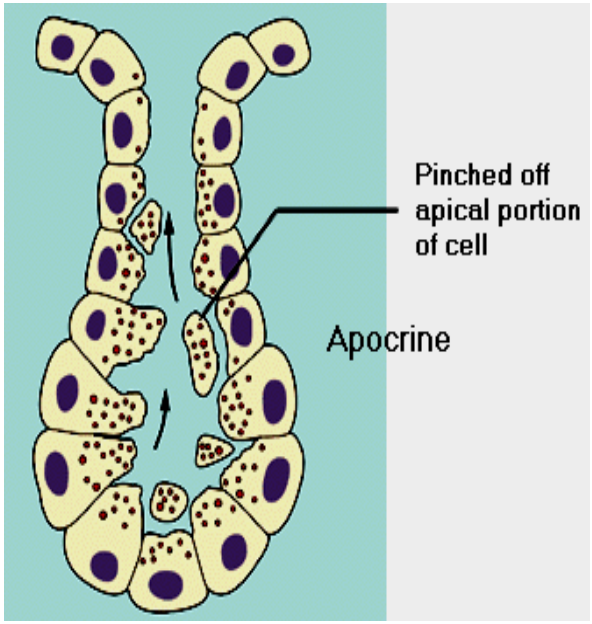
- are those that secrete a **watery substance** through the cell membrane of the secretorycells.

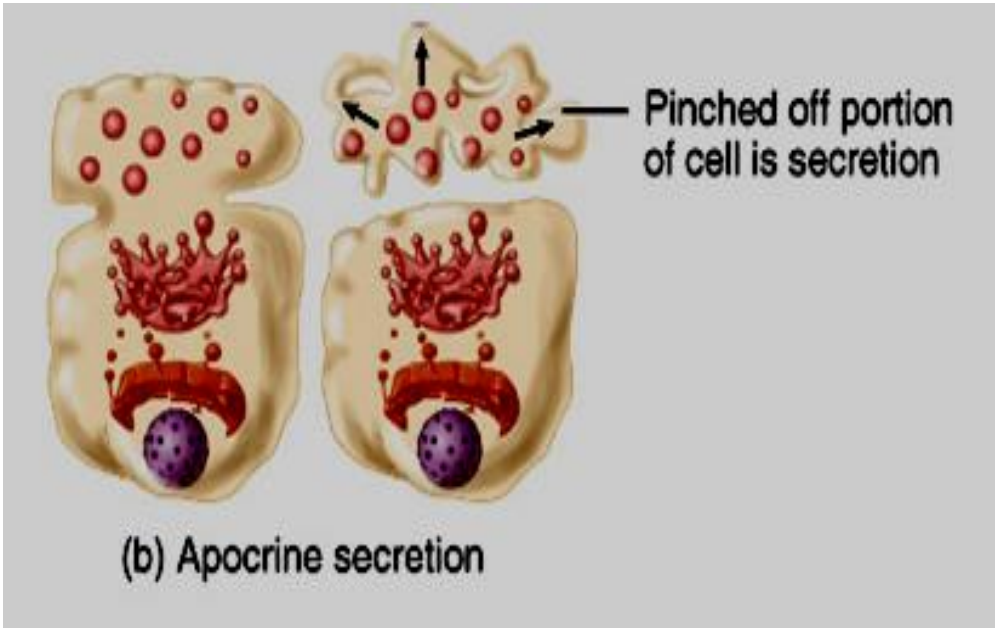
- Salivary glands , pancreatic glands , and certain sweat glands are of this type.

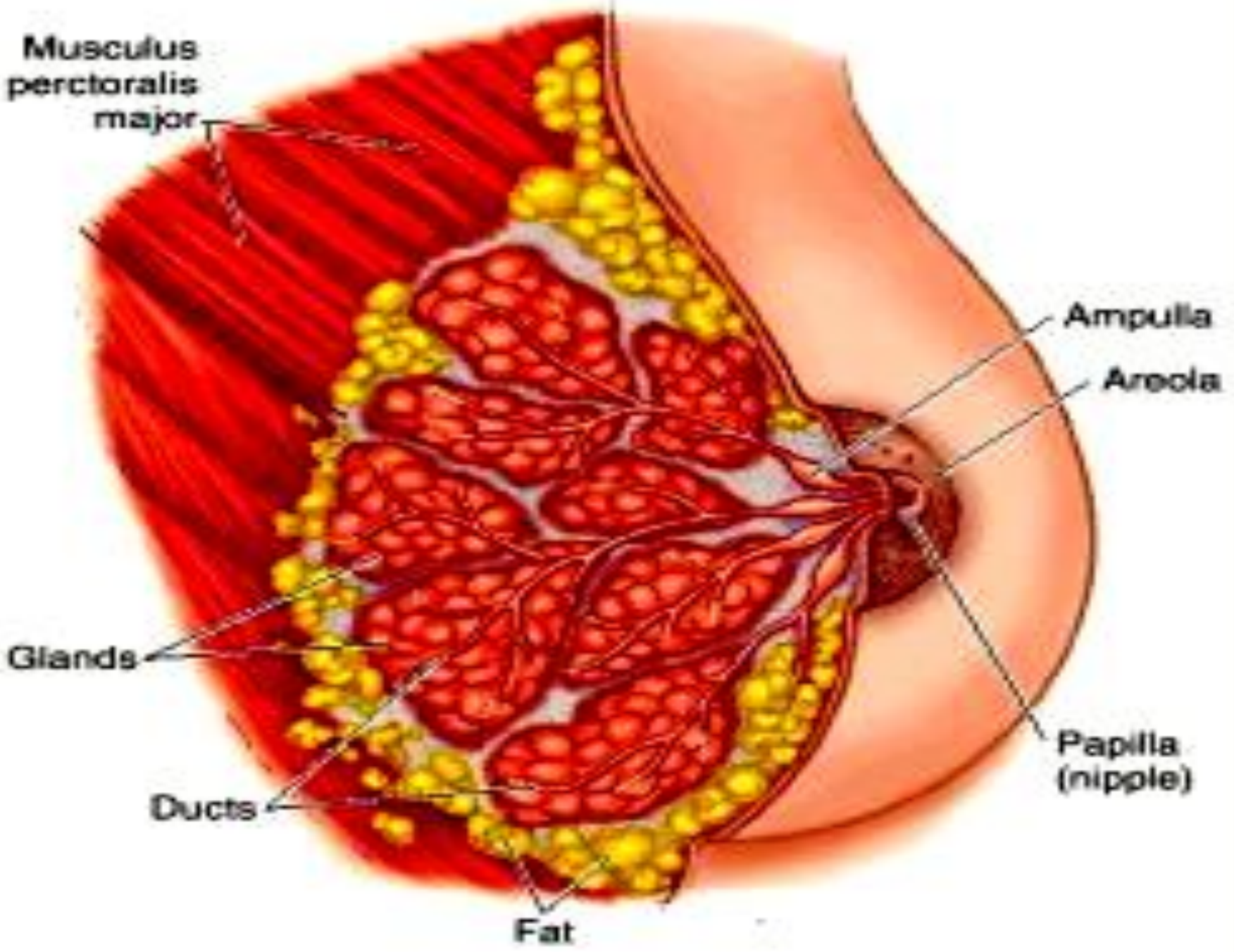




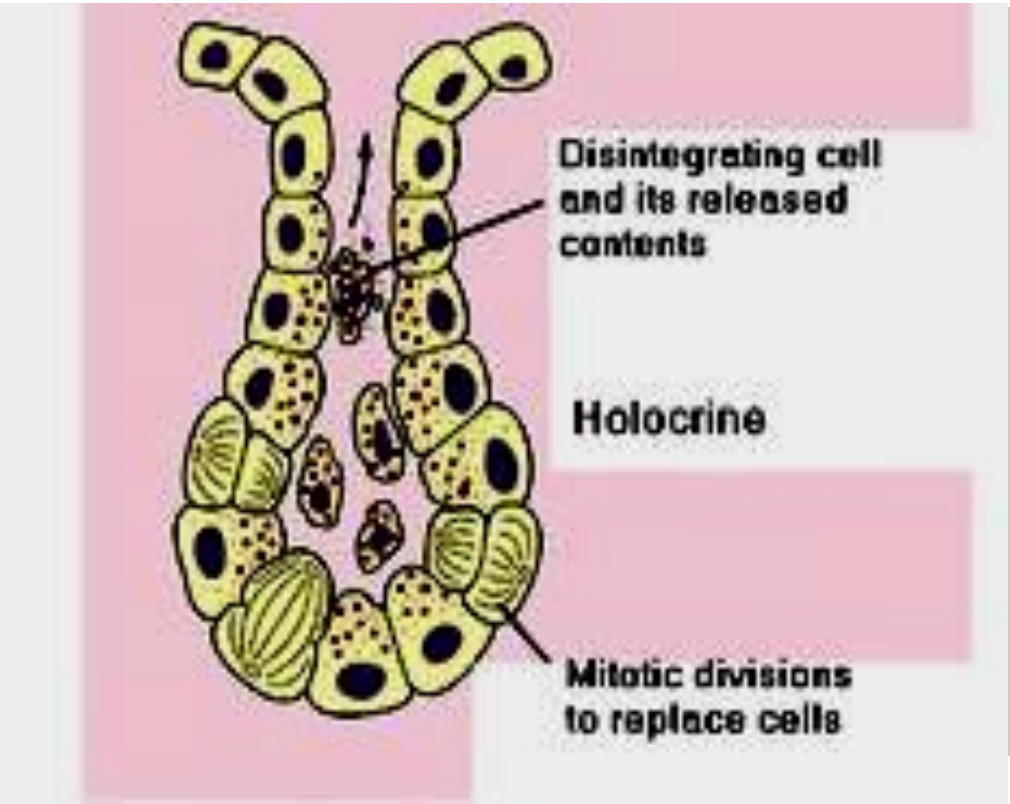
- **2. Apocrine glands are those in which the secretion accumulates on the surface of the secretory cells ; then, a portion of the cell and the secretion is pinched off and discharged.**
- **An example of a apocrine gland is mammary gland.**

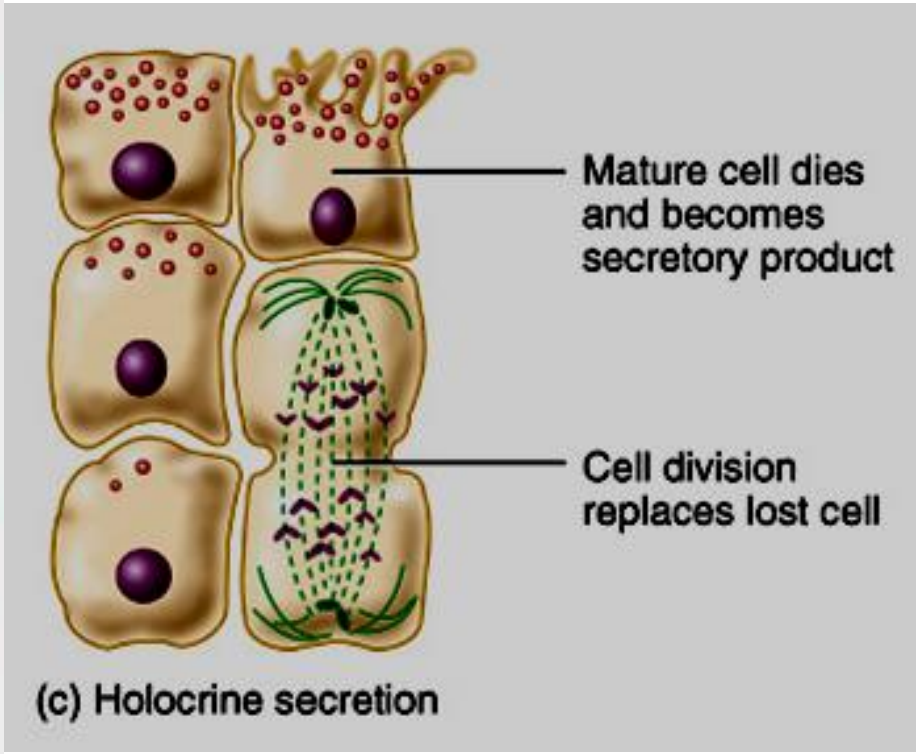


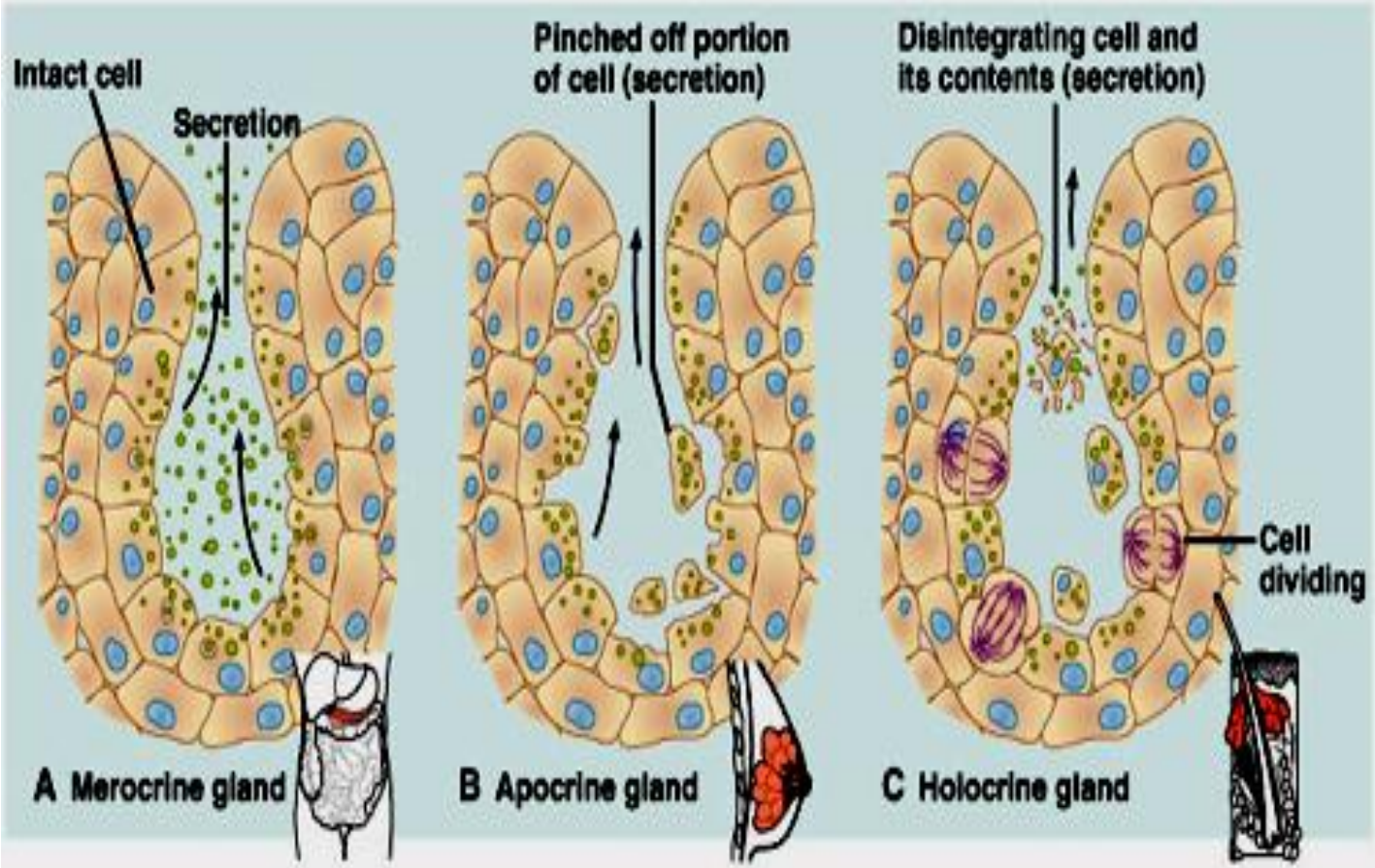



Musculus
perctoralis
major
Ampulla
Areola
Glands
Papilla
(nipple)
Ducts
Fat

- **<u>3. Holocrine glands</u> are those in which the entire secretory cell and its product are discharged.**
- **An example of a holocrine glands is an oil secreting (sebaceous)glands of the skin.**







Connective Tissue

- **Connective Tissue is dived into subtypes –**

  -according to the characteristics of the matrix

  - that binds the cells.

- **Connective Tissue provides**

  - structural support

  - metabolic support

  } **for other tissues and organs of the body.**

Functions of Connective Tissue

- binding of organs – tendons and ligaments
- support – bones and cartilage
- physical protection – cranium, ribs, sternum
- immune protection – white blood cells attack foreign invaders
- movement – bones provide lever system
- storage – fat, calcium, phosphorus
- heat production – metabolism of brown fat in infants
- transport - blood

Cell types	Main product or activity	Main function
Fibroblast	Production of fibers and ground subst.	Structural
Plasma cell	Production of antibody	Immunologic
Lymphocyte	Production of immunocompetent cell	Immunologic
Eosinophil	Phagocytosis of Ag-Ab complex	Immunologic
Macrophage & Neutrophil	Phagocytosis of foreign subst. & bacteria	Defense
Mast cell & Basophil	Liberation of histamine	Defense
Adipose	Storage of neutral fat, heat production	Energy reservior; heat production

- **Connective Tissue is**

  - the most abundant tissue in the body.

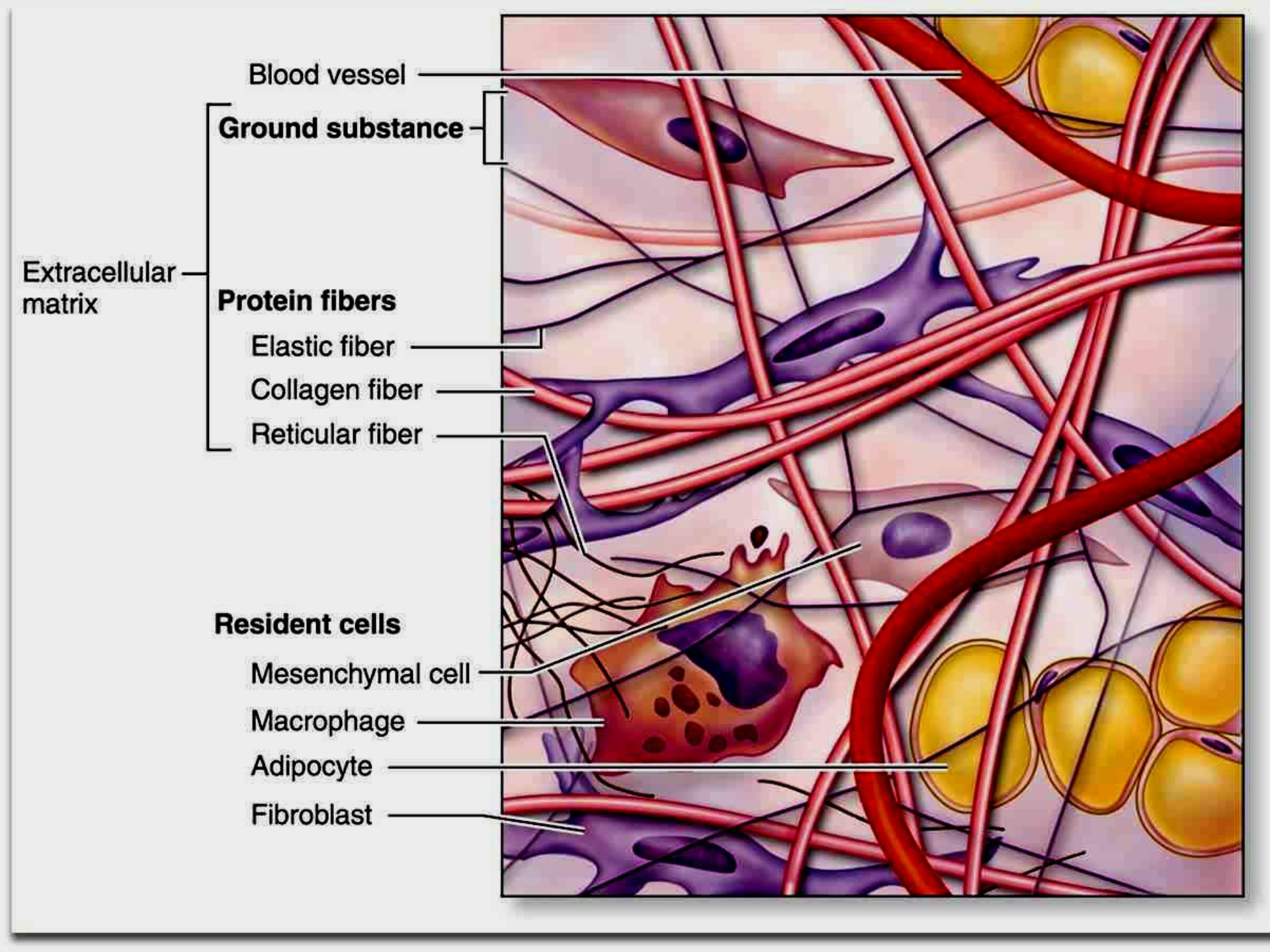
- **It supports or binds other tissues and organs**

  - provides for the metabolic needs of all body organs.

- **Unlike epithelial tissue which is composed of tightly fittest cells,**

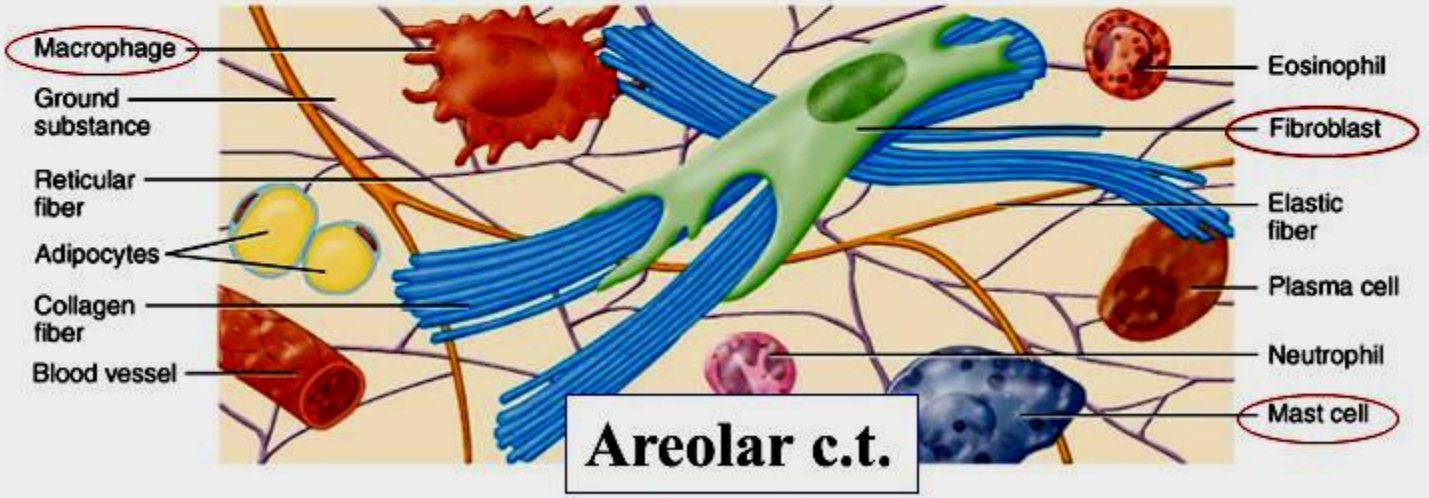
  - considerable more matrix than cells.

- **rarely touch an another at all.**

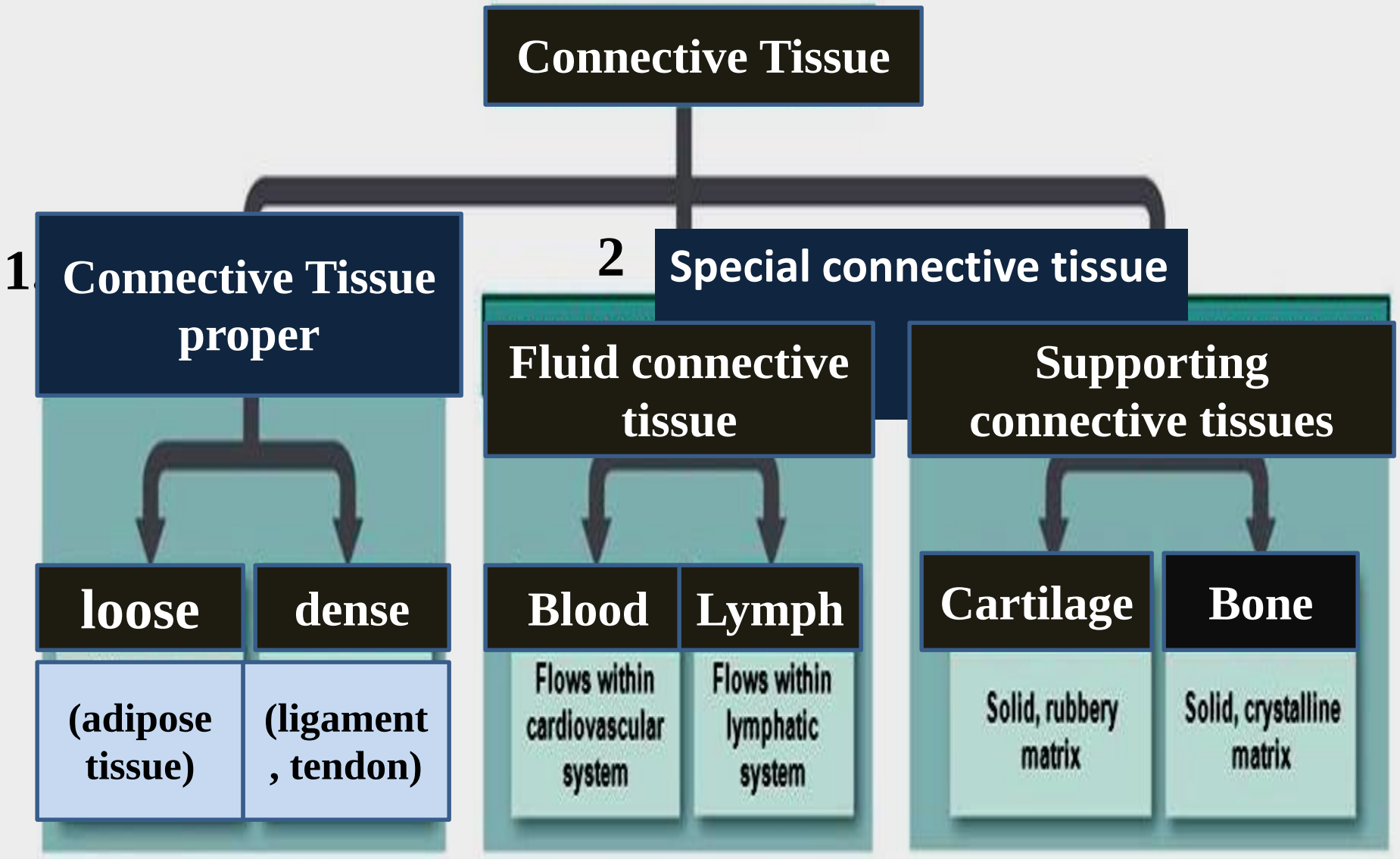

Blood vessel
Ground substance
Extracellular matrix
Protein fibers
Elastic fiber
Collagen fiber
Reticular fiber
Resident cells
Mesenchymal cell
Macrophage
Adipocyte
Fibroblast

Connective Tissues

- Cells rarely touch due to usually large amount of intercellular material (extracellular **matrix**)
- Matrix(fibers & ground substance) secreted by cells
- Consistency varies from liquid or gel to solid
- Function is to support, connect, protect and insulate
- Good nerve & blood supply except cartilage & tendons



What are the three major cell types often found in connective tissues, and what are their functions?


Connective Tissue
1
Connective Tissue proper
2
Special connective tissue
Fluid connective tissue
Supporting connective tissues
loose
dense
Blood
Lymph
Cartilage
Bone
(adipose tissue)
(ligament , tendon)
Flows within cardiovascular system
Flows within lymphatic system
Solid, rubbery matrix
Solid, crystalline matrix

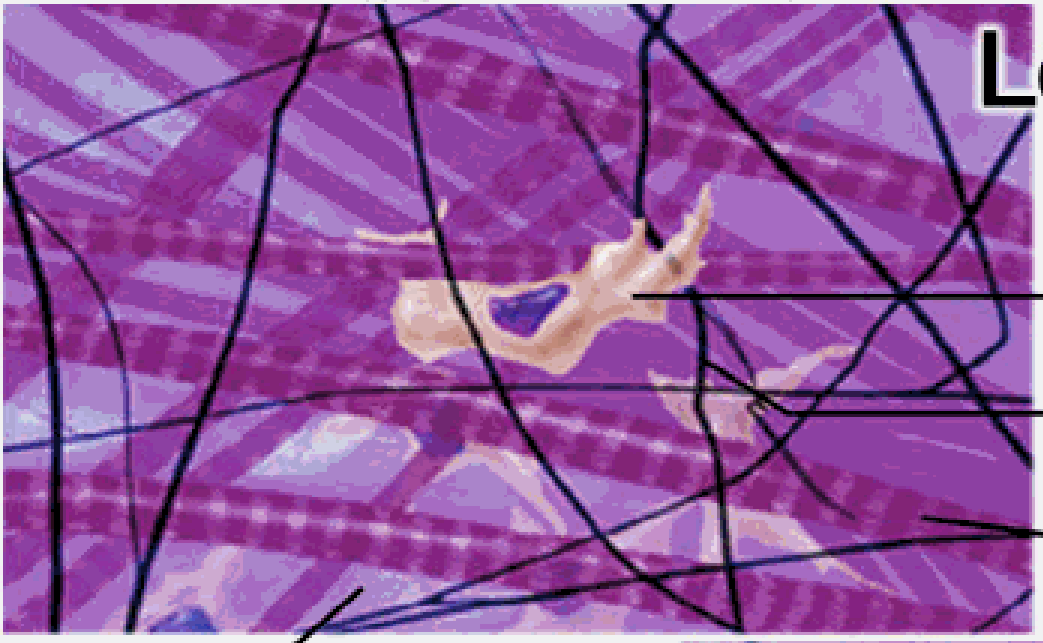
Connective tissue proper

- **Connective tissue proper has**
  - **a loose, flexible matrix,**
  - **frequently called ground substance.**
- **The most common cell within connective tissue proper is called → a fibroblast.**

produced ↓

- **Collagenous fibers**
- **Elastic fibers**
- **Reticular fibers**

Loose Connective Tissue

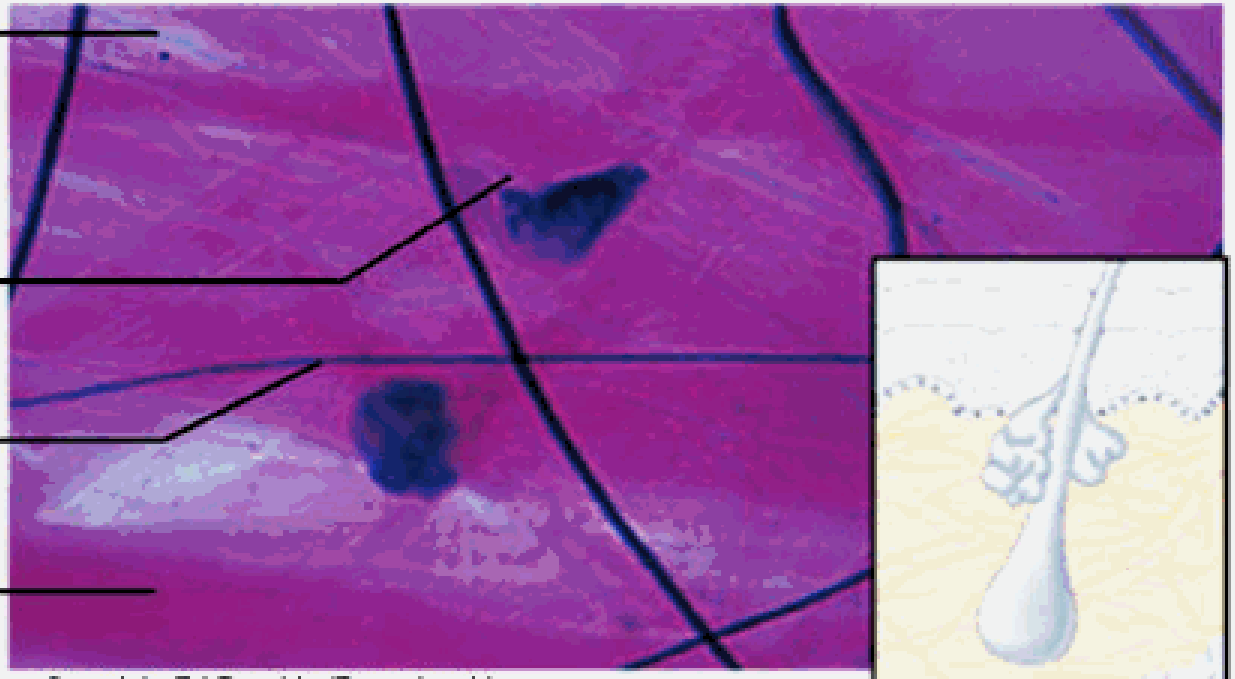


Fibroblast

Elastic fiber

Collagenous fiber

Ground substance



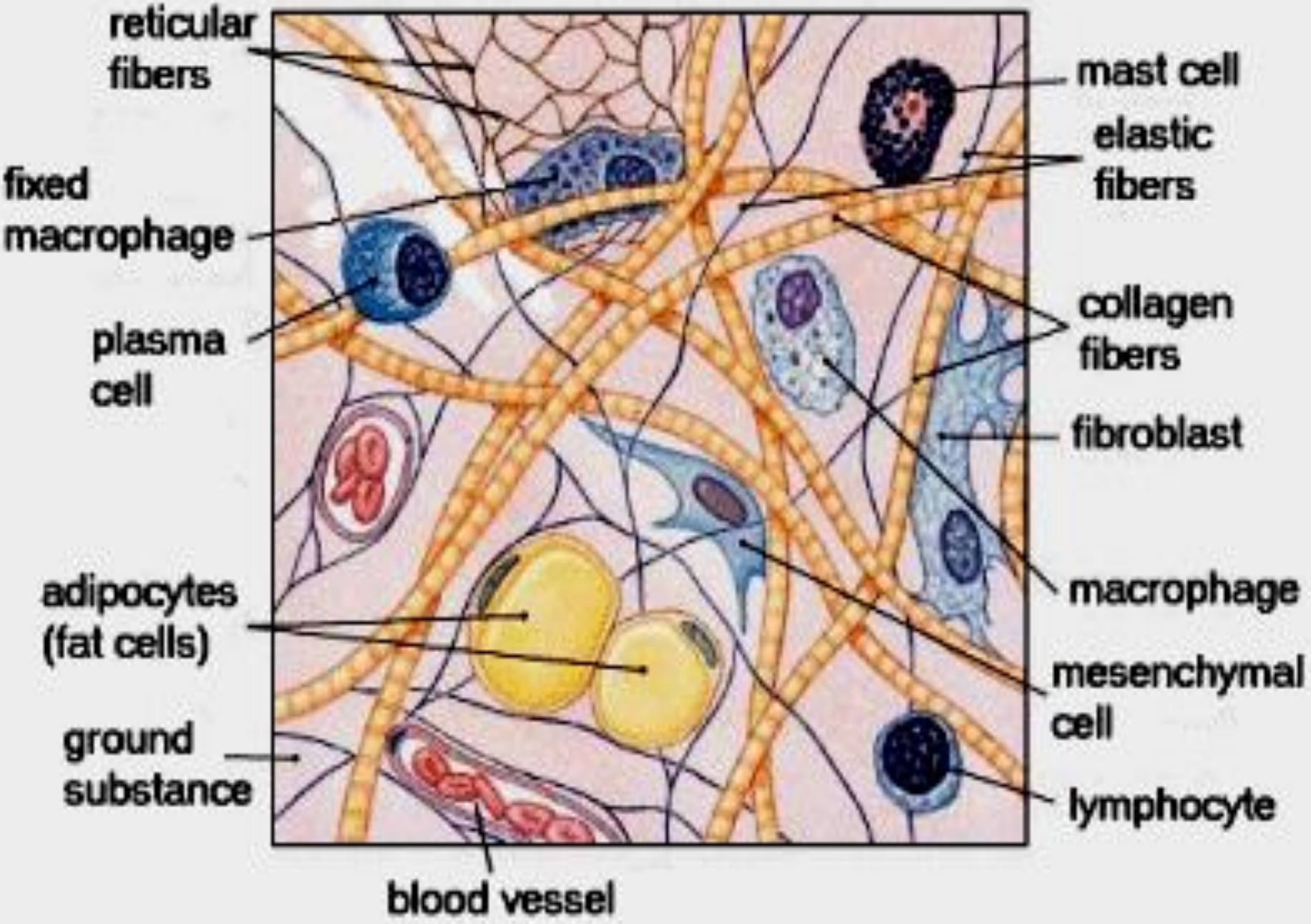
Fibroblast

Elastic fiber

Collagenous fiber

- **Reticular fibers are composed of**

- a protein reticulin form a lattice-like framework


reticular fibers
fixed macrophage
plasma cell
adipocytes (fat cells)
ground substance
blood vessel
mast cell
elastic fibers
collagen fibers
fibroblast
macrophage
mesenchymal cell
lymphocyte

Adipose Tissue

- **Contain large number of adipose cells, adipocytes.**
- **The cell store fat within their cytoplasm, causing swell and forcing their nuclei to one side.**

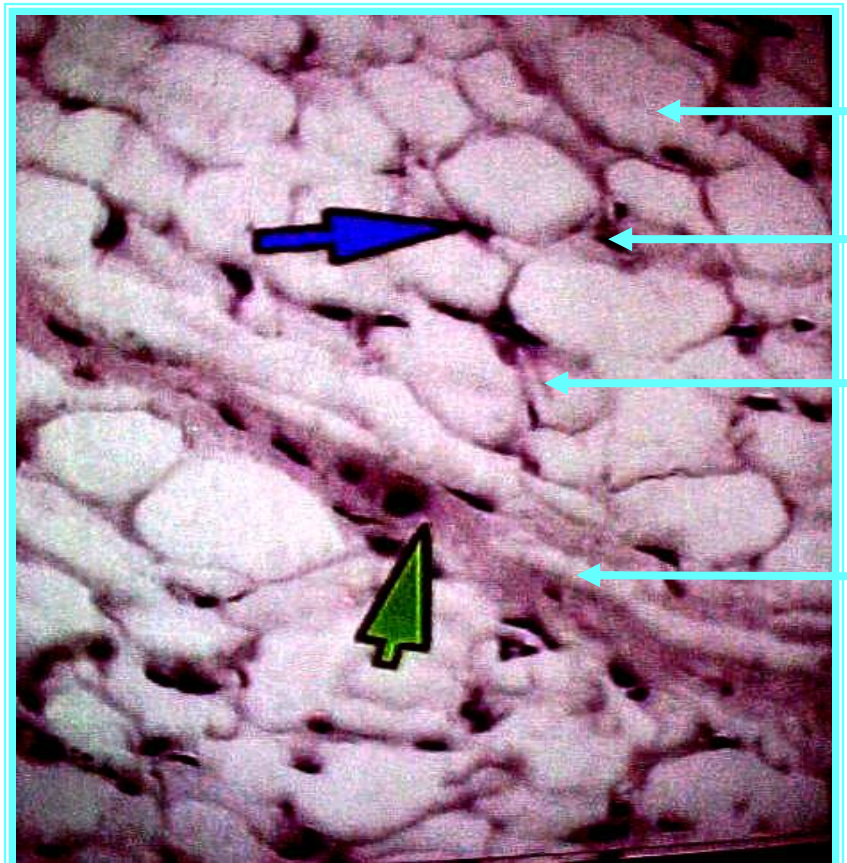


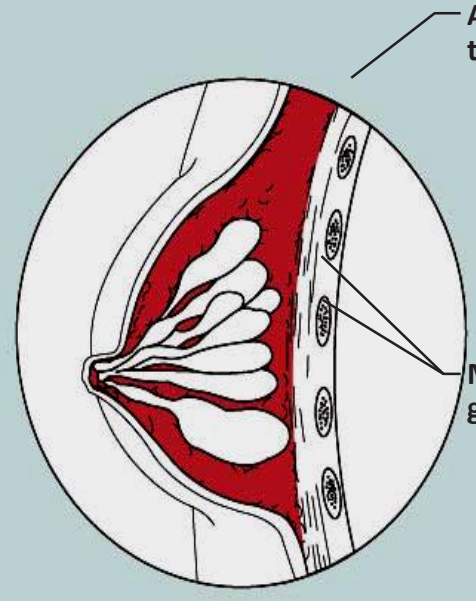
Figure 4.8b Connective tissues.

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

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

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

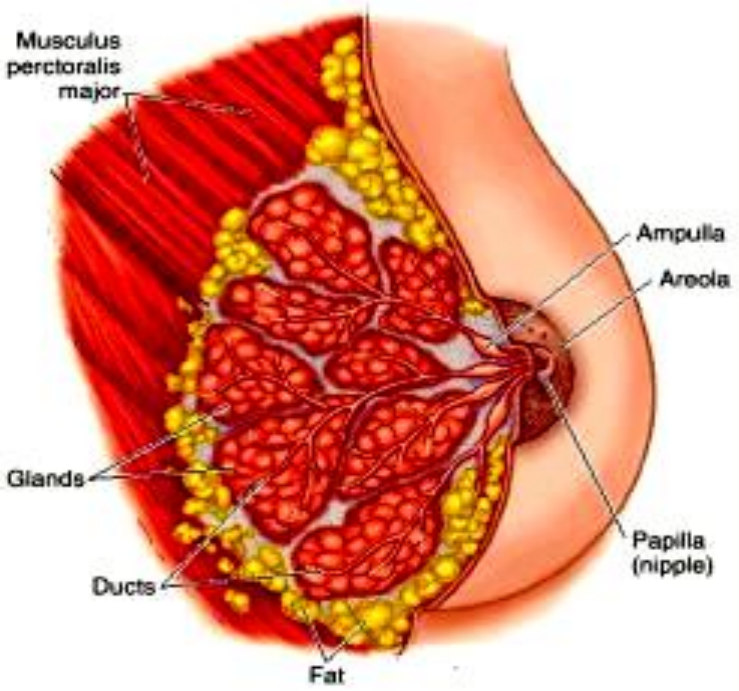
Location: Under skin in the hypodermis; around kidneys and eyeballs; within abdomen; in breasts.



Photomicrograph: Adipose tissue from the subcutaneous layer under the skin (350x).

- **Adipose tissue is found**

  - **beneath the skin,**
  - **around the kidneys,**
  - **on the surface of the heart,**
  - **surrounding joints,**
  - **in the breast of mature females.**



- **Functions not only as a food reserve,**

  - but also to support

  - and protect various organs.

- **It helps to keep the body warm.**

There are three types of cartilages

-distinguished from one another by the type & amount of fibers embedded within the matrix

a. **Hyaline cartilage**
b. **Fibro cartilage**
c. **Elastic cartilage**

2. Cartilage

Structure - **Cartilage cells (chondrocytes)**

- **Tiny spaces (lacunae)**

Function - **Support and protection**

Three Types of cartilage

(type & amount of fibers embedded within the matrix)

a. **Hyaline cartilage**

b. **Fibrocartilage**

c. **Elastic Cartilage**

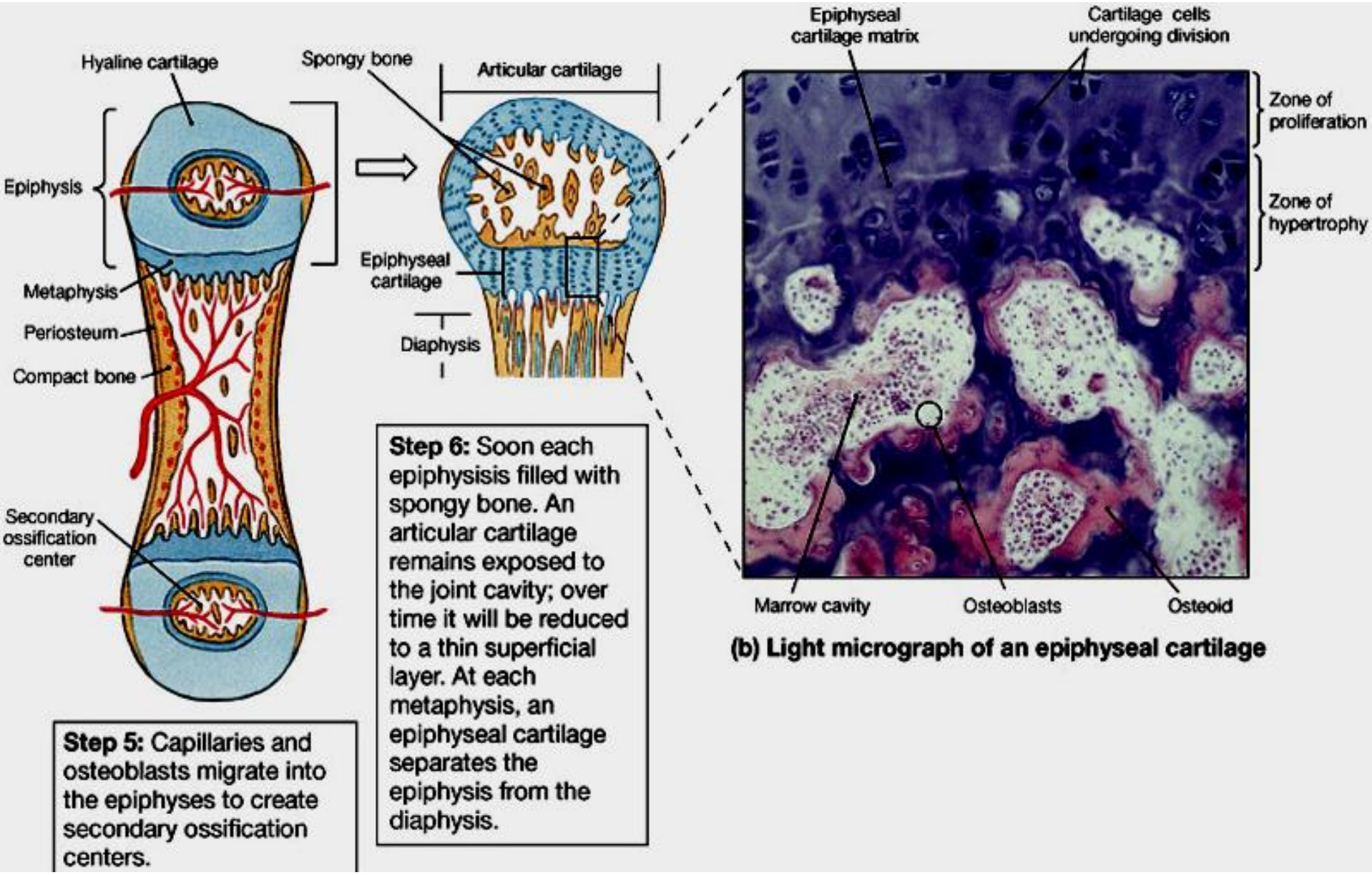
Hyaline cartilage

- **Hyaline cartilage has matrix that gives it a glassy appearance.**
- **Located in**

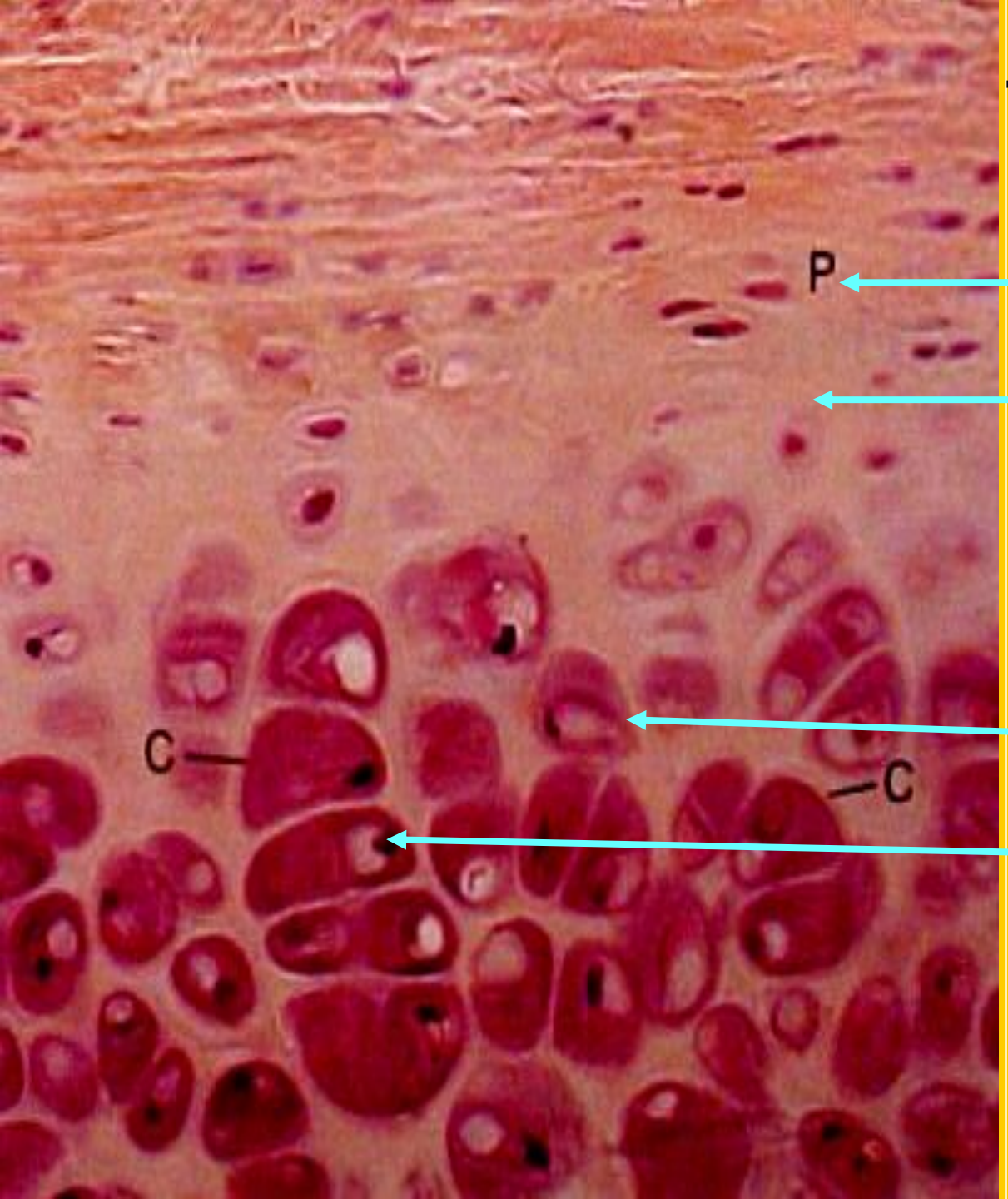
- the respiratory tract,

- rib cage, and

- developing bone.


Hyaline cartilage
Spongy bone
Articular cartilage
Epiphysis
Epiphyseal cartilage
Metaphysis
Periosteum
Diaphysis
Compact bone
Secondary ossification center
Epiphyseal cartilage matrix
Cartilage cells undergoing division
Zone of proliferation
Zone of hypertrophy
Marrow cavity
Osteoblasts
Osteoid
(b) Light micrograph of an epiphyseal cartilage
Step 5: Capillaries and osteoblasts migrate into the epiphyses to create secondary ossification centers.
Step 6: Soon each epiphysisis filled with spongy bone. An articular cartilage remains exposed to the joint cavity; over time it will be reduced to a thin superficial layer. At each metaphysis, an epiphyseal cartilage separates the epiphysis from the diaphysis.

Hyaline cartilage



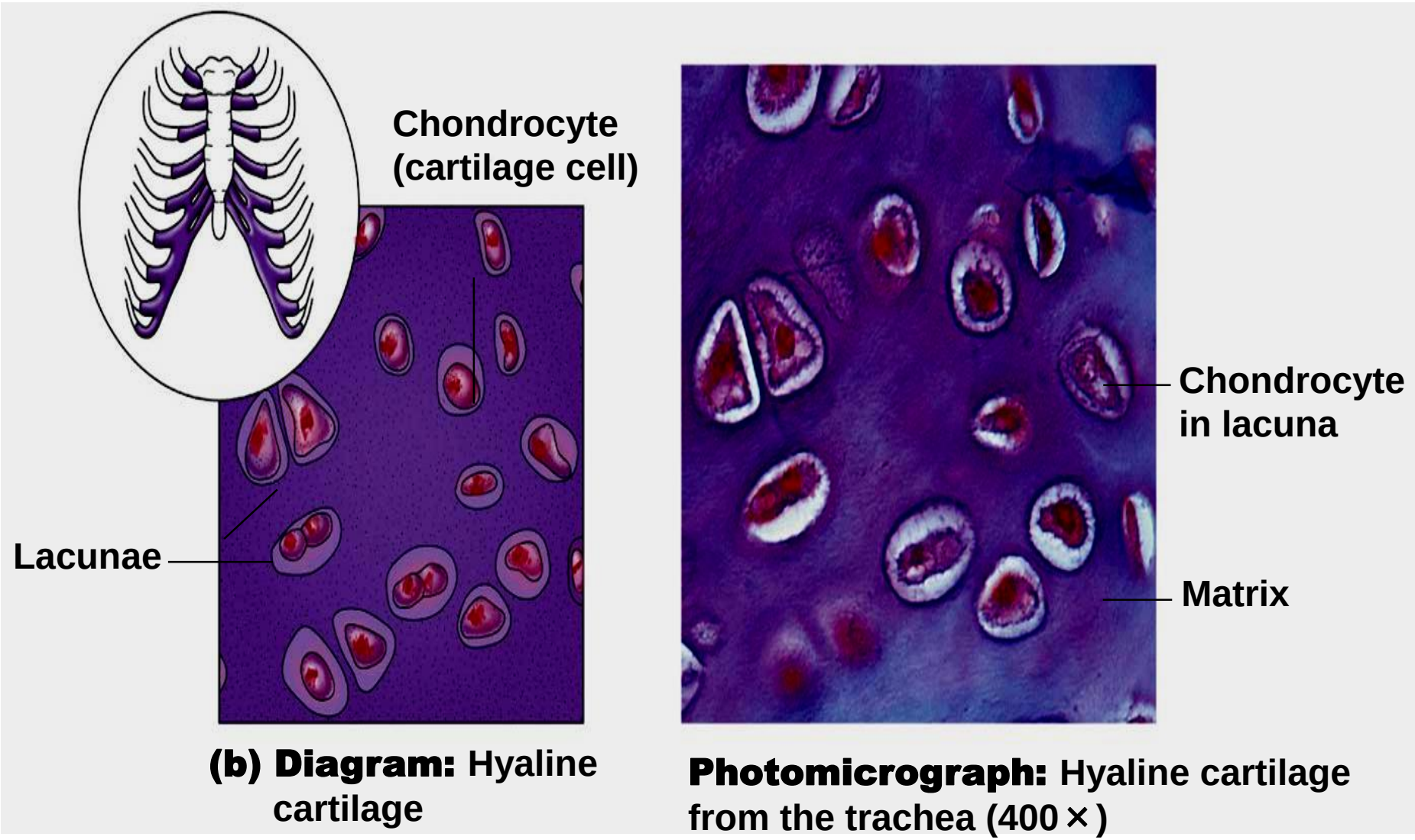
Perichondrium

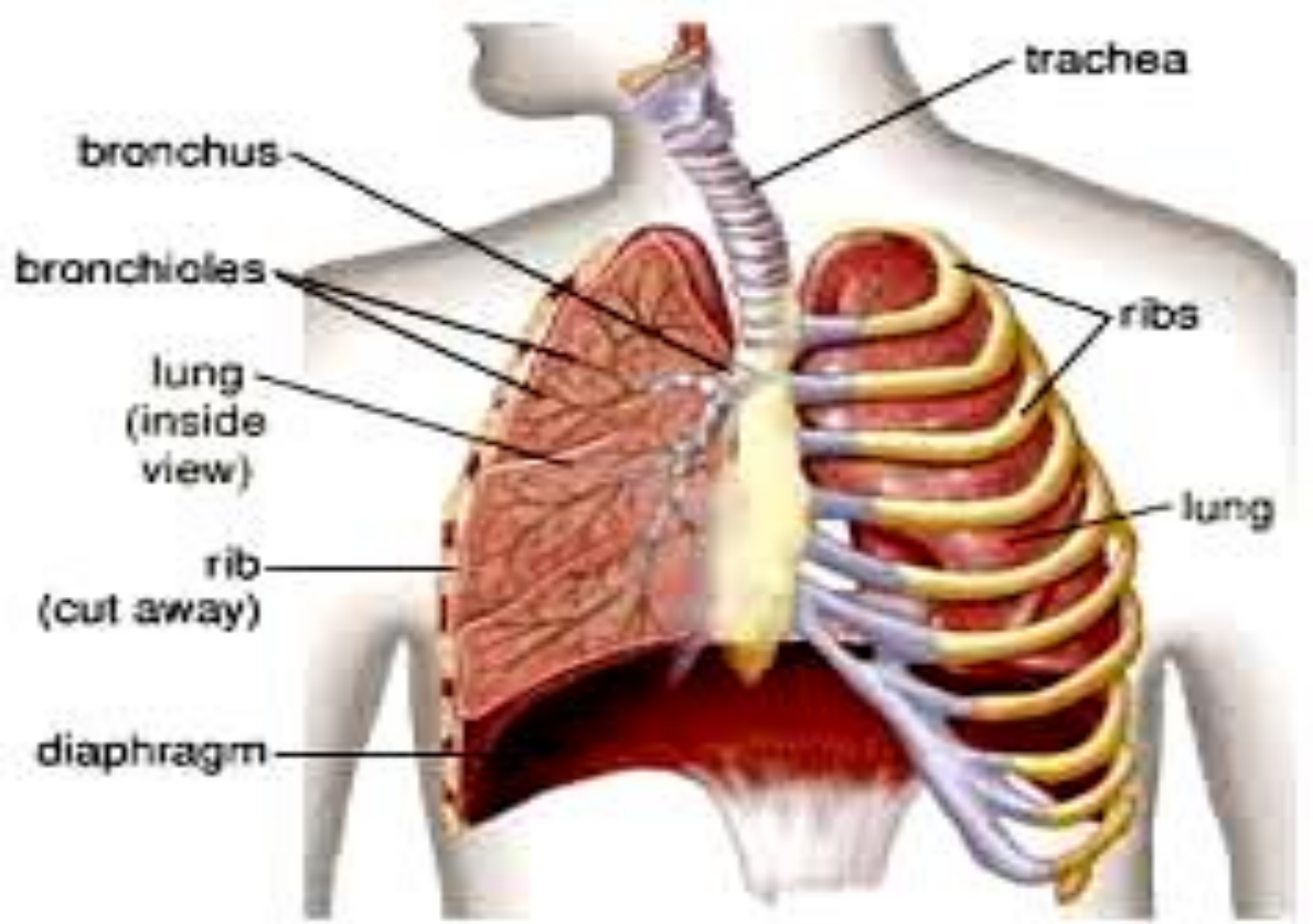
Chondrin matrix

Lacuna

Cartilage cell in lacuna

Figure 3.19b Connective tissues and their common body locations.

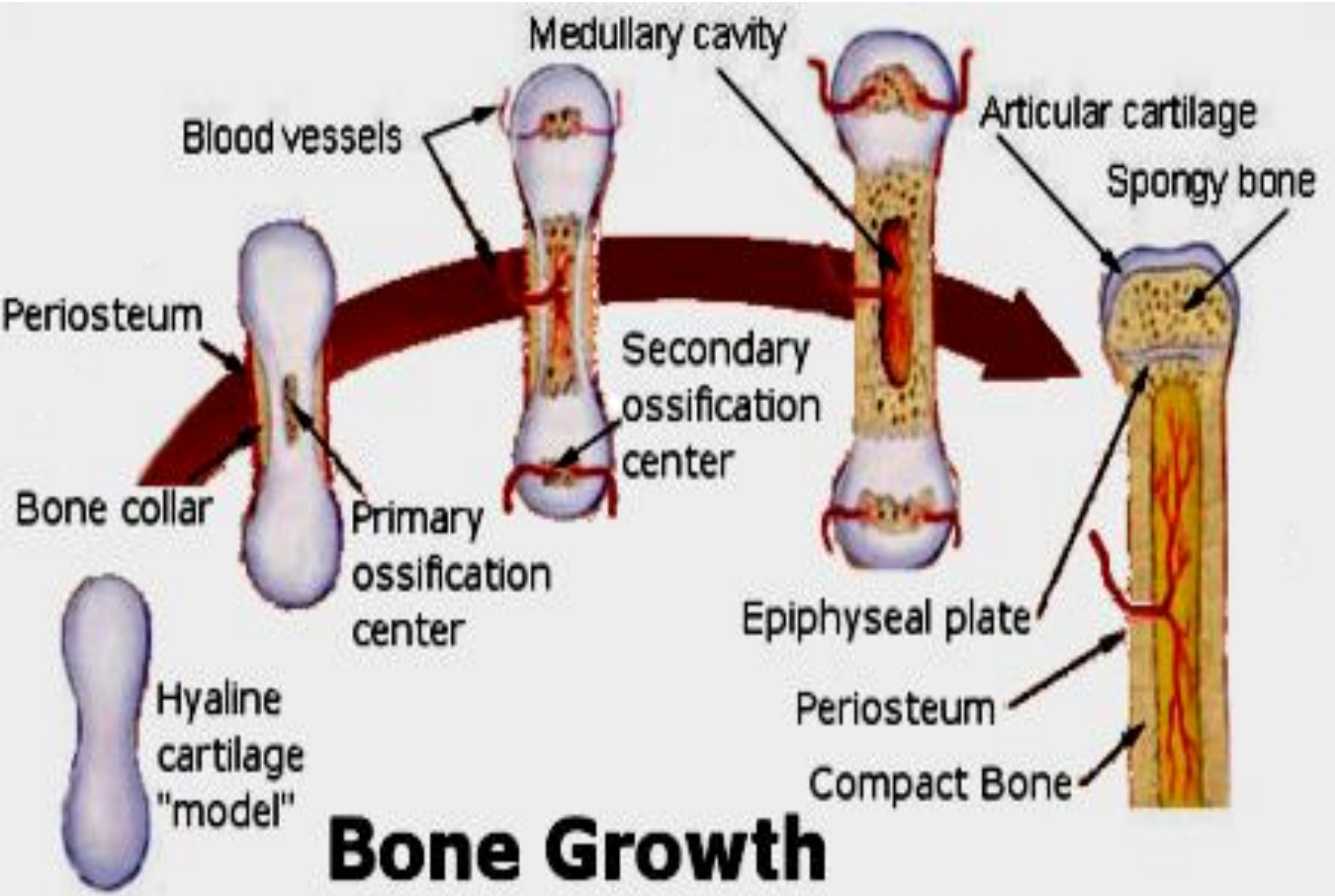




Fibrocartilage

- **has a matrix reinforced with many collagenous fibers.**
- **It is a durable tissue**

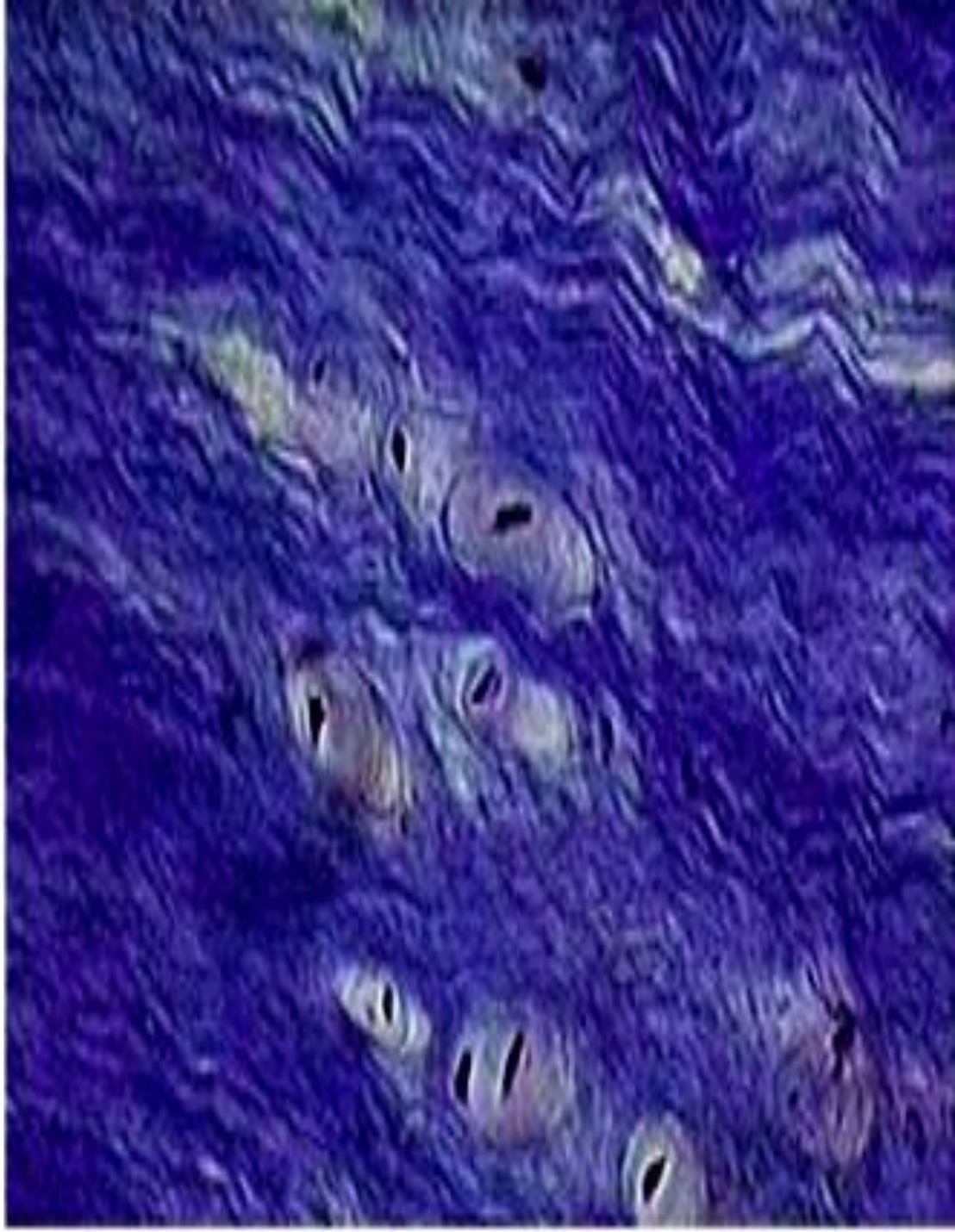
-adapted to withstand tension and developing bone.

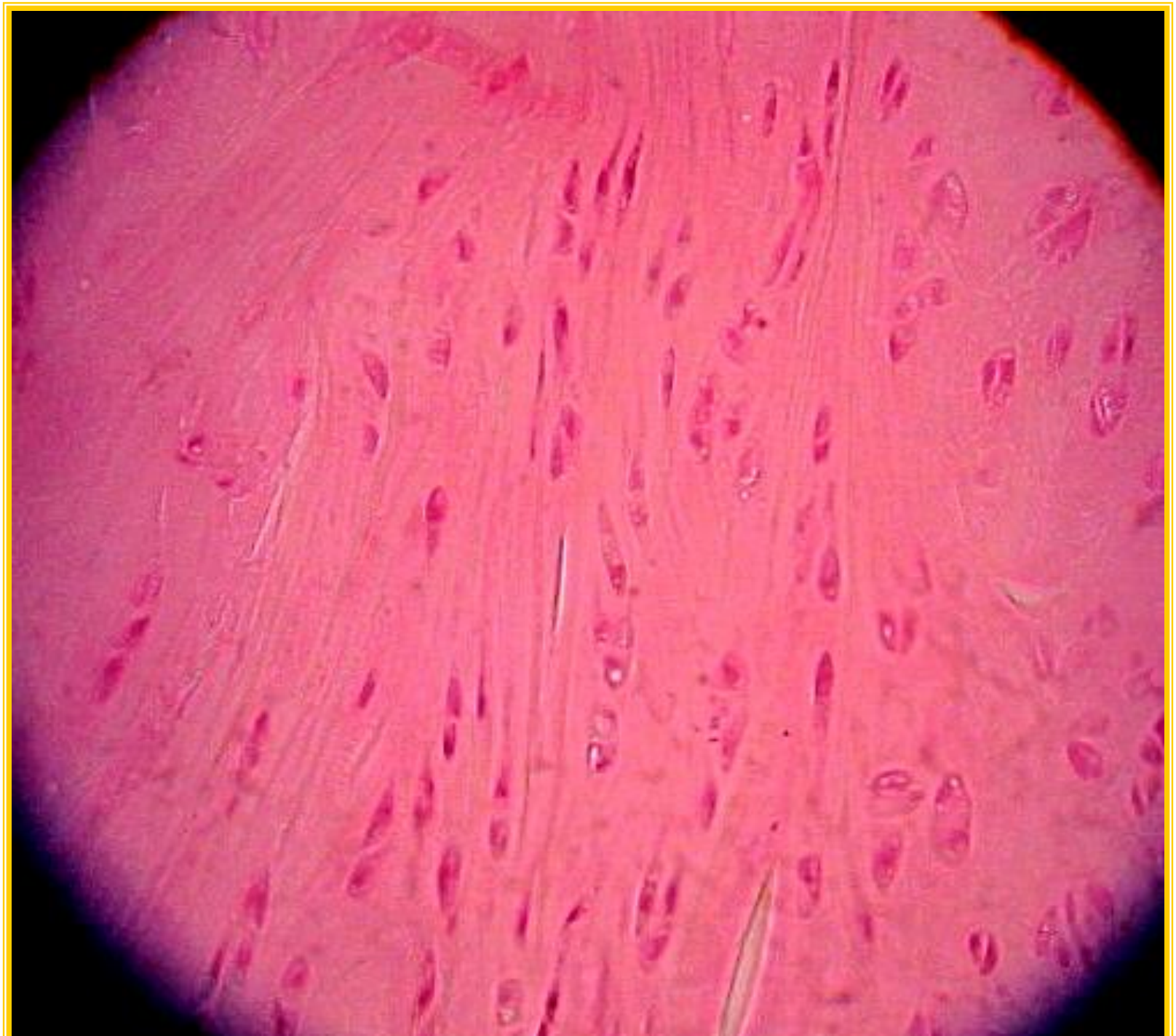

Medullary cavity
Blood vessels
Articular cartilage
Spongy bone
Periosteum
Secondary ossification center
Bone collar
Primary ossification center
Epiphyseal plate
Periosteum
Compact Bone
Hyaline cartilage "model"

Bone Growth

Fibrocartilage

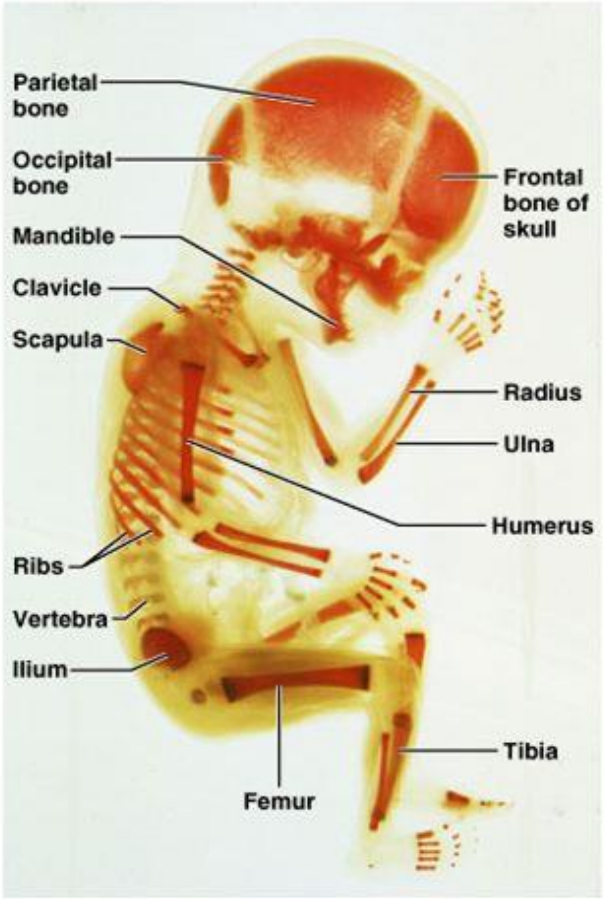
- Fibrocartilage is quite similar to hyaline cartilage but its matrix contains many coarse collagen fibers running parallel to each other.
- It is found in pubic symphysis , intervertebral discs and the menisci of knees.
  - Functions:
    1. Resists compression
    2. Prevents bone-to-bone contact





Cartilage

- Embryo
  - More prevalent in the embryo than in adult
  - Skeleton is initially mostly cartilage
  - Bone replaces cartilage in fetal and childhood periods
  - 3 types: hyaline, elastic and fibrocartilage



So what is cartilage? It is a connective tissue which has differing properties, depending on it's function. Hyaline cartilage lines the ends of bones and cushions them. The hyaline wears better than bone.

Elastic cartilage is still but will bend and return to it's original shape.

Fibrocartilage has great tensile strength and can absorb shock.

Fracture Repair Step 3: Bony Callus

- Bony callus formation
  - New spongy bone trabeculae appear in the fibrocartilaginous callus
  - Fibrocartilaginous callus converts into a bony (hard) callus
  - Bone callus begins 3-4 weeks after injury, and continues until firm union is formed 2-3 months later

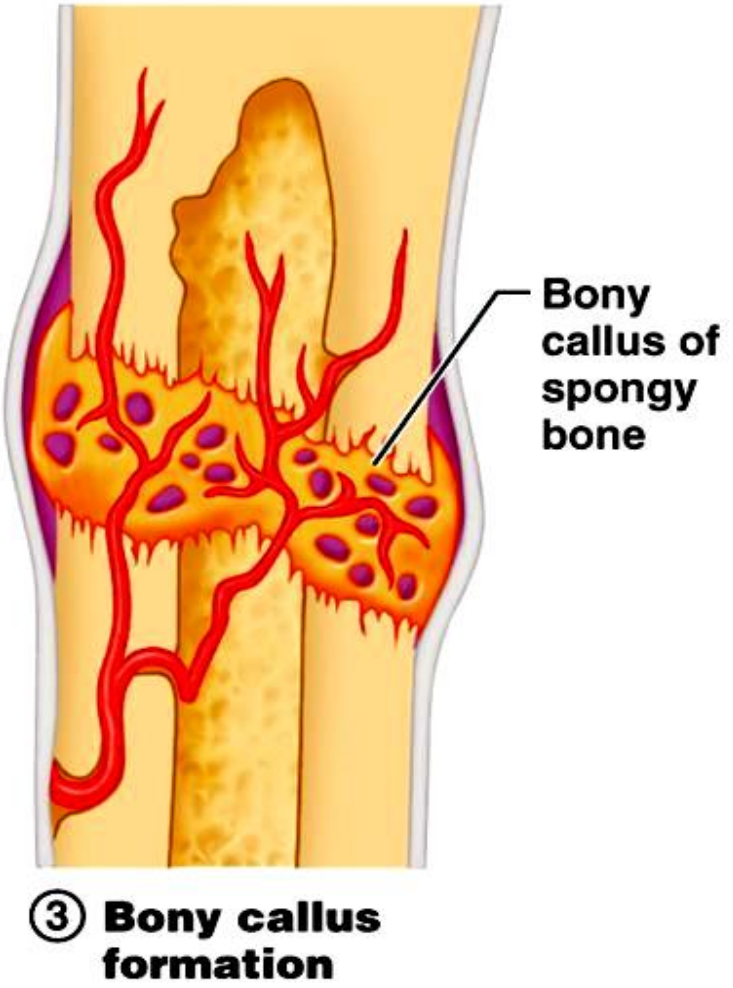


Figure 6.13.3

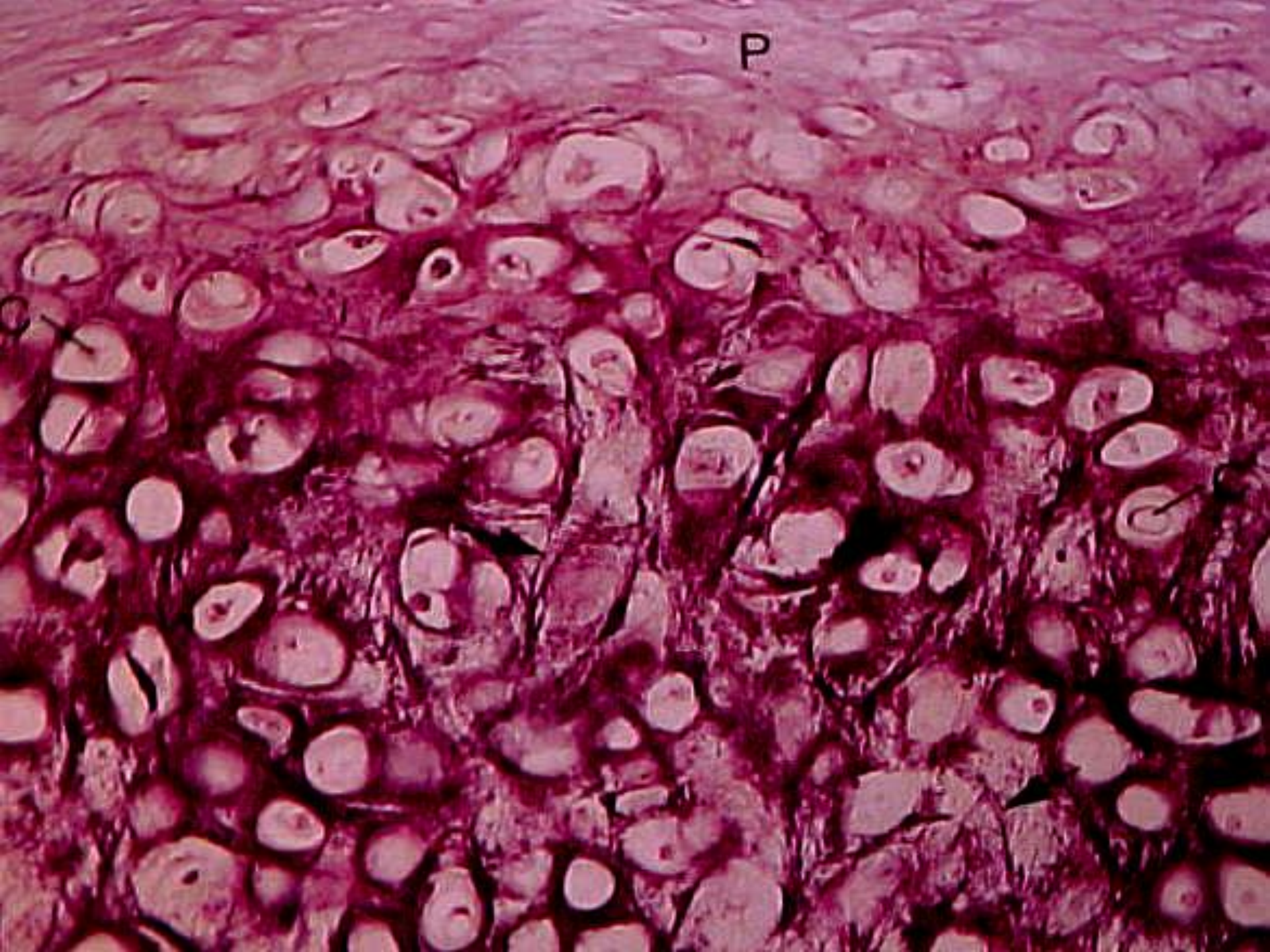
Elastic cartilage

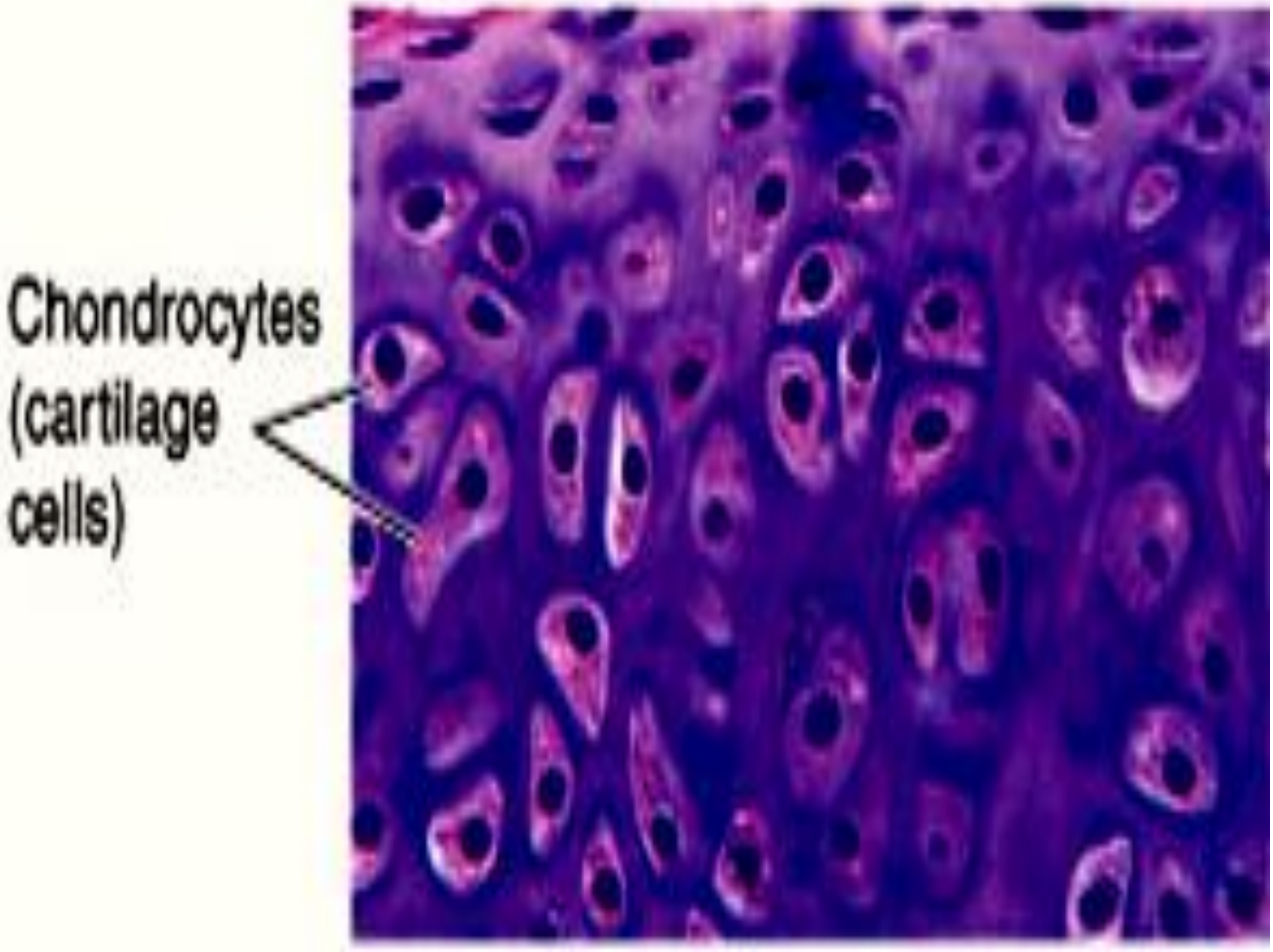
- **Elastic cartilage,**

  - presence of abundant elastic fibers,

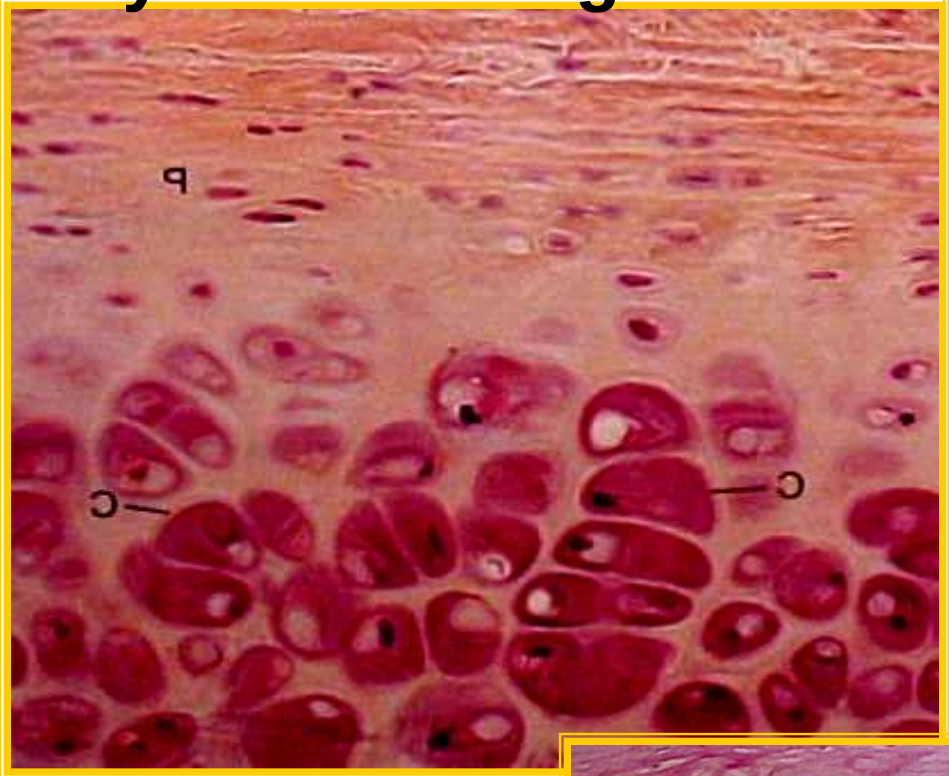
  - which makes very flexible and strong

found in
- **the outer ear (Pinnae),**
- **portions of the larynx &**
- **auditory canal.**

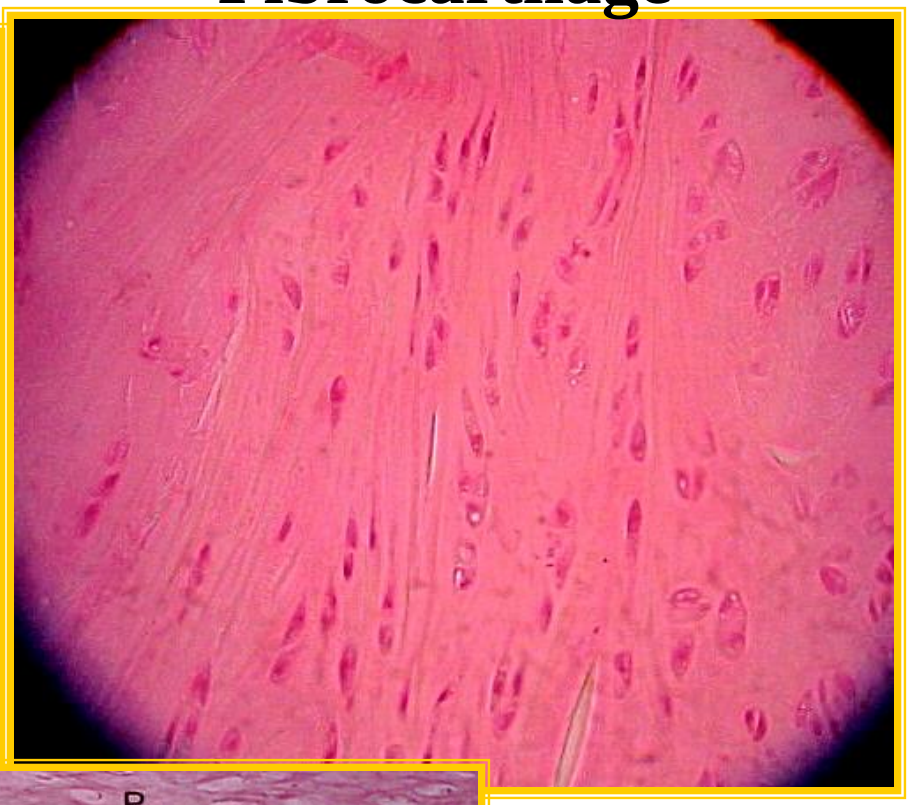

P


Chondrocytes
(cartilage
cells)

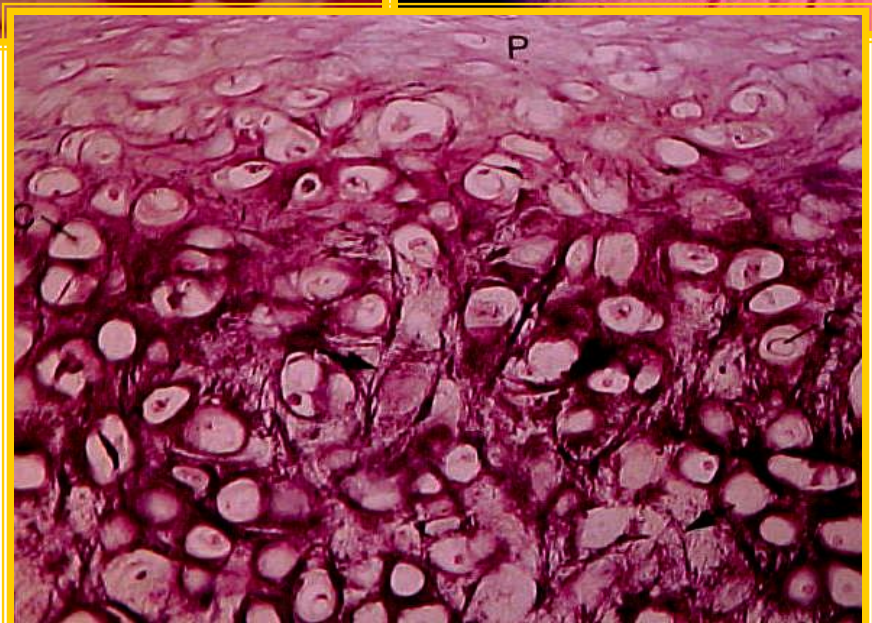
Hyaline cartilage

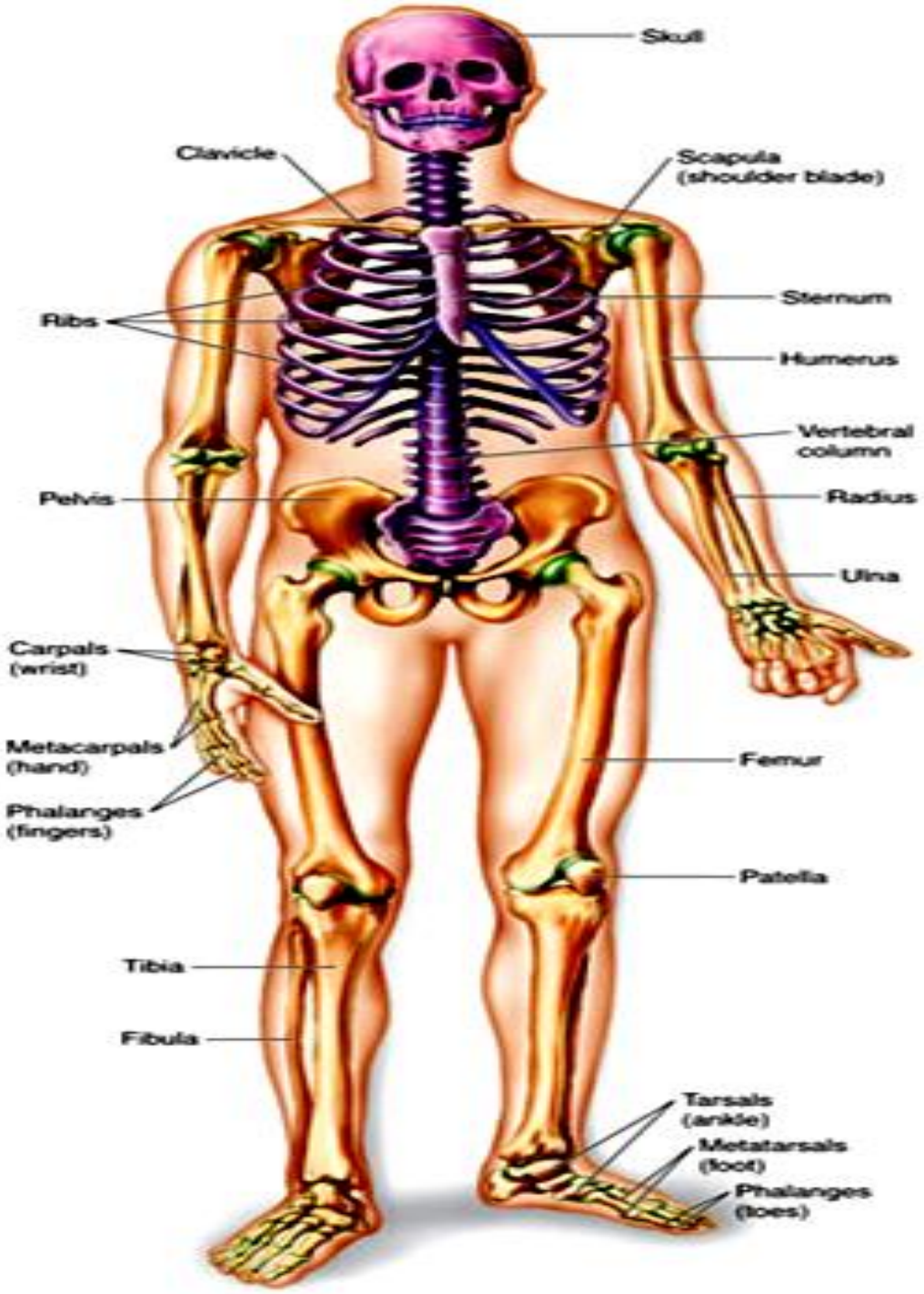


Fibrocartilage



Elastic cartilage



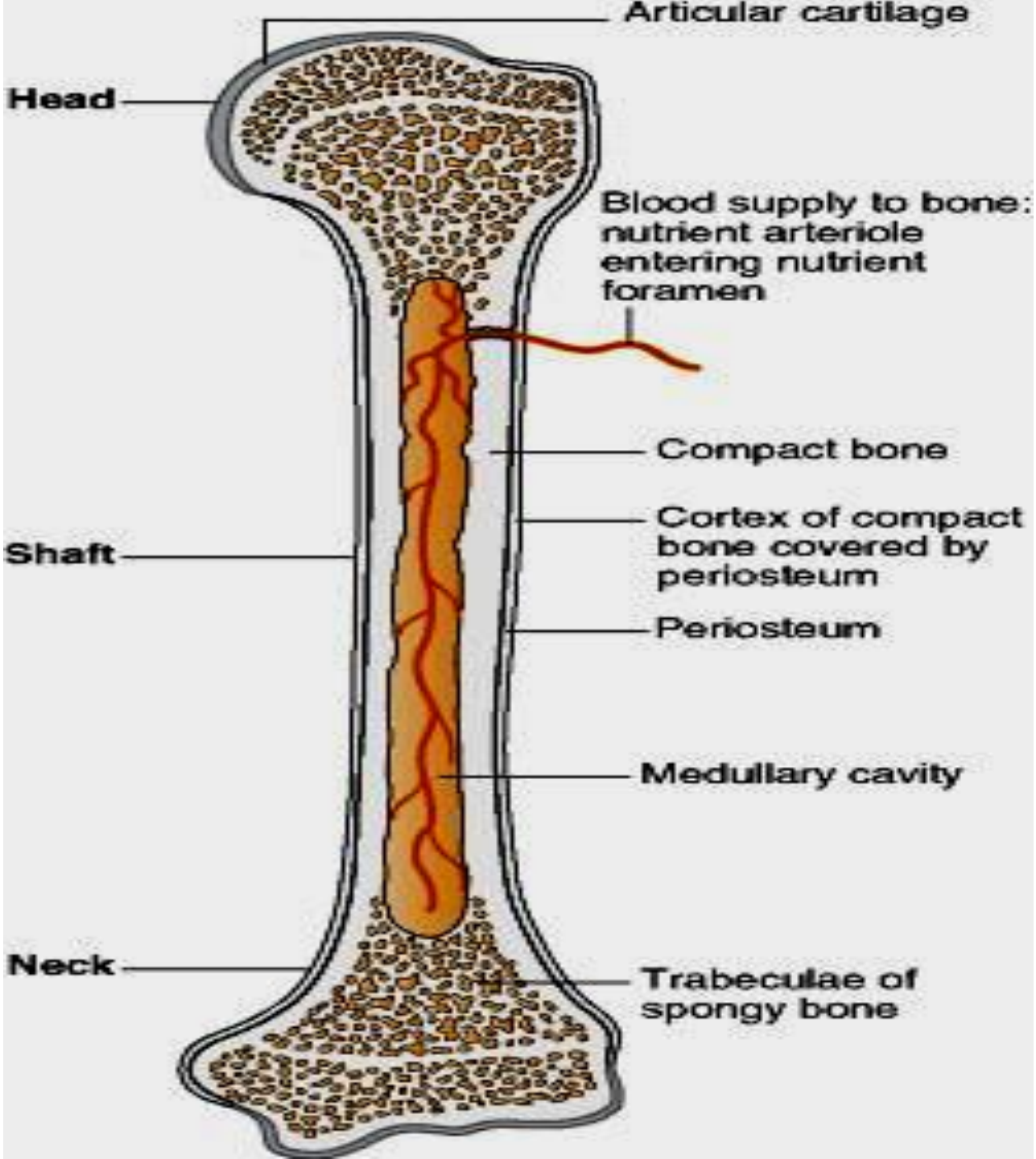

Skull
Clavicle
Scapula
(shoulder blade)
Sternum
Ribs
Humerus
Vertebral
column
Pelvis
Radius
Ulna
Carpals
(wrist)
Metacarpals
(hand)
Phalanges
(fingers)
Femur
Patella
Tibia
Fibula
Tarsals
(ankle)
Metatarsals
(foot)
Phalanges
(toes)

Bone (Osseous) Tissue

- **Most rigid of all connective tissues, bone has a rich blood supply.**
- **The hardness of bone is due to the calcium phosphate located within the matrix.**
- **Bone tissue is classified**

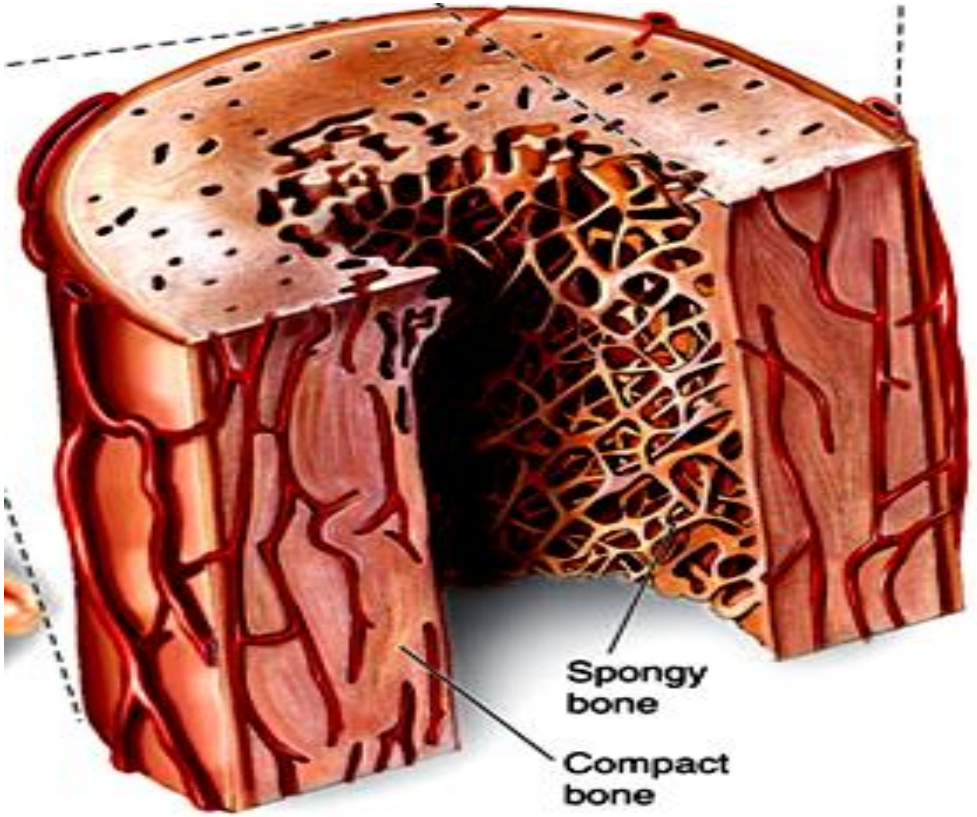
- compact bone or

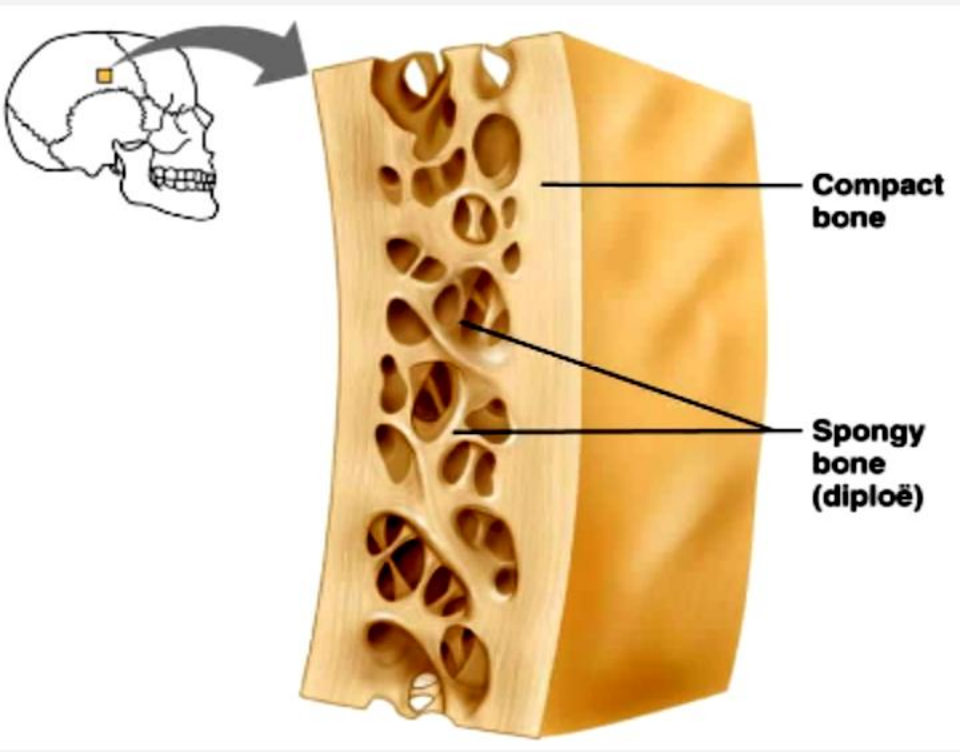
- spongy bone

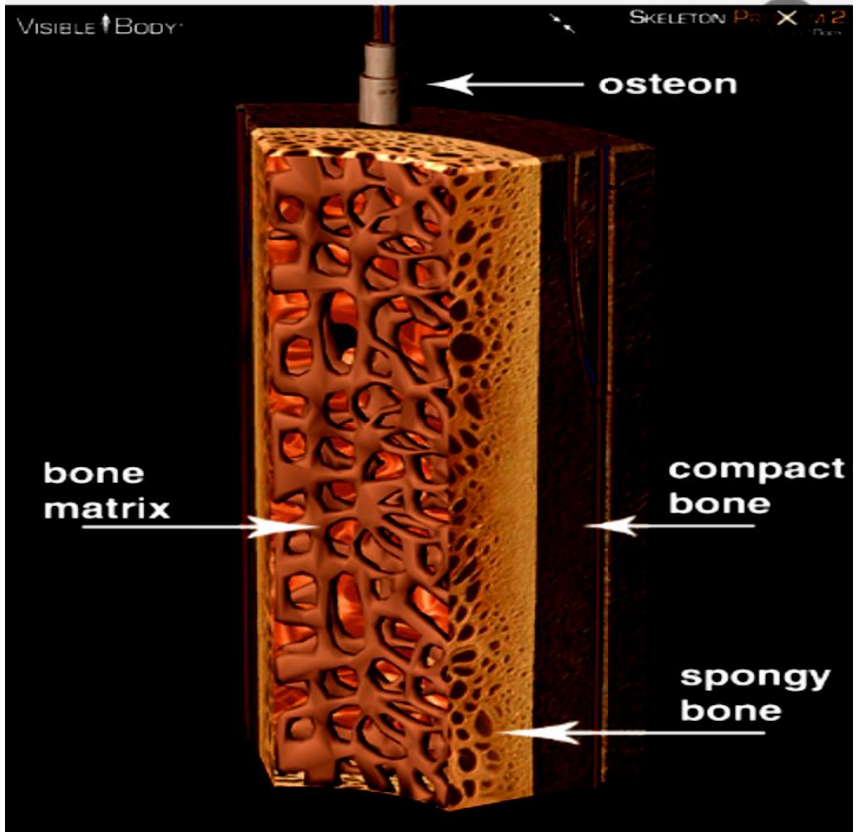

Articular cartilage
Head
Blood supply to bone: nutrient arteriole entering nutrient foramen
Compact bone
Cortex of compact bone covered by periosteum
Shaft
Periosteum
Medullary cavity
Neck
Trabeculae of spongy bone

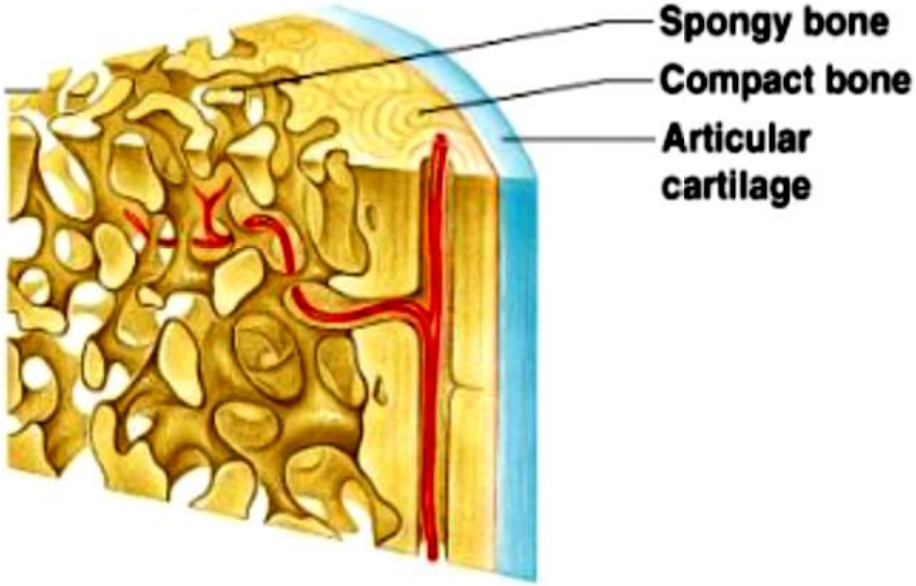
- **Compact bone tissue constitutes hard outer portion of a bone,**

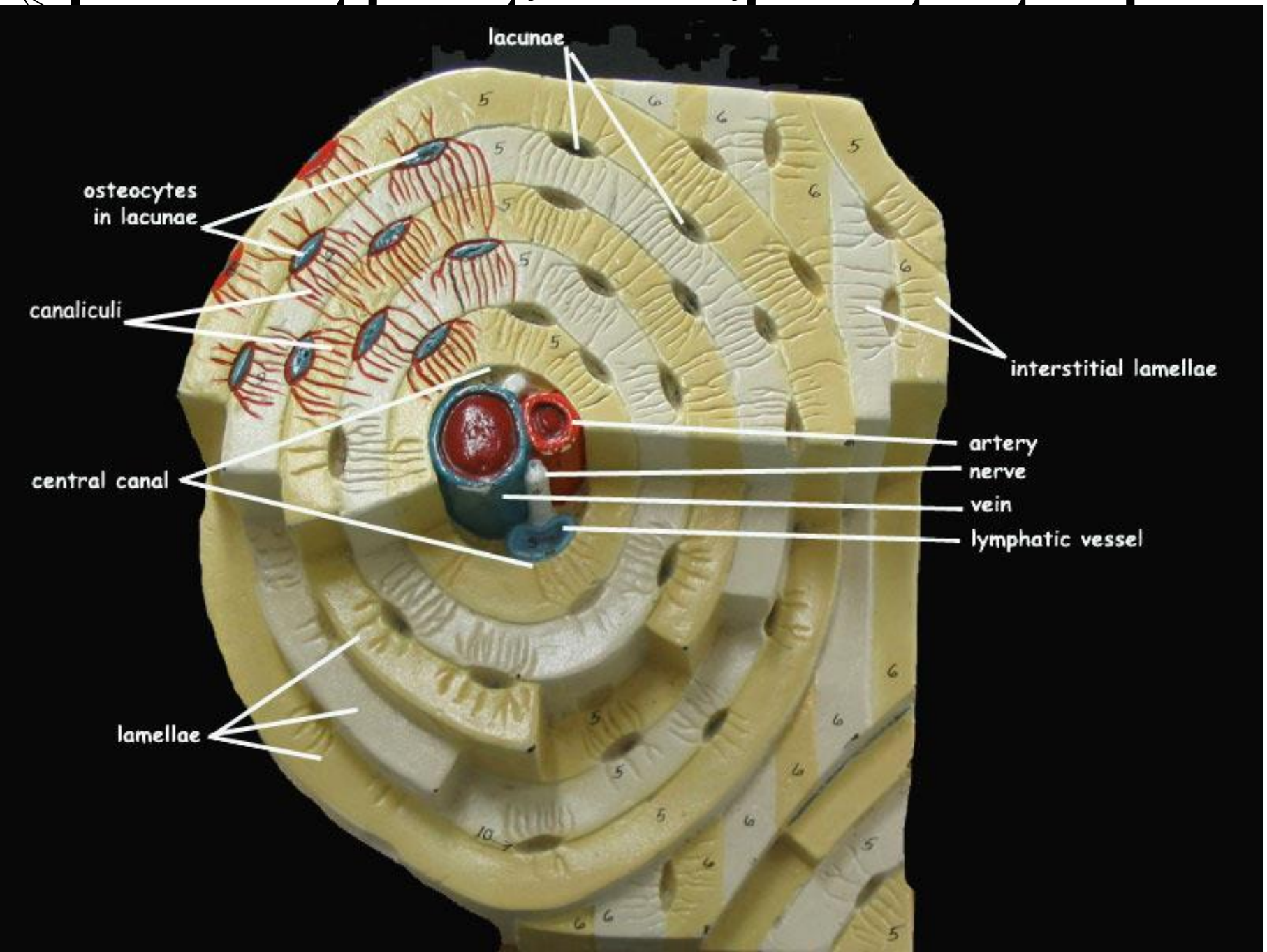
- spongy bone tissue constitutes the porous, highly vascular inner portion.




Compact bone
Spongy bone (diploë)


VISIBLE BODY
SKELETON
osteon
bone matrix
compact bone
spongy bone


Spongy bone
Compact bone
Articular cartilage


lacunae
osteocytes
in lacunae
canaliculi
interstitial lamellae
artery
nerve
vein
lymphatic vessel
central canal
lamellae

Ground bone X.S.

Haversian system

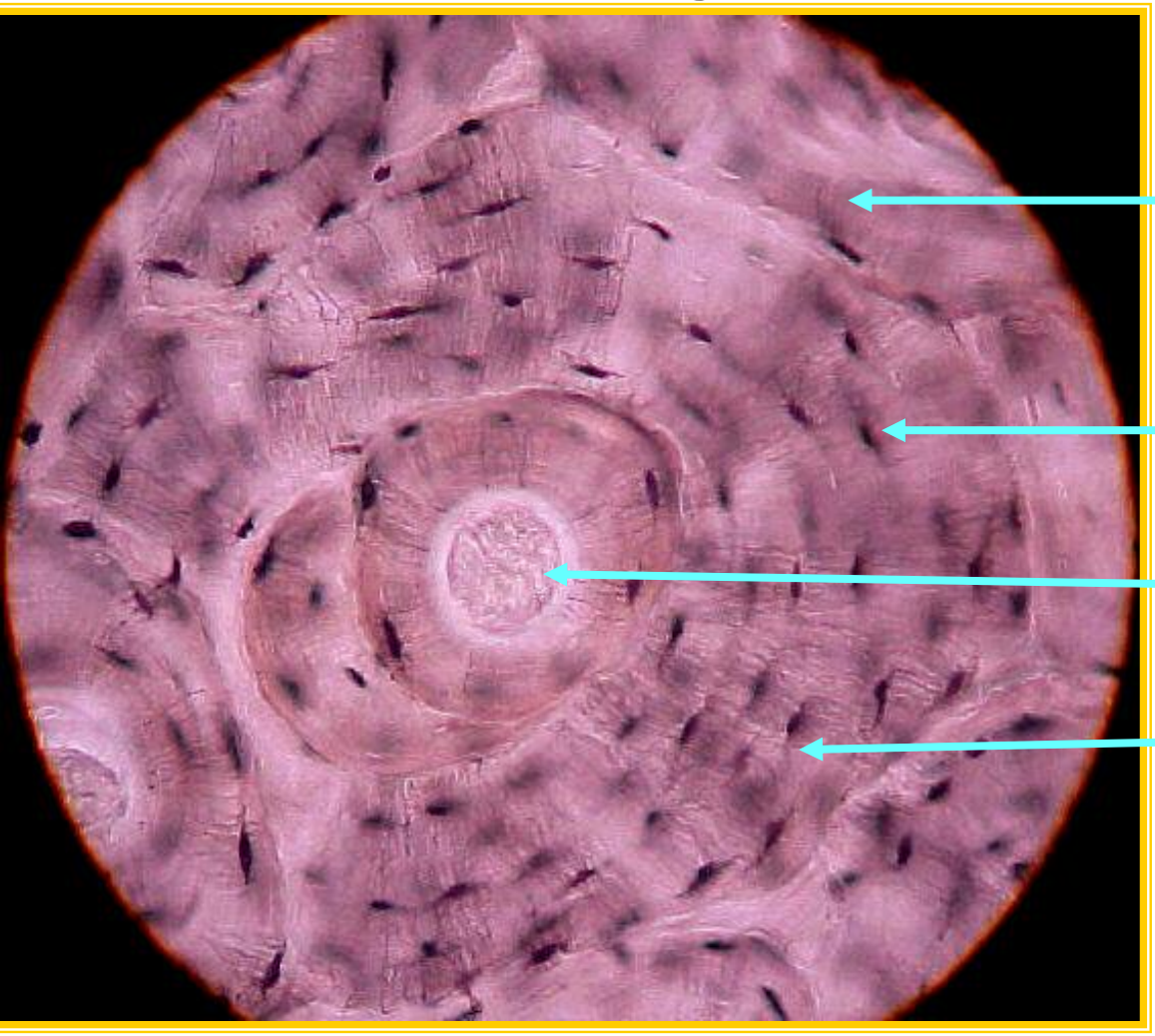
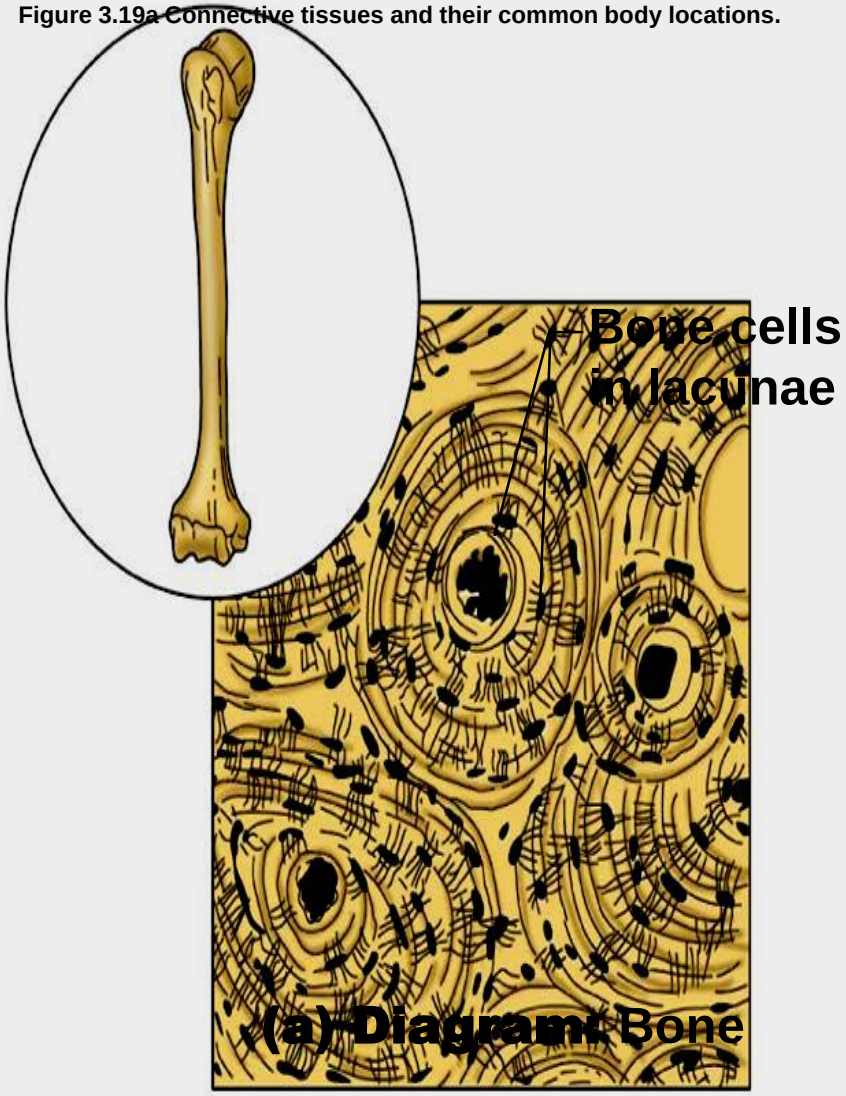
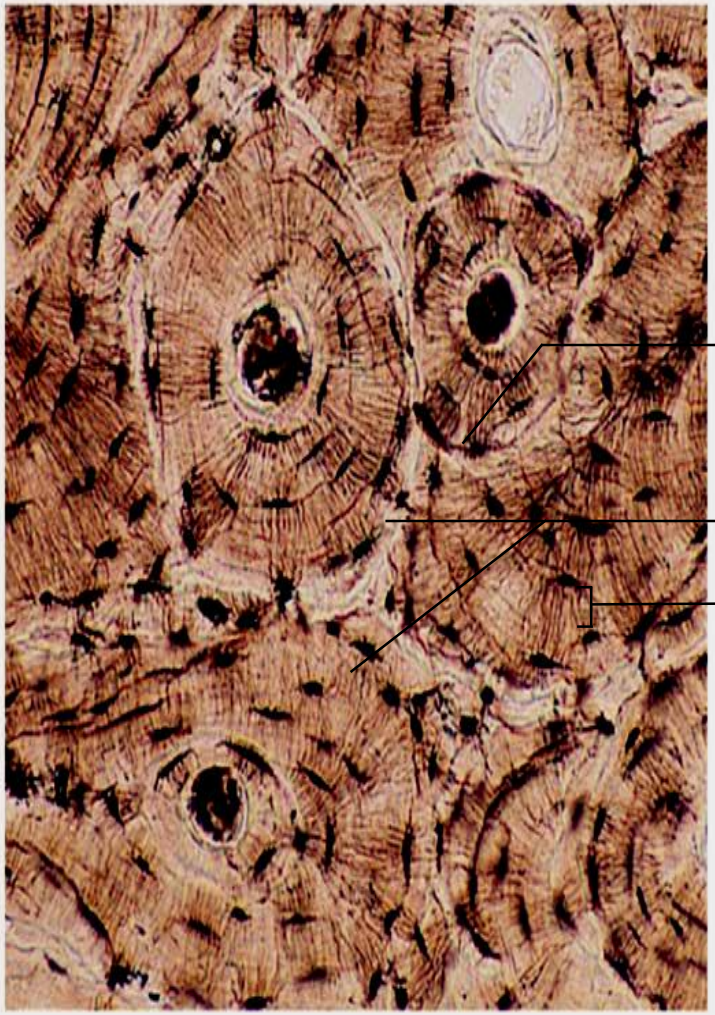


Figure 3.19a Connective tissues and their common body locations.





Photomicrograph: Cross-sectional view of ground bone (165×)

- **Bone cells, osteocyte occupies a space called**

  a lacuna.

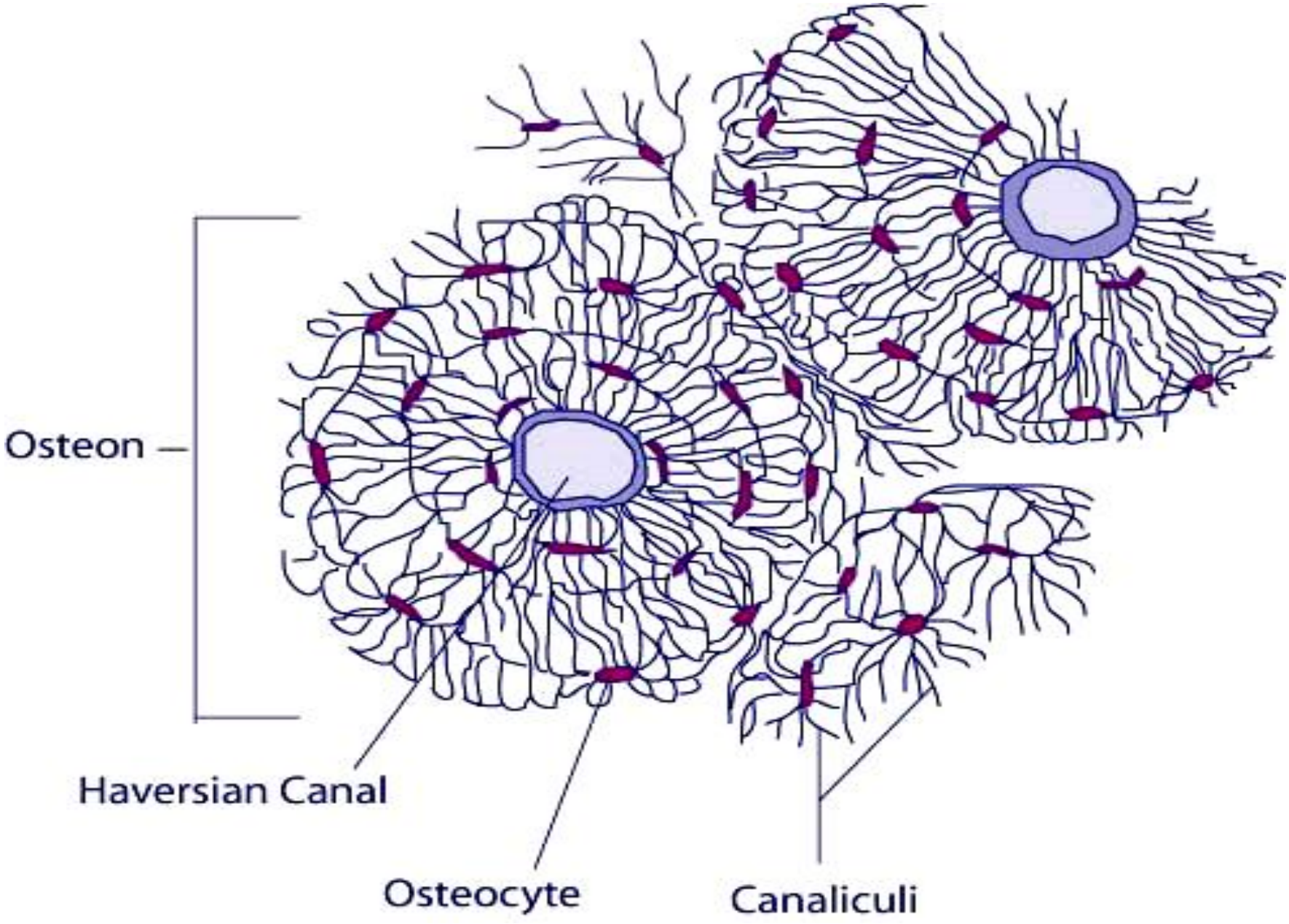
- **Radiating from lacuna are tiny canals, called**

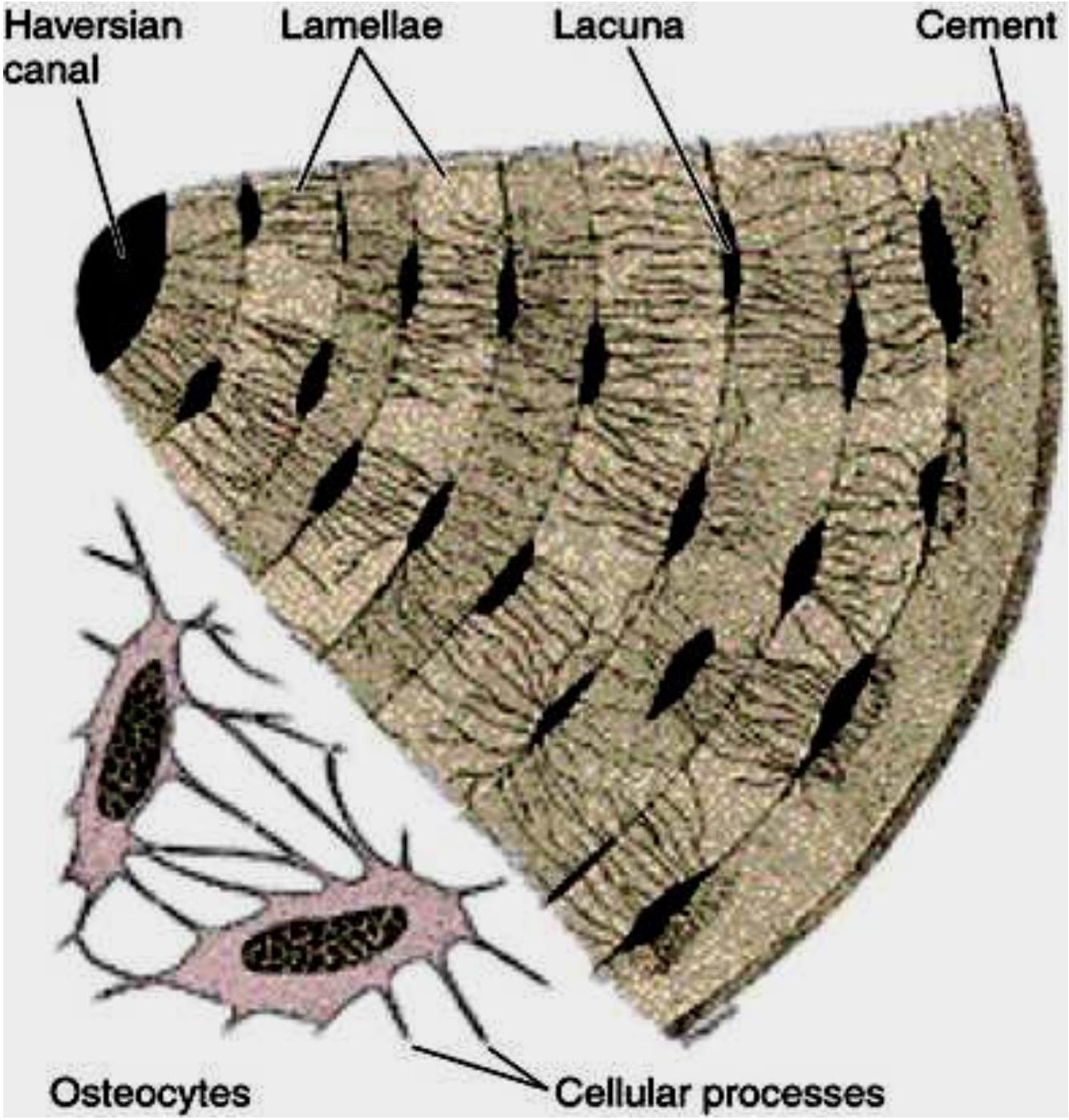
  canaliculi.

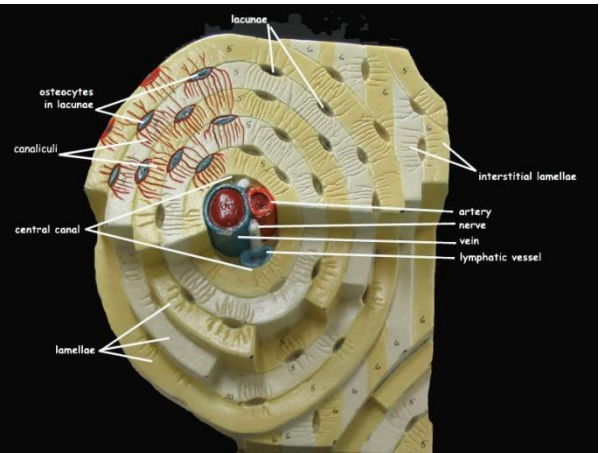
- **Nutrients diffuse through the canaliculi to reach each osteocyte.**

- **The matrix layers of bone tissue are called**

  lamellae.


Osteon
Haversian Canal
Osteocyte
Canaliculi


Haversian canal
Lamellae
Lacuna
Cement
Osteocytes
Cellular processes


lacunae
osteocytes in lacunae
canaliculi
interstitial lamellae
artery
nerve
vein
lymphatic vessel
central canal
lamellae

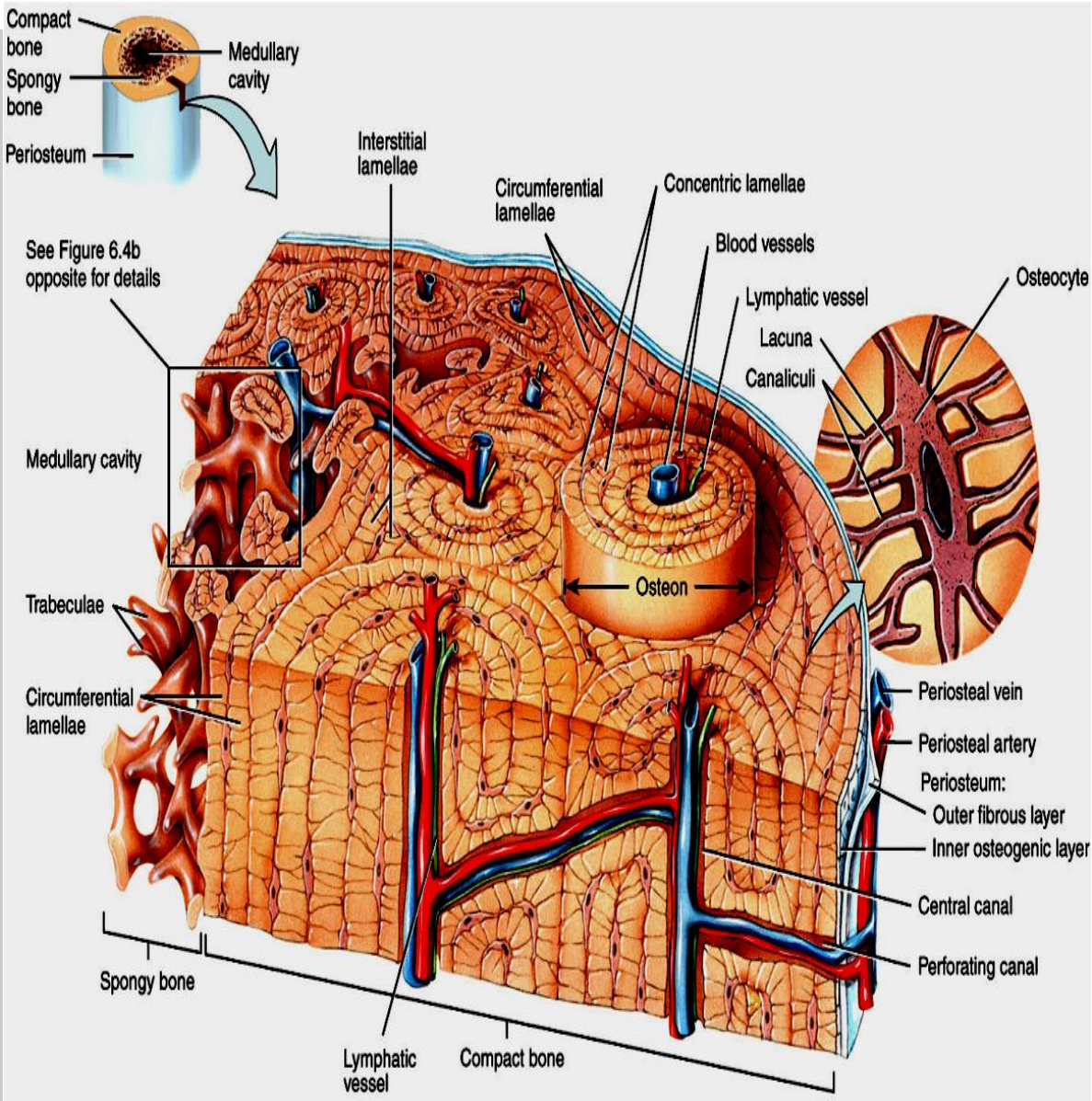
Compact Bone

Lamellae :- 3 types

1. Concentric: surrounds Haversian canal

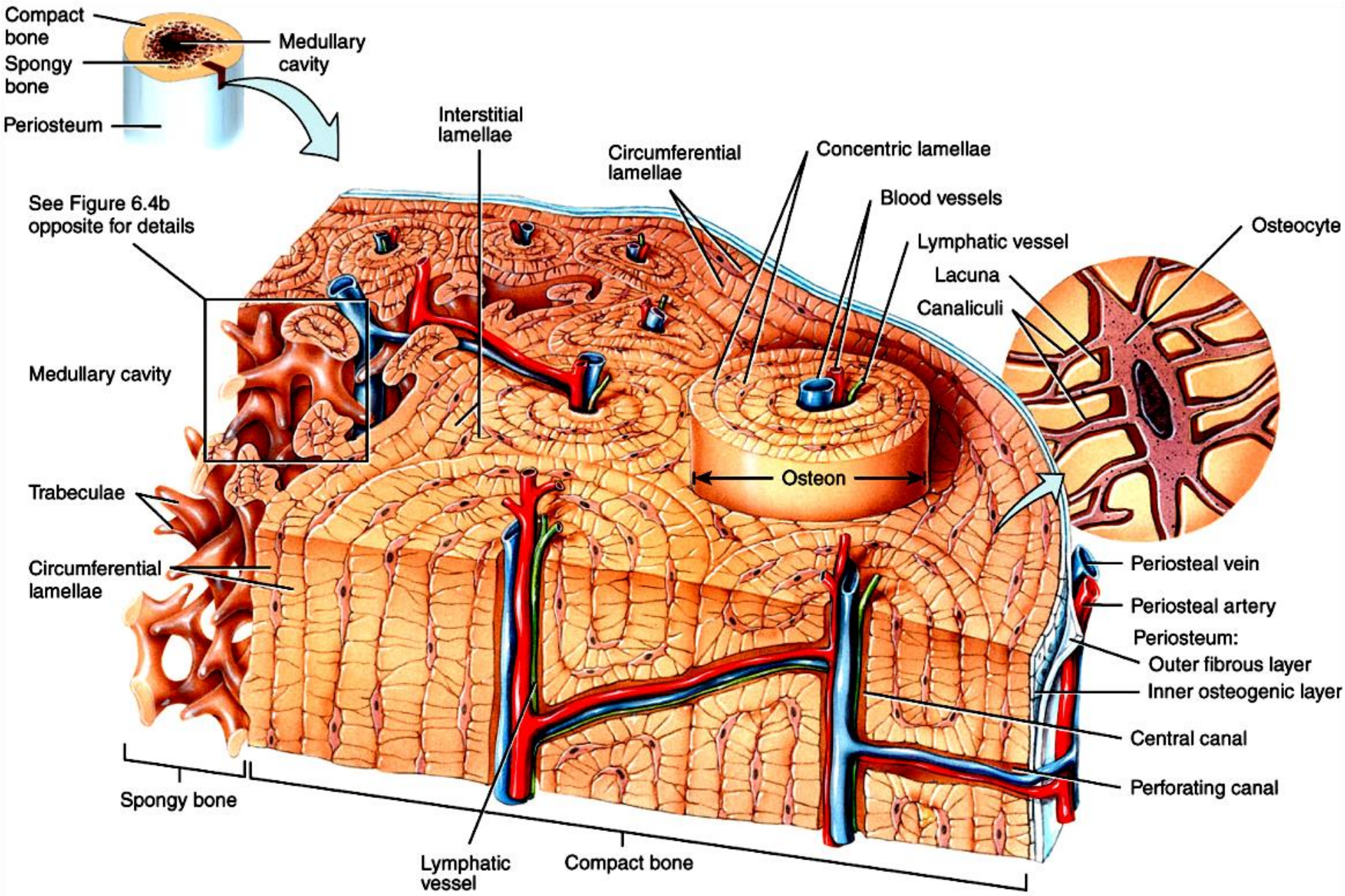
2. Interstitial: lie between osteons

3. Circumferential: flat plates extend around the bone



(a) Osteons (haversian systems) in compact bone and trabeculae in spongy bone

Figure 06.04a Tortora - PHA 11/e



(a) Osteons (haversian systems) in compact bone and trabeculae in spongy bone

Figure 06.04a Tortora - PHA 11/e

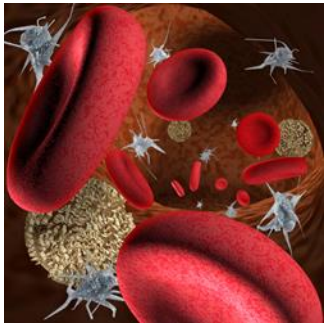
Enjoy Your Learning

&

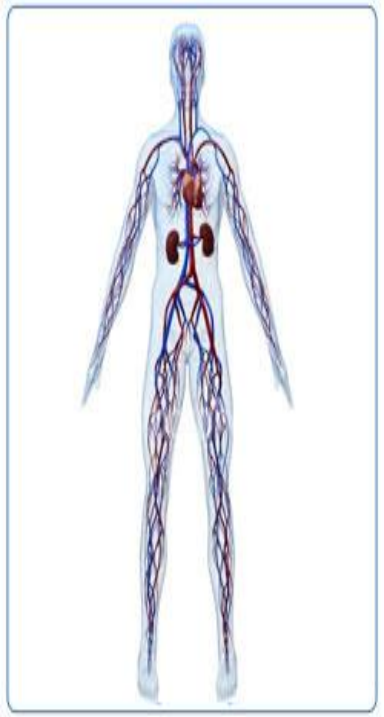
Your University Student Life

Good Luck

Composition of Blood

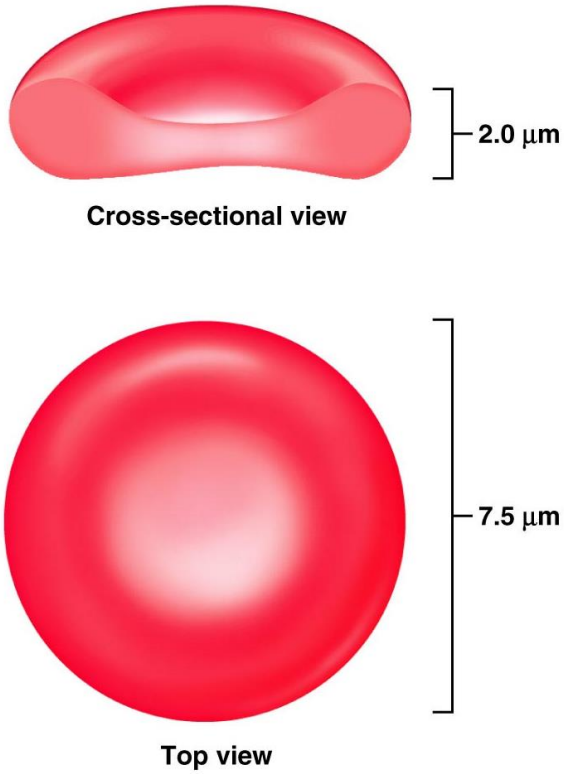


- **Blood is responsible for…..**
  - **– Transporting gases (oxygen & carbon dioxi**
  - **– Transporting waste products**
  - **– Transporting nutrients**
  - **– Helping remove toxins from the body**



RBC Structure And Function

- Have no organelles or nuclei
- Hemoglobin – oxygen carrying protein
  - Each RBC has about 280 million hemoglobin molecules
- Biconcave shape – 30% more surface area



Blood (Vascular) Tissue

- **Blood, or vascular tissue,**

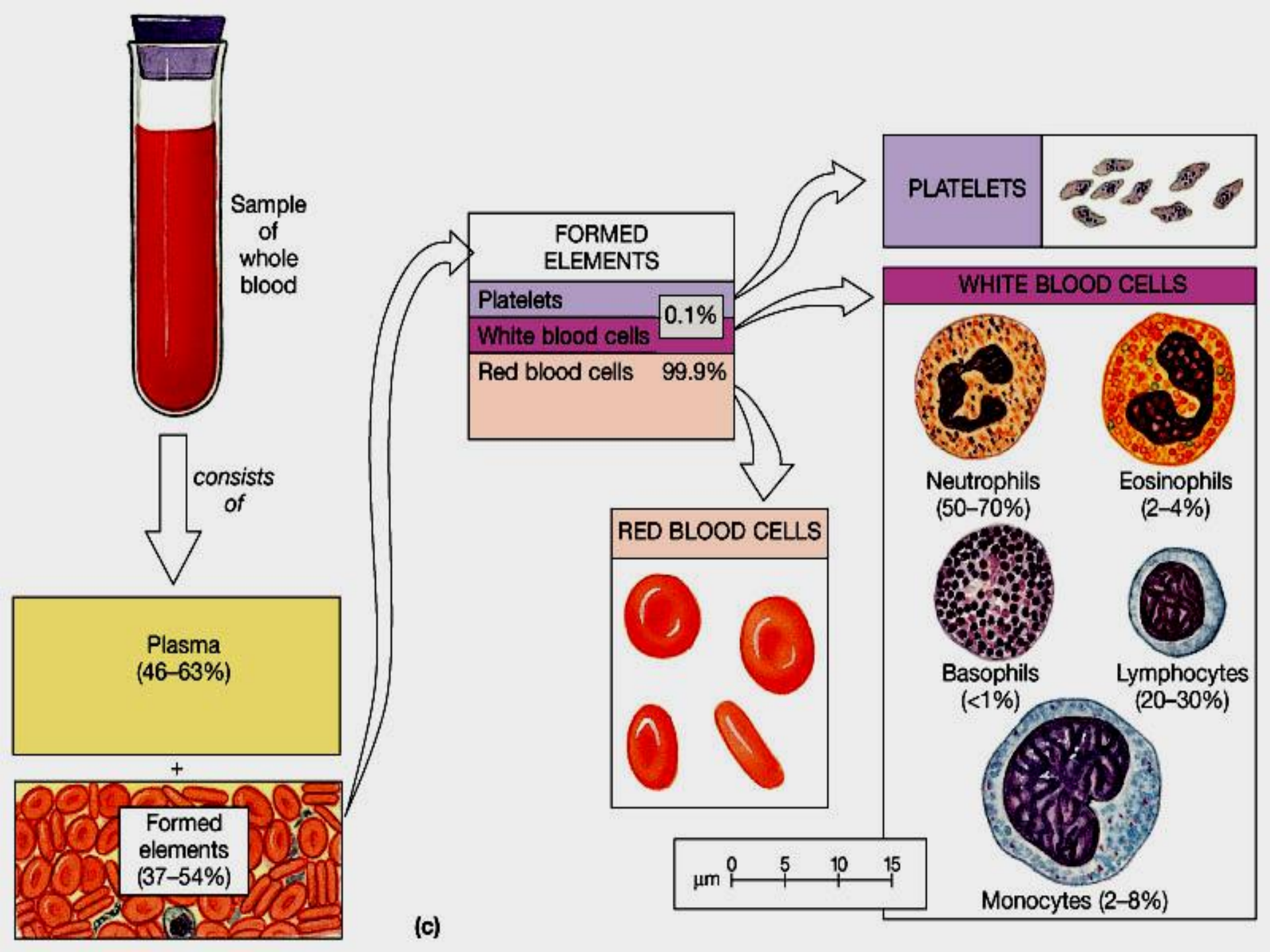
- **is specialized fluid connective tissue**

- **that plays a vital role in maintaining internal body homeostasis.**

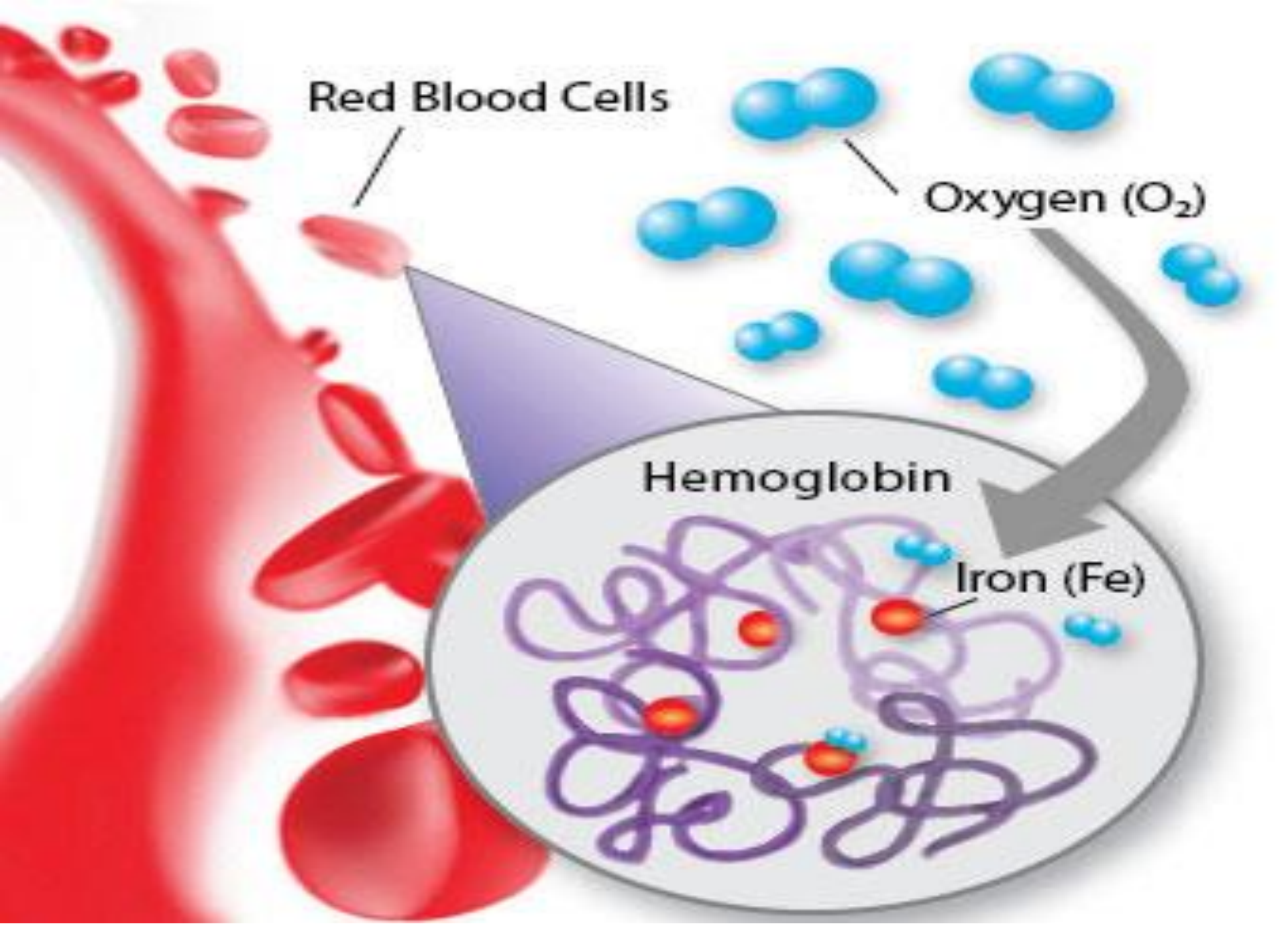
Homeostasis

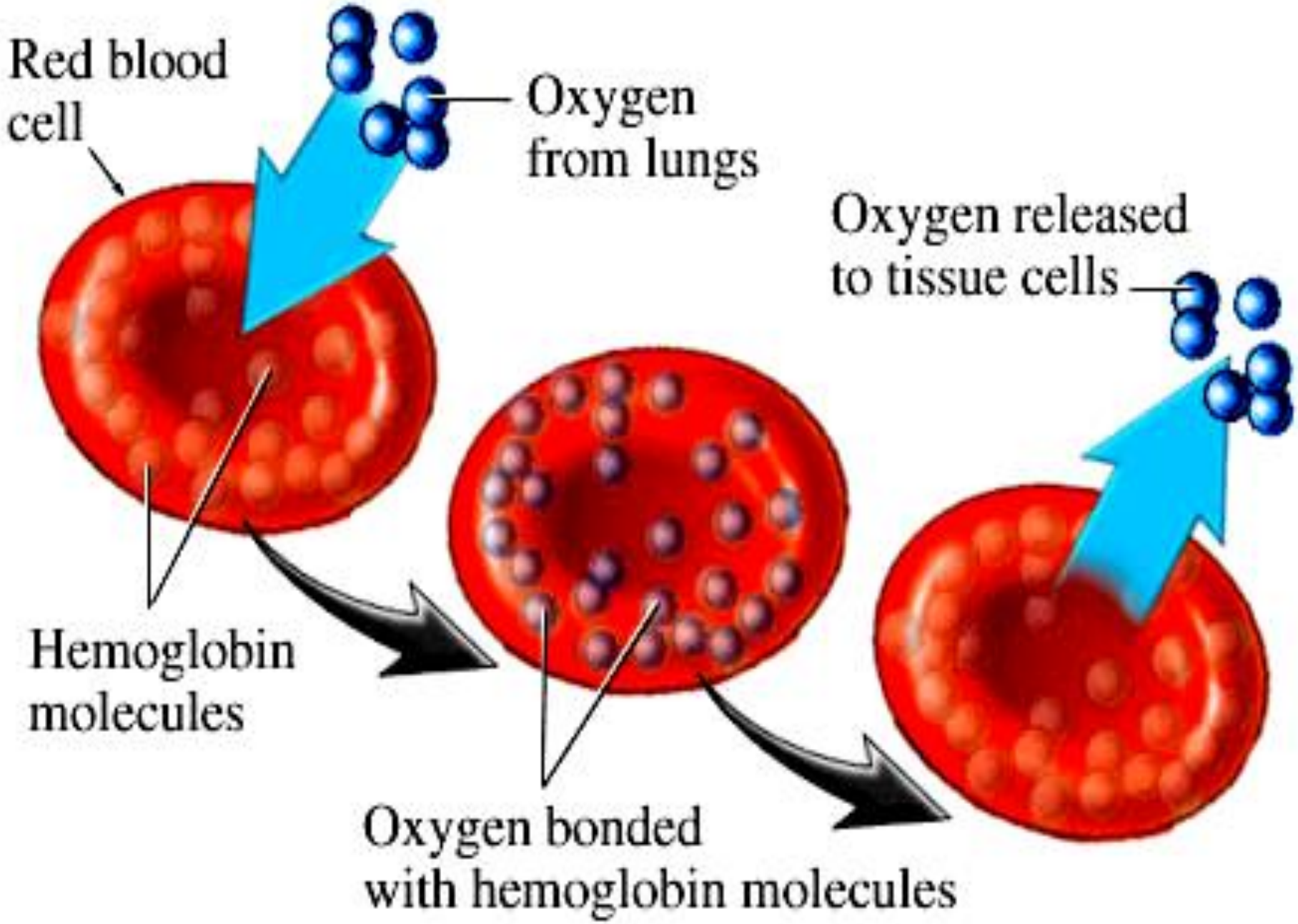
- Definition
  - Maintaining stable internal conditions
  - Keeping everything in the body “normal”

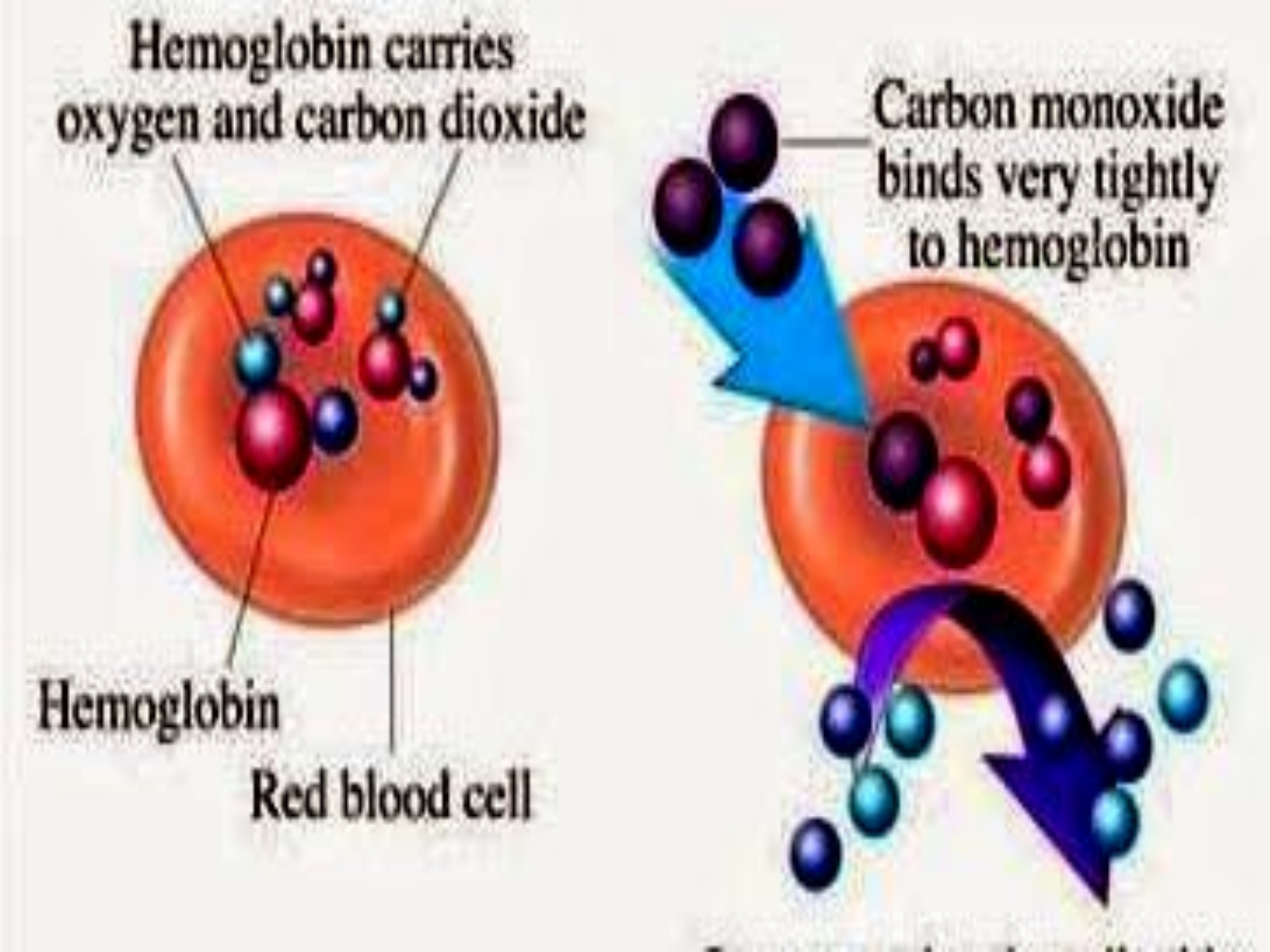
- Examples:
  - Body temperature
  - Blood sugar
  - Blood pressure


Sample of whole blood
consists of
Plasma (46–63%)
+
Formed elements (37–54%)
FORMED ELEMENTS
Platelets
White blood cells
0.1%
Red blood cells 99.9%
PLATELETS
WHITE BLOOD CELLS
RED BLOOD CELLS
Neutrophils (50–70%)
Eosinophils (2–4%)
Basophils (<1%)
Lymphocytes (20–30%)
Monocytes (2–8%)
µm 0 5 10 15
(c)

- **1. Erythrocytes or red blood cells(RBCs), tiny biconcave discs that lack nuclei,**
- **Their red color is due to the protein hemoglobin.**
- **Oxygen attaches to and is transported on the hemoglobin molecules.**
- **The life span of erythrocytes is between 90 and 120 days.**


Red Blood Cells
Oxygen (O_2)
Hemoglobin
Iron (Fe)

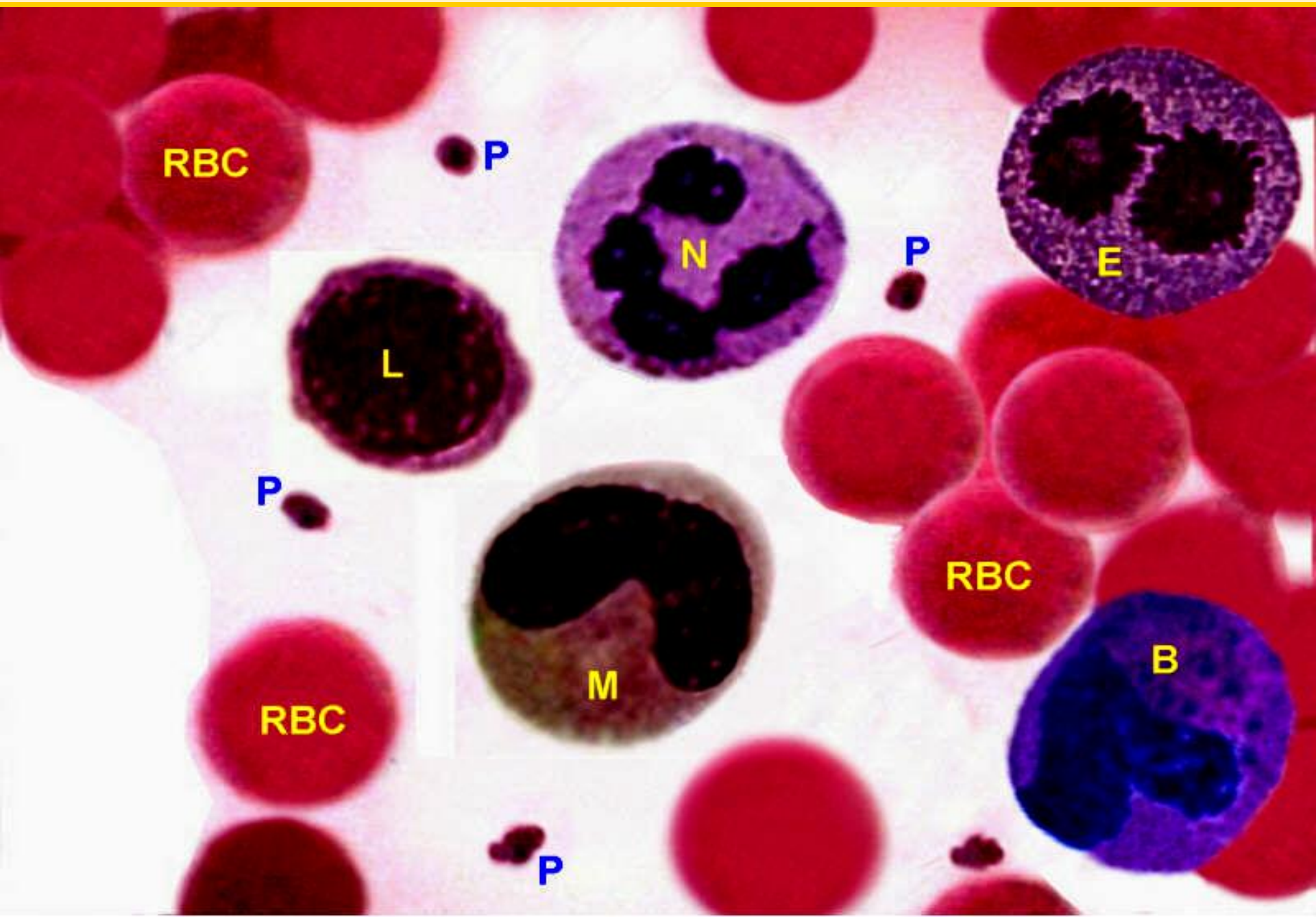

Red blood cell
Oxygen from lungs
Oxygen released to tissue cells
Hemoglobin molecules
Oxygen bonded with hemoglobin molecules


Hemoglobin carries oxygen and carbon dioxide
Hemoglobin
Red blood cell
Carbon monoxide binds very tightly to hemoglobin

2.Leukocytes or white blood cells(WBCs),

- nucleated, exhibit amoeboid movement by forming cytoplasmic extensions and serve to protect the body against invasions by microorganisms.

Blood tissue



- They are produced in

  bone marrow & lymphatic tissue

- & have a life span ranges from 3 to 300 days.

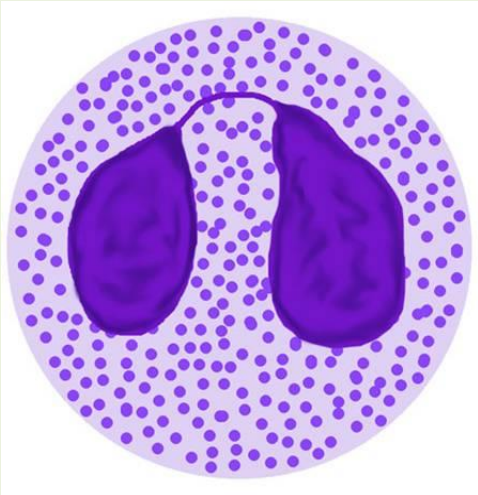
- There are five kinds of leukocytes;

  - neutrophils,
  - eosinophils,
  - basophils ,

  } granulocyte

  - lymphocytes
  - monocytes.

  } agranulocyte



Neutrophils

Eosinophils

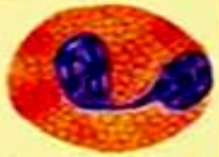
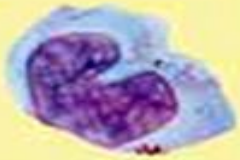
Basophils

Lymphocytes

Monocytes

Platelets

Erythrocytes

	A Blood cell type	B Lifespan in blood	C Function
1	Neutrophil 	7 hours	Immune defenses
2	Eosinophil 	8 to 12 days	Defense against parasites
3	Basophil 	a few hours to a few days	Inflammatory response
4	Monocyte 	3 days	Immune surveillance
5	B-lymphocyte 	memory cells may live for years	Antibody production
6	T-lymphocyte 	memory cells may live for years	Cellular immune response

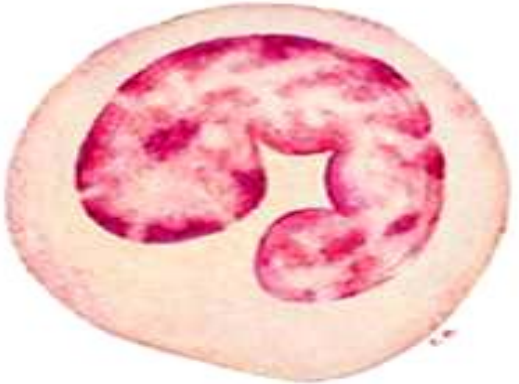
Neutrophilic granulocyte

Eosinophilic granulocyte

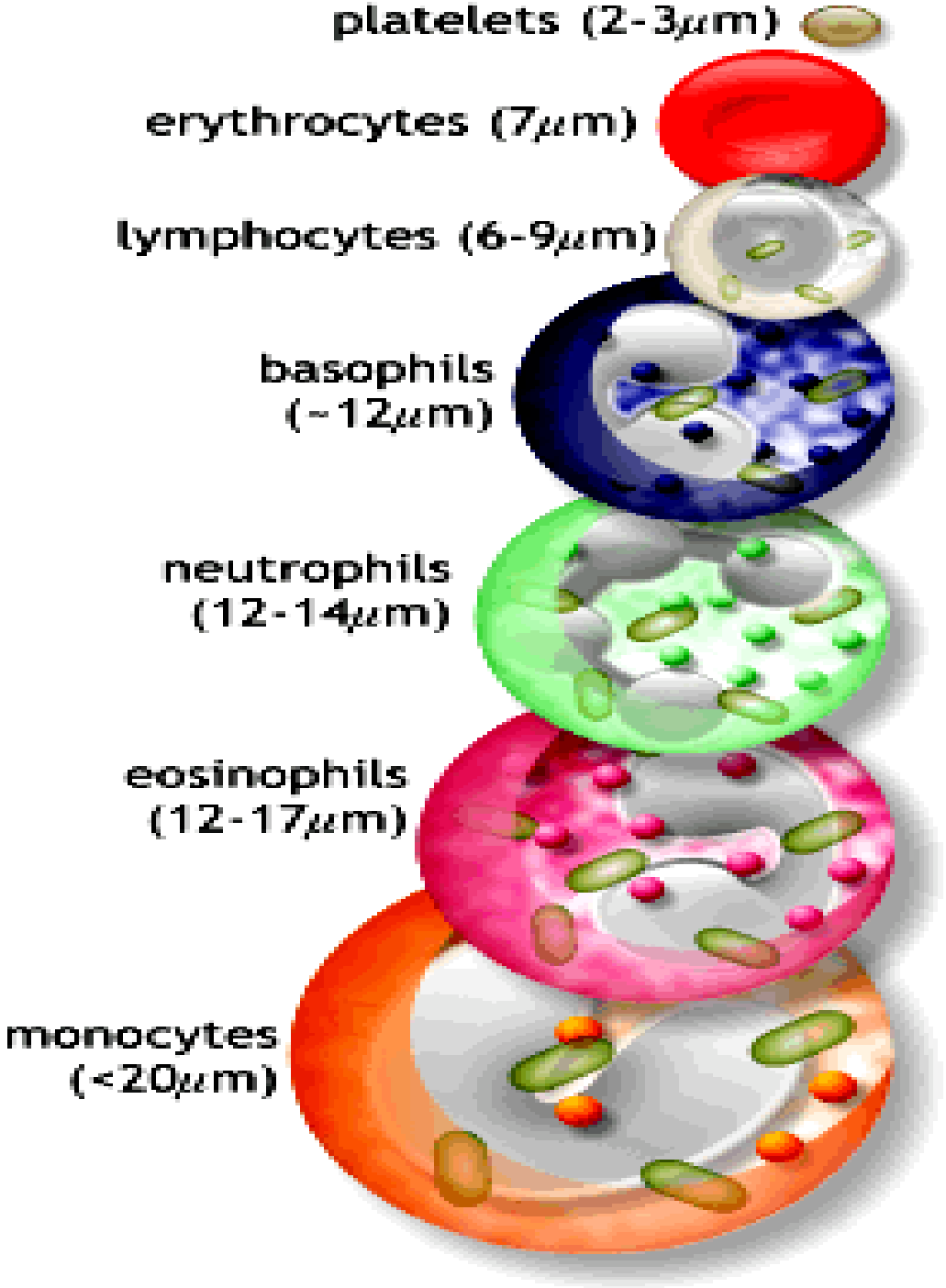
Basophilic granulocyte

Lymphocyte

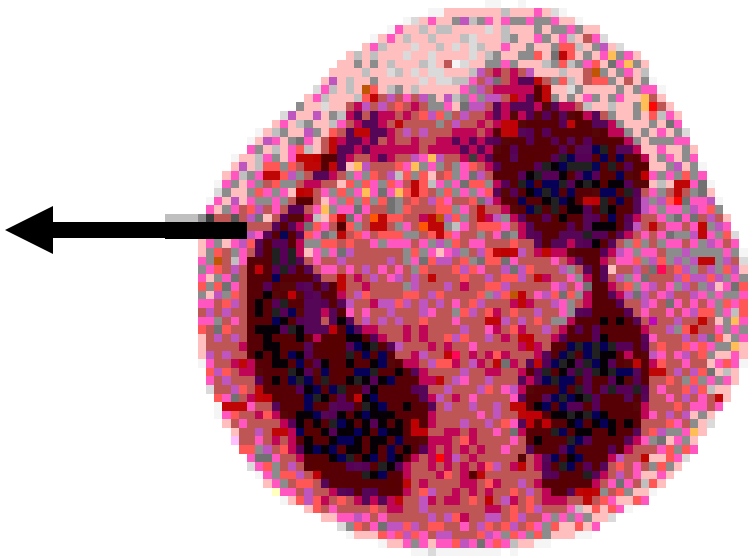
Monocyte



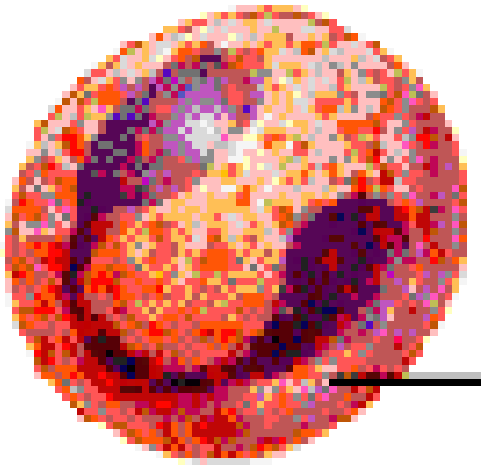
Monocyte


platelets (2-3μm)
erythrocytes (7μm)
lymphocytes (6-9μm)
basophils
(~12μm)
neutrophils
(12-14μm)
eosinophils
(12-17μm)
monocytes
(<20μm)

Neutrophils



- **40%-70% WBCs**
- **Nucleus multilobed**
- **Duration of development: 6-9 days**
- **Life Span: 6 hours to a few days**
- **Function: phagocytize bacteria**



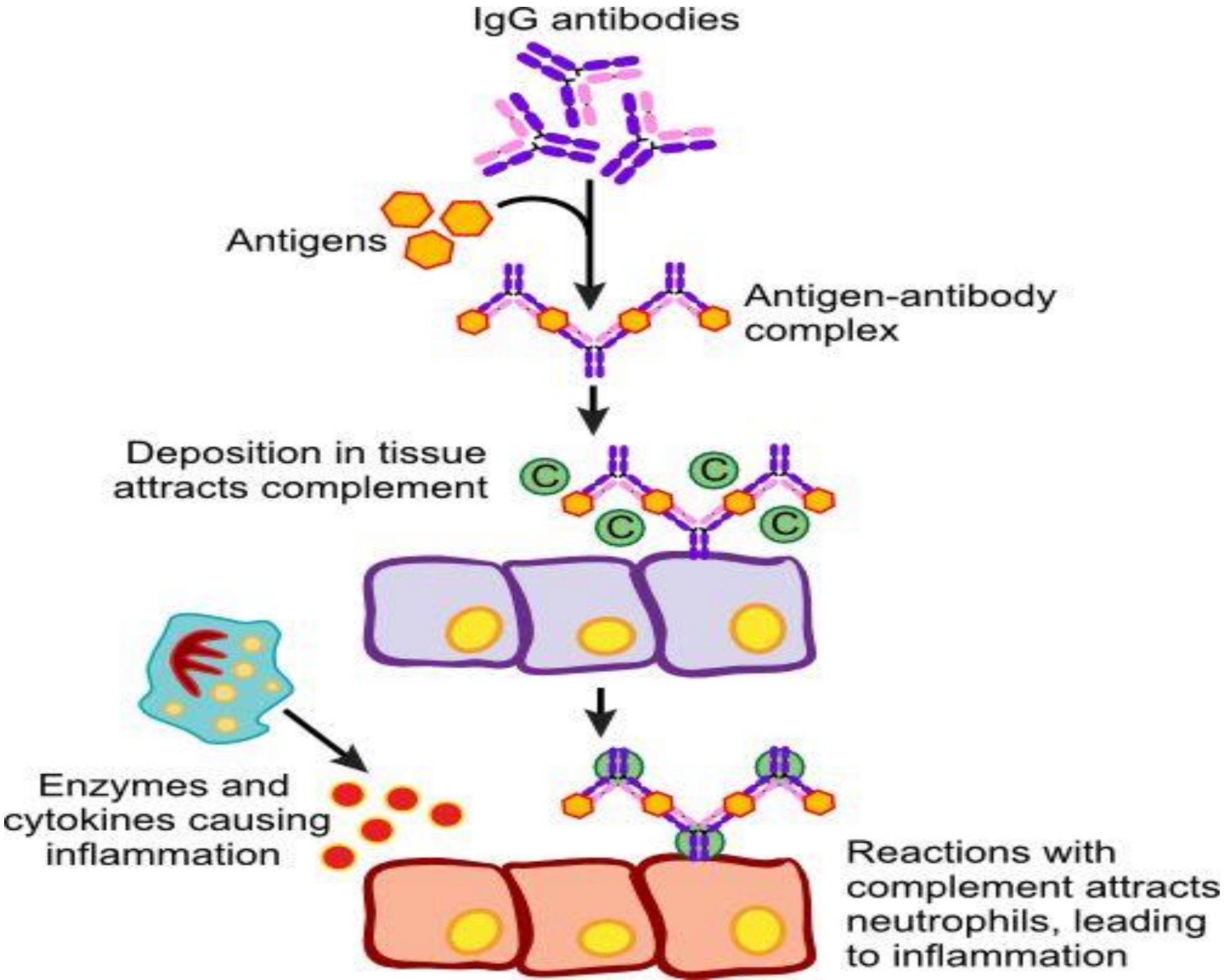
Eosinophils

- **1%-4% WBCs**
- **Nucleus bilobed**
- **Development:6-9 days**
- **Life Span: 8-12 days**
- **Function:**

    1) Kill parasitic worms

    2) destroy antigen-antibody complexes

    3) inactivate some inflammatory chemical of allergy


IgG antibodies
Antigens
Antigen-antibody complex
Deposition in tissue attracts complement
C
C
C
C
Enzymes and cytokines causing inflammation
Reactions with complement attracts neutrophils, leading to inflammation

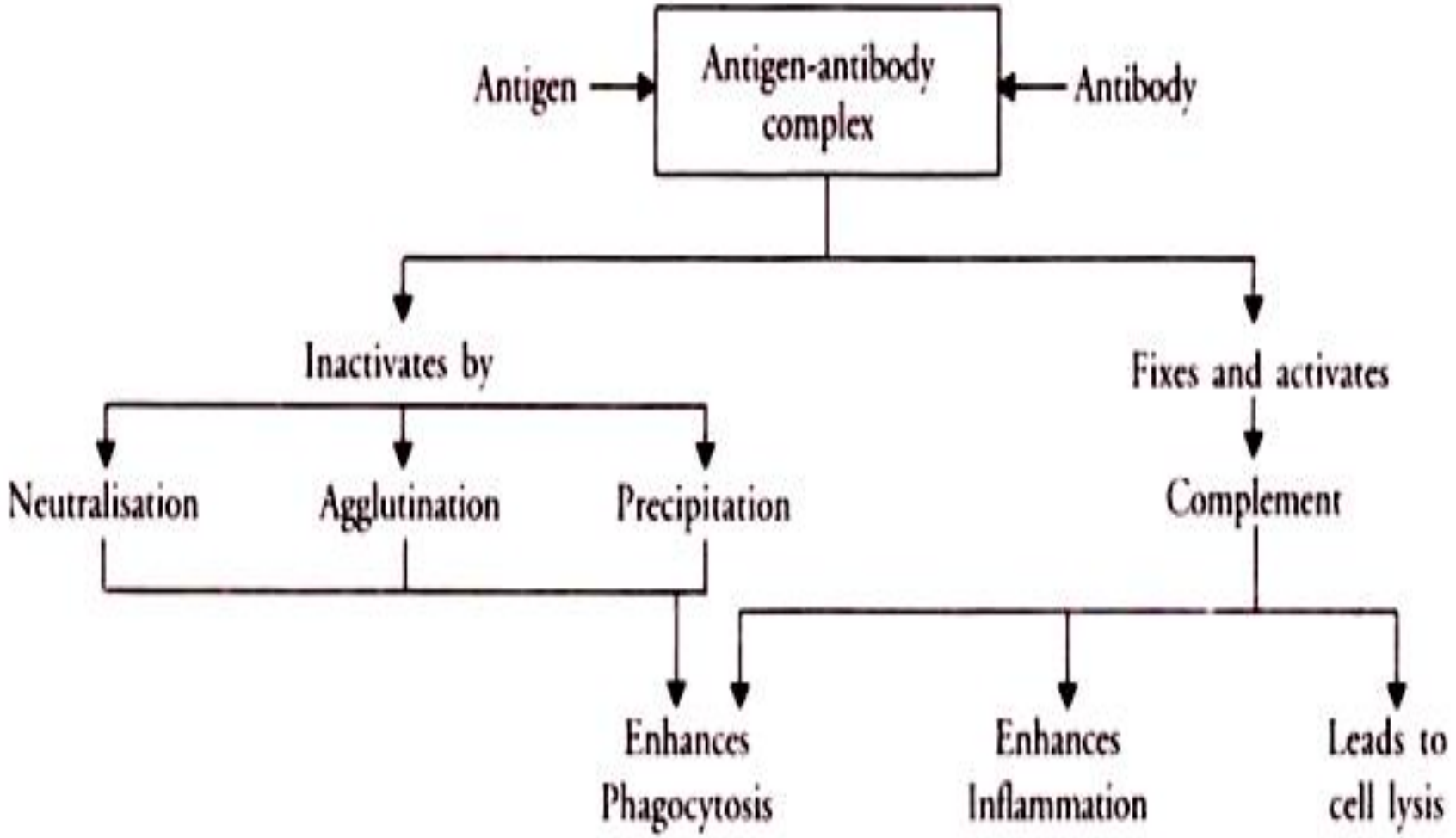
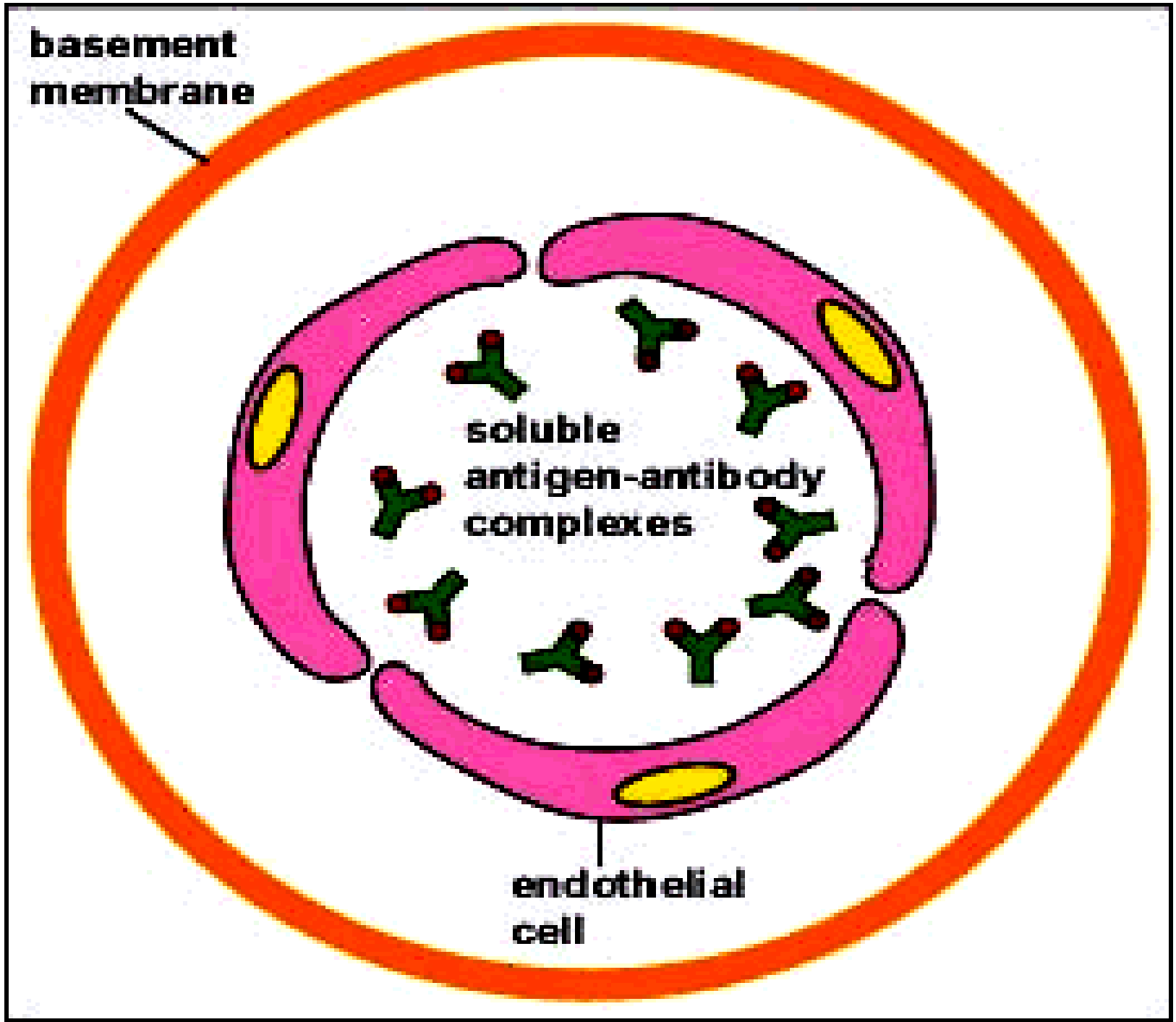
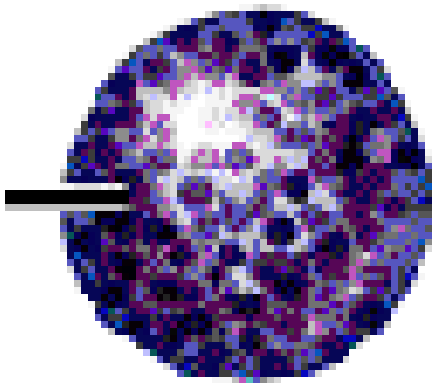


Fig. 8 Action of antigen-antibody complex.


basement membrane
soluble antigen-antibody complexes
endothelial cell

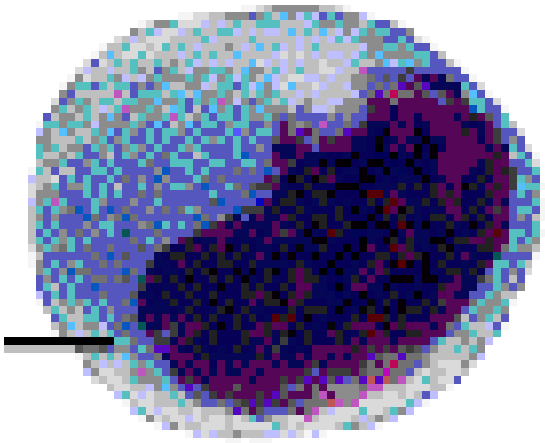
Basophils



- **0.5% WBCs**
- **Nucleus lobed**
- **Development: 3-7 days**
- **Life Span: a few hours to a few days**
- **Function:**

contain heparin, an anticoagulant

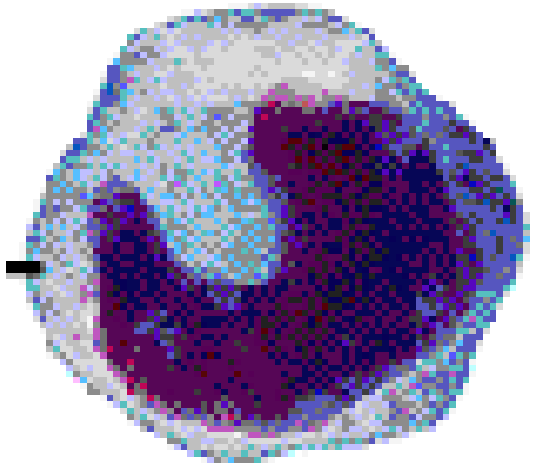
Lymphocytes



- T cells and B cells
- 20%-45% WBCs
- Nucleus spherical or indented
- Development: days to weeks
- Life Span: hours to years
- Function

  Mount immune response by direct cell attack (T cells) or via antibodies (B cells)

Monocytes



- **4%-8% WBCs**
- **Nucleus U-shaped**
- **Development: 2-3 days**
- **Life Span: months**
- **Function:**

  Phagocytosis

  develop into *macrophages* in tissues

- **Thrombocytes or platelets**

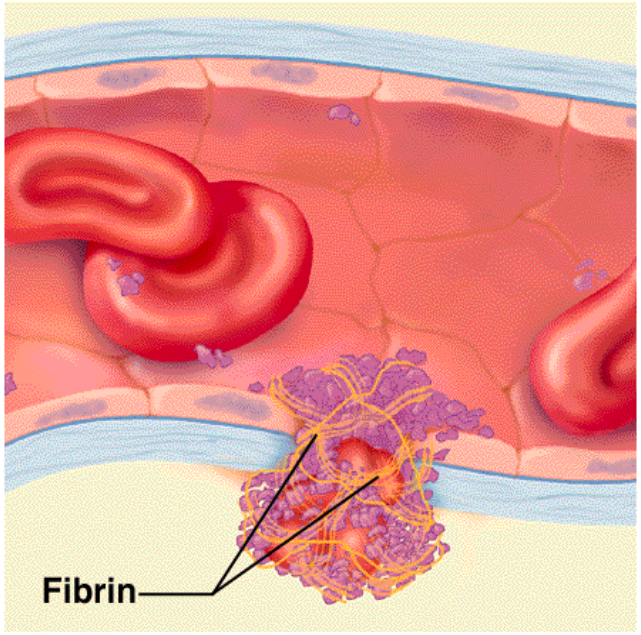
  - along with the protein fibrinogen

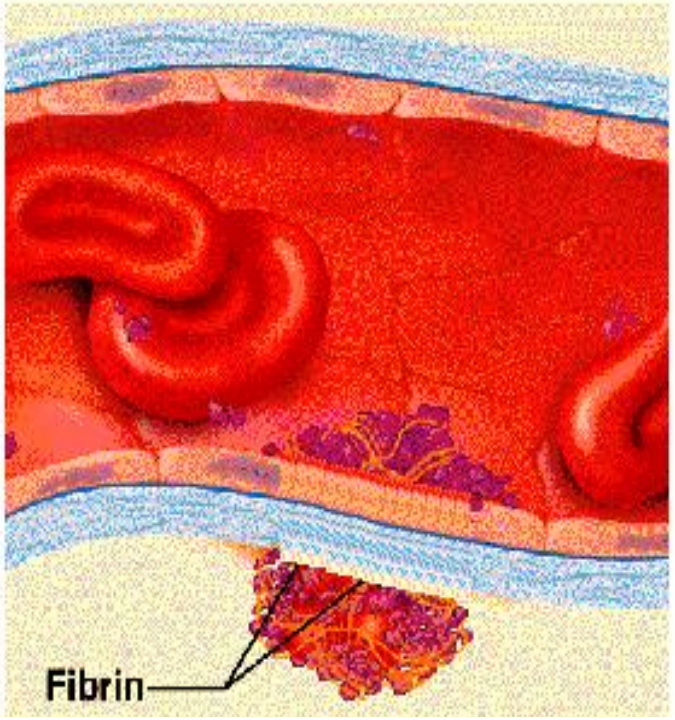
  - found in the plasma,

  - play a role in blood clotting.

- **Platelets have a life span between 5 and 7 days.**

Hemostasis — Blood Clot





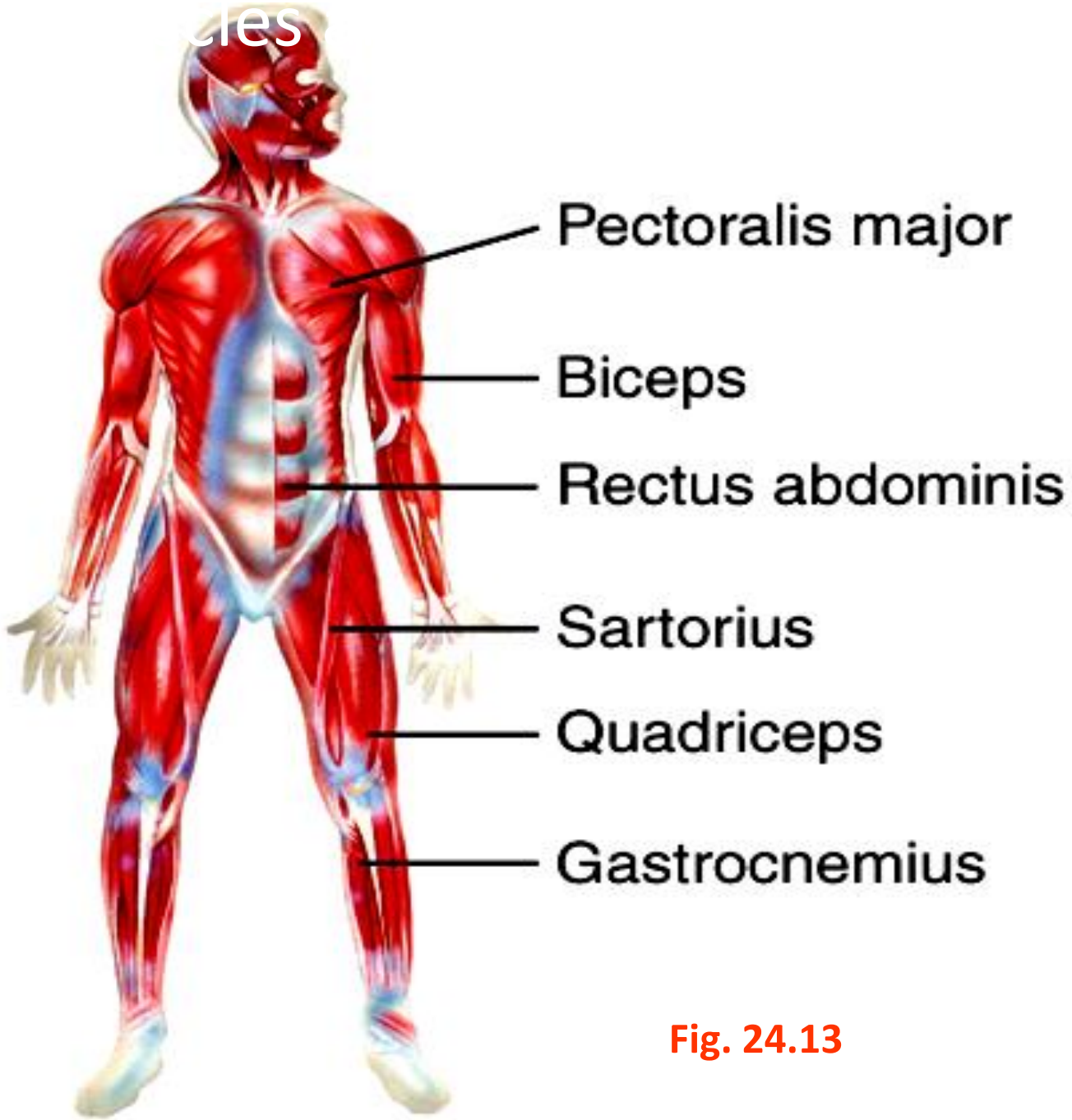
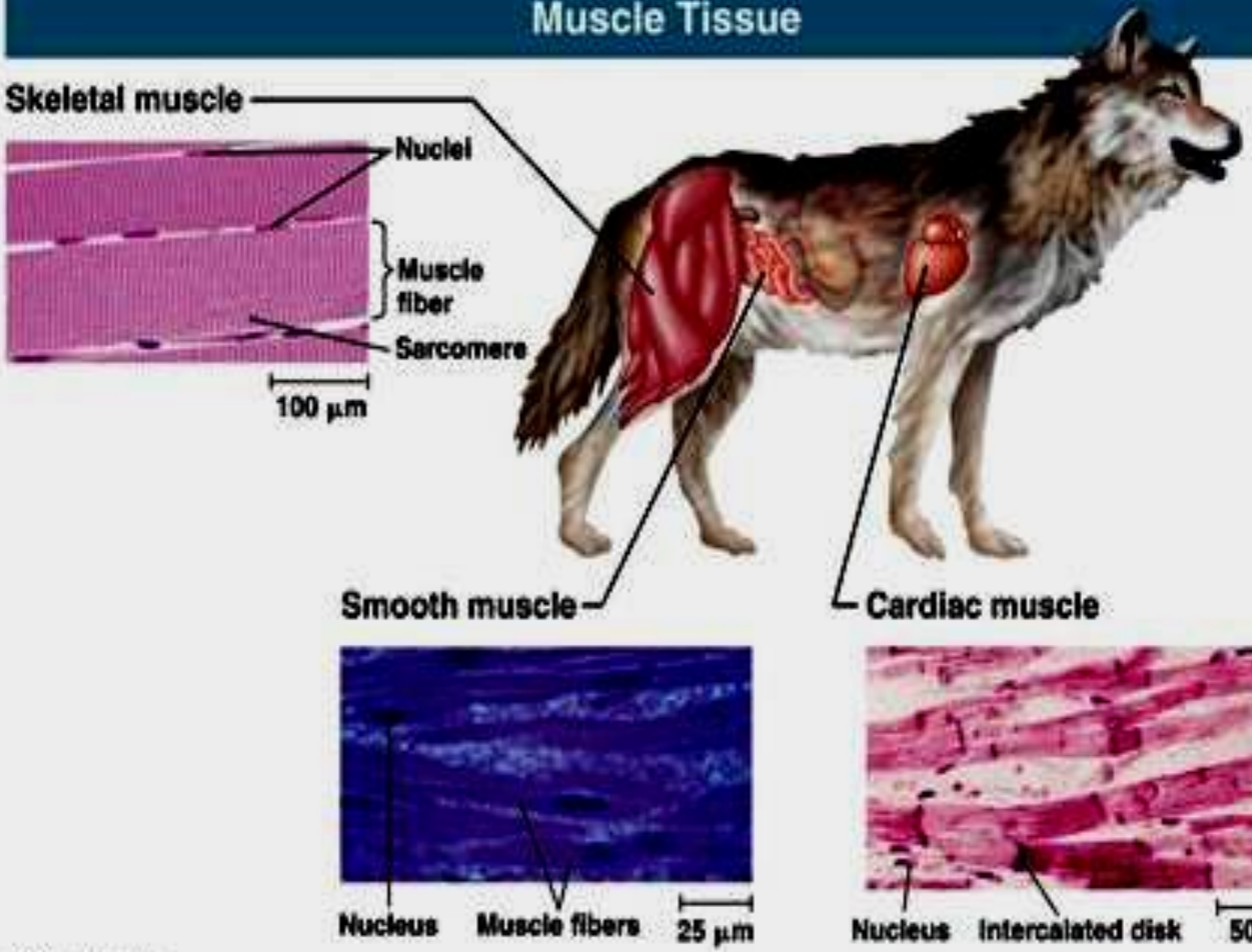

Pectoralis major
Biceps
Rectus abdominis
Sartorius
Quadriceps
Gastrocnemius

Fig. 24.13

Muscle Tissue



- **Muscle Tissue**

➢ **Muscle tissue is unique because it is able to contract, thus making movement possible.**

➢ **The muscle cells, or fibers, are long and cylindrical.**

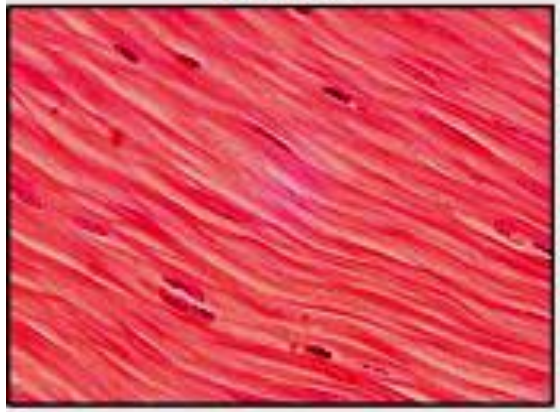
➢ **Three types of muscle are**

- smooth muscle tissue

- cardiac muscle tissue

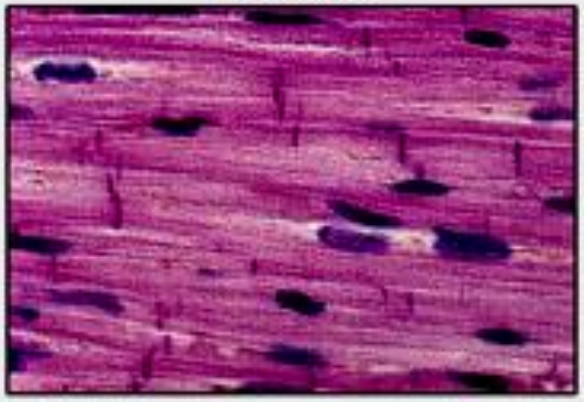
- skeletal muscle tissue.

Smooth Muscle Tissue



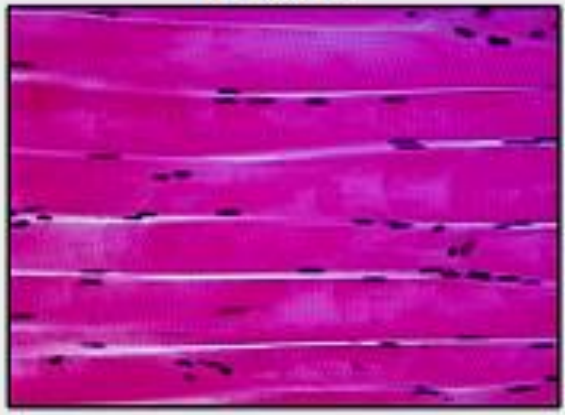
Involuntary Control

Cardiac Muscle Tissue



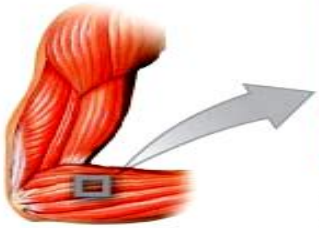
Involuntary Control

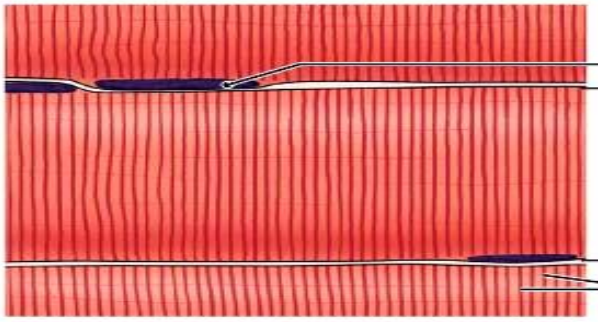
Skeletal Muscle Tissue

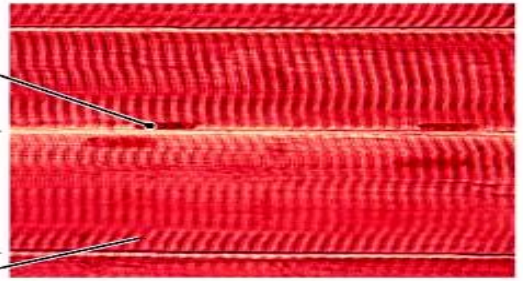


Voluntary Control

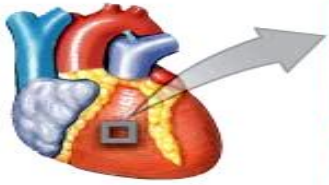
The structure and function of the three types of muscle tissue

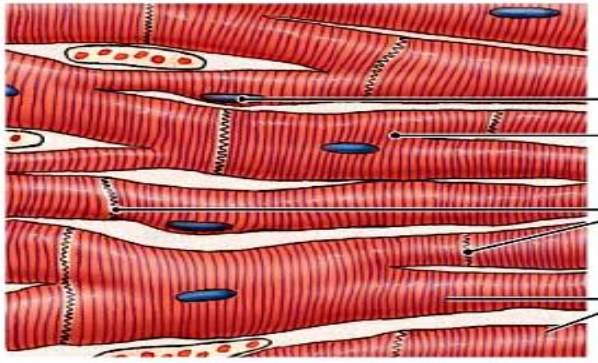


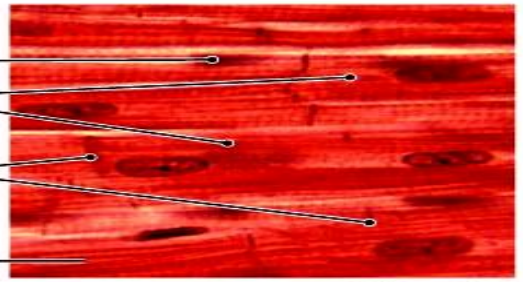




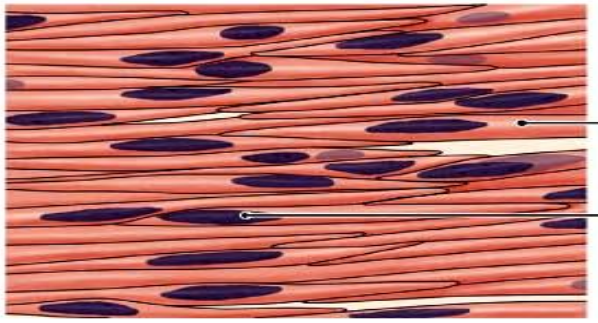
Skeletal muscles move or stabilize the position of the skeleton; guard entrances and exits to the digestive, respiratory, and urinary tracts; generate heat; and protect internal organs.

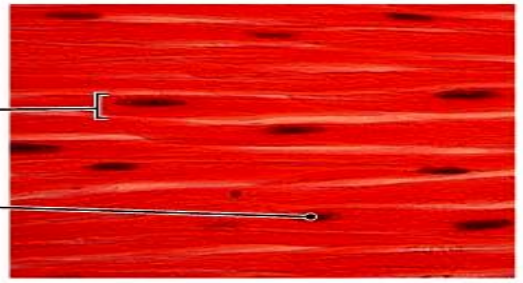






Cardiac muscle moves blood and maintains blood pressure.



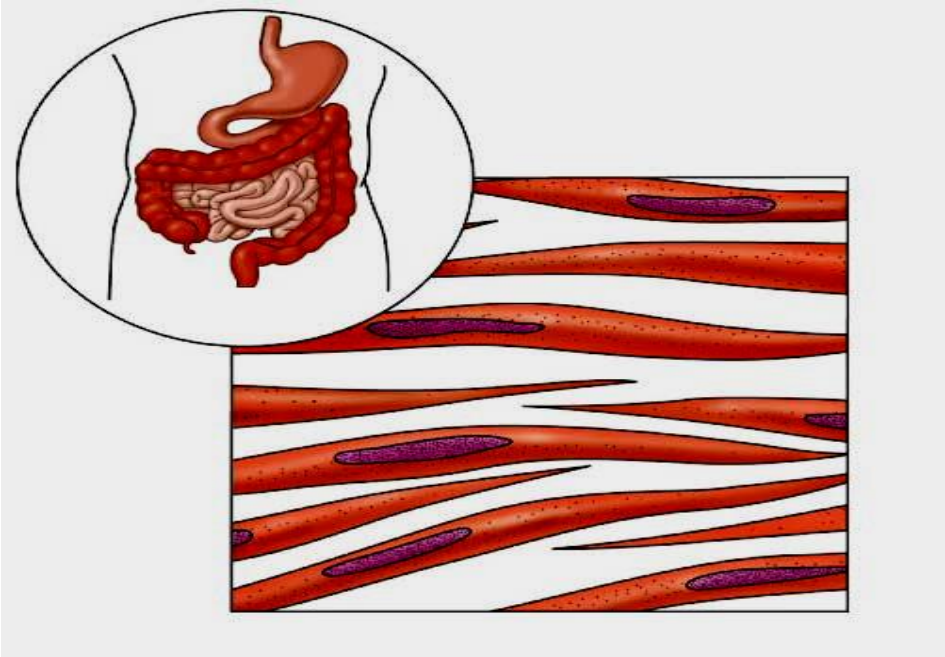


Smooth muscle moves food, urine, and reproductive tract secretions; controls diameter of respiratory passageways and regulates diameter of blood vessels.

- **Smooth muscle**

➢ **Smooth muscle fibers are long, spindle –shaped cells that contains a single nucleus.**

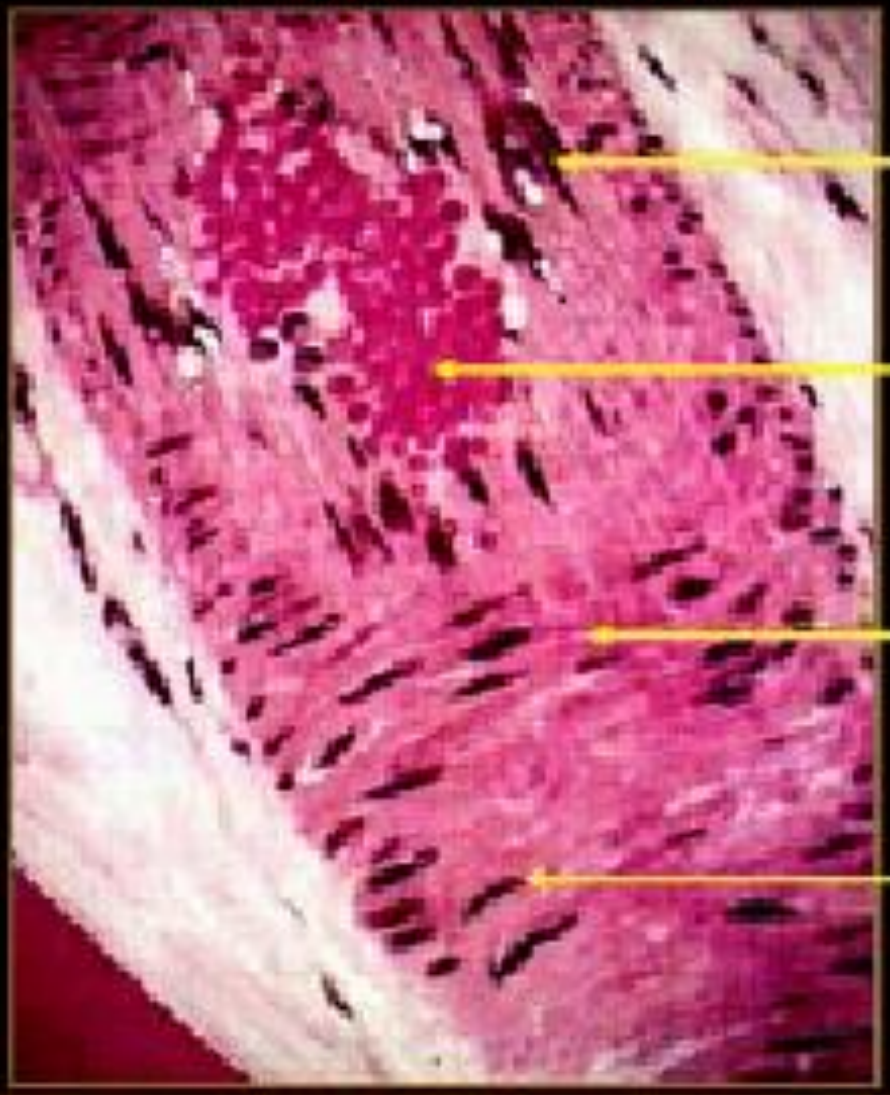
➢ **These cells are usually grouped together in flattened sheets, forming the muscular portion of the wall around a lumen**



- **Smooth muscle tissue is common throughout the body.**
- **Smooth muscle is also found in**
  - **the walls of blood vessels,**
  - **the walls of respiratory passage, and**
  - **in the urinary and reproductive duct.**
- **The contraction of smooth muscle is under involuntary (unconscious) nervous control.**

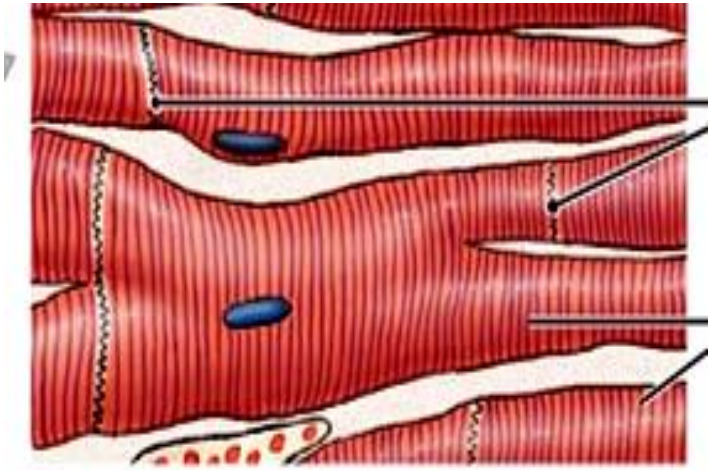
Smooth muscle

Wall of blood vessel



- **Cardiac muscle**

➢ **Make up most of the wall of the heart**



- characterized by

-- branching fibers,

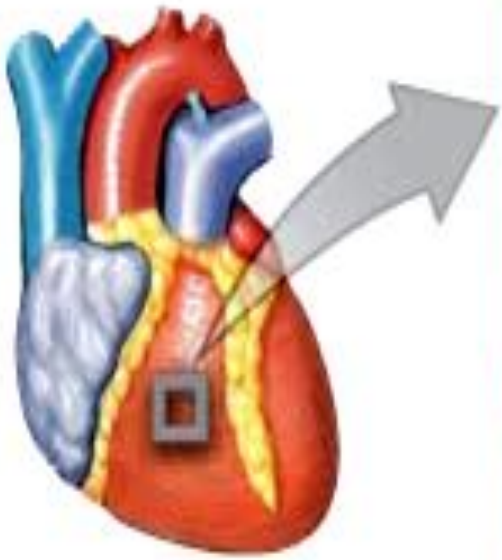
-- a central nucleus,

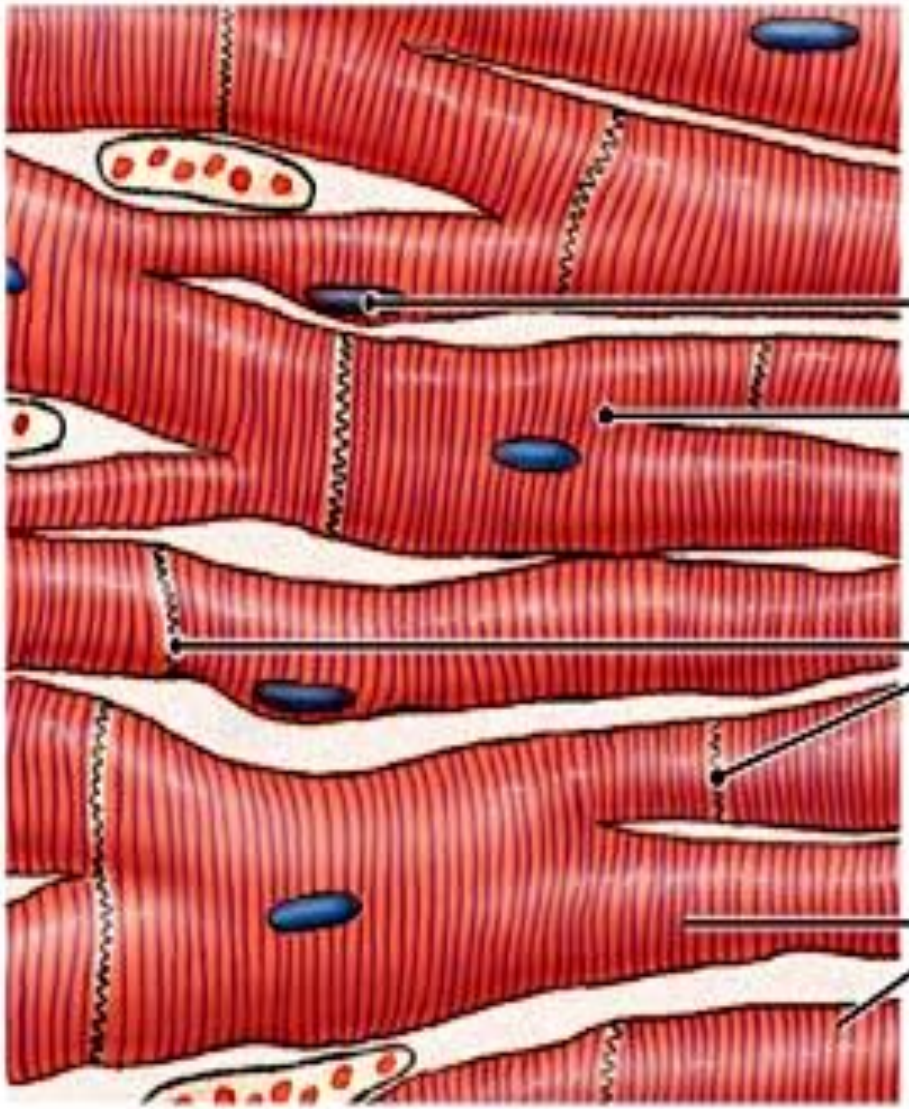
-- banding patterns called striations.

➢ **The cardiac muscle fibers are joined by intercalated discs.**

- **Intercalated discs help to hold neighboring cells together and spread the contract from cell to cell.**
- **Cardiac muscle tissue**

- also contracts involuntarily.





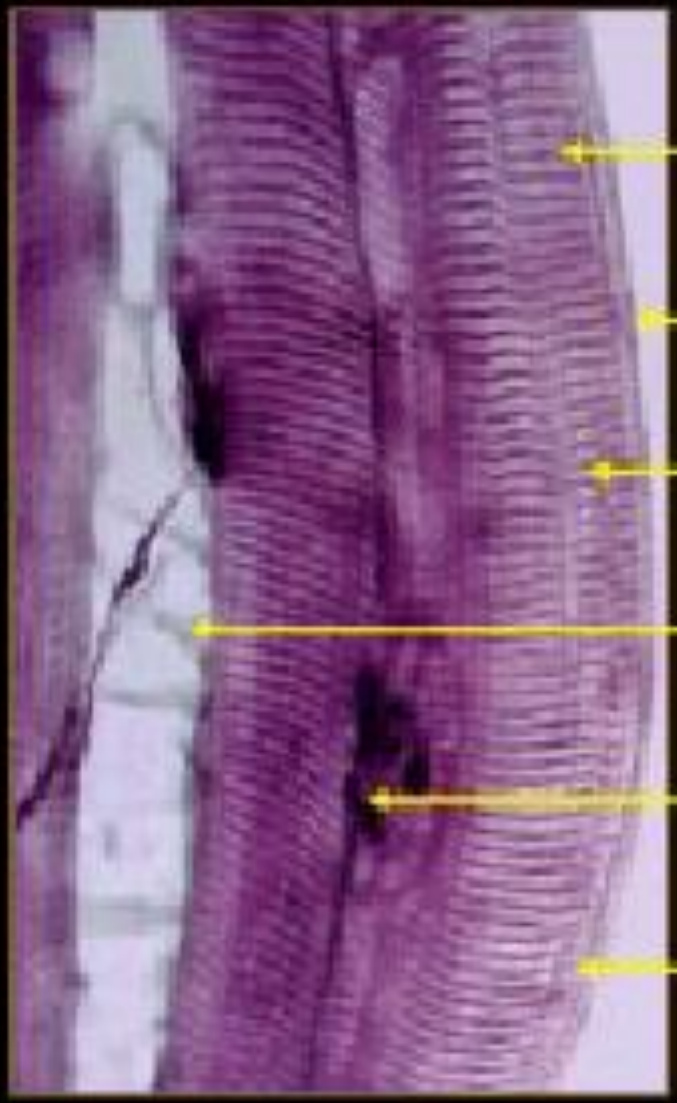
Cardiac muscle moves blood and maintains blood pressure.

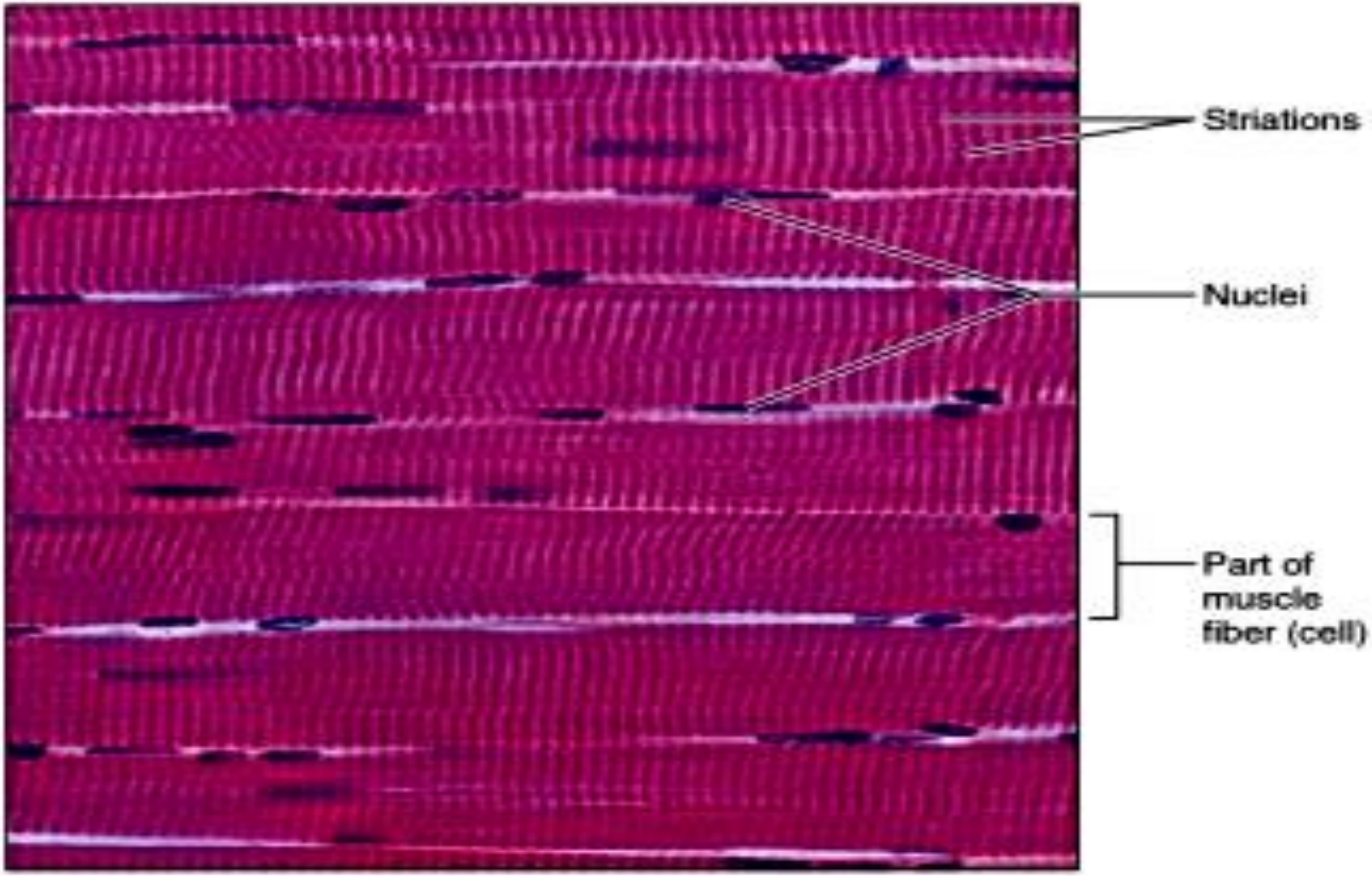
Cardiac muscle

- **Skeletal (Striated) Muscle**

- **Makes up the skeletal muscle that attached to the bones of the skeleton.**
- **Contraction of results in voluntary or involuntary body movements.**
- **Skeletal muscle fibers are long and multinucleate.**
- **The striations easily seen through a microscope.**

Striated muscle





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

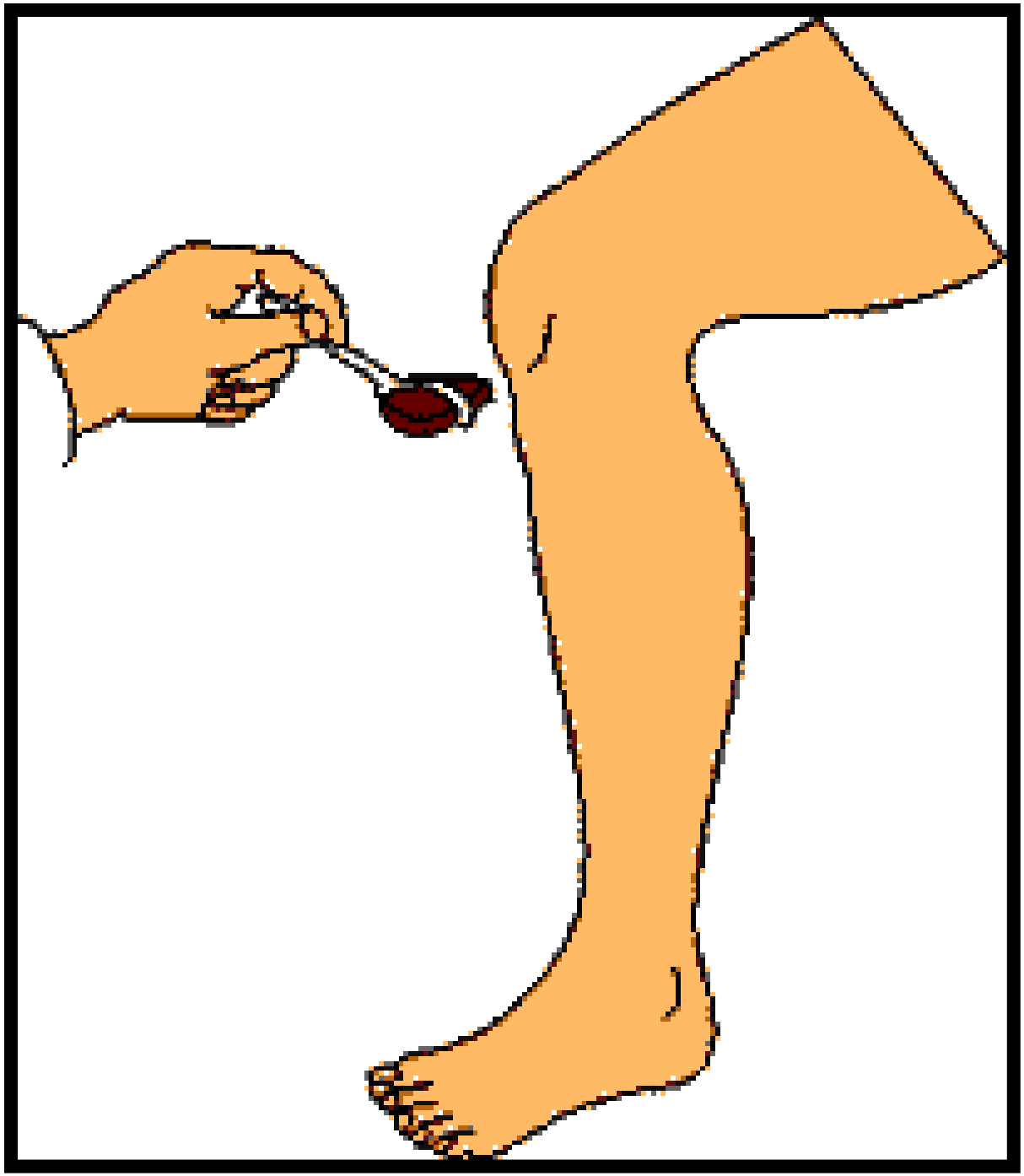
Skeletal Muscle

- Human body contains over 400 skeletal muscles
  - 40-50% of total body weight
- Functions of skeletal muscle
  - Force production for locomotion and breathing
  - Force production for postural support
  - Heat production during cold stress

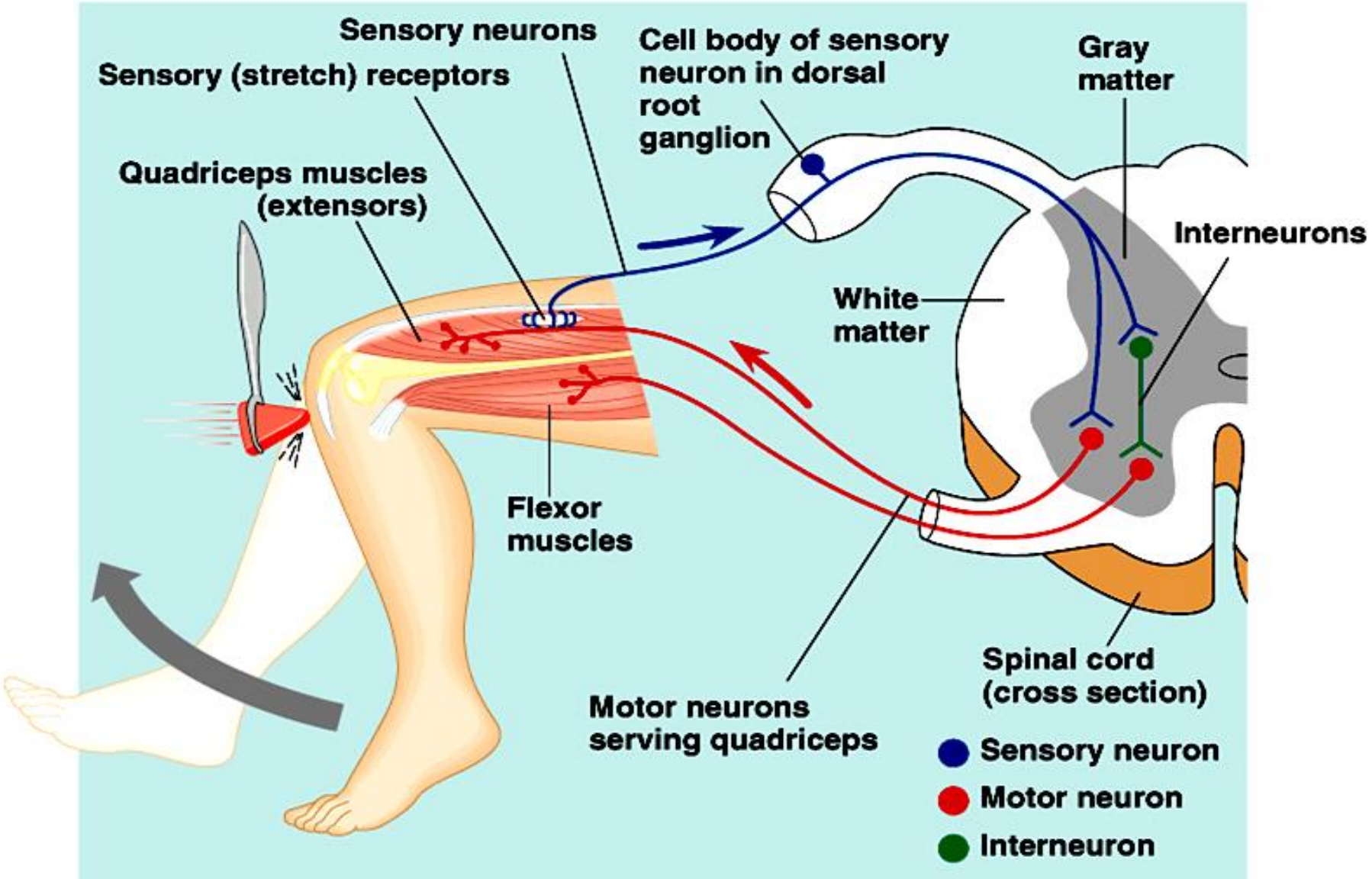
(4) Somatic Reflexes

- **Involuntary Movement of Skeletal Muscle**

- **Examples:**
  - **Touching a Hot Stove**
  - **Knee-Jerk Reflex**
  - **Touching a Sharp Object**



- A Simple Nerve Circuit – the Reflex Arc.
  - A **reflex** is an autonomic response.



- **Nervous Tissue**

➢ **Nervous Tissue , contained within**

- the brain,

- spinal cord, and

➢ **composed of two kinds of cells-**

- neurons and

- neuroglial cells.

- **Neurons, or nerve cells are**

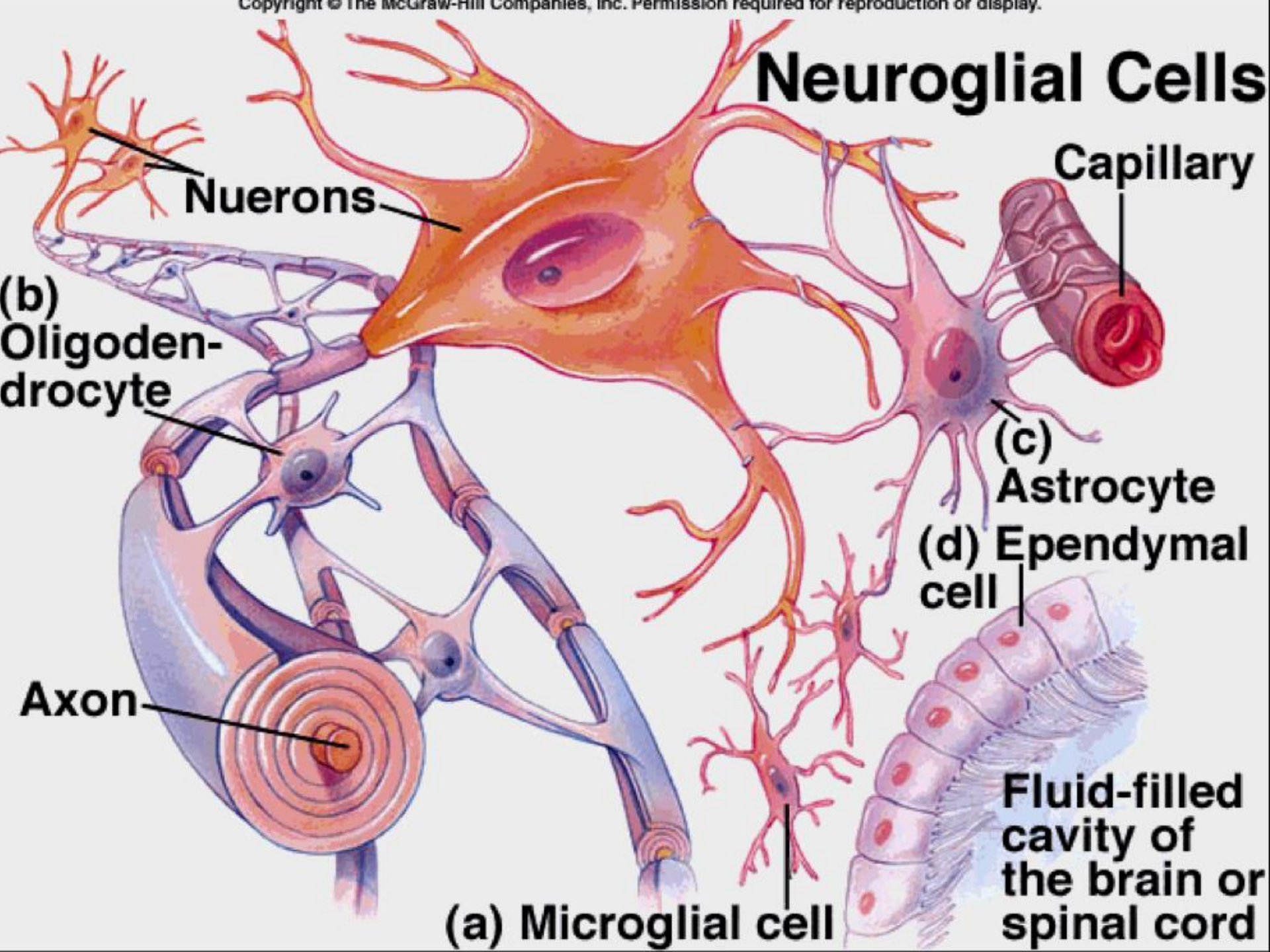
- the basic structural and

- functional units,

- specialized to respond to { **physical stmuli and** / **chemaical stmuli &**

- to generate impulses and

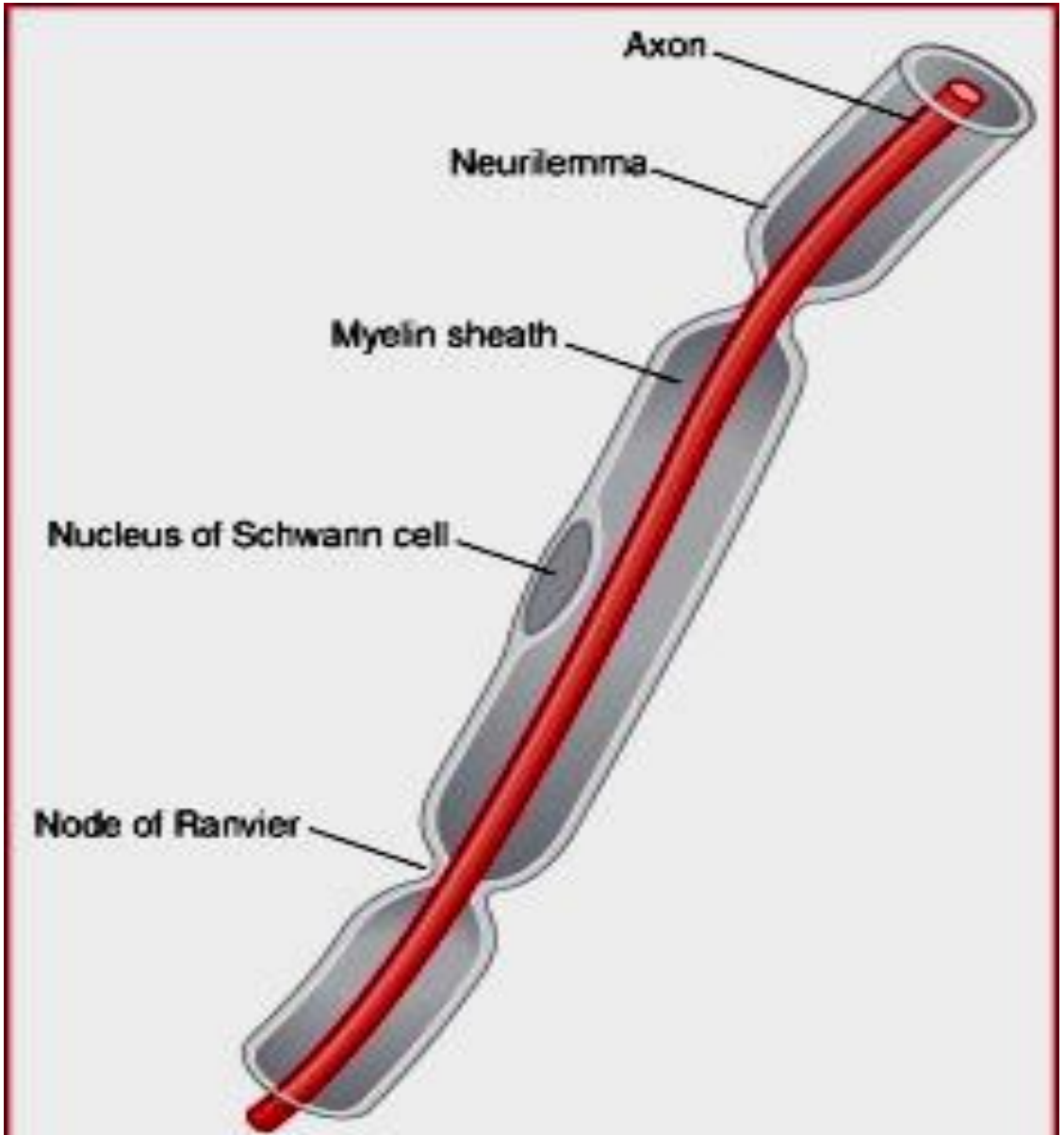
- conduct impulses to and from the various body organs.

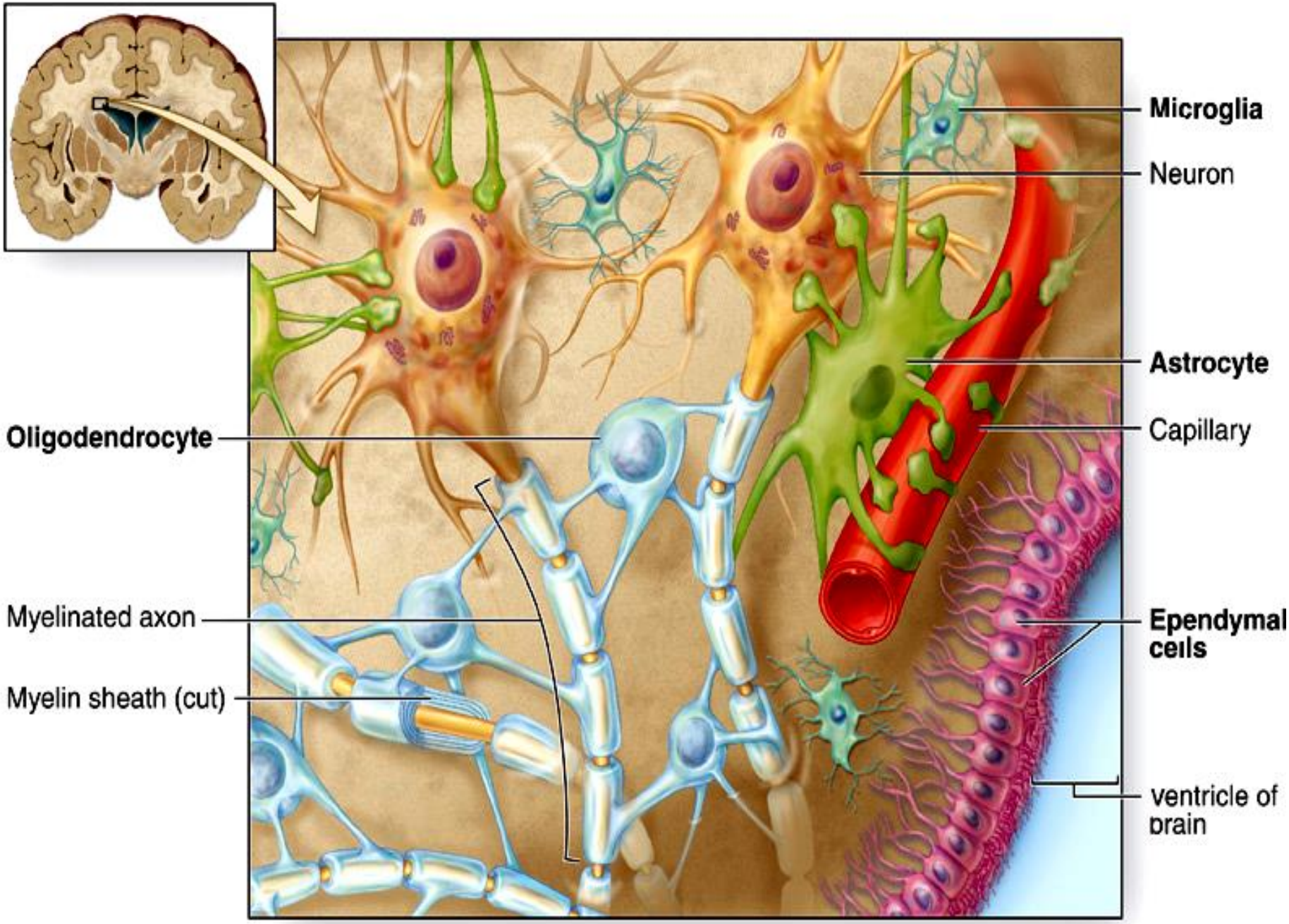


- **A neuron has three principal components.**
- **1.The cell body contains the nucleus and specialized organelles and microtubules.**
- **2.The dendrites function to receive a stimulus and conduct the impulse toward the cell body.**
- **3.The axon is a long extension that conducts an impulse away from the cell body.**

Neuron

The term nerve fiber usually refers to an axon and the myelin sheath that surrounds it.



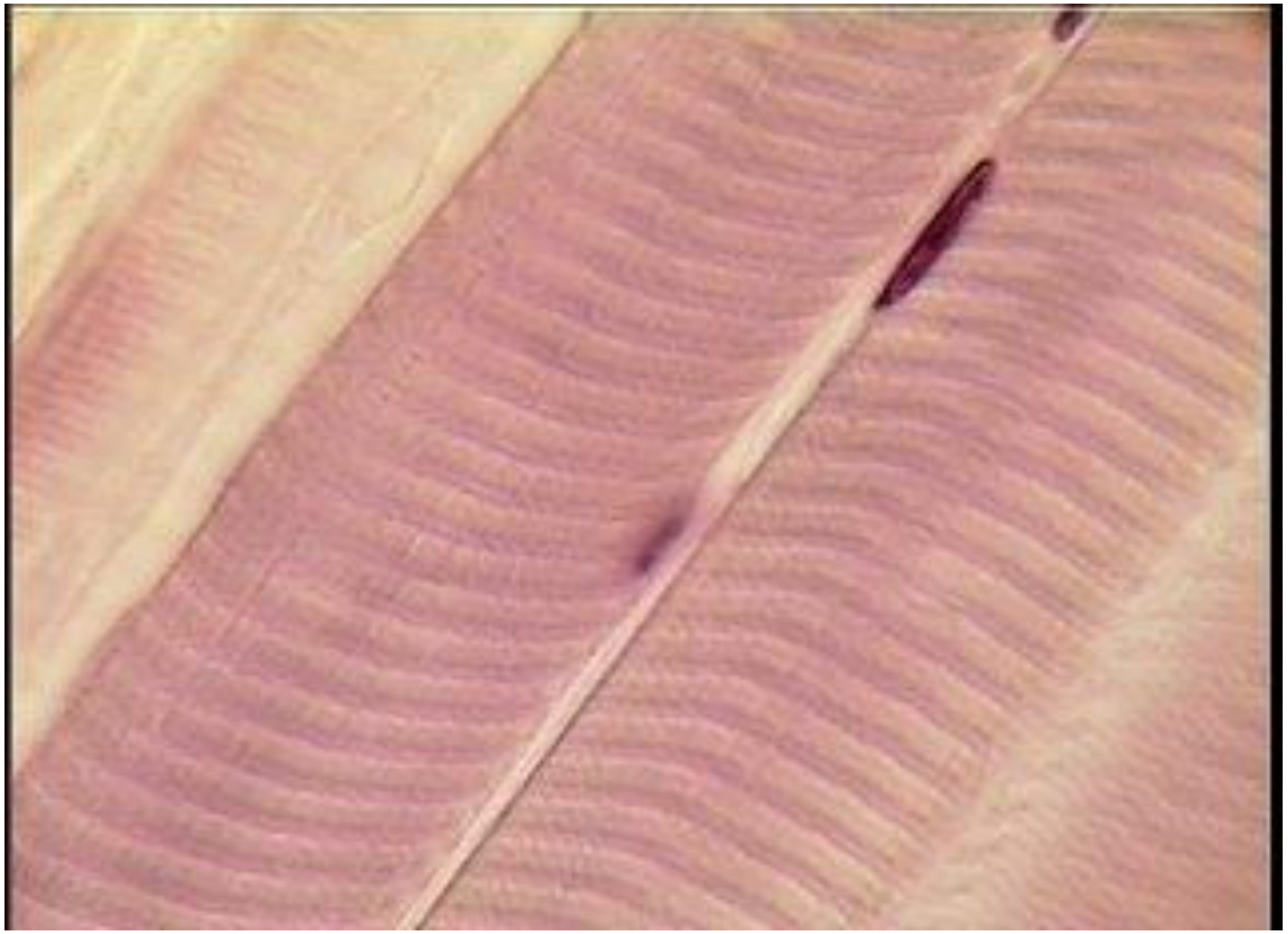


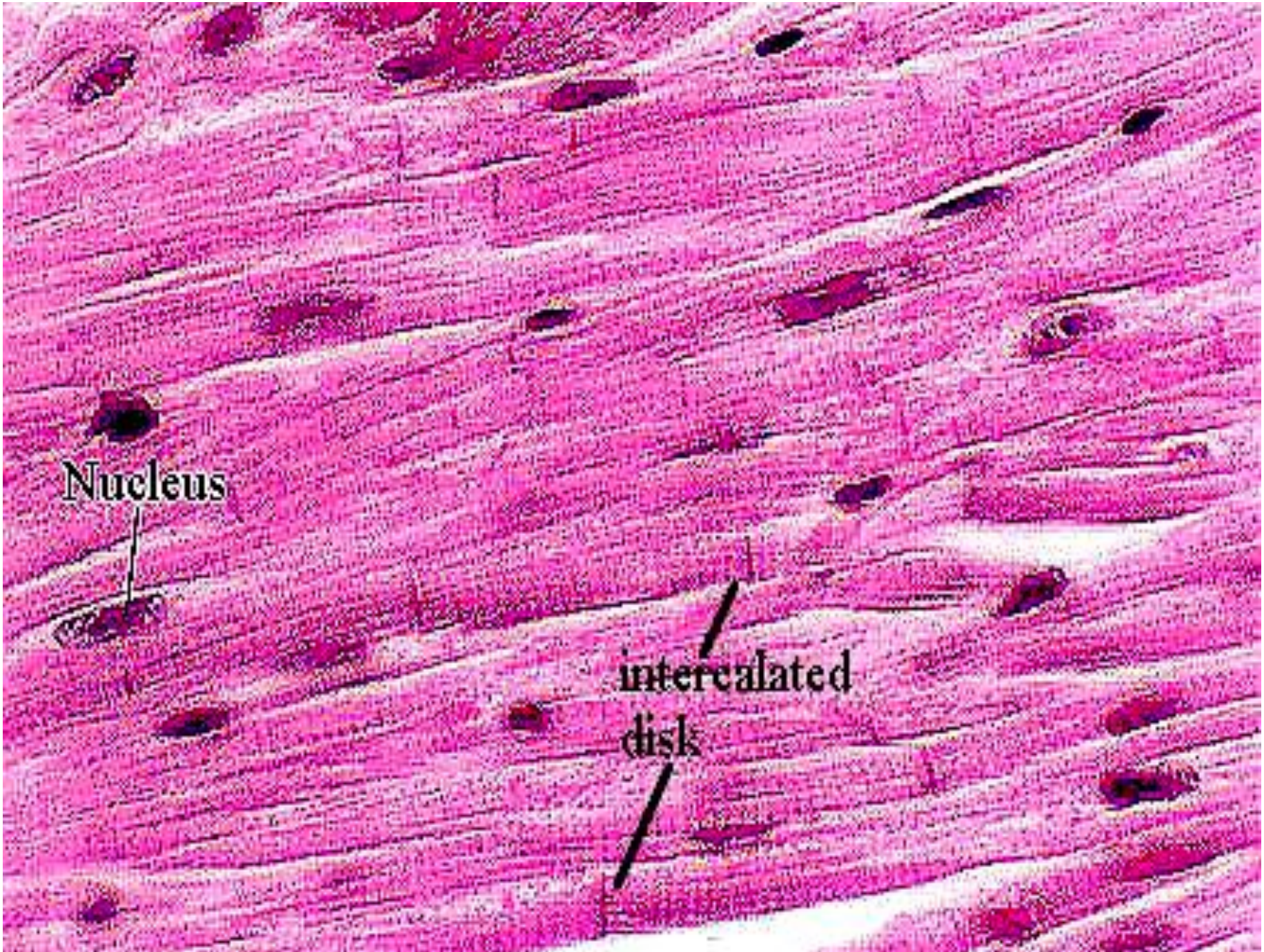
Enjoy Your Learning

&

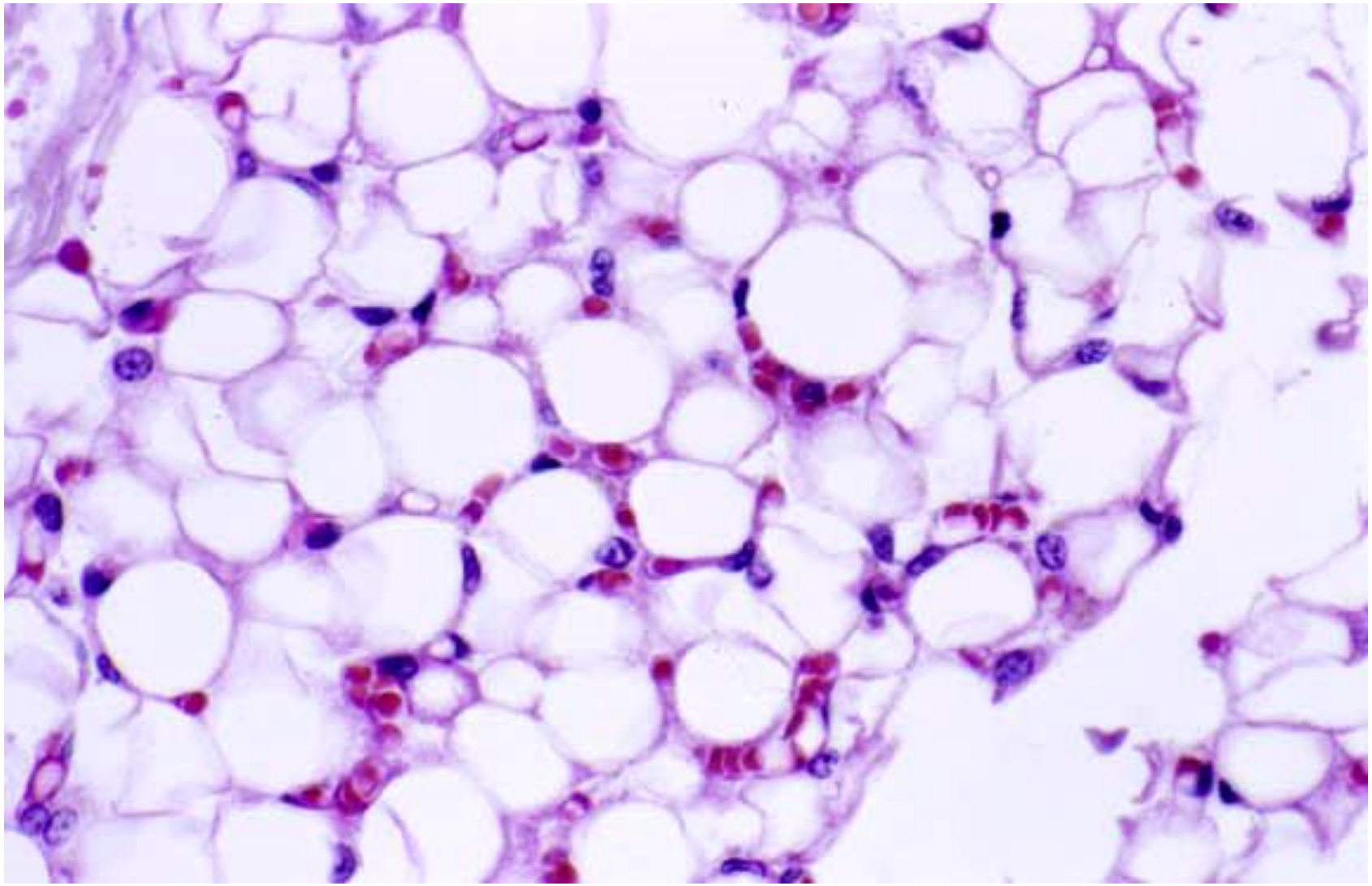
Your University Student Life

Good Luck




Nucleus
intercalated
disk

Adipose



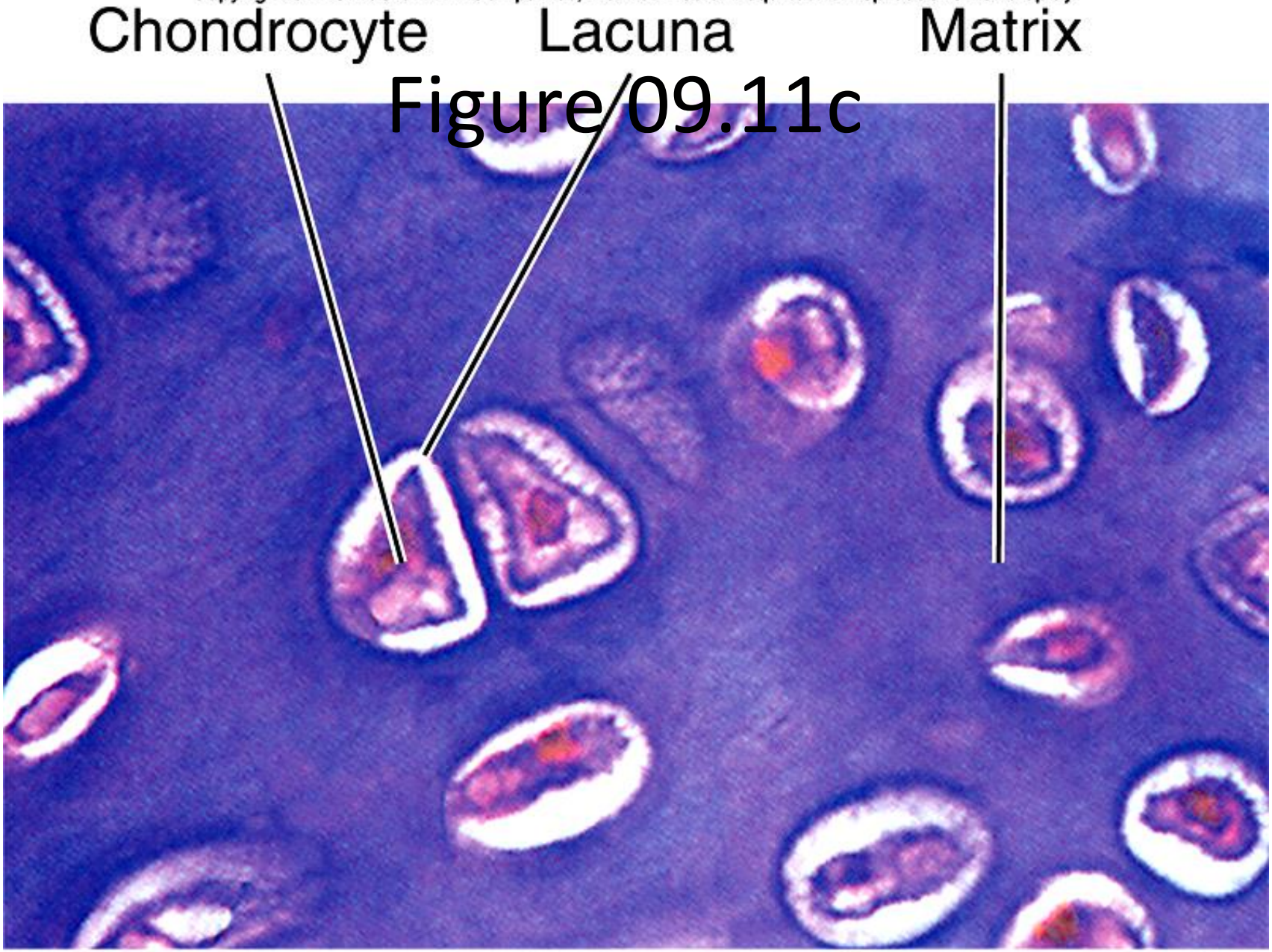
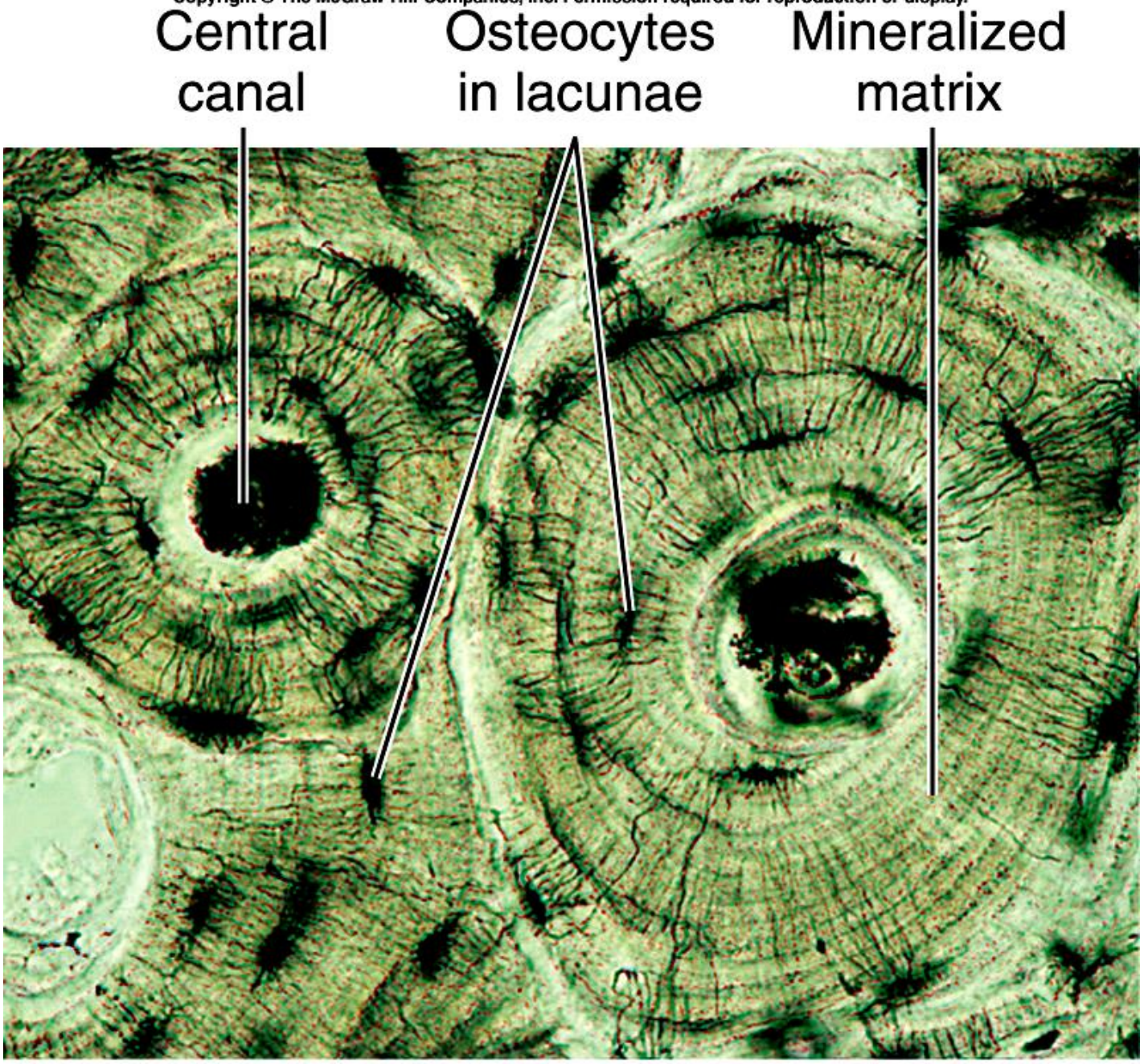


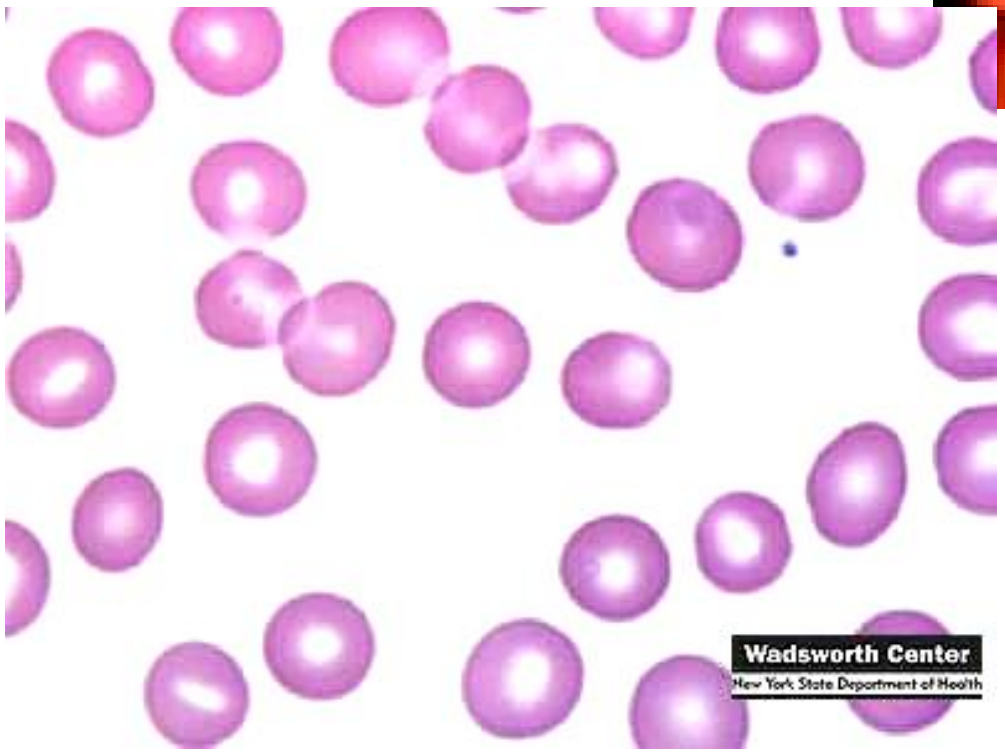
Figure 09.11c

C **Cartilage**

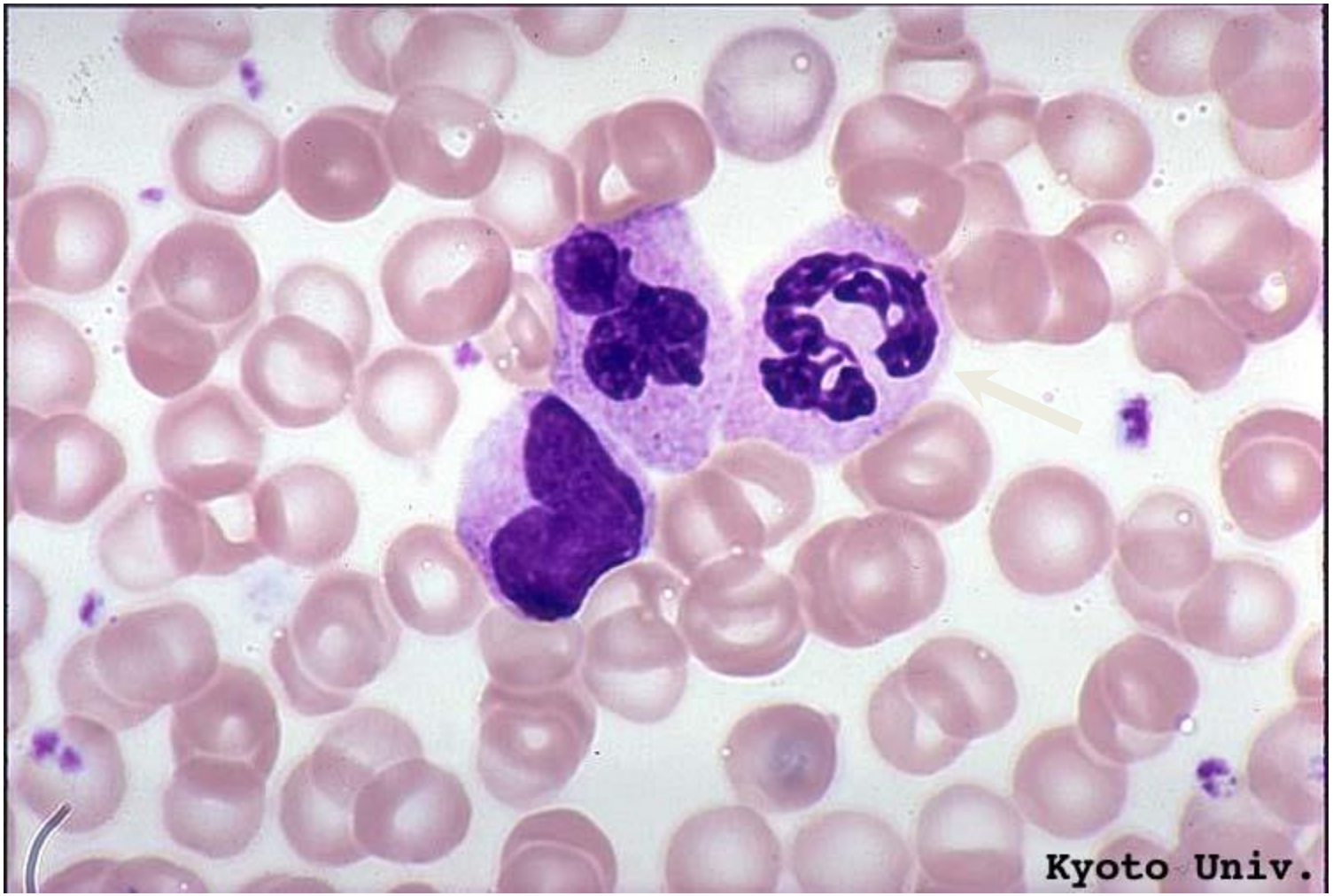


D **Bone**

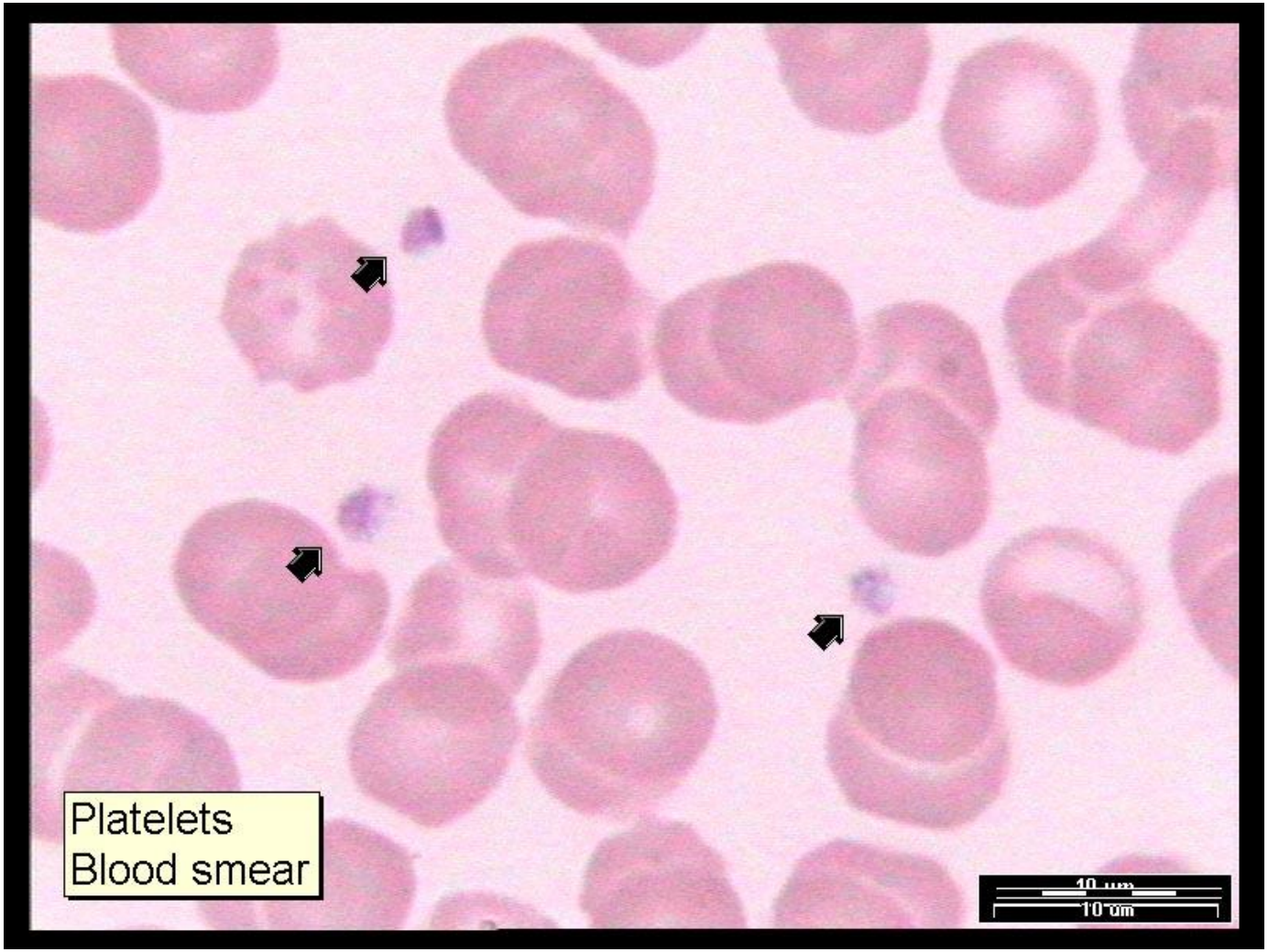
Erythrocytes: Red Blood Cells



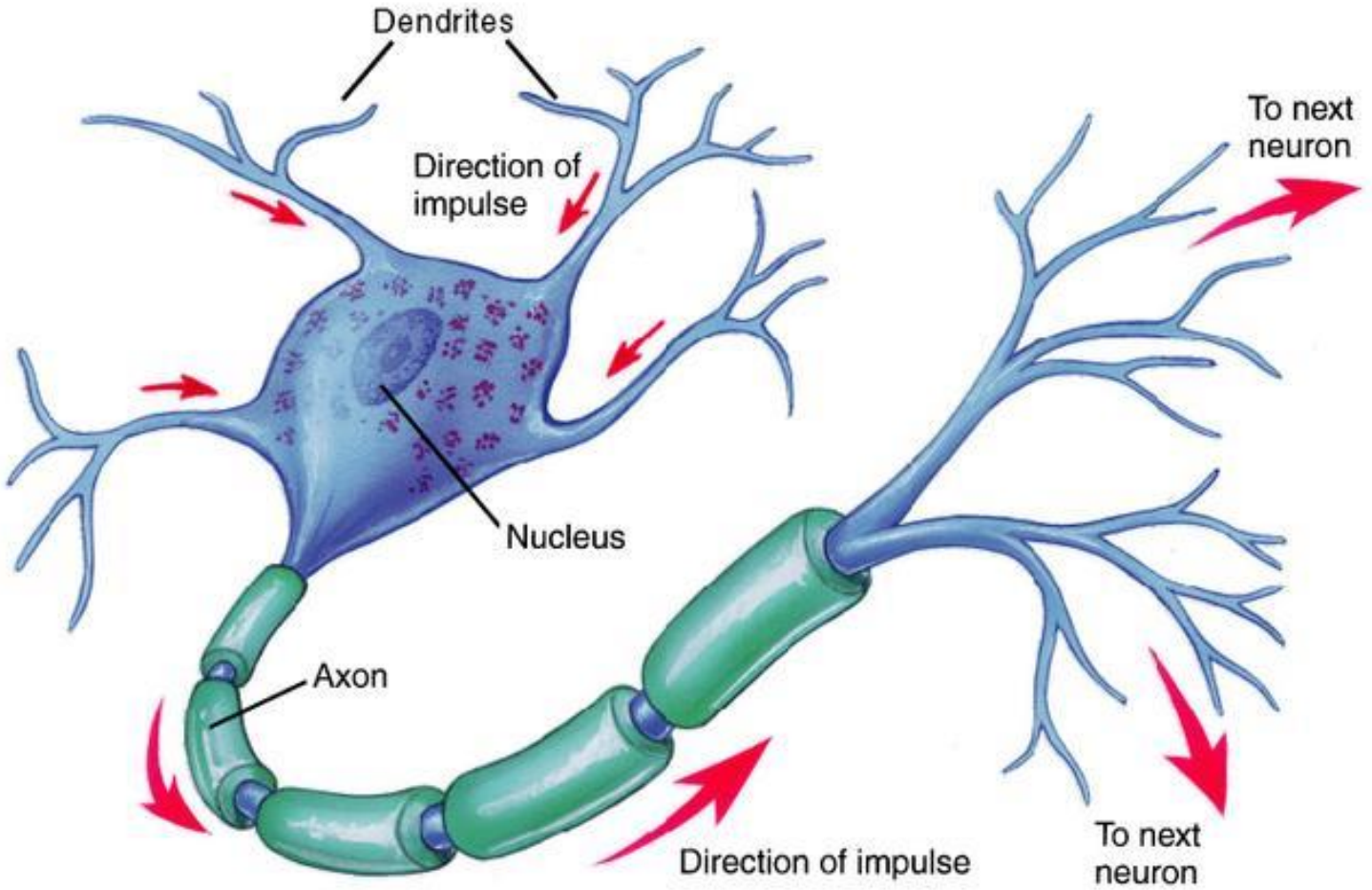
Leucocytes: White Blood Cells



Platelets



Neuron


Dendrites
Direction of impulse
To next neuron
Nucleus
Axon
Direction of impulse
To next neuron