

# Histology

lecture from Human Morphology

12. 10. 2023

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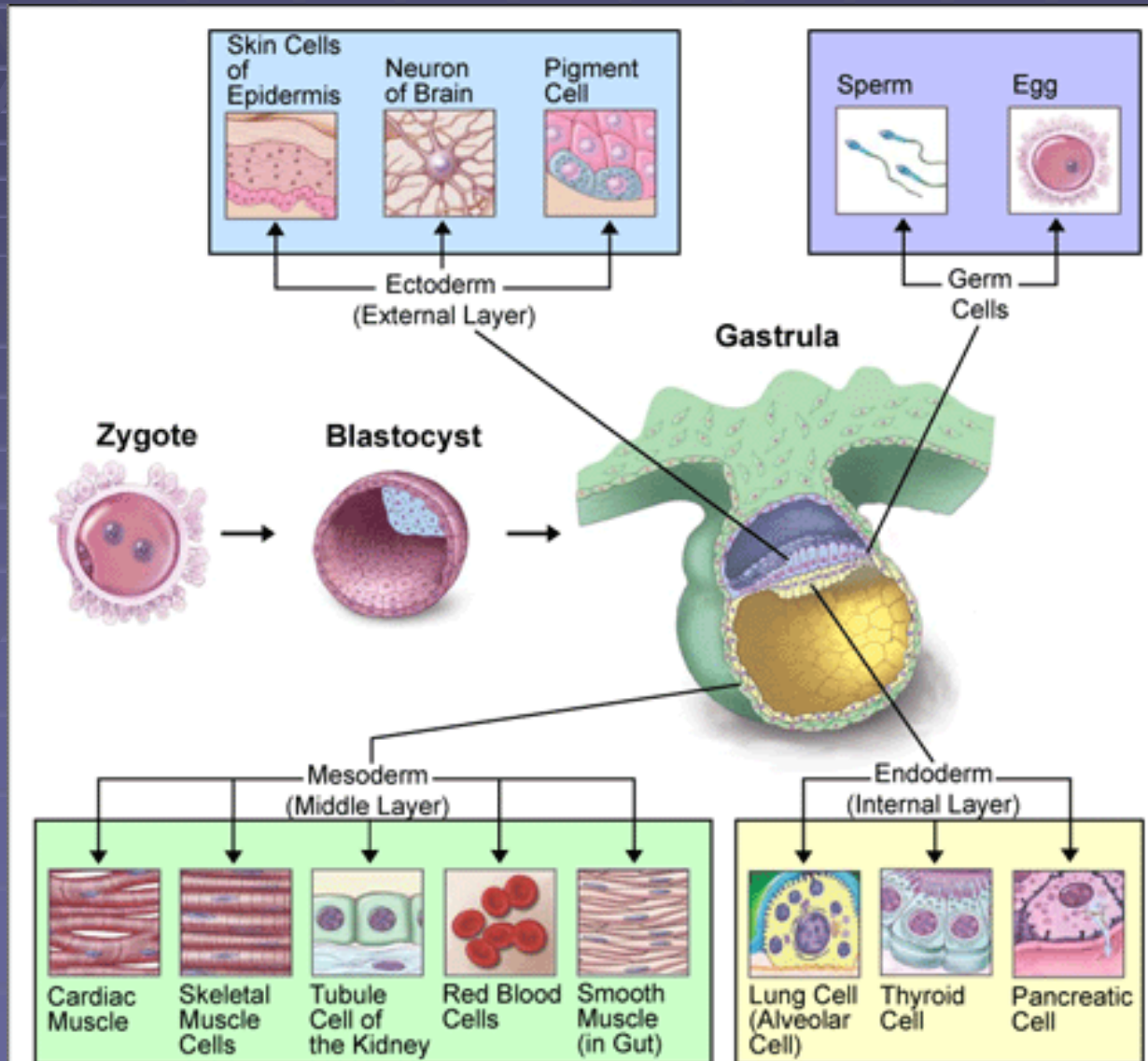
# HISTOLOGY

- the study of the microscopic structure of cells, tissues and organs
- it is performed by examining a thin sections of tissue under a light or electron microscope

# TISSUE ORIGIN

- during embryonic period tissues are differentiated from the **germ layers**
- ECTODERM
- MESODERM
- ENDODERM

# TISSUE ORIGIN



# HISTOLOGICAL TECHNIQUE

## ■ Tissue sampling

- necropsy – samples taken from dead bodies
- biopsy
  - probatory excision – during the surgery
  - probatory puncture – sucking of cells or pieces of tissue through the syringe with thick needle
  - curettage – in gynaecology and obstetrics



# HISTOLOGICAL TECHNIQUE

## ■ FIXATION

- autolysis – each living tissue gradually loses the structural features and undergoes decay and disintegration by means of degrading enzymes
- fixing – stopping the autolysis; denaturation of cell and tissue proteins and their precipitation
- physical means of fixing – dry hot, boiling, lyophilisation (desiccation during lower temperature)
- chemical means of fixing – ethanol, methanol, acetone, acetic acid, triacetic acid, picric acid, mercuric chlorid, copper dichromate, formaldehyde, glutaraldehyde
- common fixing time 12 – 24 hours
- washing after fixation – by means of water or alcohol

# HISTOLOGICAL TECHNIQUE

## ■ EMBEDDING

- water-soluble media – hot gelatine, cellodal, polyethylenglycols
- water-insoluble media – paraffin, celloidin, celloidin-paraffin

## ■ SECTIONS

- microtoms
- slice thickness – for studying purposes 10  $\mu\text{m}$  thin slices
- slice processing – put albumen fixative on the slide, adding a few drops of distilled water, arranging the sections on the slides, warming the slide to spread the sections and drying in air

# HISTOLOGICAL TECHNIQUE

## ■ STAINING

- rendering of outlines and structures more distinct by giving them a color contrast with their surroundings (color image), the differentiation of particular structures or substances, which by their selective staining facilitate the histological analysis
- removal of embedding media
- staining
  - hematoxylin and eosin: nuclei and cartilage (hematoxyline), fibrous tissue, cytoplasm, muscle tissue (eosin)
  - Azan: nuclei, erythrocytes, collagen tissue, muscle tissue
  - Weigert – van Gieson: muscle tissue, collagen, nuclei

## ■ MOUNTING

- it means to arrange it upon some suitable support (glass slide) in a suitable mounting medium to be satisfactorily studied with the microscope
- canadian balsam, gum arabic sirup, glycerine





# TISSUE

- ensemble of cells, not necessarily identical, but from the same embryonic origin, that together perform the same function

- epithelial tissue
- connective tissue
- muscle tissue
- nervous tissue
  
- body fluids



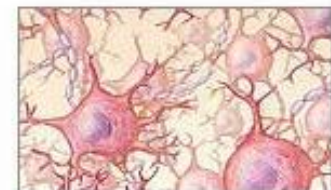
Connective tissue



Epithelial tissue

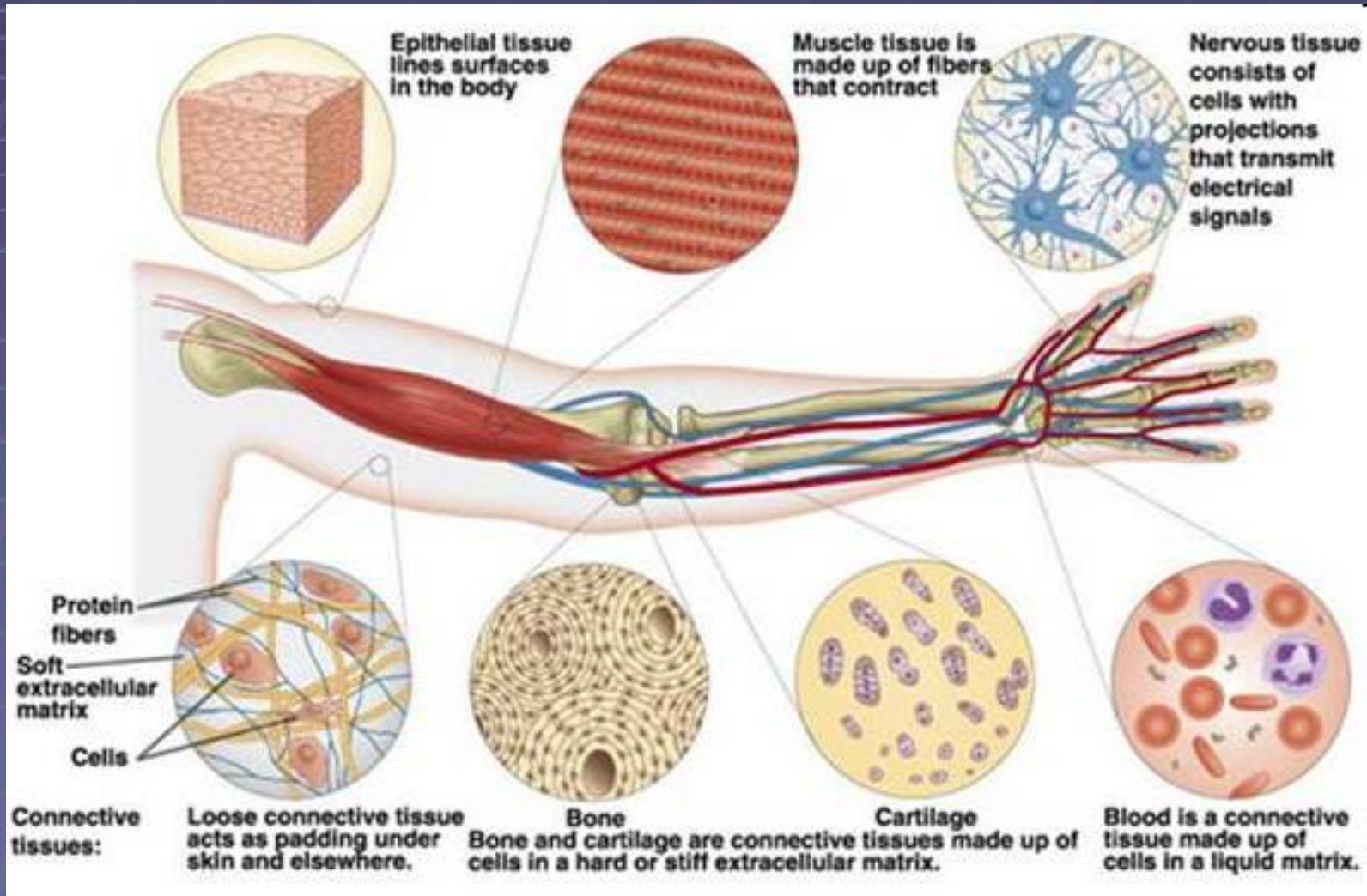


Muscle tissue



Nervous tissue

# TISSUES



# EPITHELIA

## ■ SIMPLE EPITHELIA


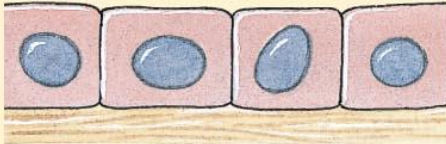
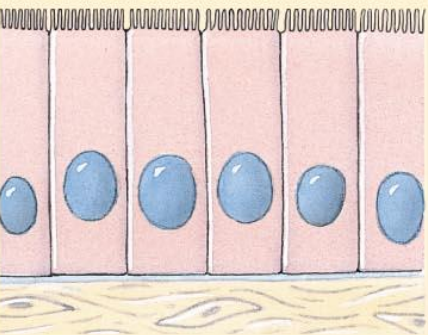
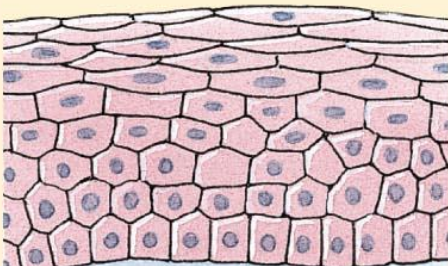
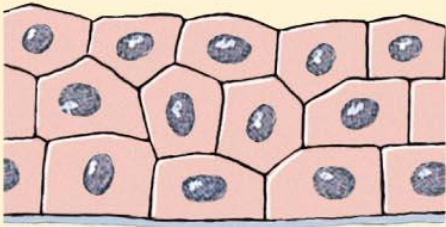
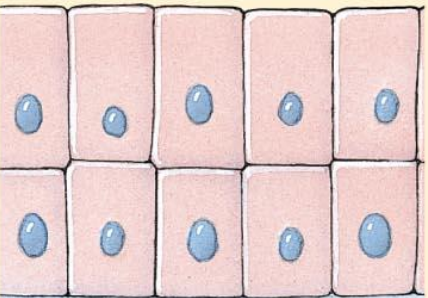
- simple squamous
- simple cuboidal
- simple columnar

## ■ STRATIFIED EPITHELIA

- stratified squamous
- stratified cuboidal
- stratified columnar
  
- transitional

# Types of Epithelium

TABLE 4 - 1 *Classifying Epithelia*

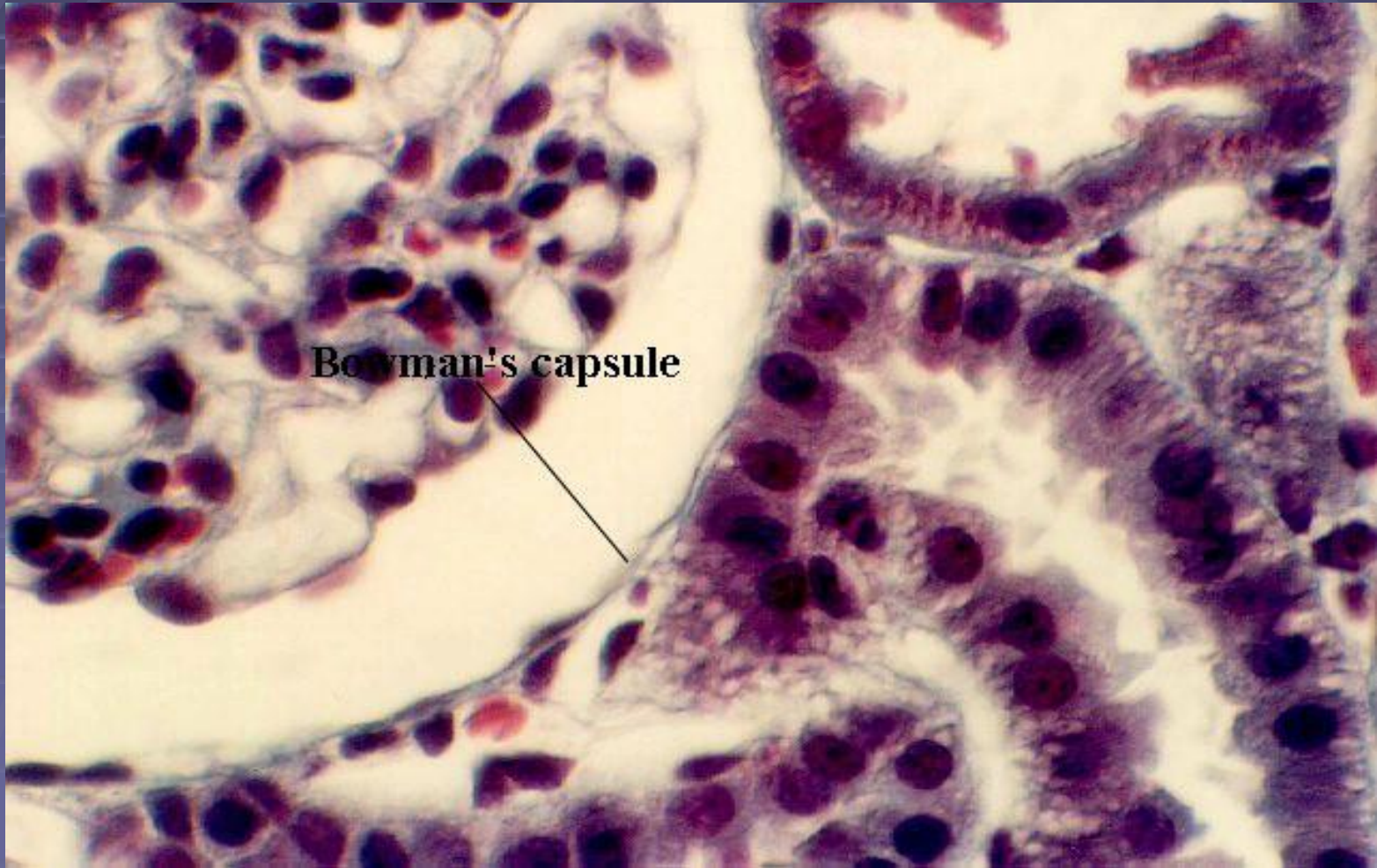
|            | Squamous   | Cuboidal  | Columnar   |
|------------|--|---|--|
| Simple     |  <p>Simple squamous epithelium</p>      |  <p>Simple cuboidal epithelium</p>      |  <p>Simple columnar epithelium</p>      |
| Stratified |  <p>Stratified squamous epithelium</p> |  <p>Stratified cuboidal epithelium</p> |  <p>Stratified columnar epithelium</p> |

**basement membrane**

# EPITHELIAL FUNCTIONS

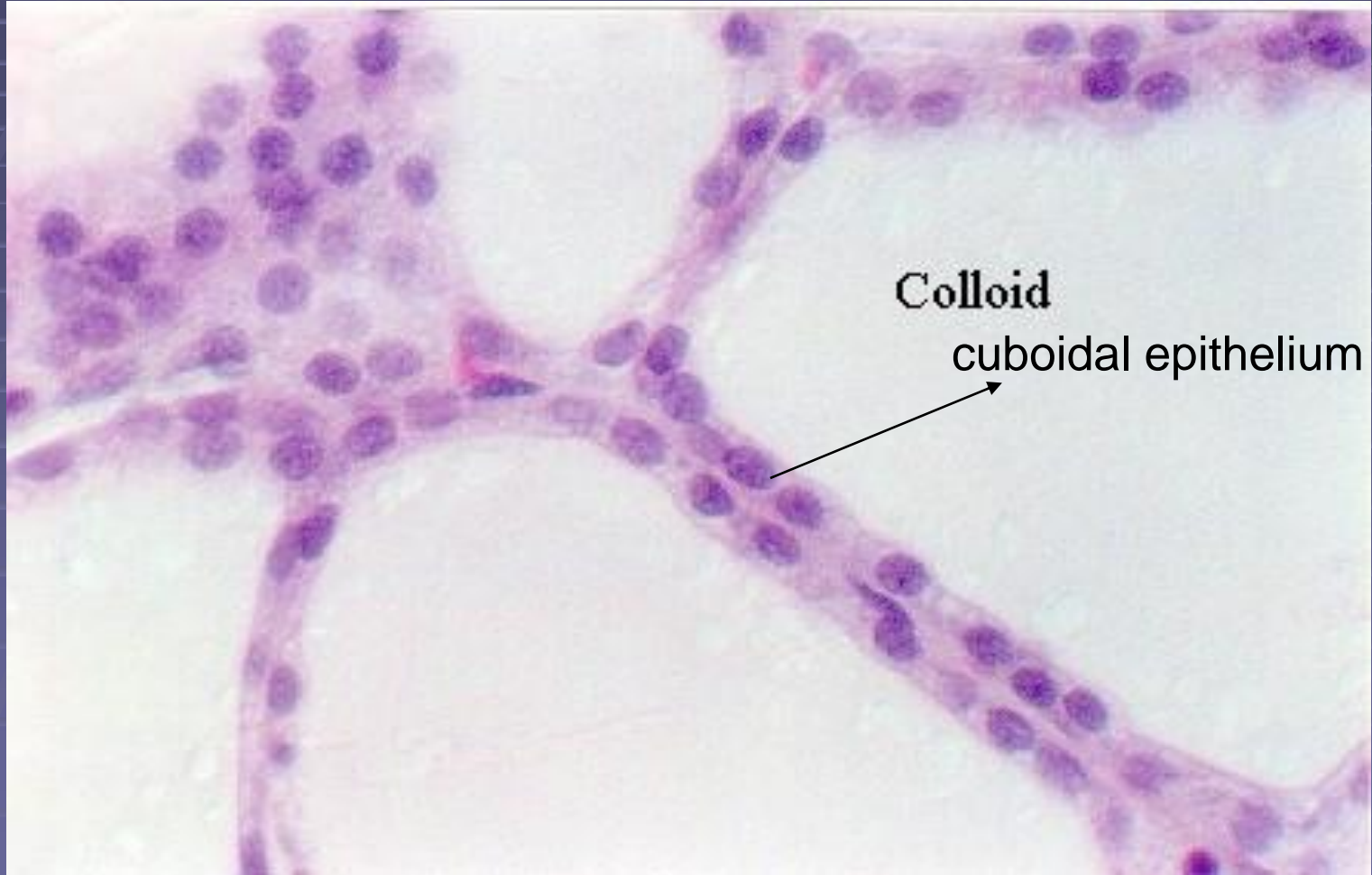
- protection
- secretion (glands)
- excretion
- absorption
- diffusion (capillaries, lungs)
- sensation

# SIMPLE SQUAMOUS EPITHELIUM kidney



# SIMPLE CUBOIDAL EPITHELIUM

thyroid gland

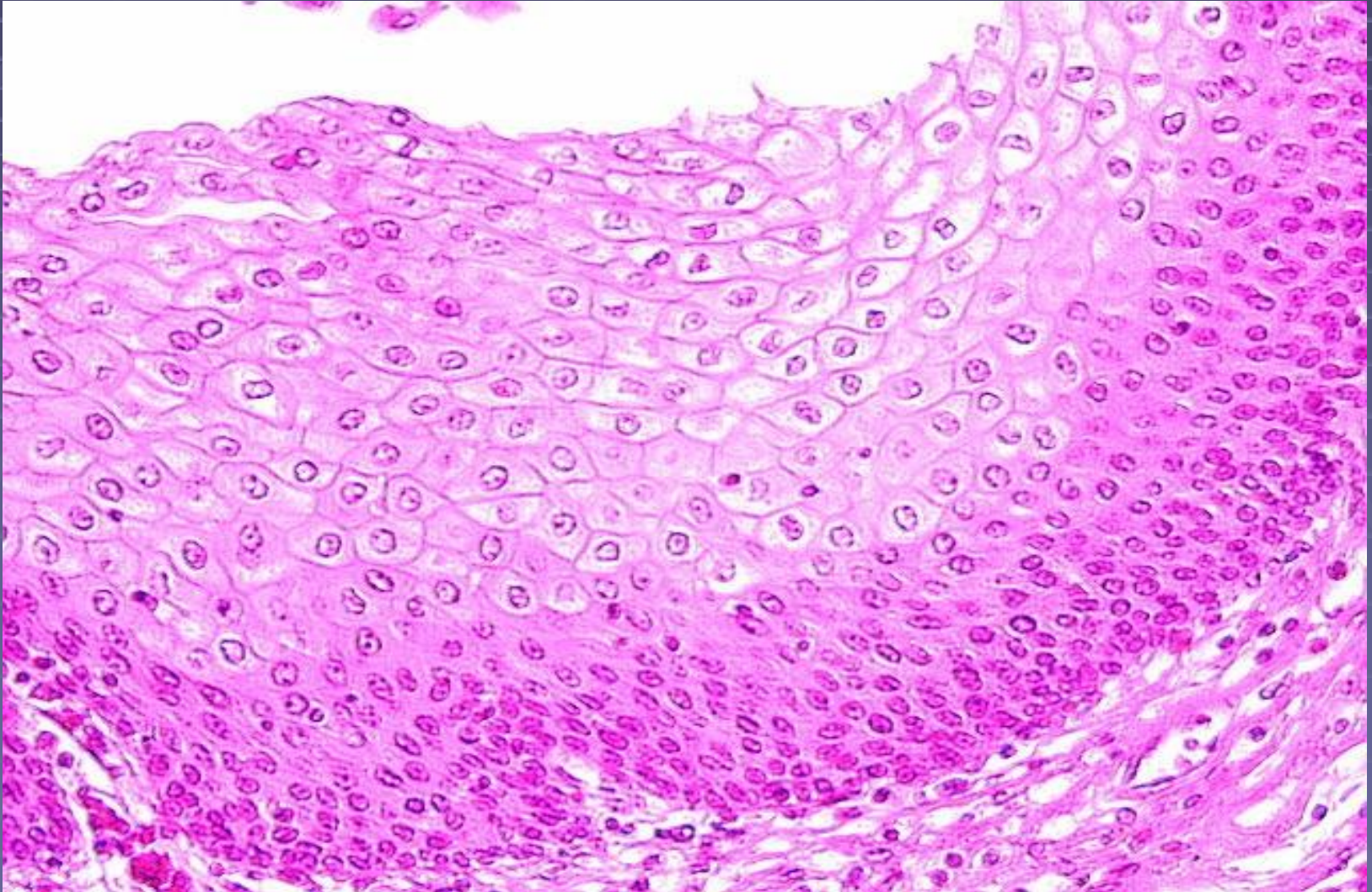


# SIMPLE COLUMNAR EPITHELIUM jejunum

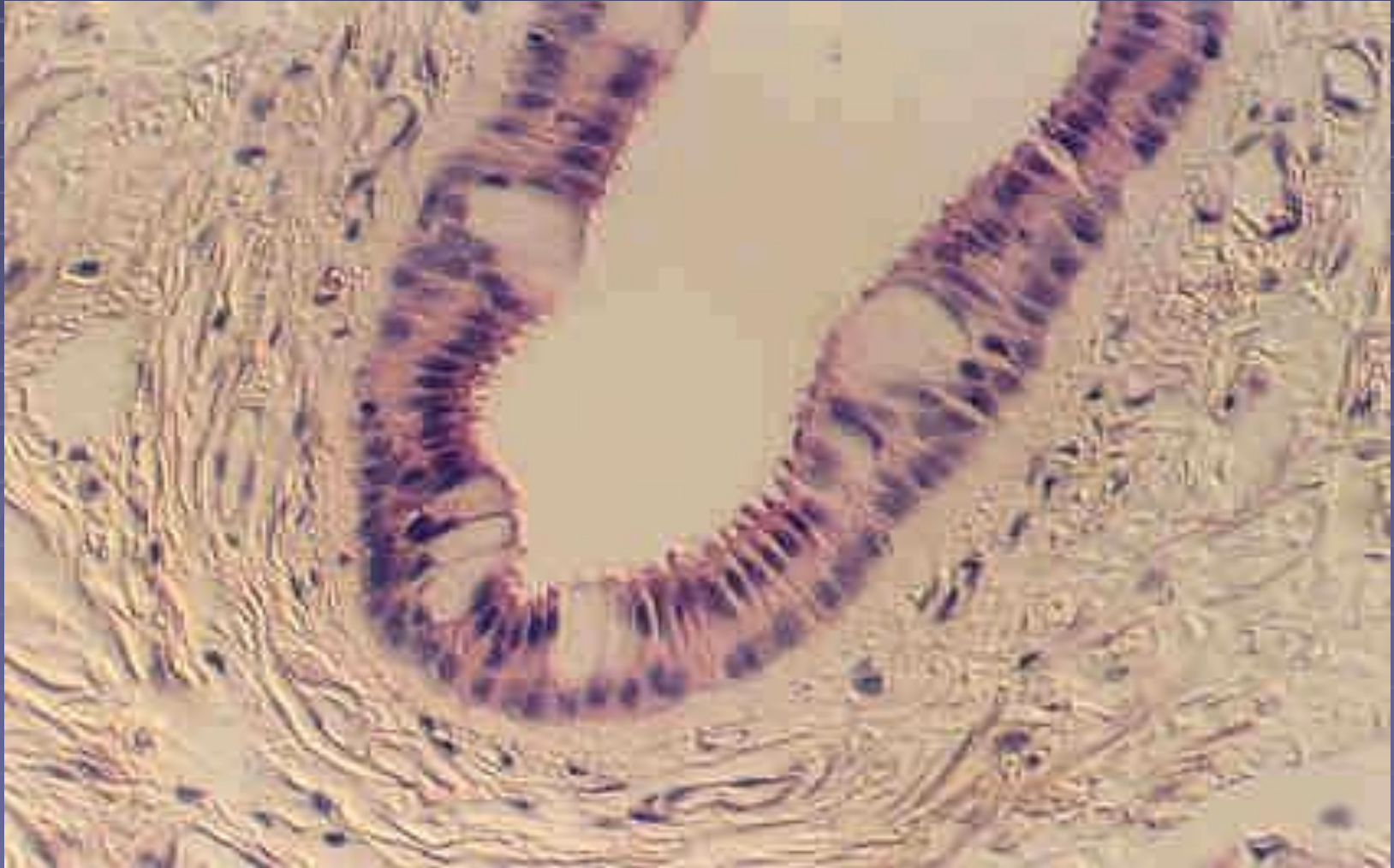




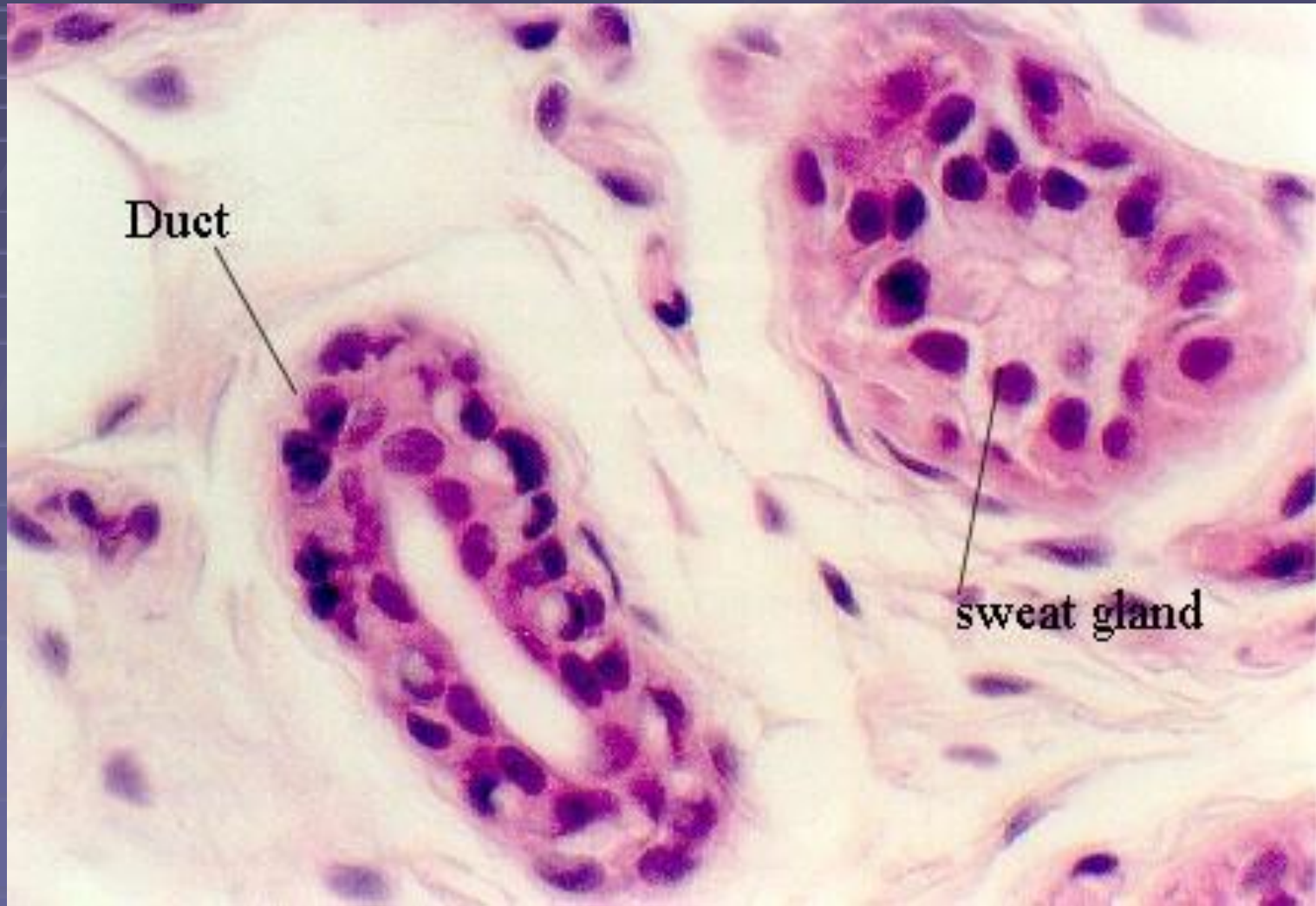
# STRATIFIED SQUAMOUS EPITHELIUM gullet / esophagus



# STRATIFIED COLUMNAR EPITHELIUM salivary gland



# STRATIFIED CUBOIDAL EPITHELIUM sweat gland



# TRANSITIONAL EPITHELIUM

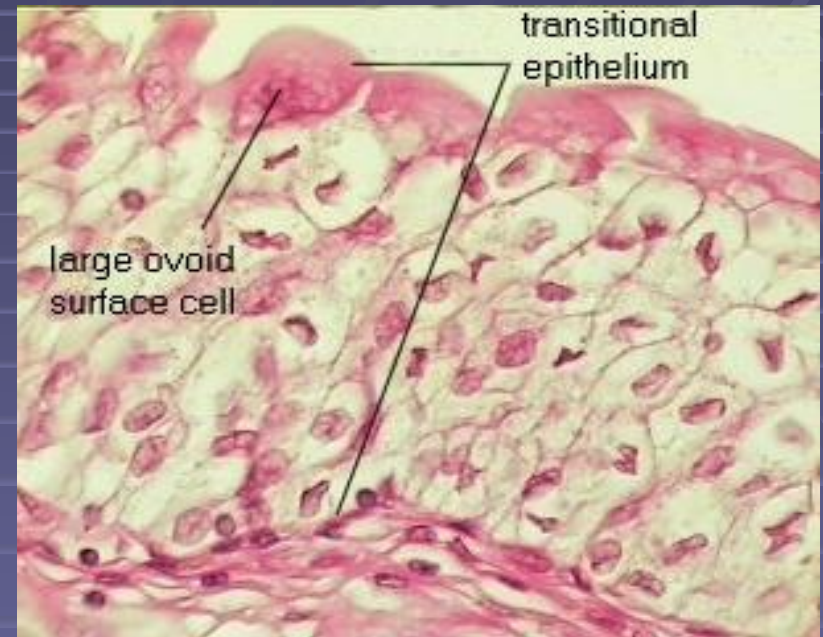
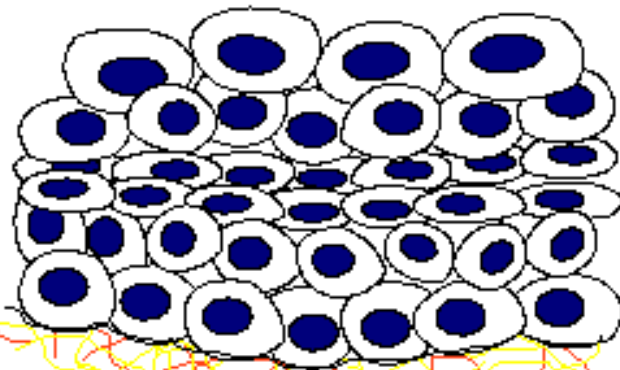
## urinary bladder

large, ovoid surface cells

normal

transitional

stretched



# GLANDULAR EPITHELIUM

## ■ UNICELLULAR GLANDS

- goblet cells
- gastroenteropancreatic system

## ■ MULTICELLULAR GLANDS

- endocrine
- exocrine

- types of secretion: **serous** – thin watery, protein-rich secretion
- mucinous** – viscous secretion, which has a lubricating or protective function
- seromucinous** – mixed type



# GLANDS



Simple tubular



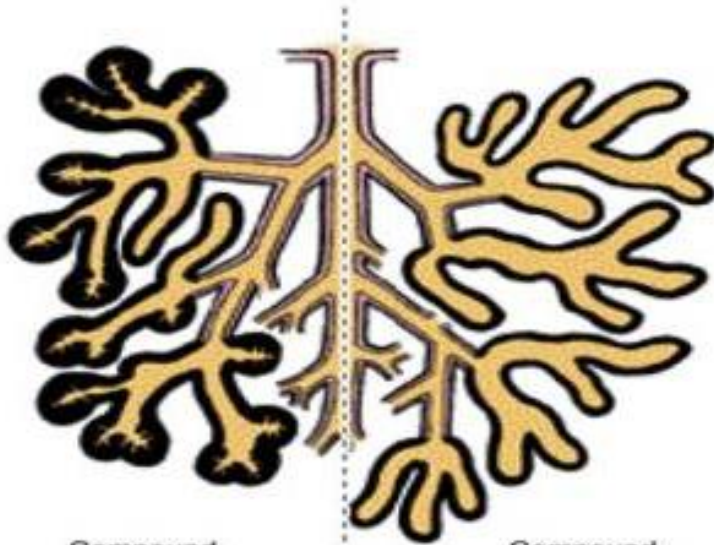
Simple coiled tubular



Simple branched tubular



Simple branched acinar



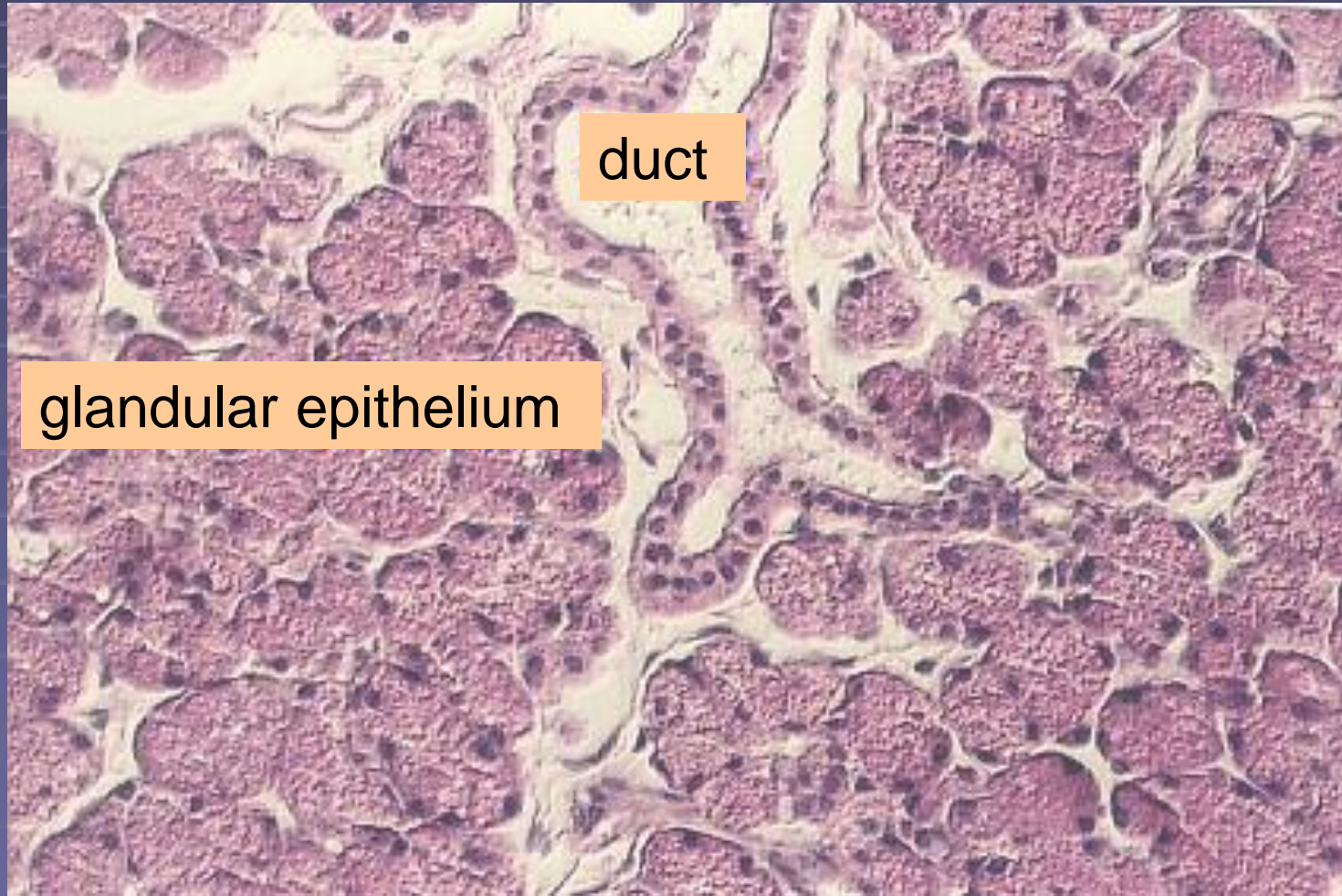
Compound tubuloacinar

Compound tubular

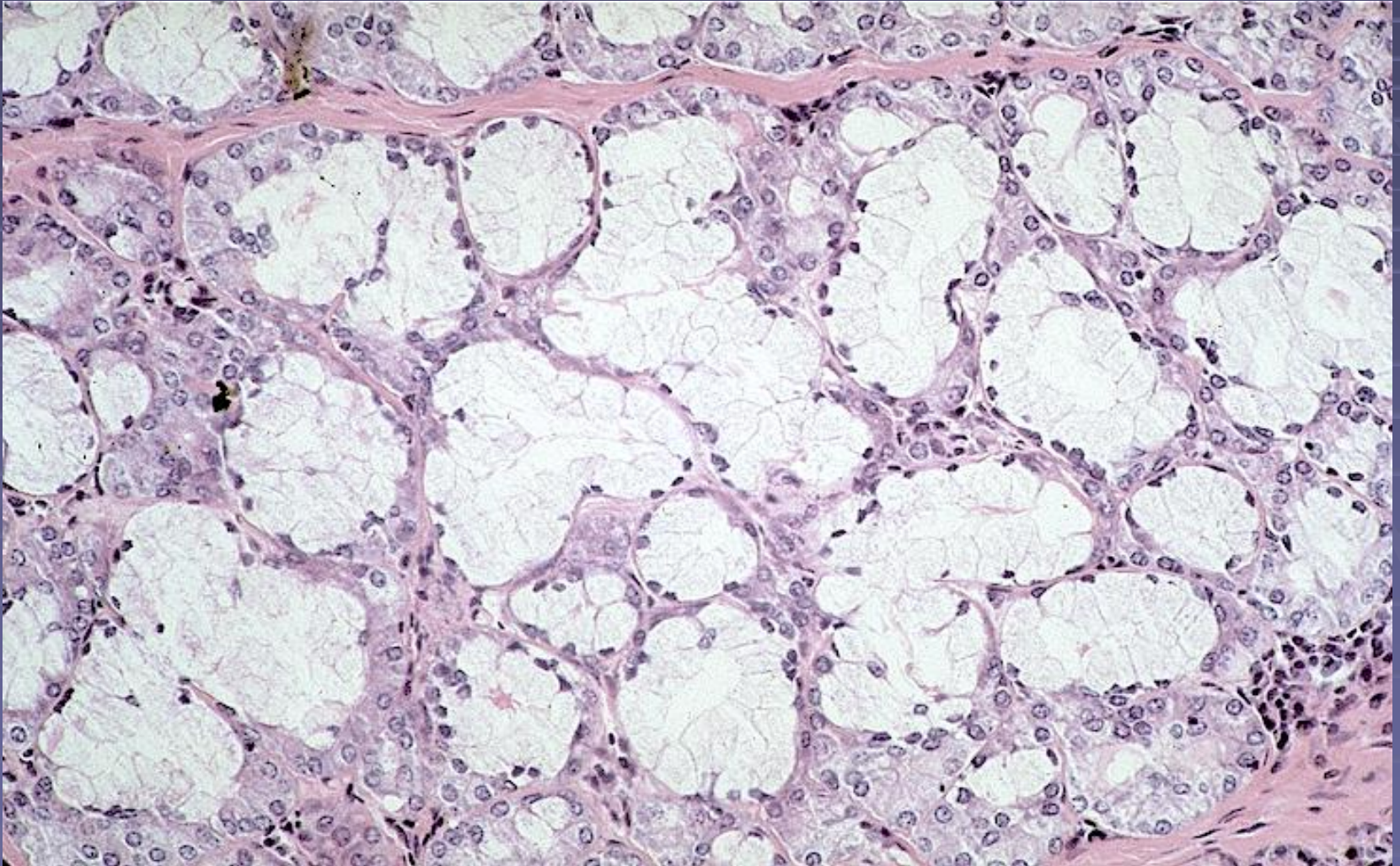


Compound acinar

# PAROTID GLAND serous acini



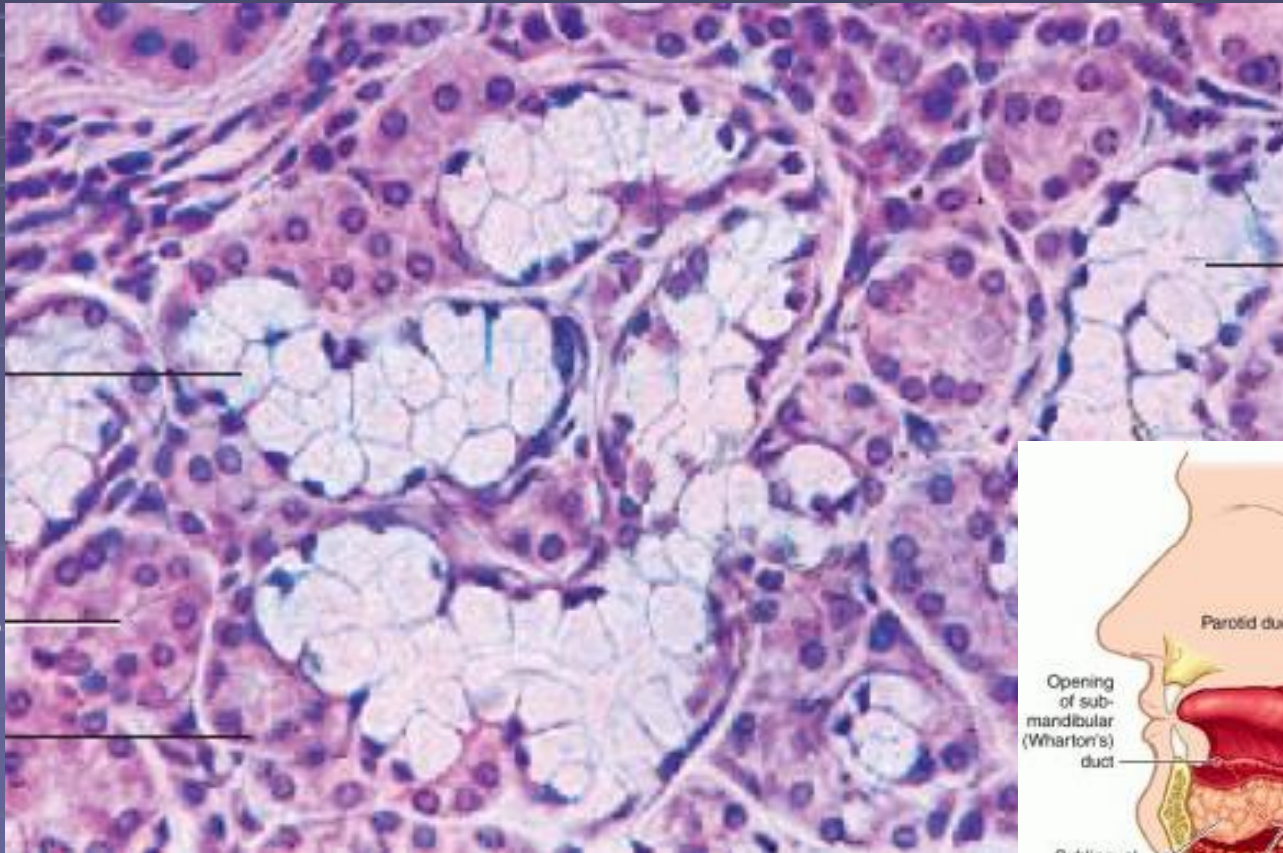
# SUBLINGUAL GLAND mucinous tubules





# SUBMANDIBULAR GLAND

mixed type

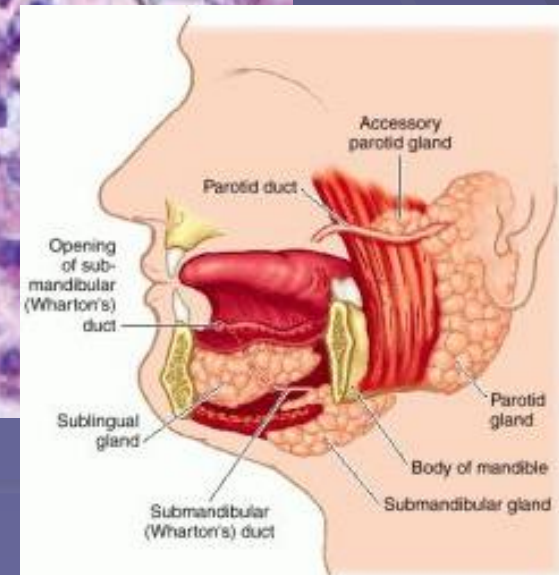


mucinous tubules

serous acines

Giannuzzi lunules

mucinous tubules



Accessory parotid gland  
Parotid duct  
Opening of submandibular (Wharton's) duct  
Sublingual gland  
Submandibular (Wharton's) duct  
Parotid gland  
Body of mandible  
Submandibular gland

# SENSORY EPITHELIUM

- specialised epithelial cells that detect sensory stimuli, found in the skin, eyes, ear, nose or on the tongue
  - rods and cones in the retina
  - olfactory region in the nose
  - taste bud cells
  - hair cells in auditory and balance organ

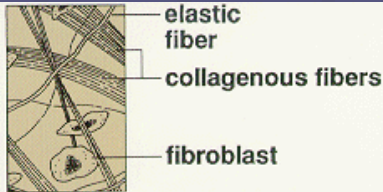
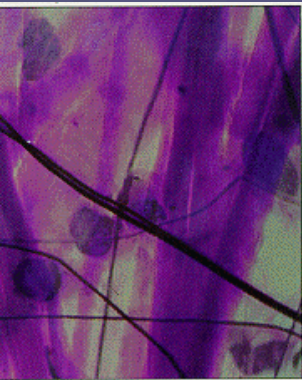
# CONNECTIVE TISSUE

- FIBROUS CONNECTIVE TISSUE
- CARTILAGE
- BONE

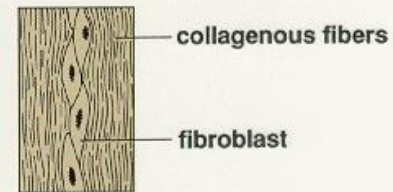
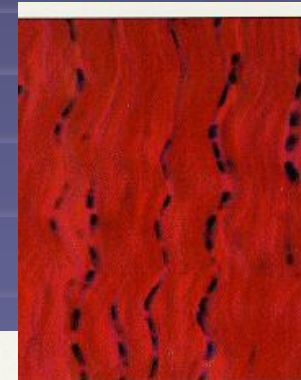
# CONNECTIVE TISSUE

## ■ FIBROUS CONNECTIVE TISSUE

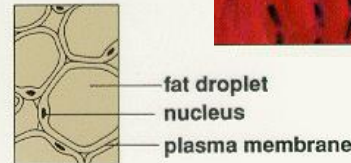
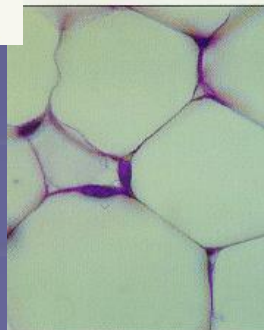
- dense
  - regular – tendons and ligaments
  - irregular – dermis, lining of various organs
- loose
  - collagen – interstitial, submucous tissues
  - elastic – skin, lungs, veins
  - reticular – bone marrow, spleen, lymph nodes
  - adipose – white and brown



TYPE: Loose  
COMMON LOCATIONS:  
Under skin, most epithelia  
FUNCTION: Support, elasticity

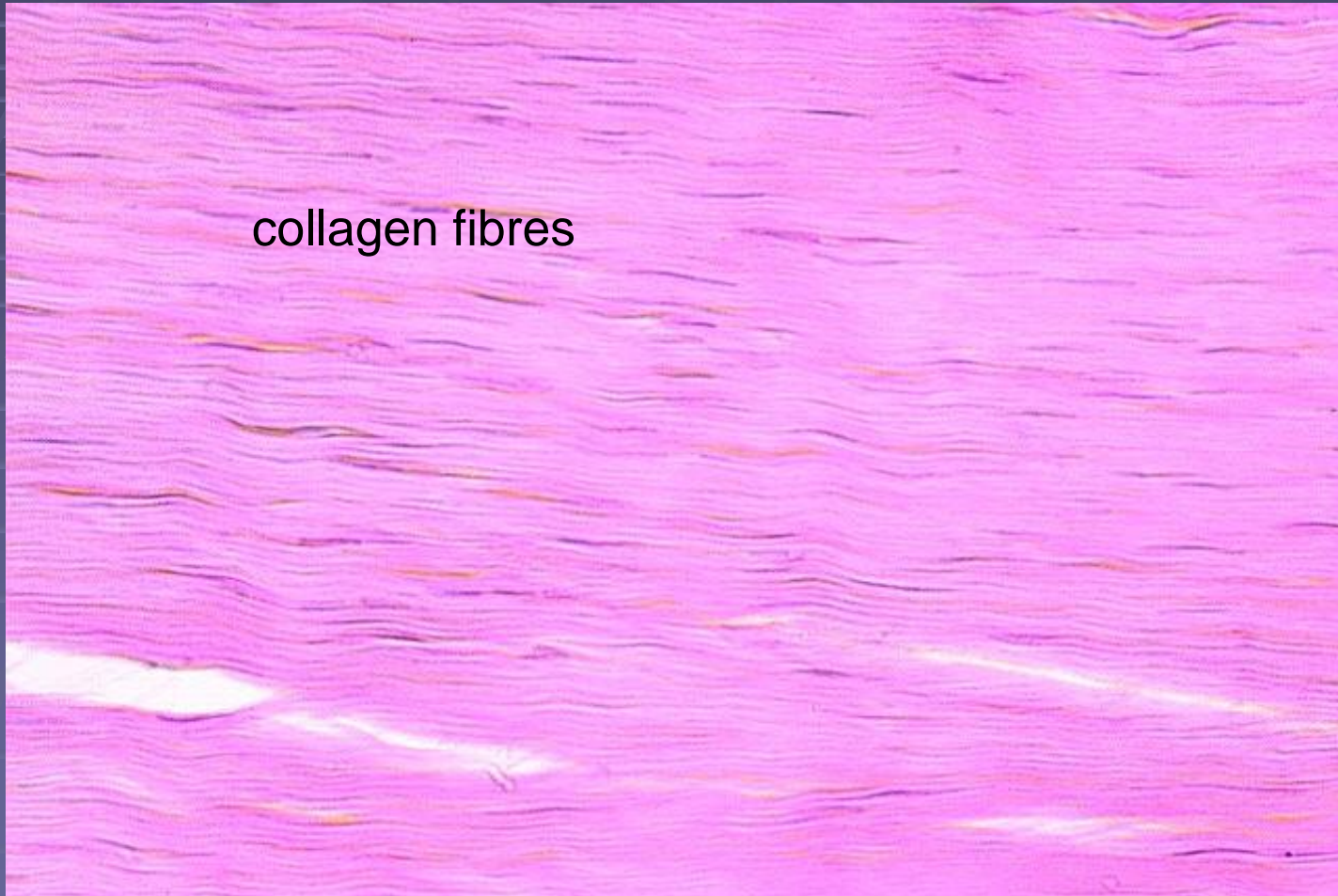


TYPE: Dense, regular  
COMMON LOCATIONS:  
Tendons, skin, kidney capsule  
FUNCTION: Support, elasticity

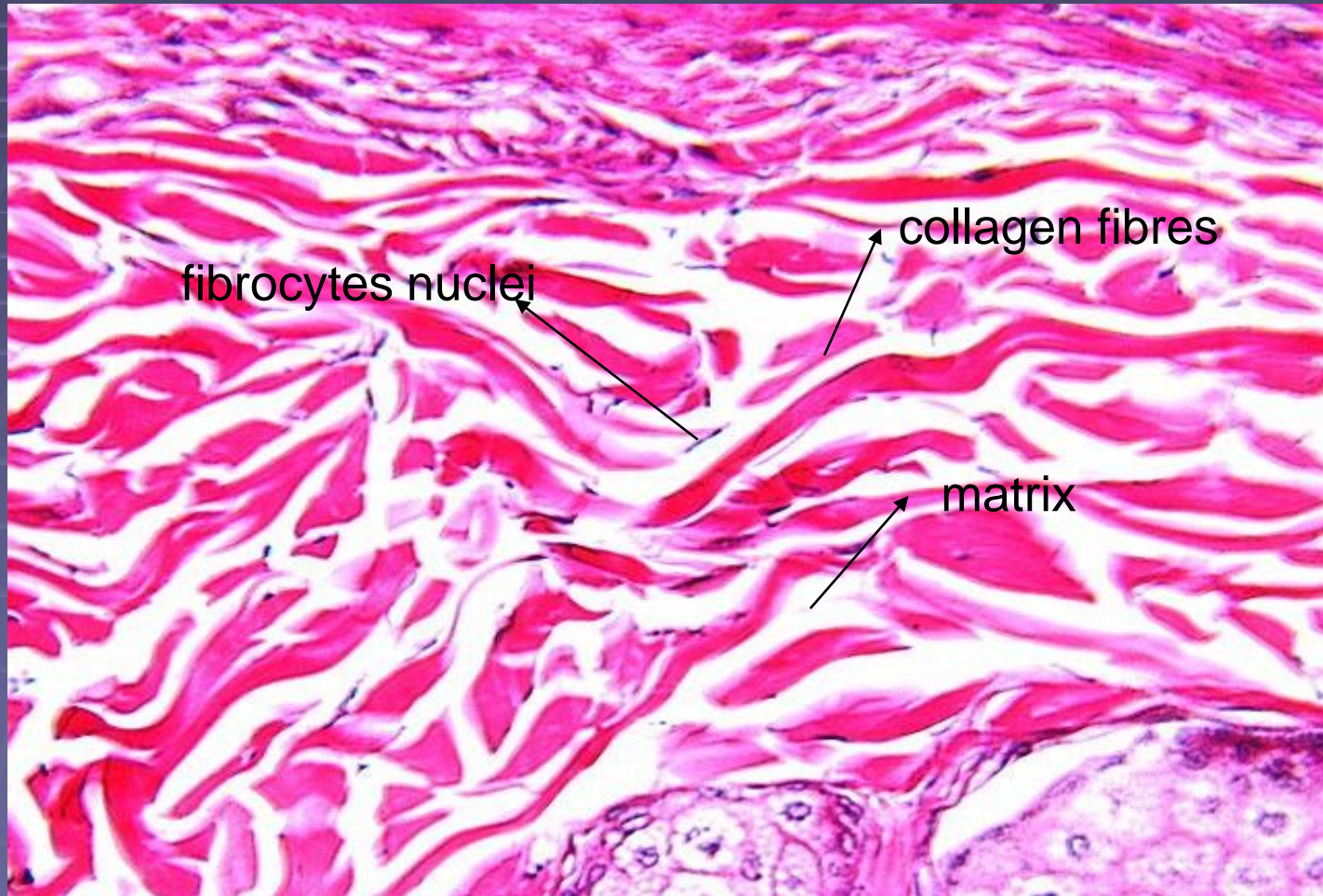


TYPE: Adipose  
COMMON LOCATIONS: Under skin,  
around kidneys, heart  
FUNCTION: Energy reserve, insulation,  
padding

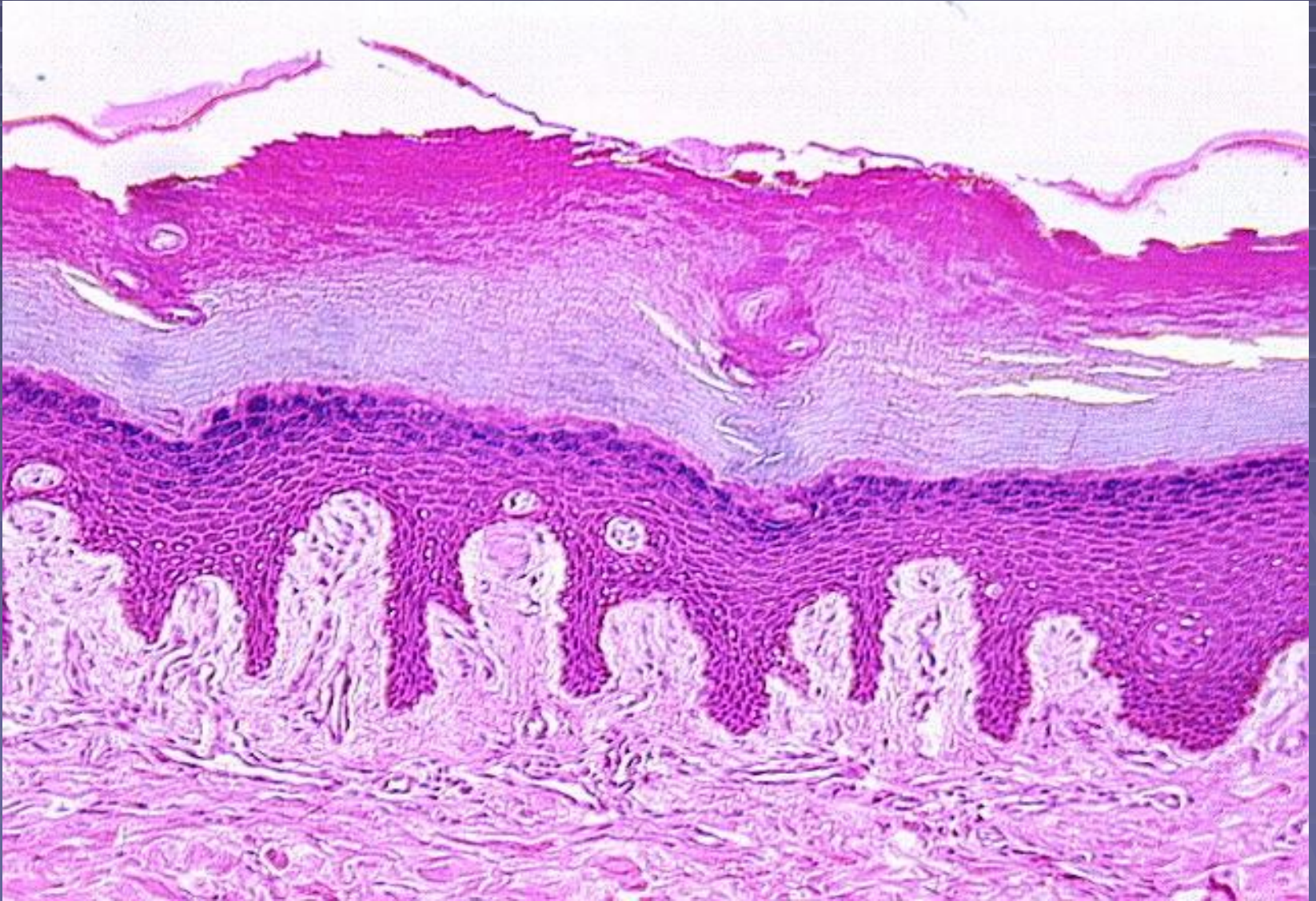
# DENSE REGULAR CONNECTIVE TISSUE tendons



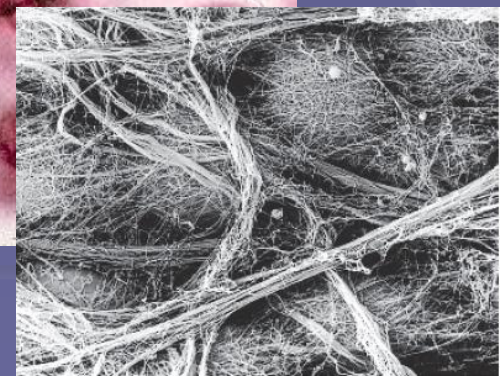
# DENSE IRREGULAR CONNECTIVE TISSUE



# LOOSE CONNECTIVE TISSUE skin

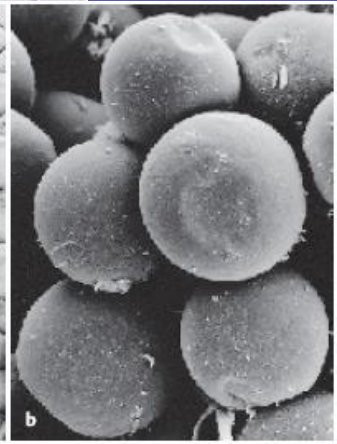
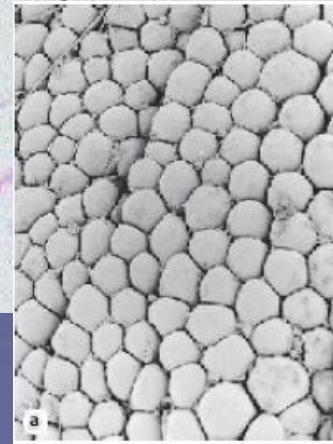
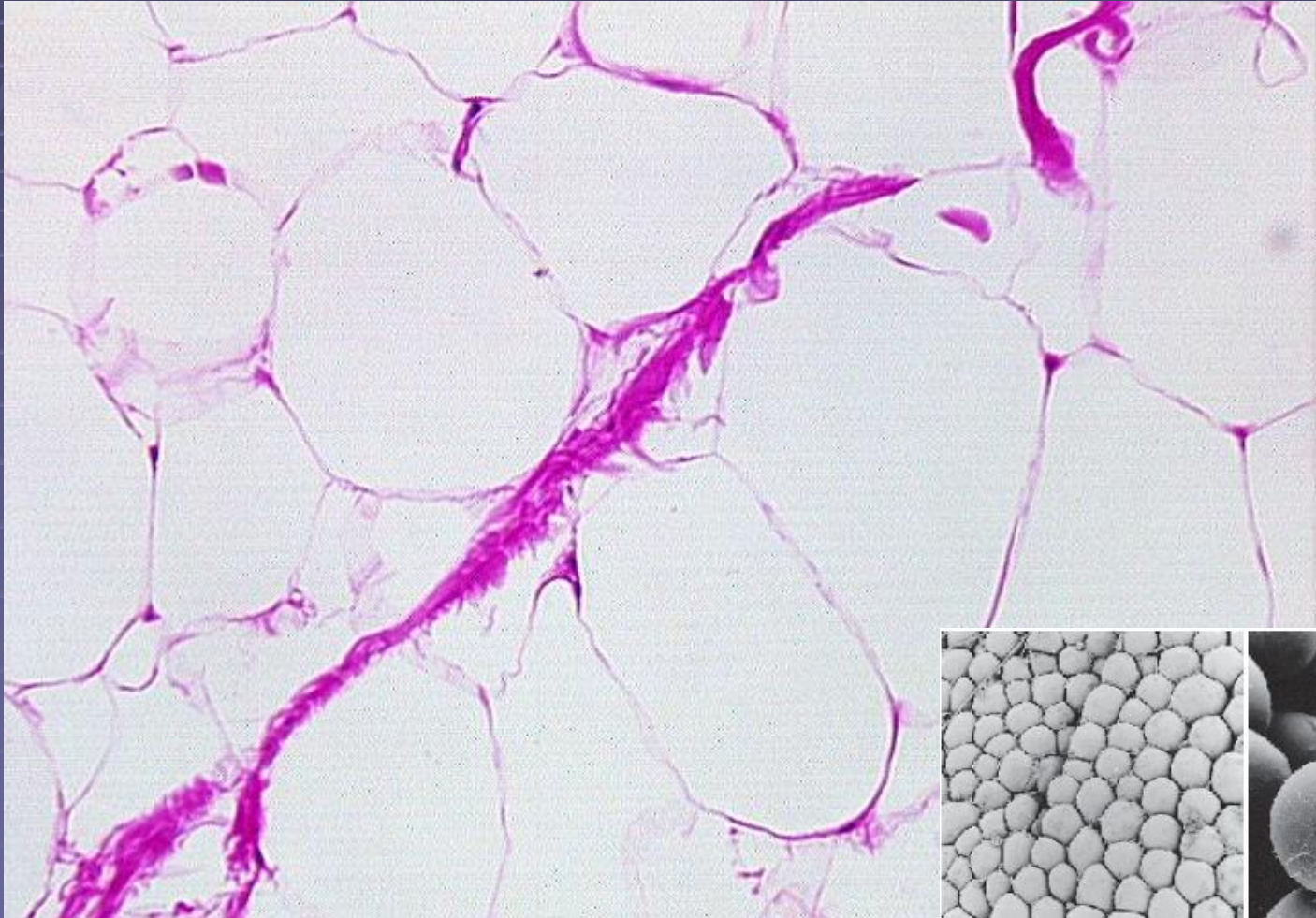


# RETICULAR CONNECTIVE TISSUE





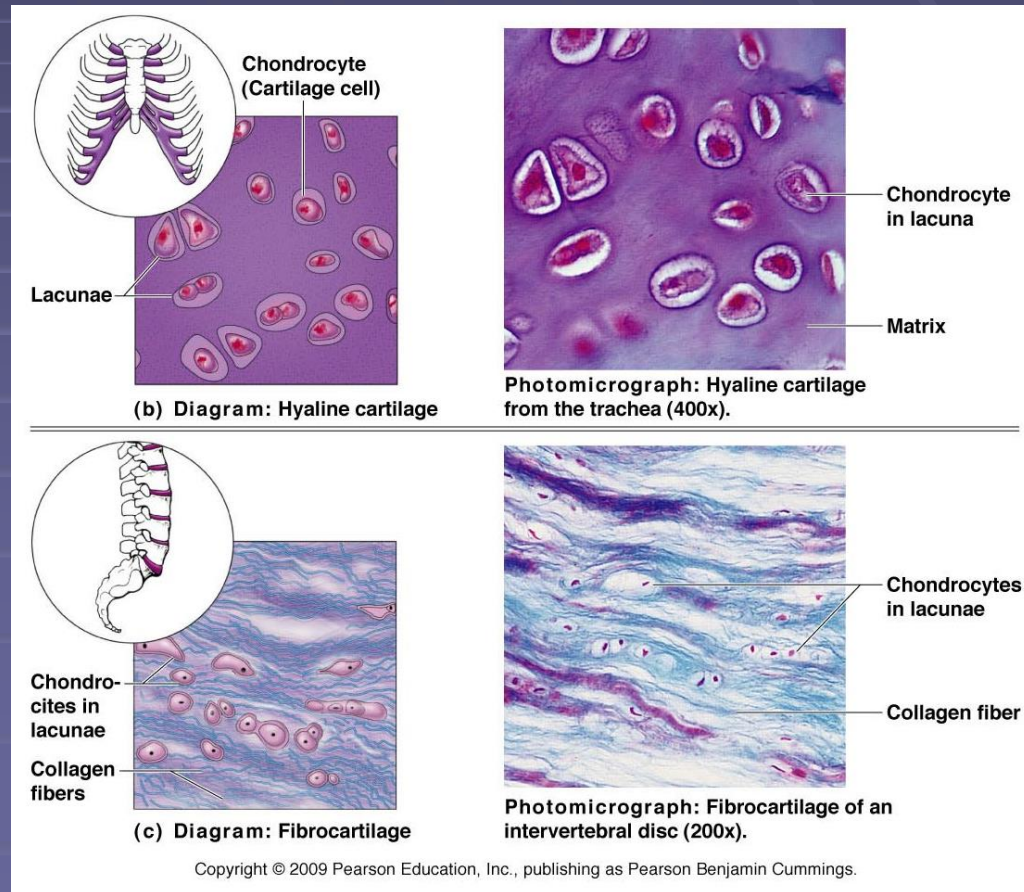
# ADIPOSE TISSUE



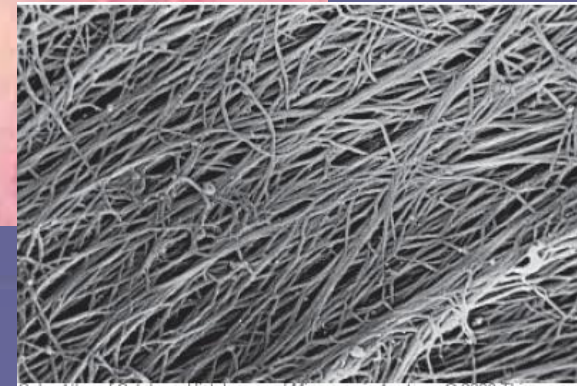
# CONNECTIVE TISSUE

## ■ CARTILAGE

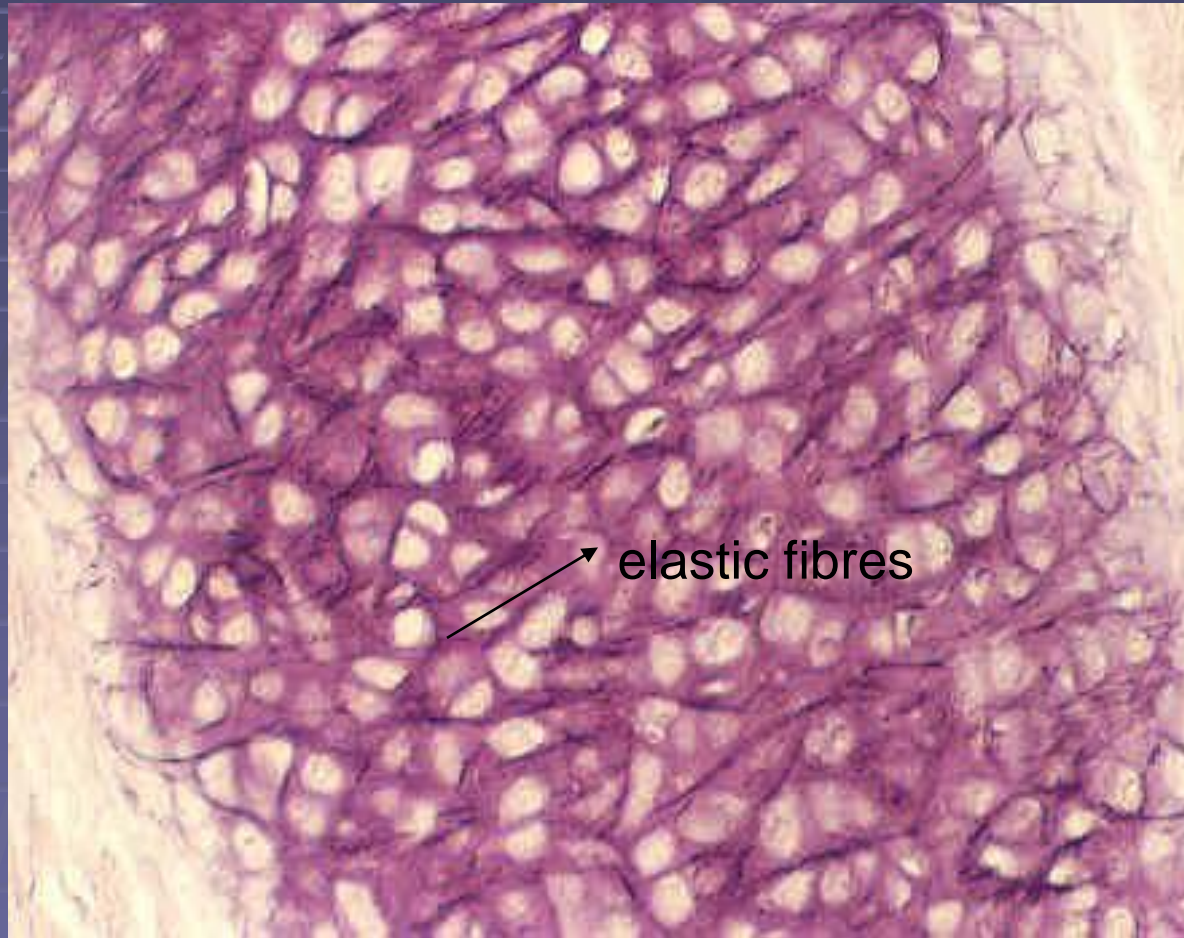
- hyaline
  - joints, ribs, nasal cartilages
- elastic
  - auricle, Eustachian tube, laryngeal cartilages
- fibrocartilage
  - intervertebral discs, symphysis



# HYALINE CARTILAGE

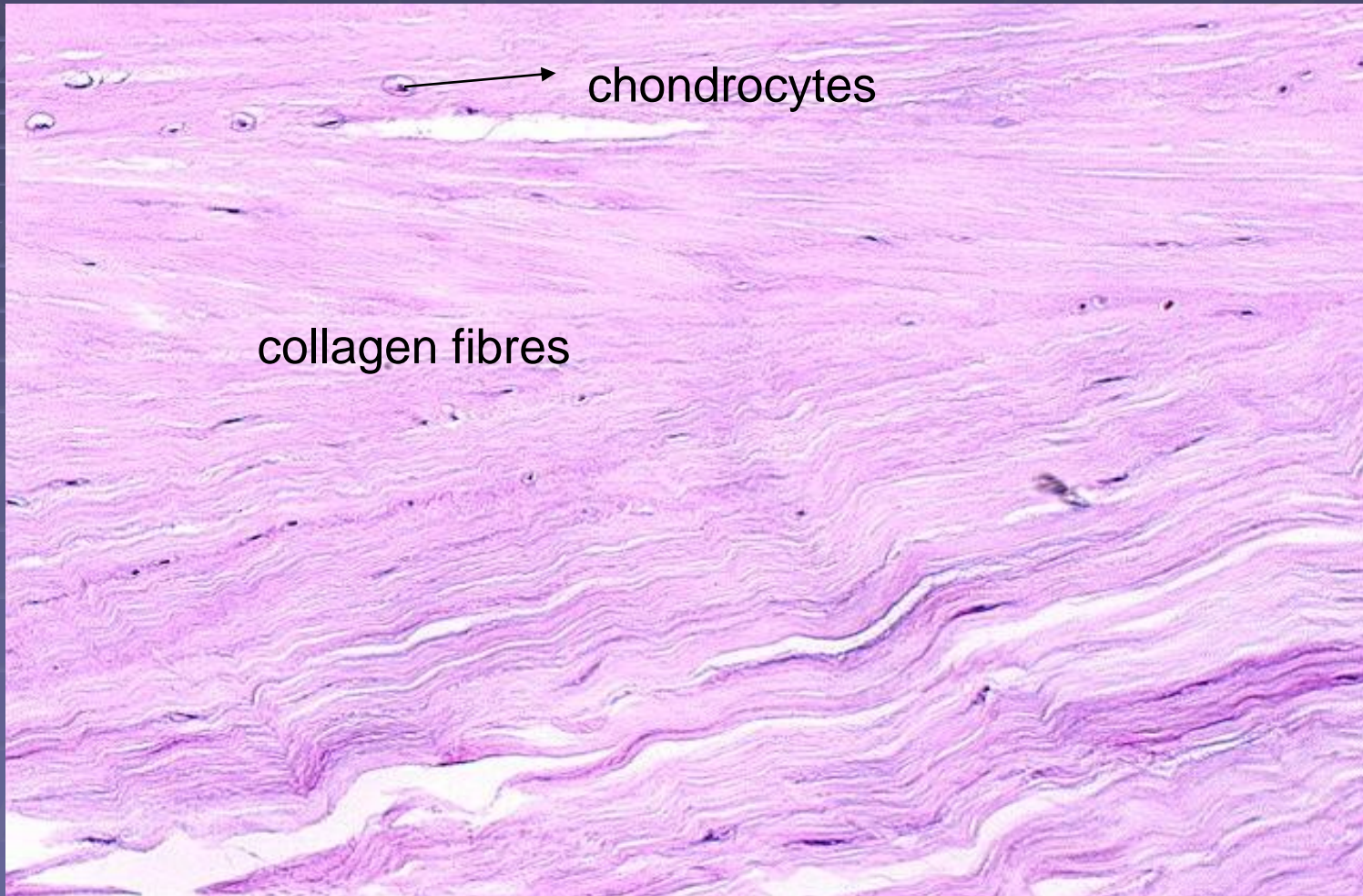


# ELASTIC CARTILAGE



# FIBROCARILAGE

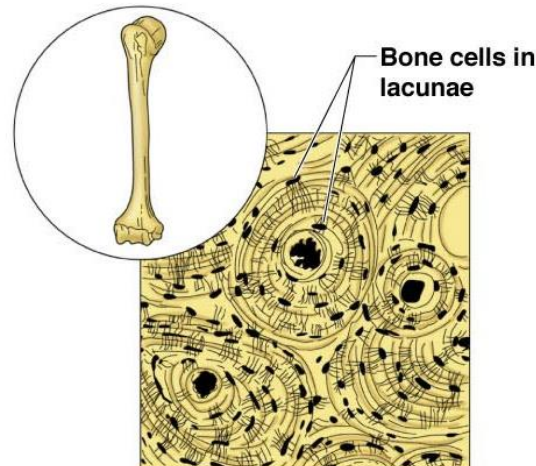
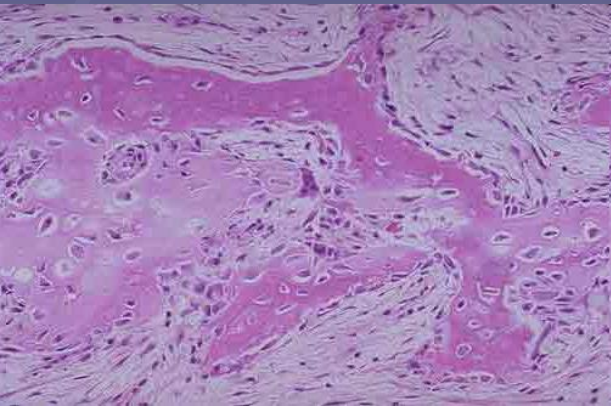
## intervertebral discs



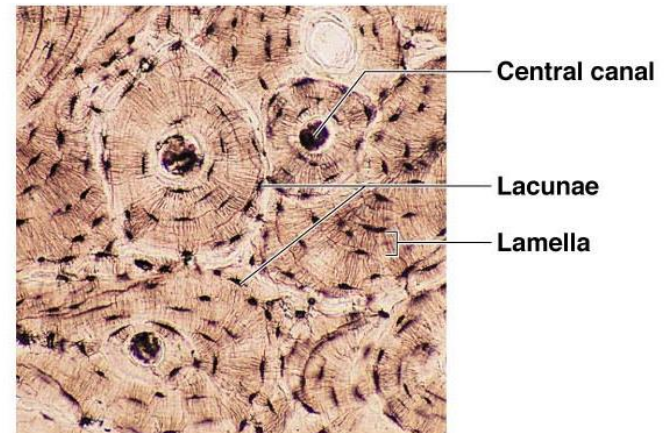
# CONNECTIVE TISSUE

## ■ BONE

- woven – tooth cementum
- lamellar → compact – diaphyses of long bones  
→ spongy – epiphyses of long bones, flat skull bones, short bones



(a) Diagram: Bone



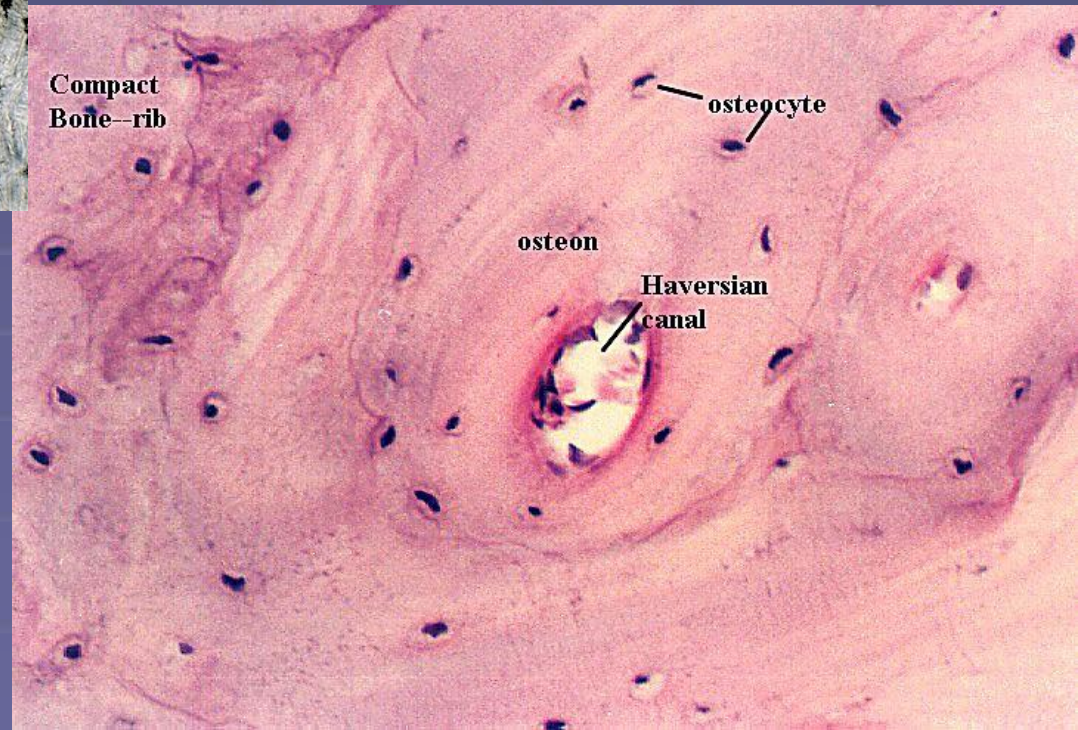
Photomicrograph: Cross-sectional view of ground bone (250x).

# LAMELLAR COMPACT BONE

rib



Compact  
Bone—rib



# MUSCULAR TISSUE

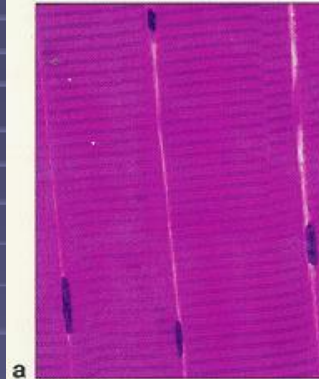
## ■ skeletal / striated

## ■ smooth

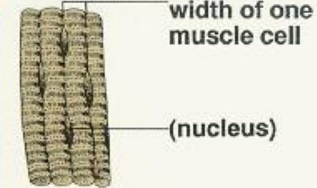
- the wall of the vessels
- gastrointestinal system

## ■ cardiac

©1992 Wadsworth, Inc.



a

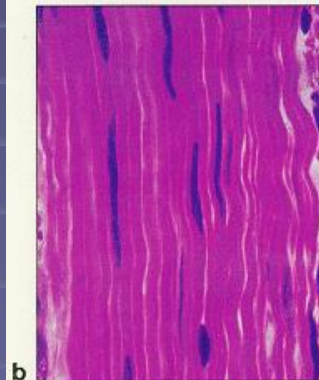


TYPE: Skeletal muscle

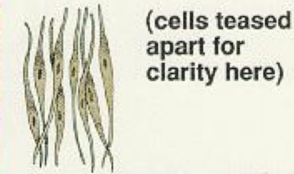
DESCRIPTION: Long, striated cells with multiple nuclei

COMMON LOCATIONS: In skeletal muscles

FUNCTION: Contraction for voluntary movements



b

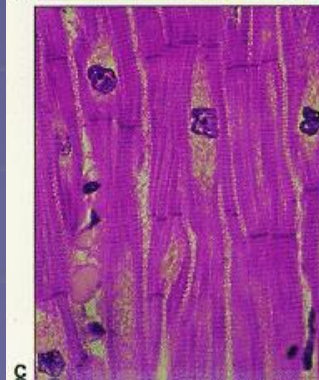


TYPE: Smooth muscle

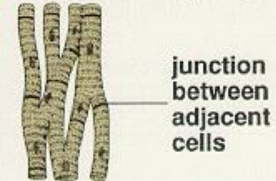
DESCRIPTION: Long, spindle-shaped cells, each with a single nucleus

COMMON LOCATIONS: In hollow organs (e.g., stomach)

FUNCTION: Propulsion of substances along internal passageways



c



TYPE: Cardiac muscle

DESCRIPTION: Branching, striated cells fused at plasma membranes

COMMON LOCATIONS: Wall of heart

FUNCTION: Pumping of blood in the circulatory system



# SKELETAL / STRIATED MUSCLE

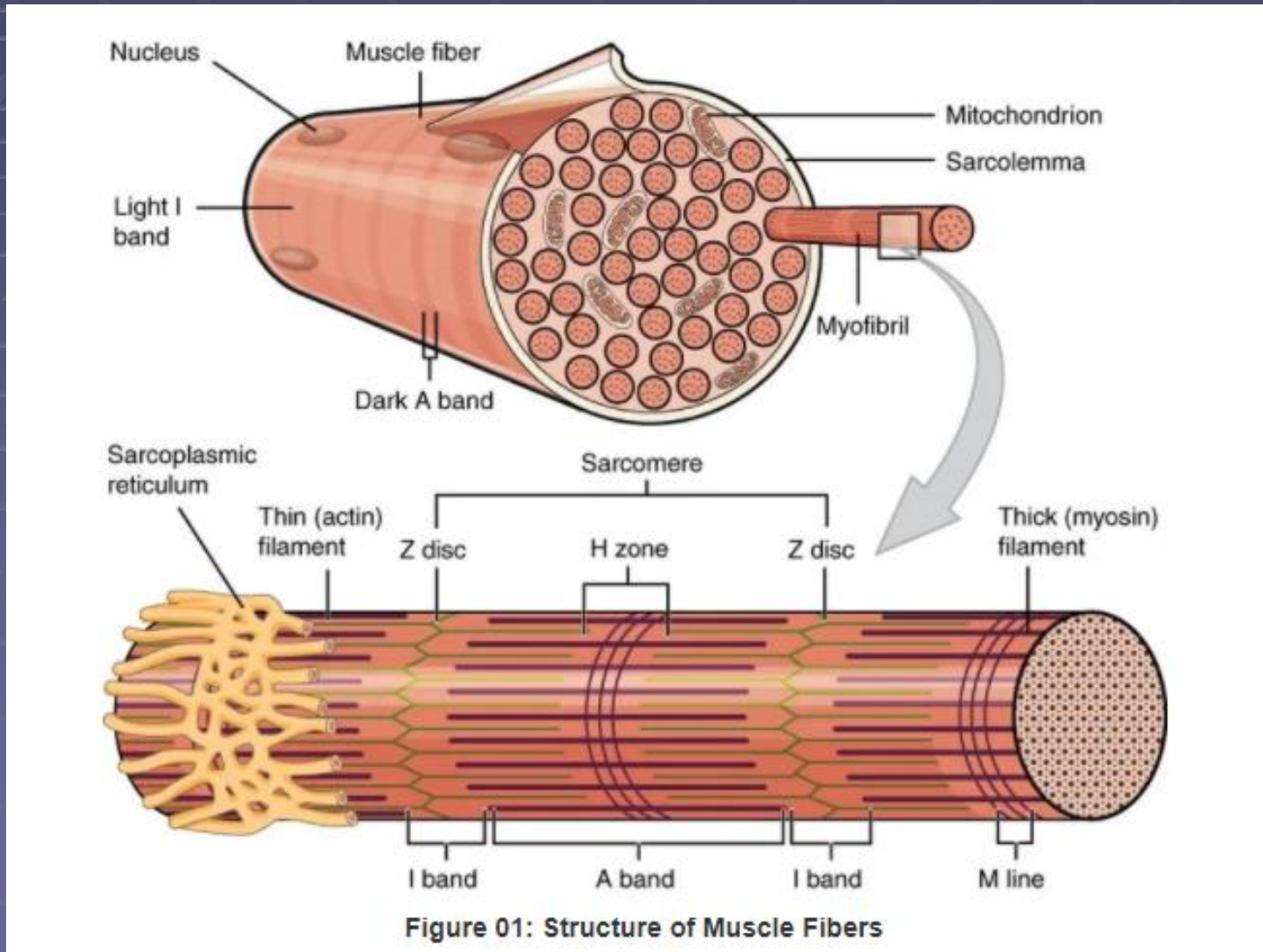
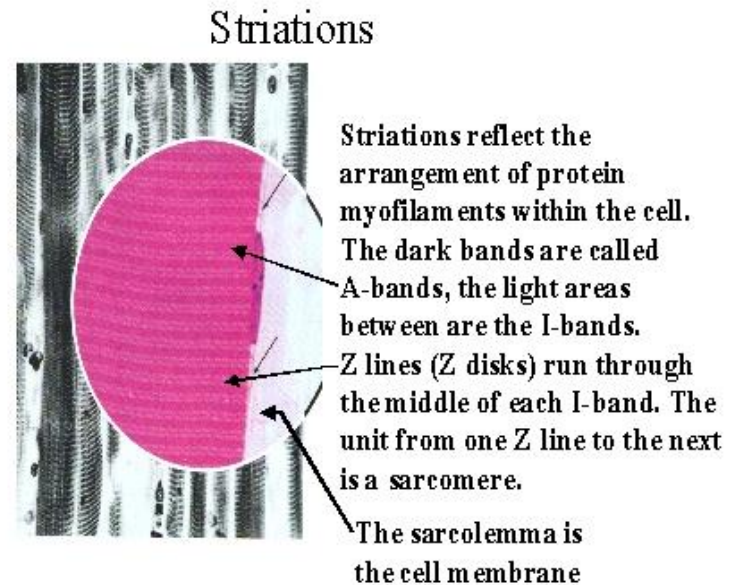
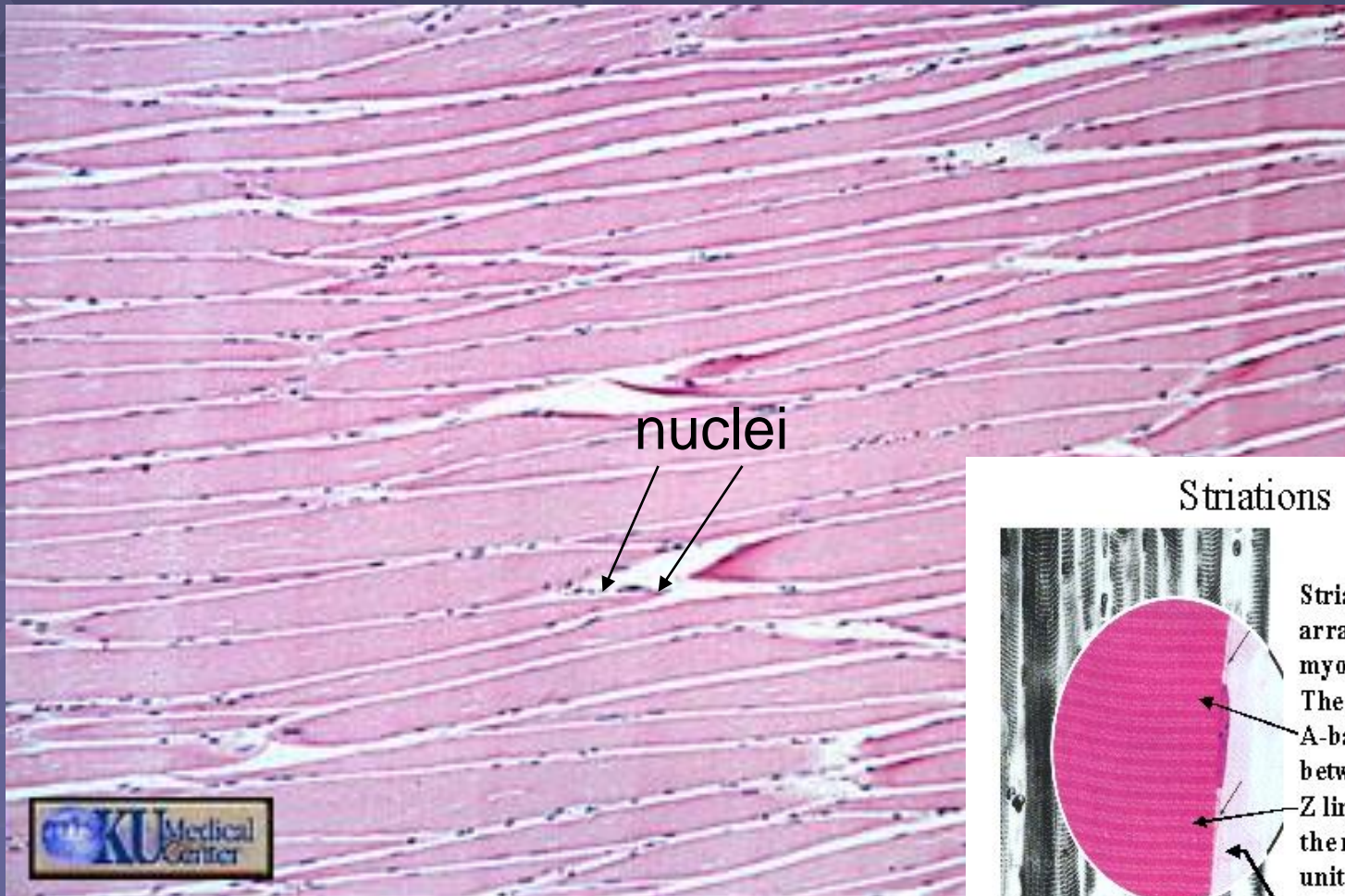


Figure 01: Structure of Muscle Fibers

# STRIATED SKELETAL MUSCLE

## longitudinal cut

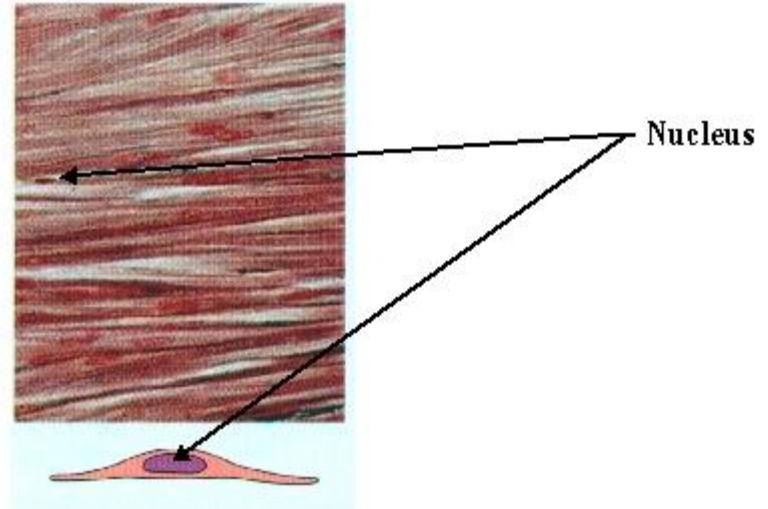


# SMOOTH MUSCLE



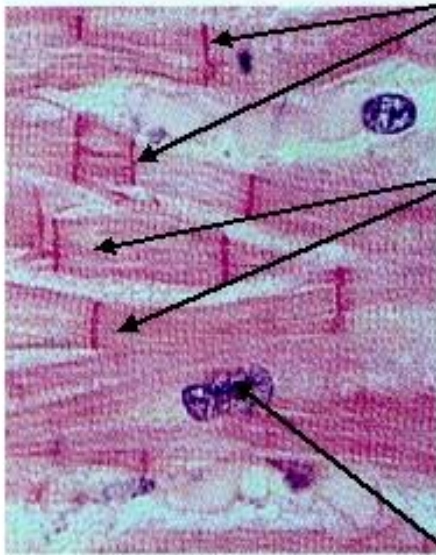
## Smooth Muscle Characteristics

Smooth muscle cells connect to form **single-unit syncytia** similar to cardiac muscle. But impulses and contractions occur much more slowly in smooth than in cardiac muscle.



# CARDIAC MUSCLE

## Cardiac Muscle Characteristics



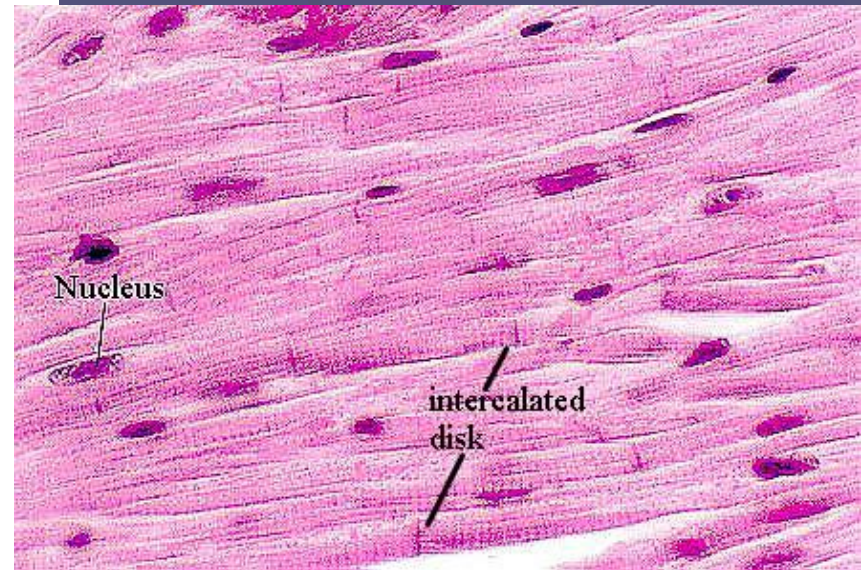
Intercalated disks

Cardiac muscle cells are faintly striated, branching cells, which connect by means of intercalated disks to form a functional network. The action potential travels through all cells connected together in the syncytium causing them to function as a unit.



nucleus

Cardiac myocytes are branched, mono-nucleated cells



Nucleus

intercalated  
disk

# NERVOUS TISSUE

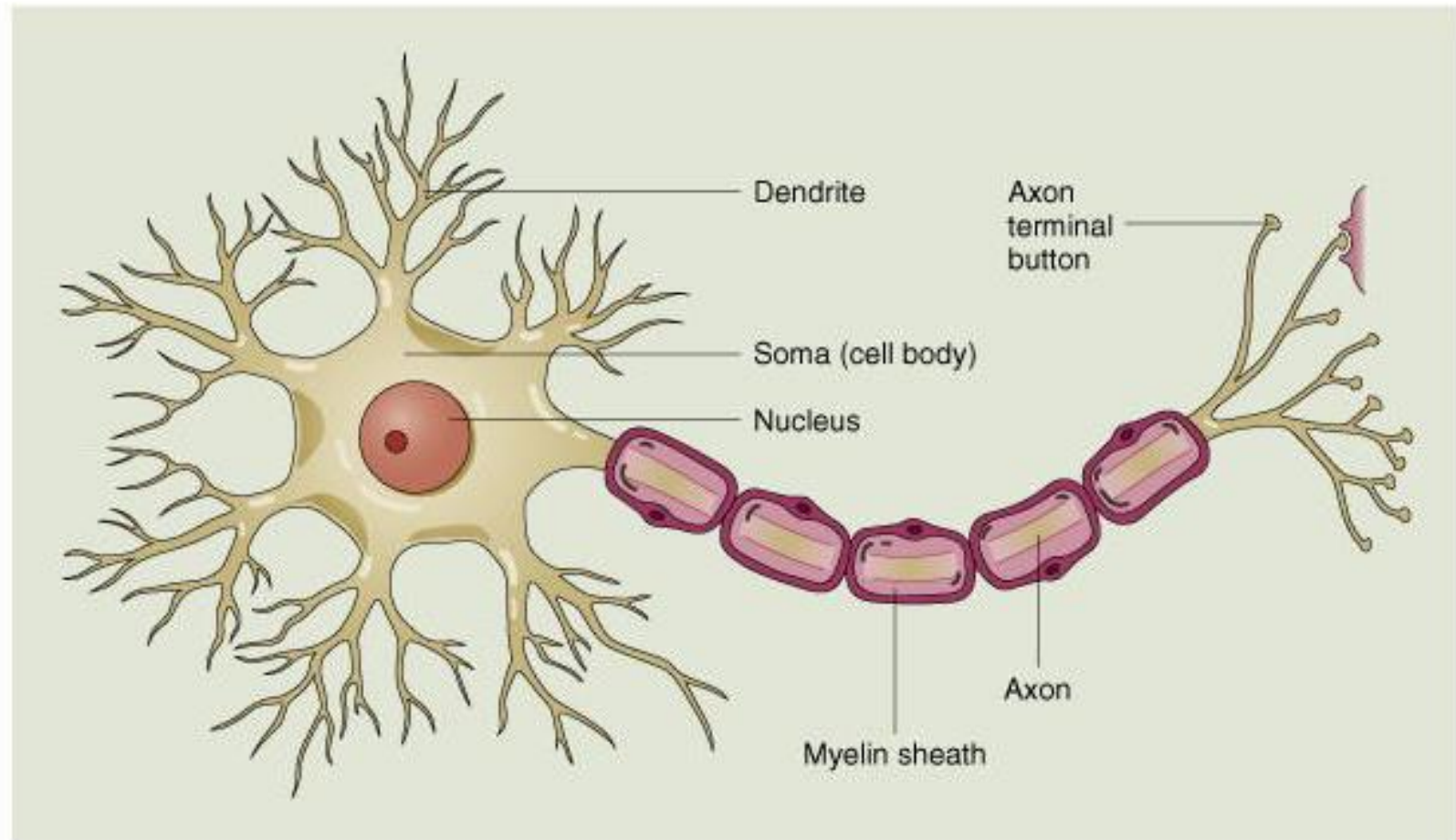
## ■ NEURON

- excitable cell that processes and transmits various information by electrochemical signals
  - soma (body)
  - dendrites
  - axon

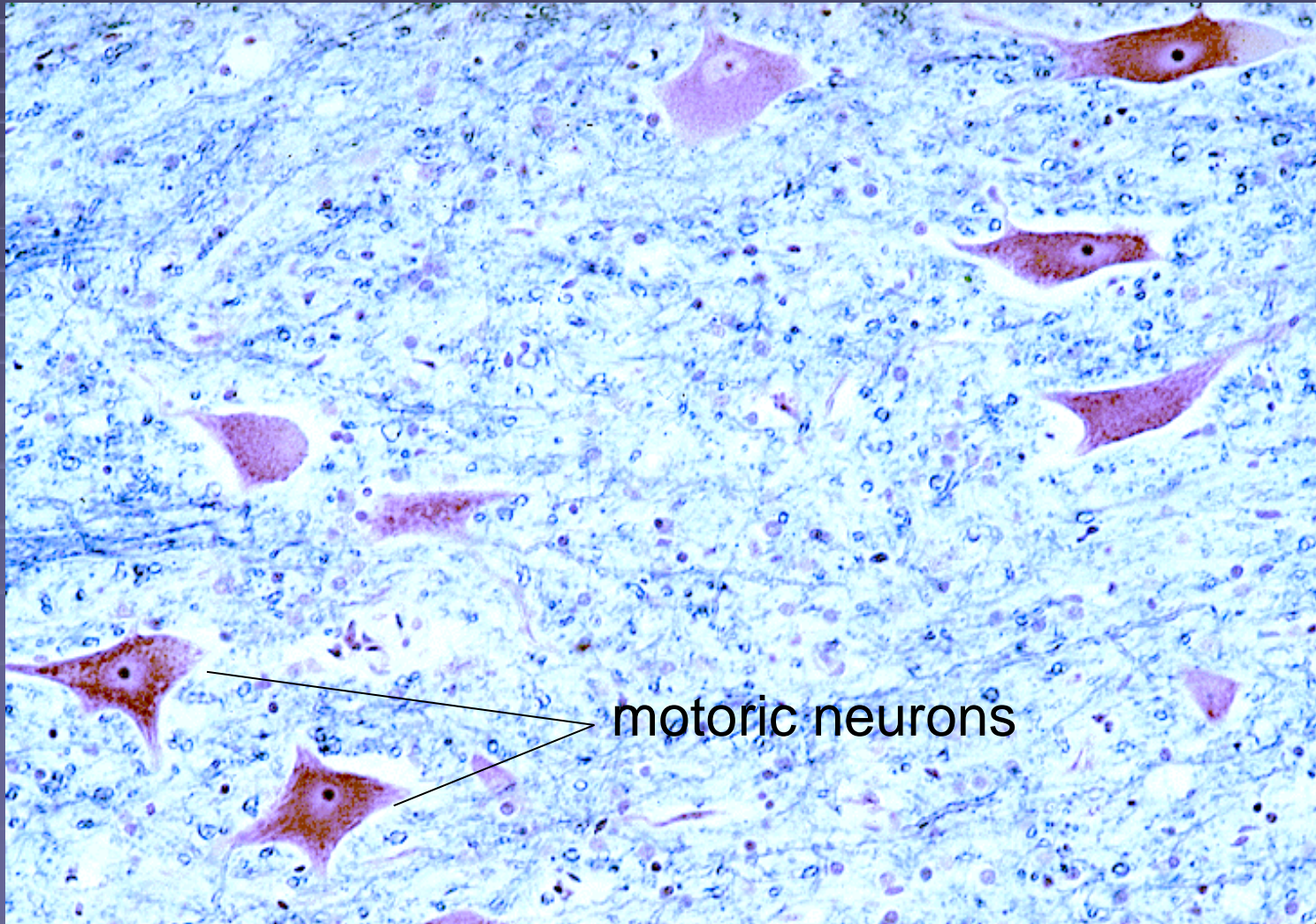
## ■ NEUROGLIA

- non-neuronal cells providing nutrition and support for neurons and improve signal transmission in the nervous system

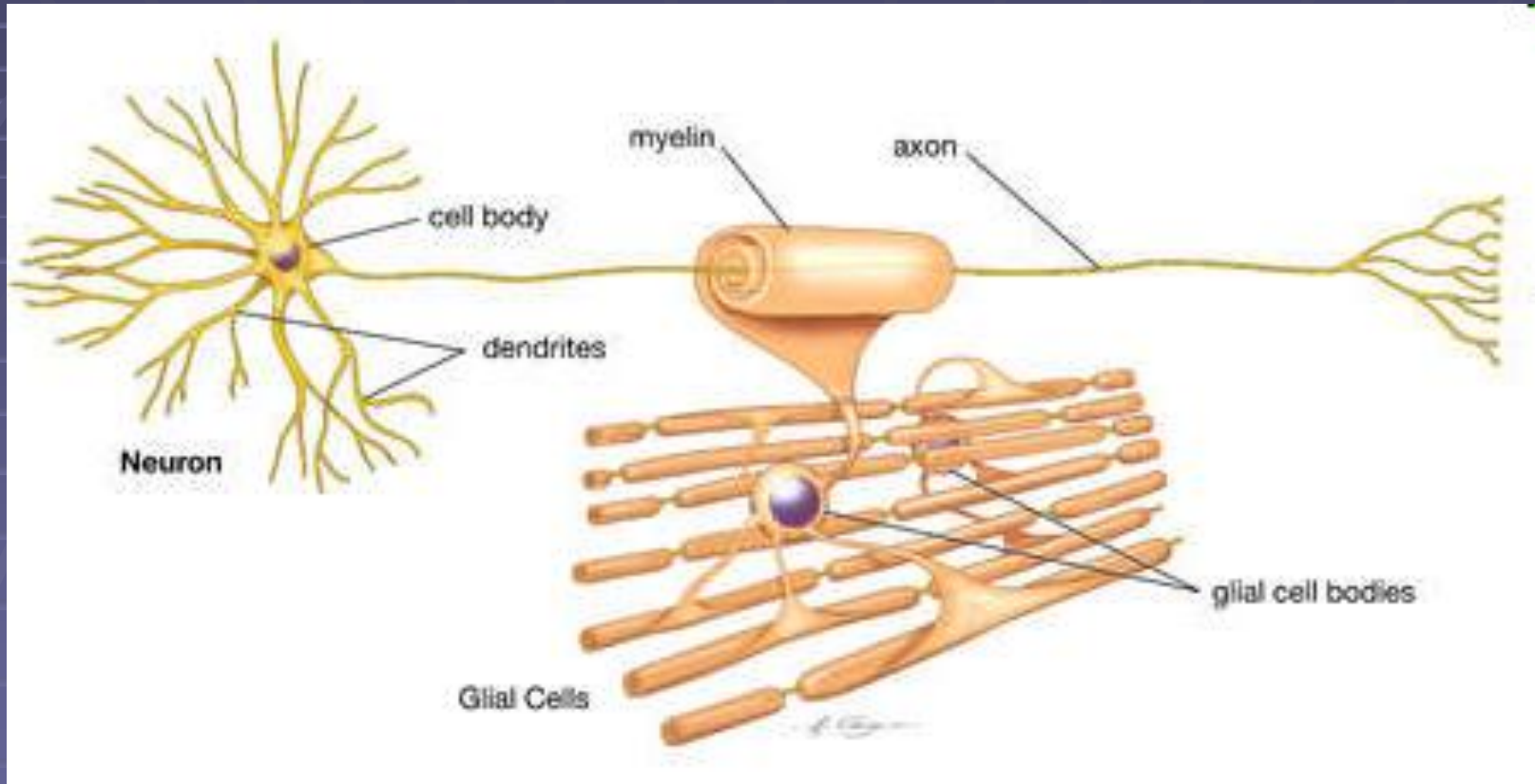
# NEURON



# NEURONS in spinal cord



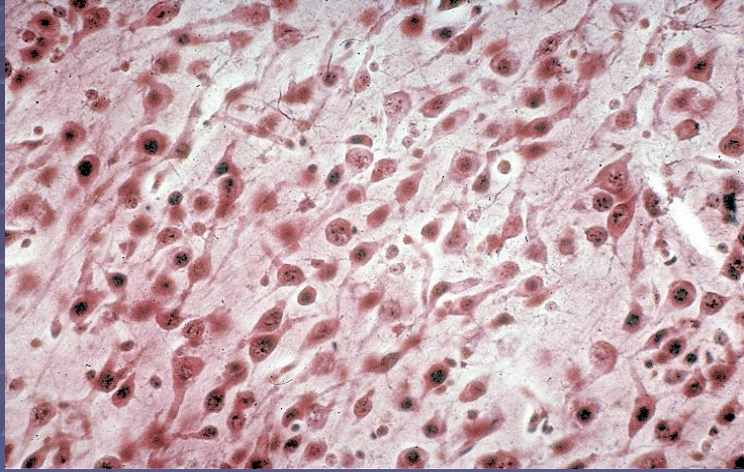
# NEUROGLIA



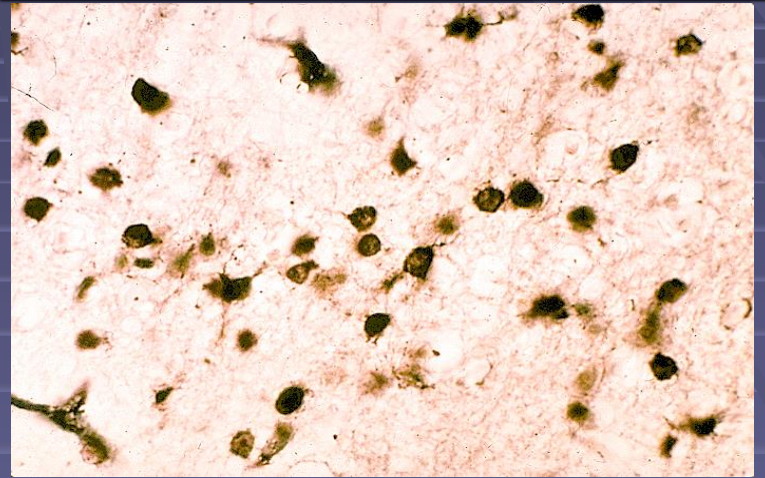


# NEUROGLIA

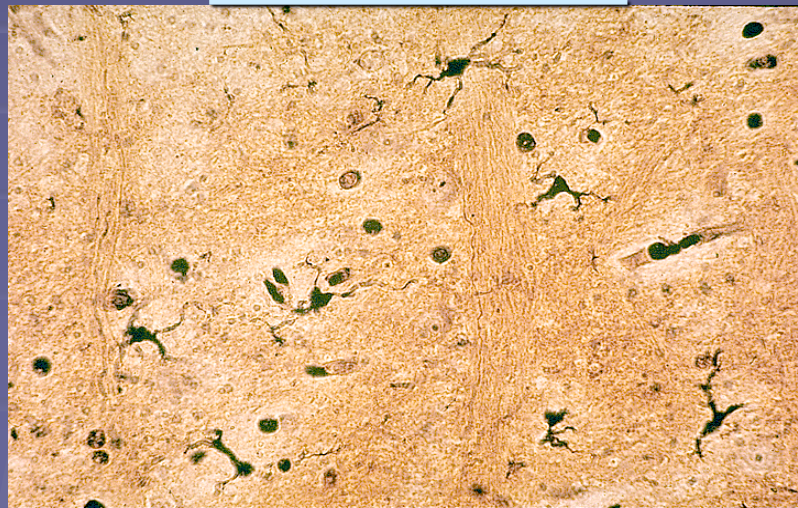
## ASTROCYTES



## OLIGODENDROCYTES



## MICROGLIA

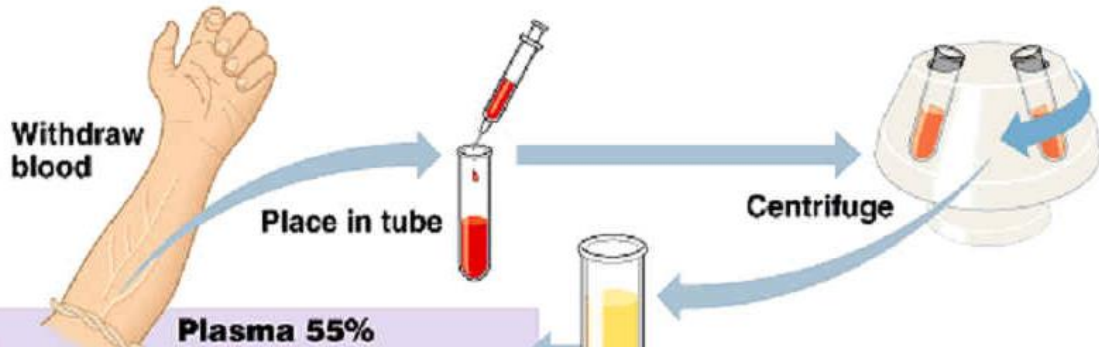


# NERVOUS TISSUE



Fig.5 Cerebrum, Cortex, Pyramidal Cells, Stain: hematoxylin-eosin

# BLOOD



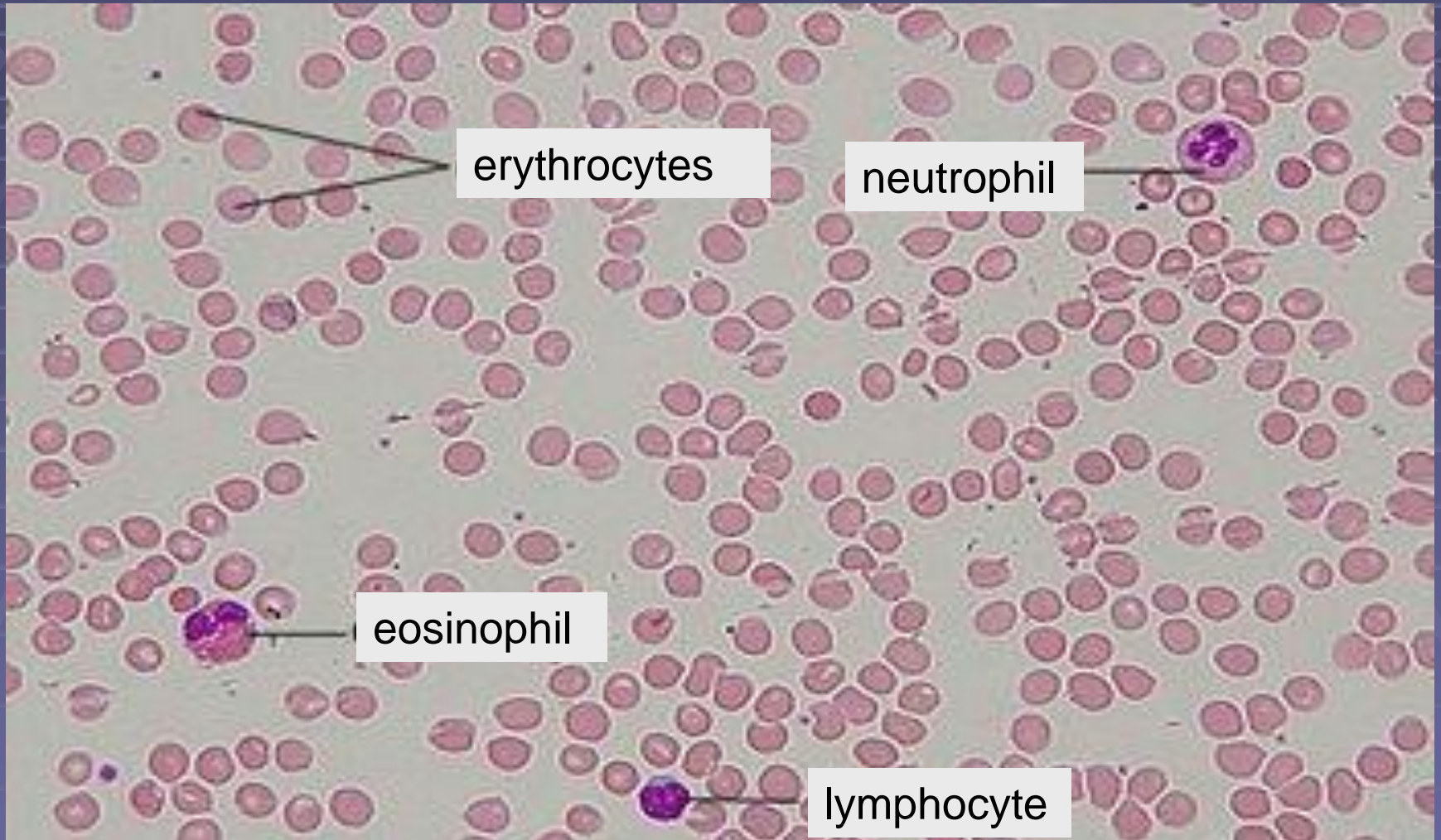
**Plasma 55%**

| Constituent   | Major functions  |
|---|--|
| Water   | Solvent for carrying other substances                                  |
| Ions<br>Sodium<br>Potassium<br>Calcium<br>Magnesium<br>Chloride<br>Bicarbonate  | Osmotic balance, pH buffering, and regulation of membrane permeability |
| Plasma proteins<br>Albumin<br>Fibrinogen<br>Immunoglobulins (antibodies)  | Osmotic balance<br>pH buffering<br>Clotting<br>Defense                 |
| <b>Substances transported by blood</b><br>Nutrients (e.g., glucose, fatty acids, vitamins)<br>Waste products of metabolism<br>Respiratory gases (O <sub>2</sub> and CO <sub>2</sub> )<br>Hormones |  |

**Cellular elements 45%**

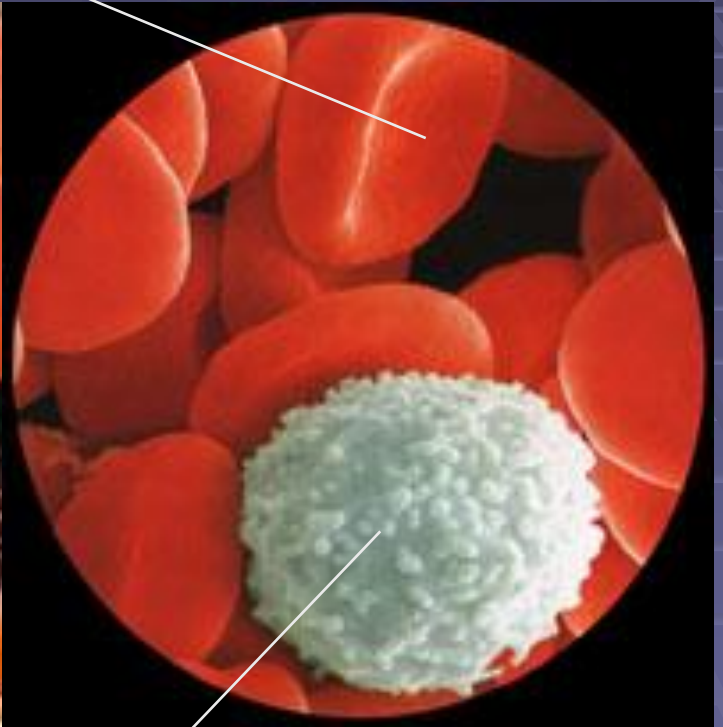
| Cell type                          | Number (per mm <sup>3</sup> of blood) | Functions  |
|------------------------------------|---------------------------------------|--|
| Erythrocytes (red blood cells)<br> | 5-6 million                           | Transport oxygen and help transport carbon dioxide |
| Leukocytes (white blood cells)<br> | 5000-10,000                           | Defense and immunity                               |
| Platelets<br>                      | 250,000-400,000                       | Blood clotting                                     |

# BLOOD FILM



# ERYTHROCYTES

red blood cells / erythrocytes



white blood cell/ leucocyte

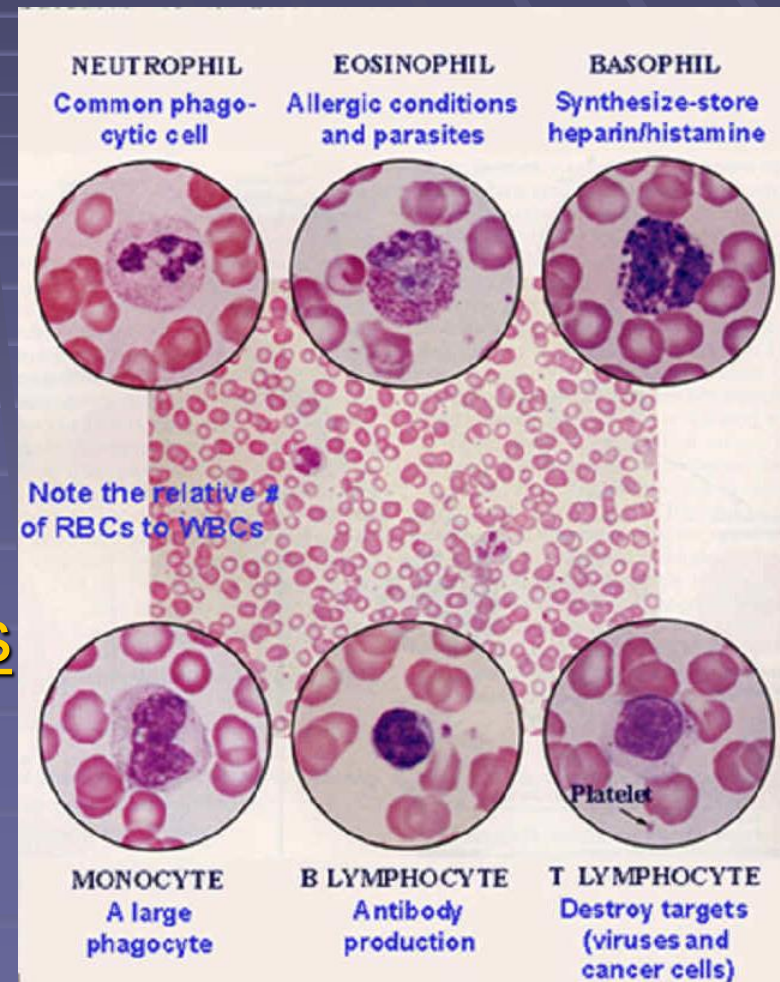
# WHITE BLOOD CELLS /Leukocytes/

## ■ GRANULOCYTES

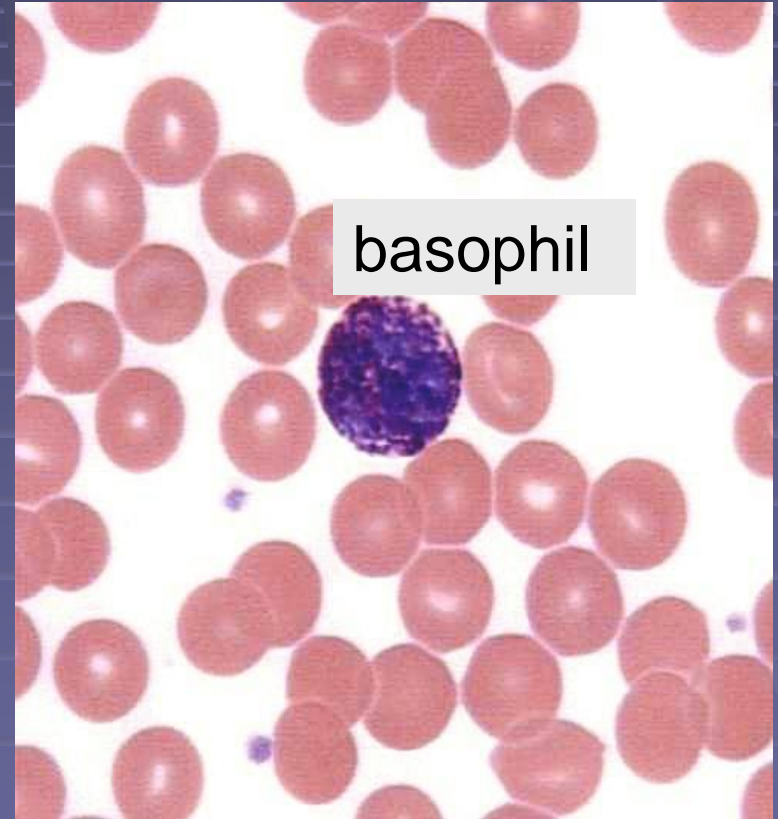
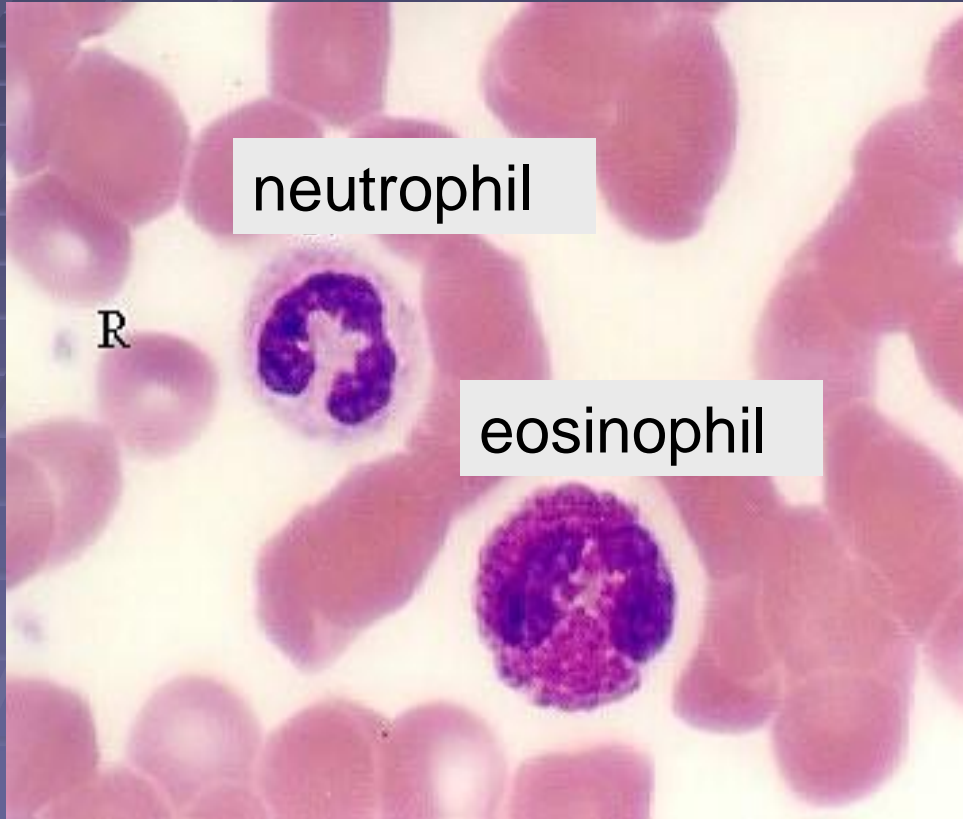
- neutrophil
- basophil
- eosinophil

## ■ AGRANULOCYTES

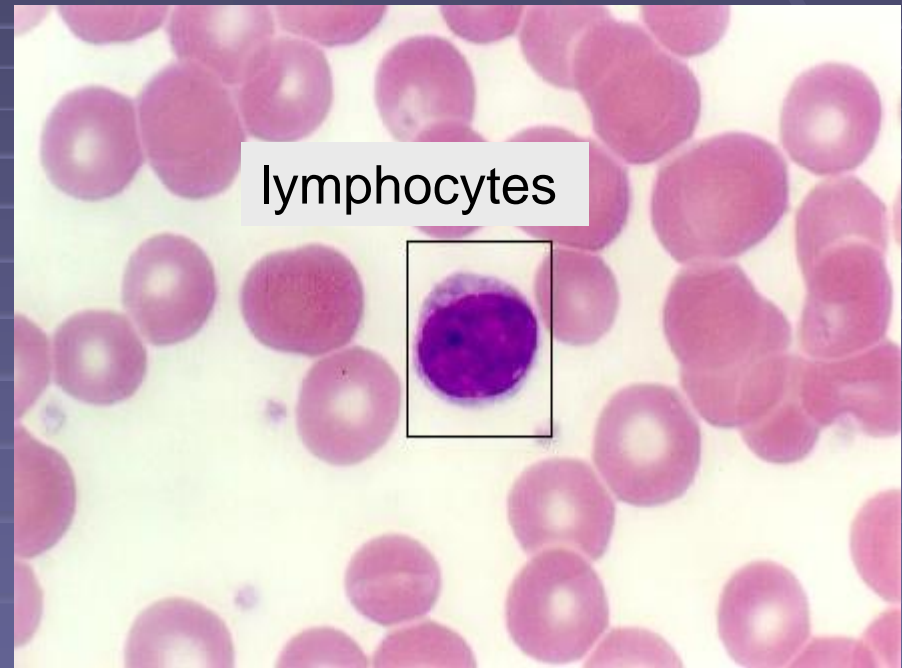
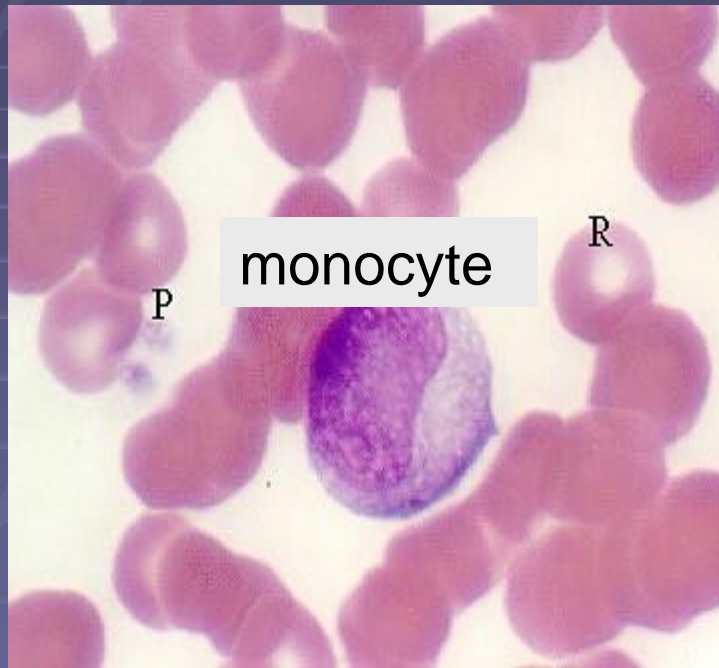
- monocytes, macrophages
- lymphocytes



# GRANULOCYTES

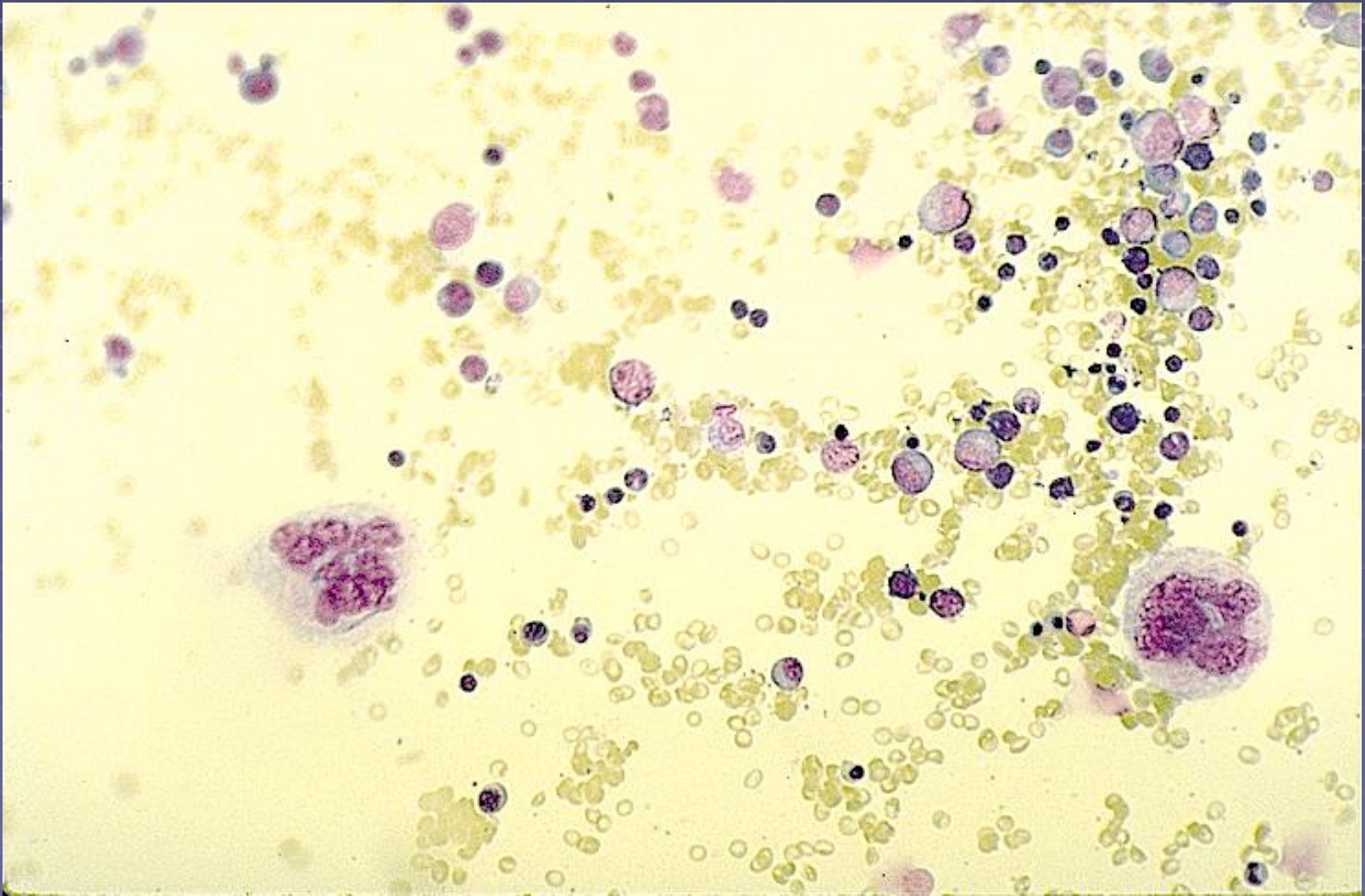


# AGRANULOCYTES





# THROMBOCYTES



# Blood cells development

