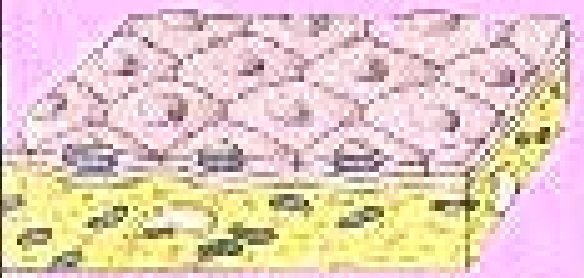
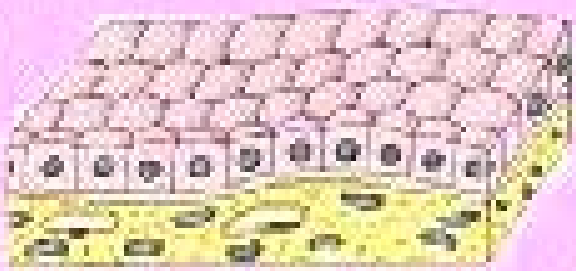
Epithelial and Connective Tissues

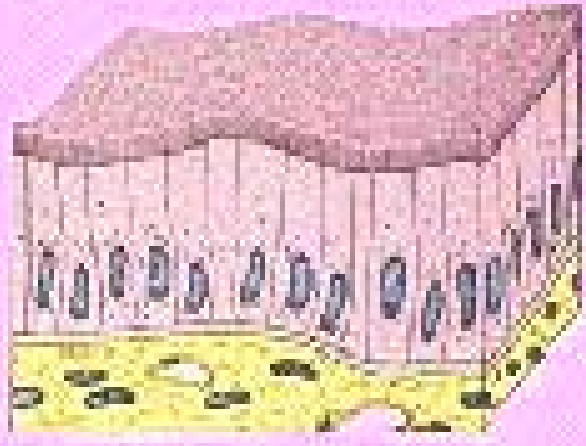
Danil Hammoudi.MD



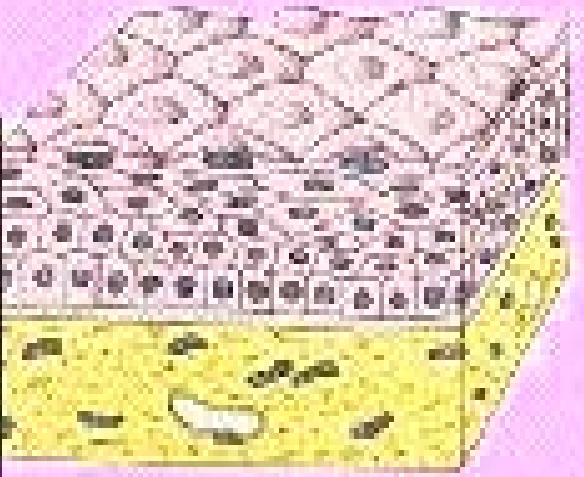
simple
squamous



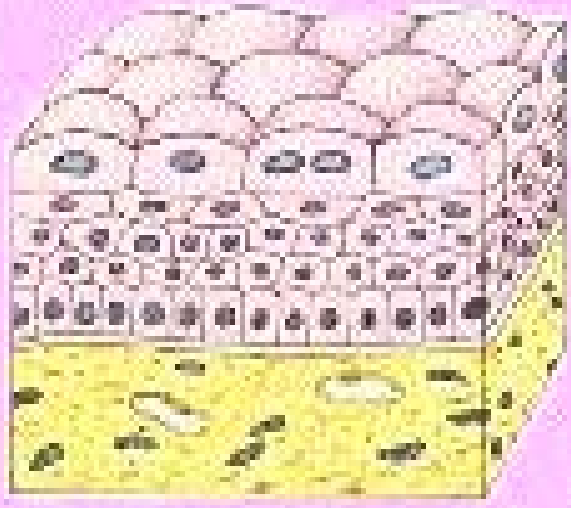
simple
cuboidal



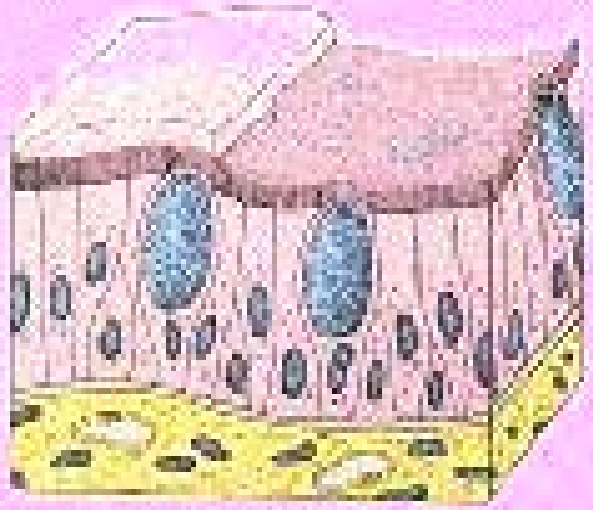
simple columnar
w/microvilli



stratified
squamous



transitional



pseudostratified columnar
w/cilia and microvilli

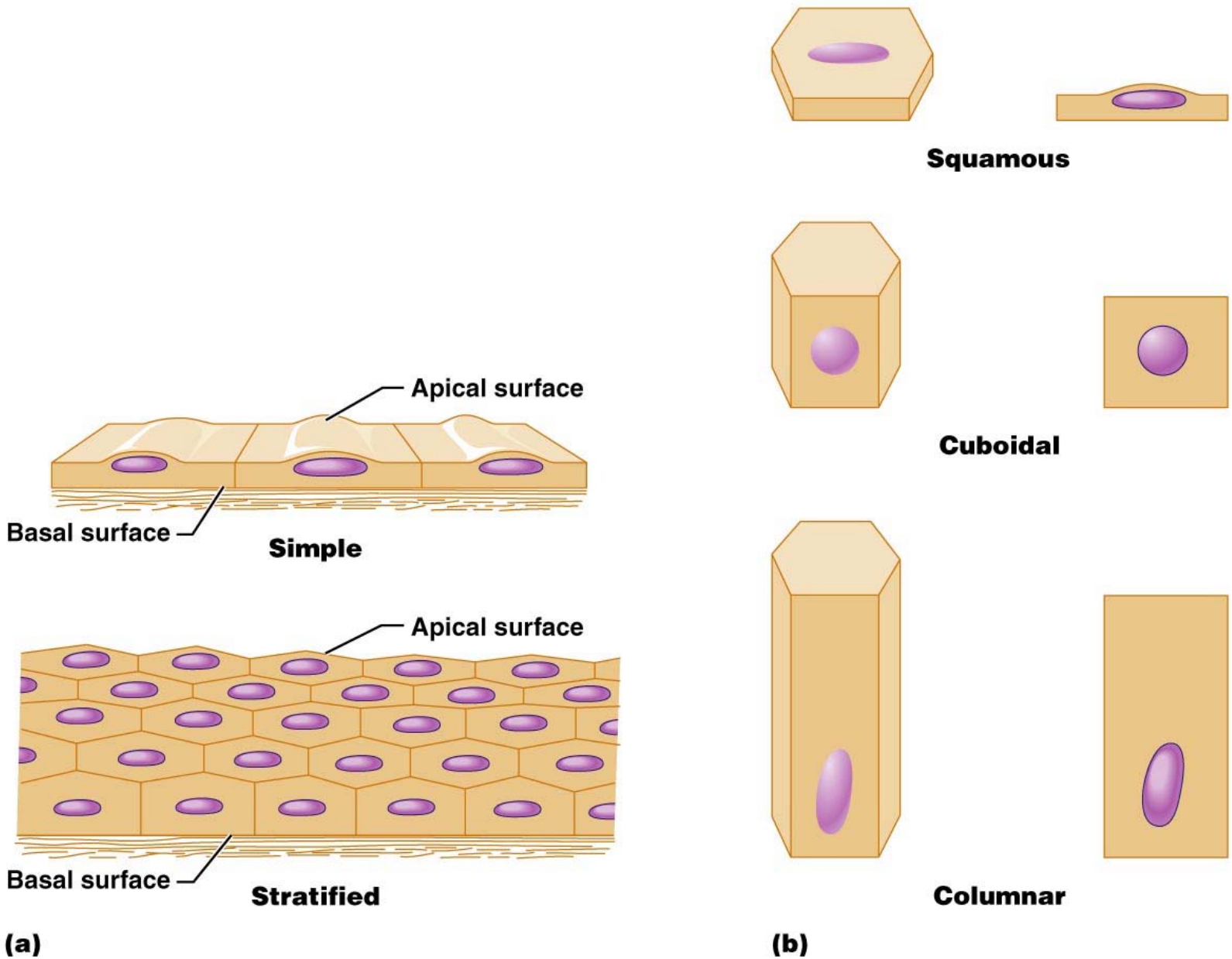


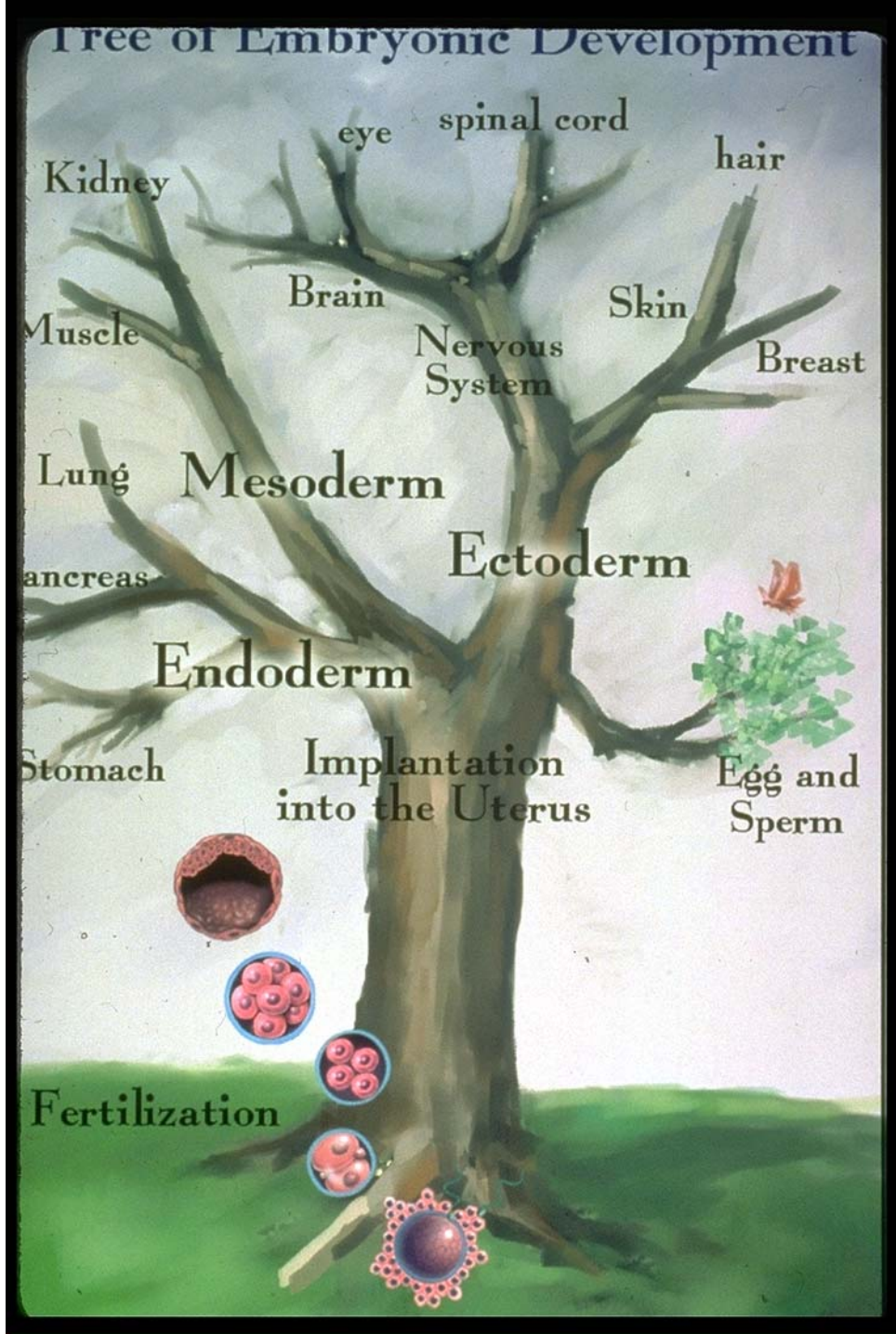
Figure 4.1

4 types of human tissues

- Epithelium
- Connective tissue
- Muscle tissue
  - Skeletal
  - Cardiac
  - Smooth muscles
- Nerve tissue

Tissue derivation

- Ectoderm
- Mesoderm
- Endoderm



Epithelium derivation

- Ectoderm forms epidermis
- Mesoderm form mesothelium
- Endoderm forms the lining of the GI

CONNECTIVE TISSUE AND MUSCLES DERIVATION

- MESODERM

NERVES DERIVATION

- ECTODERM

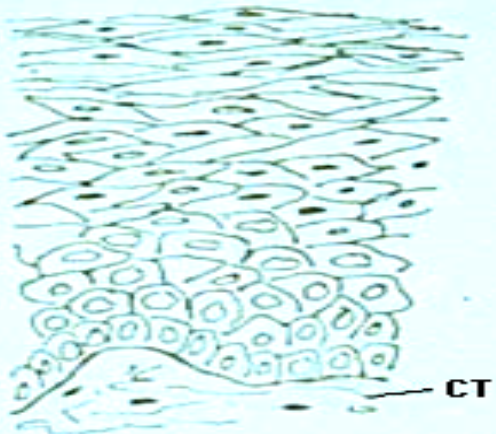
Epithelium Types

simple squamous

simple cuboidal

simple columnar

pseudostratified columnar ciliated



stratified squamous

transitional, contracted

transitional, stretched

BM = basement membrane
CT = connective tissue

EPITHELIUM

- **epithelium** is a tissue composed of a layer of cells.
- Epithelium lines both the ***outside (skin) and the inside cavities and lumen of bodies***.
- The outermost layer of our skin is composed of **dead stratified squamous epithelial** cells, as are the mucous membranes lining the inside of mouths and body cavities.
- Other epithelial cells line the insides of the lungs, the gastrointestinal tract, the reproductive and urinary tracts, and make up the exocrine and endocrine glands.

Functions of epithelial cells

- include :
  - secretion,
  - absorption,
  - protection, EXCEPT JOINTS CAVITIES, ANTERIOR SURFACE OF THE IRIS [NECKED CONNECTIVE TISSUE]
  - transcellular transport,
  - sensation detection,
  - and selective permeability.
  - Endothelium (the inner lining of blood vessels) is not related to epithelium except by name.

Functions of Epithelial Tissue

- **Protection**
  - Epithelial cells from the skin *protect underlying tissue from mechanical injury, harmful chemicals, invading bacteria and from excessive loss of water*.
- **Sensation**
  - Sensory stimuli *penetrate specialised epithelial cells*. Specialised epithelial tissue containing sensory nerve endings is found in the skin, eyes, ears, nose and on the tongue.
- **Secretion**
  - In glands, epithelial tissue is specialised to *secrete specific chemical substances* such as enzymes, hormones and lubricating fluids.
- **Absorption**
  - Certain epithelial cells lining the small intestine *absorb nutrients from the digestion of food*.
- **Excretion**
  - Epithelial tissues in the kidney *excrete waste products from the body and reabsorb needed materials from the urine*. *Sweat* is also excreted from the body by epithelial cells in the sweat glands.
- **Diffusion**
  - Simple epithelium *promotes the diffusion of gases, liquids and nutrients*. Because they form such a thin lining, they are ideal for the diffusion of gases (eg. walls of capillaries and lungs).
- **Cleaning**
  - Ciliated epithelium assists in *removing dust particles and foreign bodies* which have entered the air passages.
- **Reduces Friction**
  - The smooth, tightly-interlocking, epithelial cells that line the entire circulatory system *reduce friction between the blood and the walls of the blood vessels*.

- ENDOTHELIUM = CARDIOVASCULAR SYSTEM

- MESOTHELIUM = PERITONEAL CAVITY , THORACIC CAVITY, PERICARDIAL CAVITY

Epithelial cells:

- Sit on a basal lamina (formerly called a basement membrane).
- Have a free surface (if a cell has all of the other properties, but no free surface, it is called an epithelioid).
- Are avascular (contain no blood vessels).NOURISHMENT BY DIFFUSION
- Have almost no extracellular space.
- Renew basally.
- Are derived from all three germ layers.
- Are named for the most superficial live (nucleus-containing) layer.

(1) Each epithelium has an **apical surface**, which is exposed to the outside of the body or to the **lumen** of an internal cavity.

(2) The cells of an epithelium are held together with specialized contacts, including **tight junctions** and **desmosomes**.

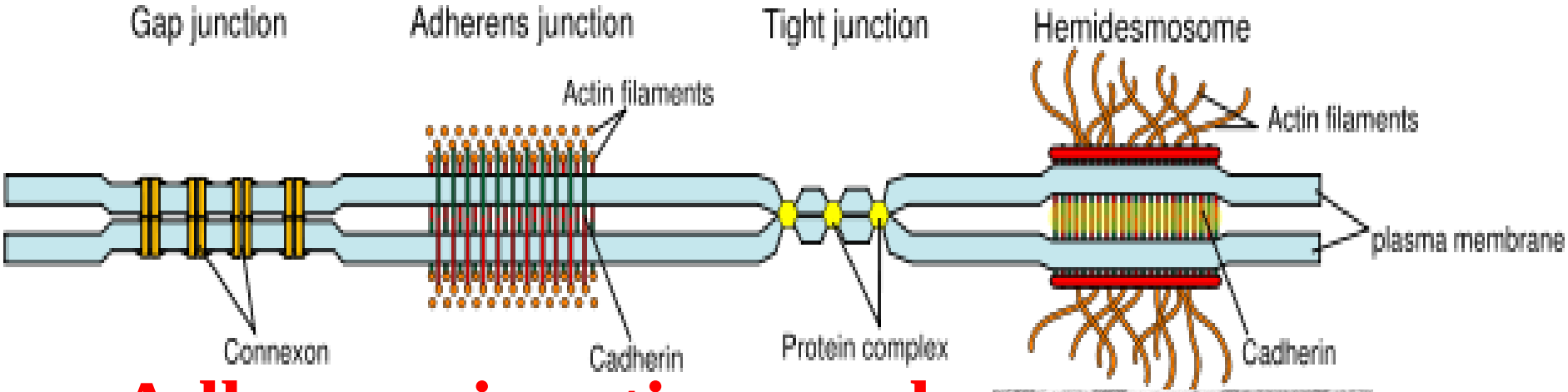
A cell junction is a structure within a tissue of a multicellular organism. Cell junctions are especially abundant in epithelial tissues. They consist of protein complexes and provide contact between neighbouring cells, between a cell and the extracellular matrix, or they built up the paracellular barrier of epithelia and control the paracellular transport.

(3) A **basement membrane** connects the **basal surface** of the

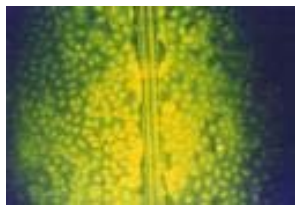
epithelium to an underlying layer of connective tissue.

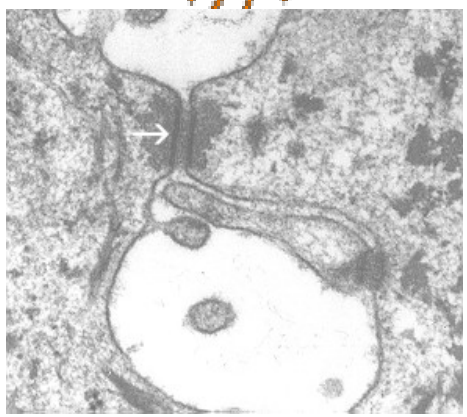
(4) Epithelial tissues are **avascular**.

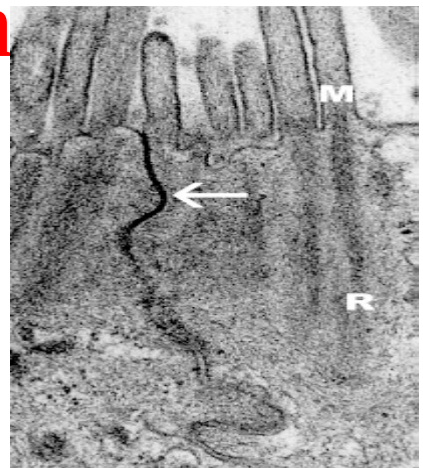
There are three major types of cell junctions:



- **Adherens junctions and Desmosomes**
- **Gap junctions**
- **Tight junction**

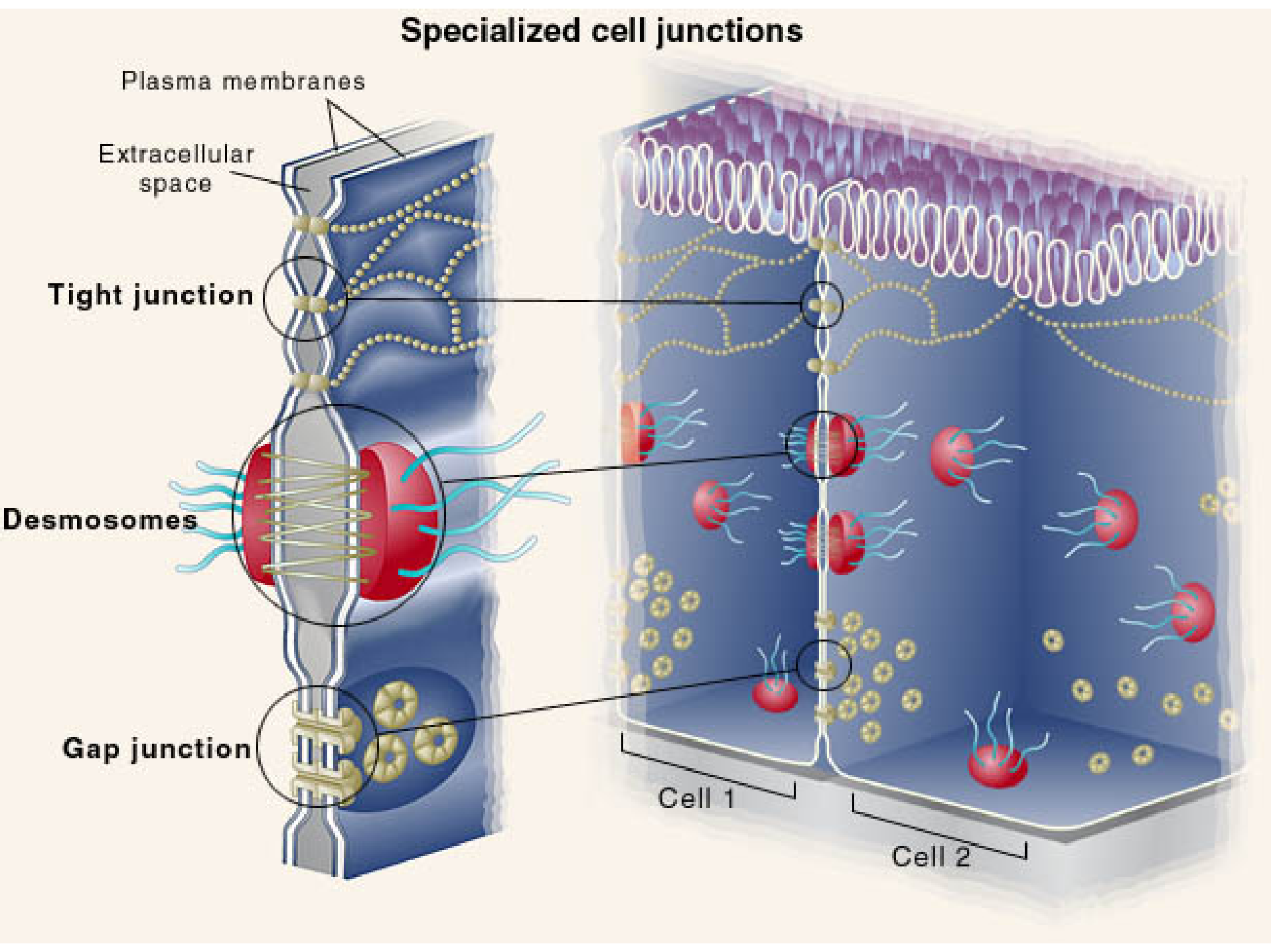


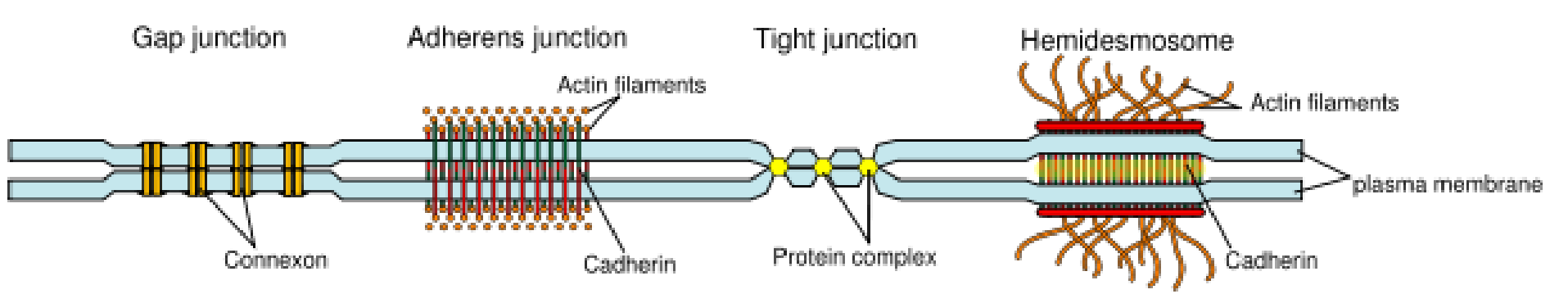




OTHERS

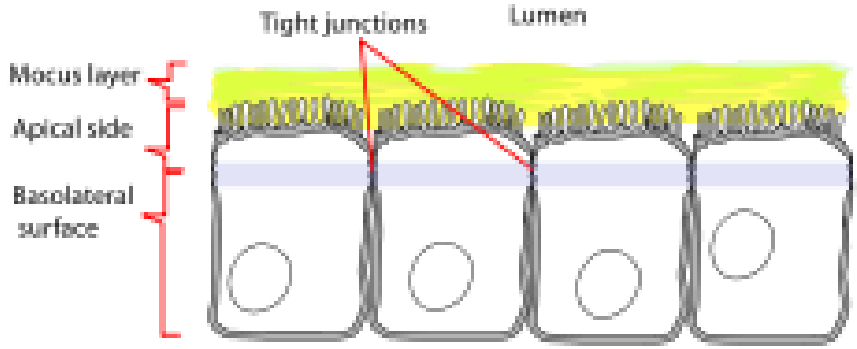
- Adhesion Plaques
  - *Actin filaments from the cell protrude and serve as the cell's anchor to the surrounding extracellular matrix.*
- Chemical Synapses
  - *These occur among adjecent cells when one cell releases chemicals into the extracellular space that bind receptors on the adjacent cell. This variety of cell-to-cell communication is common among nerve cells*
- Neurotransmission
  - *Neurotransmission is the passage of an electrical signal from a nerve cell (neuron) to another nerve cell, muscle or gland. In the process, chemicals called neurotransmitters, are released into the synapse (cleft between two neurons), where they bind receptors, changing the electrical potential in the membrane of the adjacent cell.*


Specialized cell junctions
Plasma membranes
Extracellular space
Tight junction
Desmosomes
Gap junction
Cell 1
Cell 2


Gap junction
Adherens junction
Tight junction
Hemidesmosome
Actin filaments
Actin filaments
plasma membrane
Connexon
Cadherin
Protein complex
Cadherin

Cell Junctions

- Tight Junctions = **zonul occludens**,

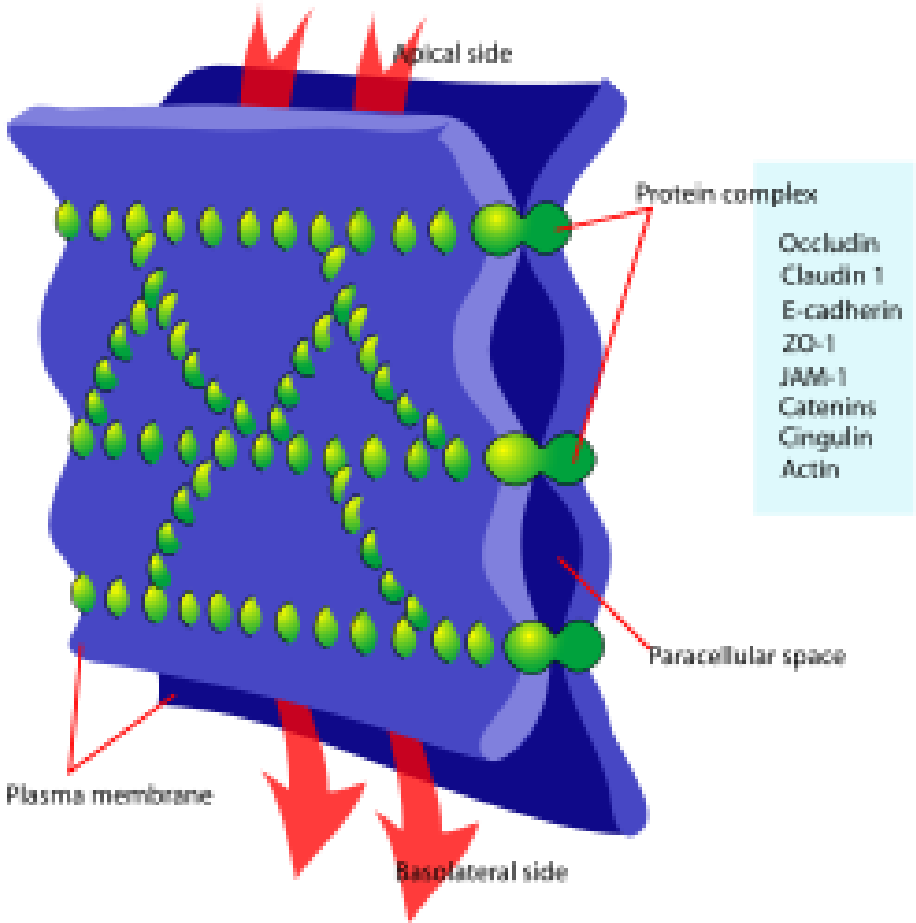


This is an occluding type of junction, where the plasma membranes of adjacent cells pinch tightly togethe

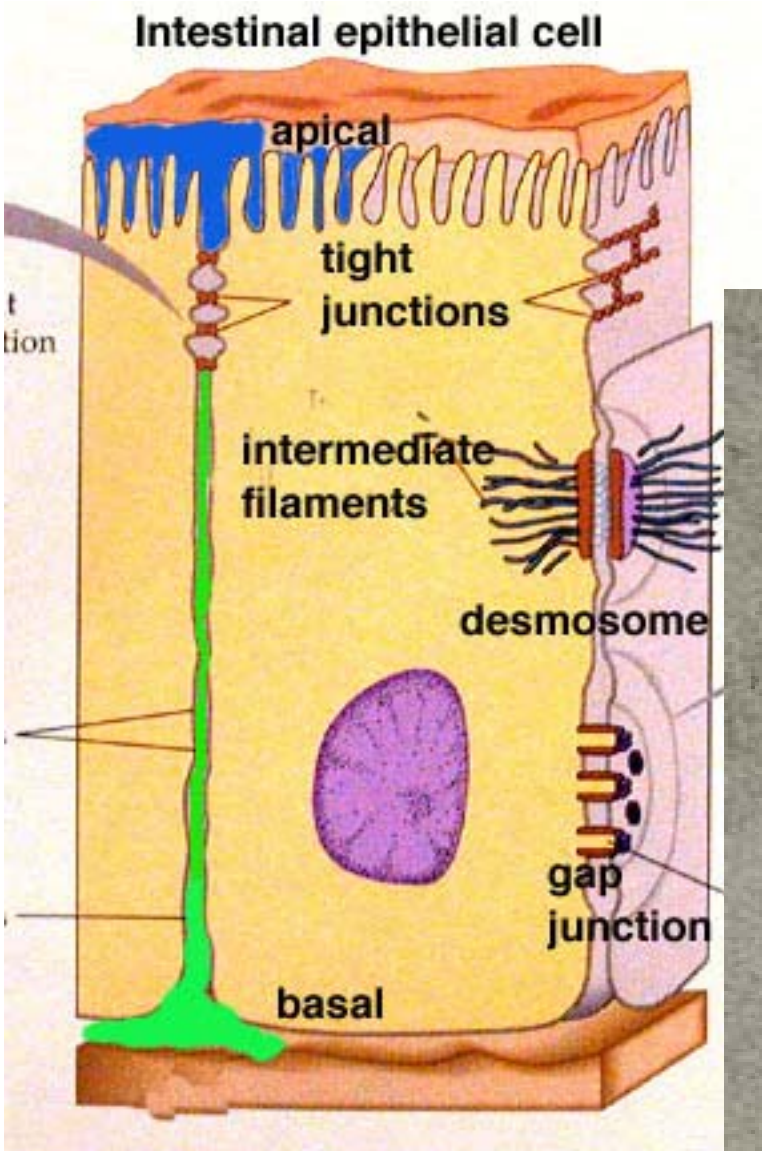
This creates a selective barrier betwee the spaces, allowing only certain materials to pass.

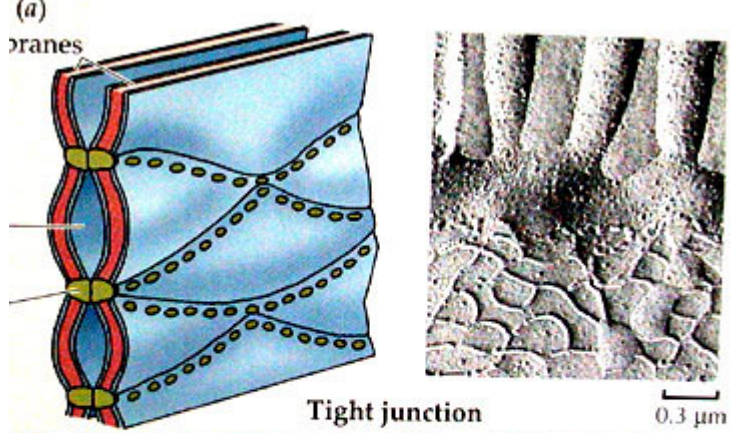
Found often between cells of ***animal intestine****,*

tight junctions assure that the correct chemical environment of intestinal lumen is maintained.

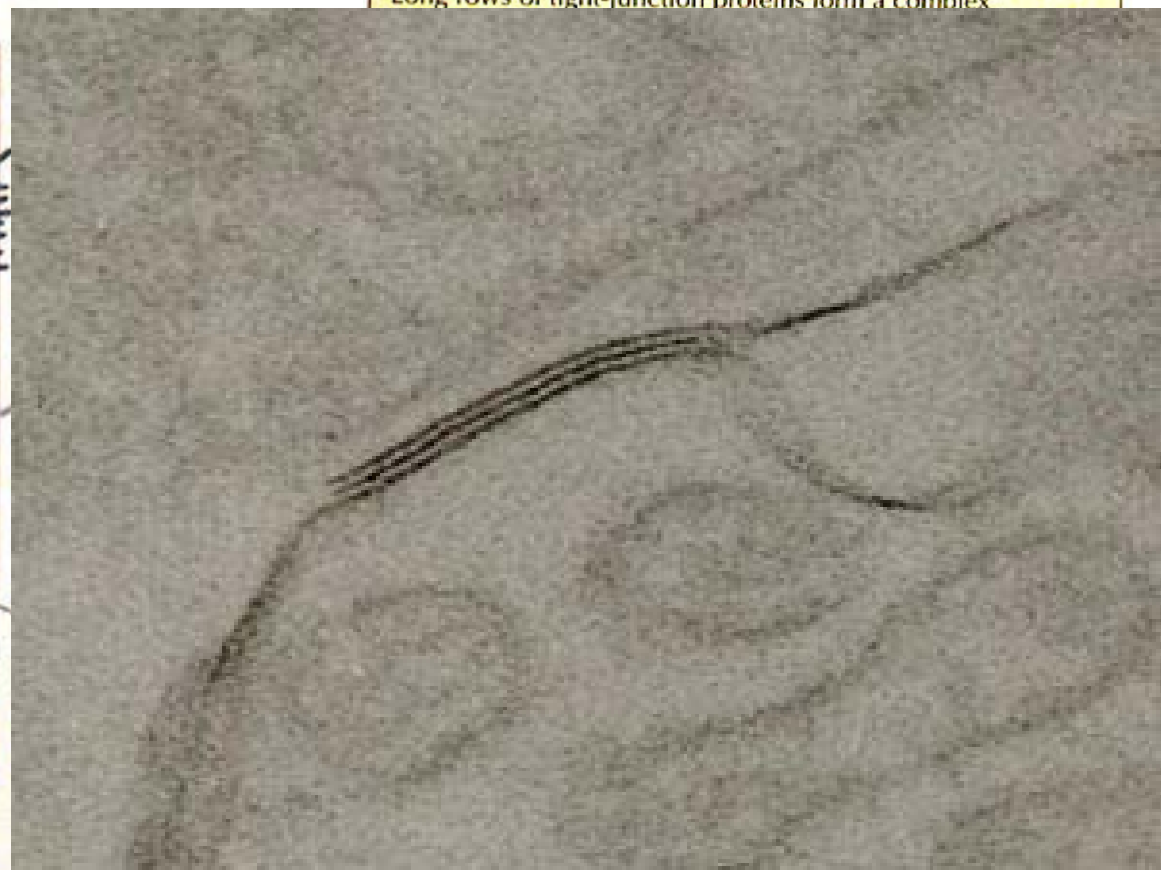


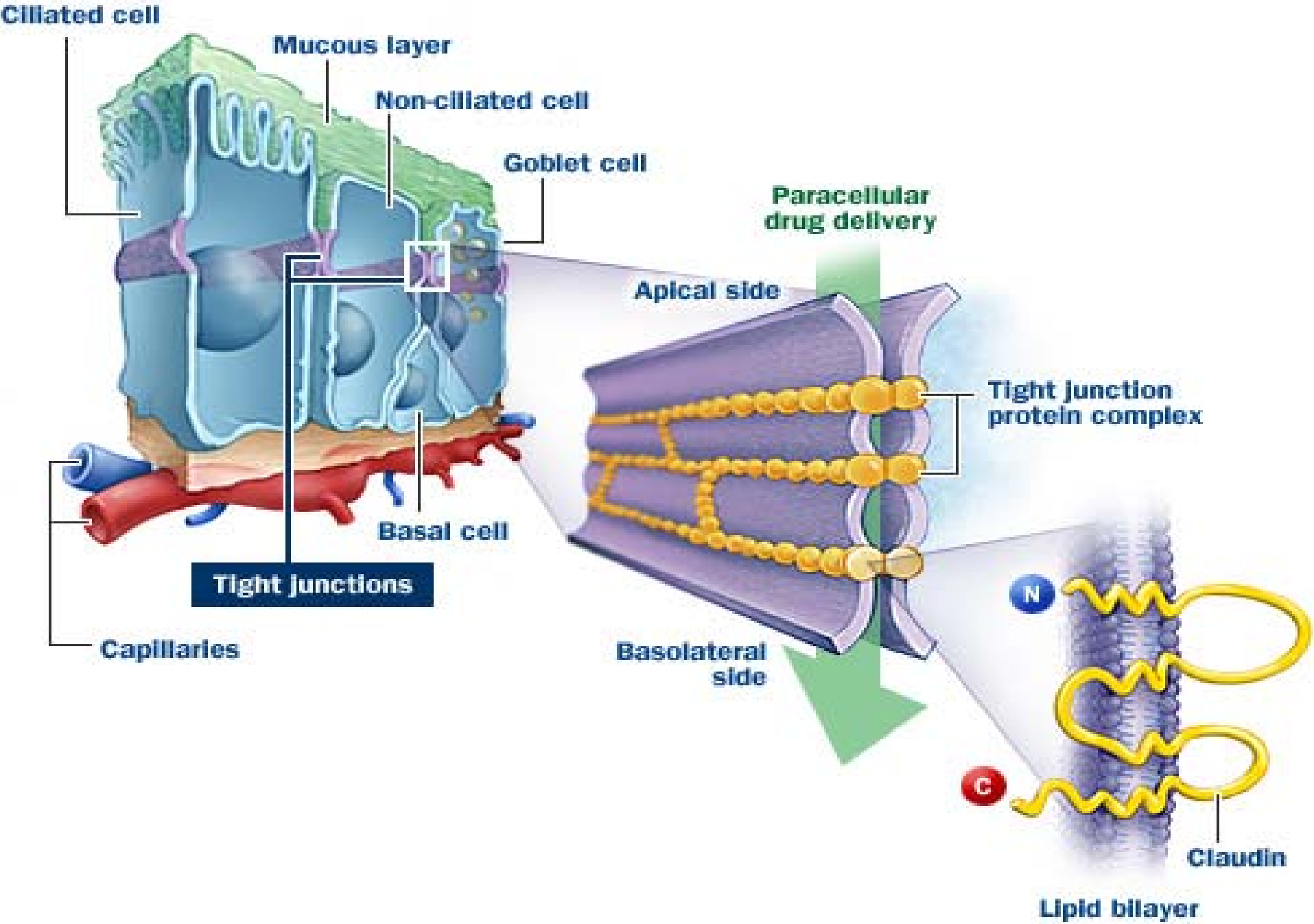
TIGHT JUNCTION





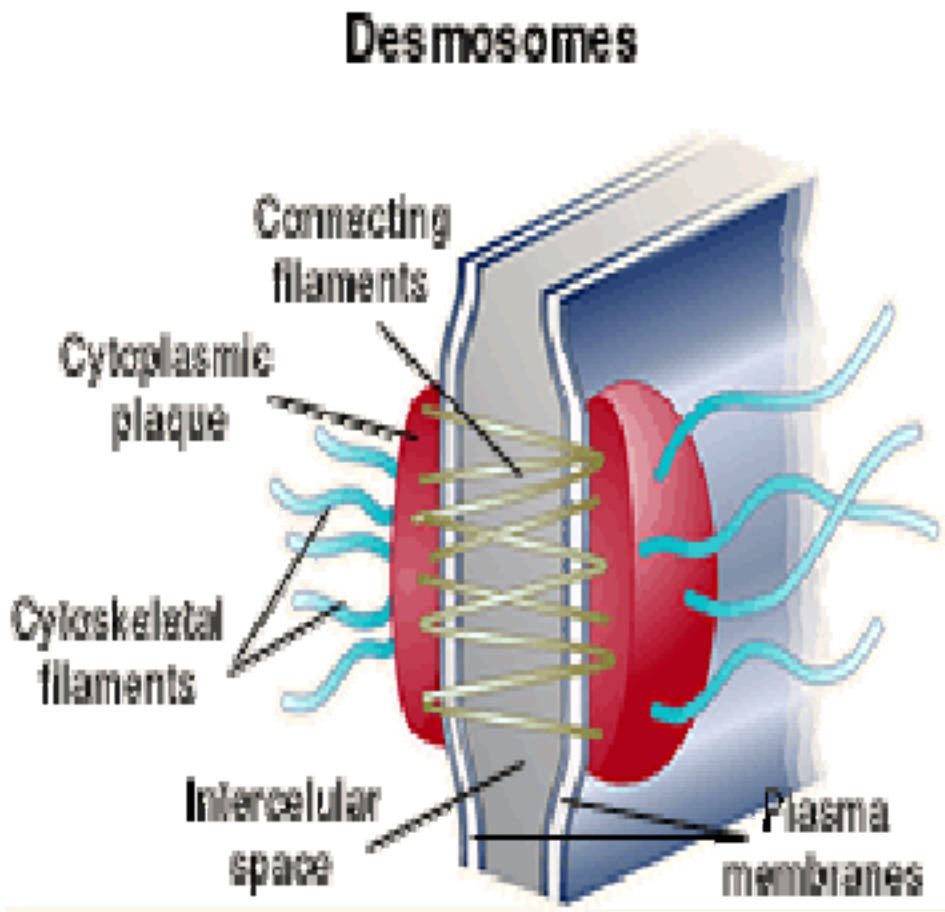
Tight junctions bar the movement of dissolved materials from the lumen through the space between epithelial cells. There is no intercellular space where there is a tight junction. Long rows of tight-junction proteins form a complex



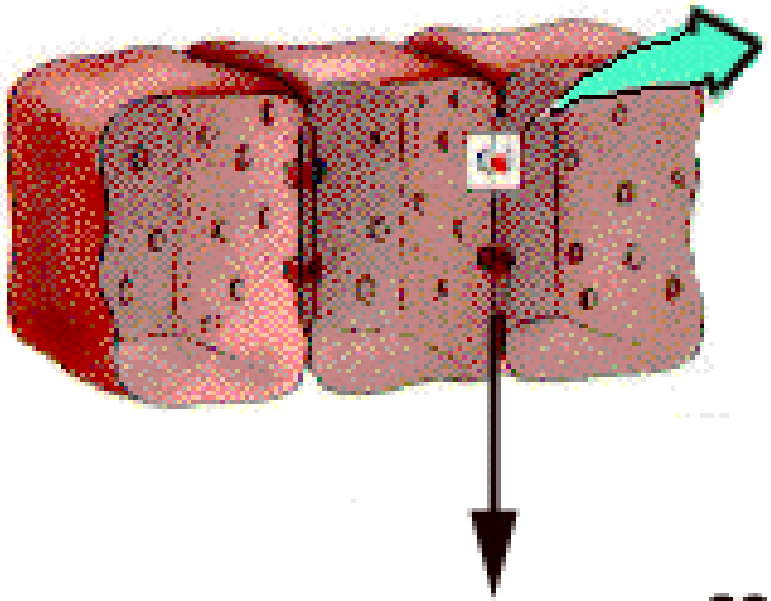

Ciliated cell
Mucous layer
Non-ciliated cell
Goblet cell
Paracellular drug delivery
Apical side
Tight junction protein complex
Basal cell
Tight junctions
Capillaries
Basolateral side
N
C
Claudin
Lipid bilayer

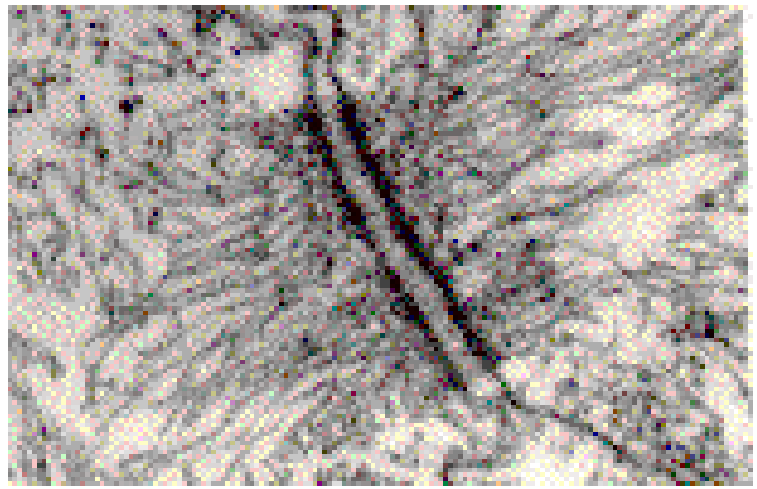
DESMOSOME

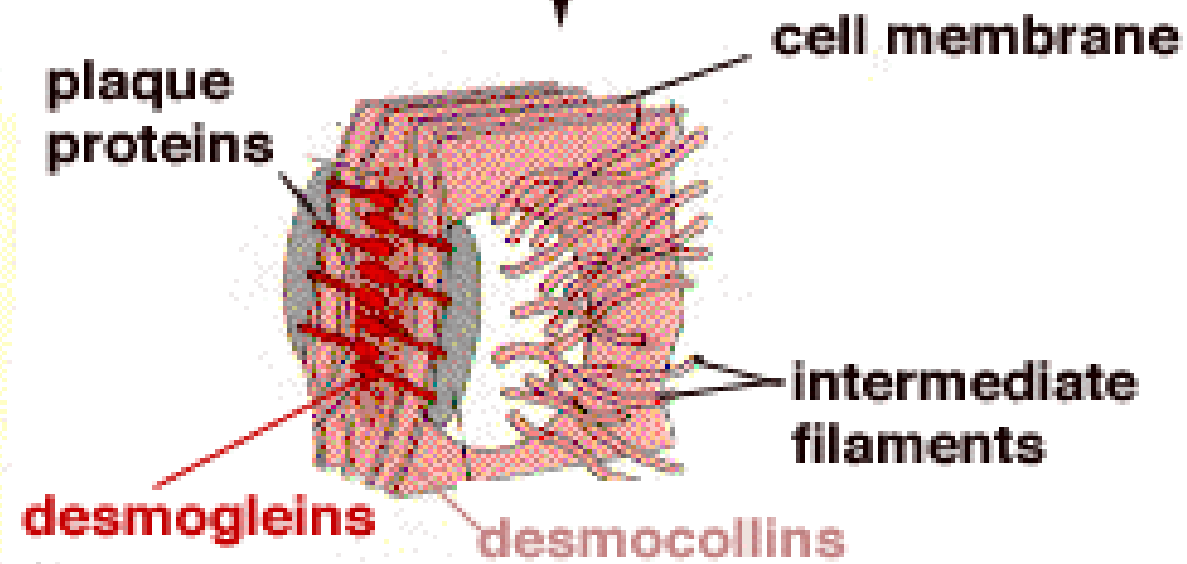
- Desmosomes form links between cells, and provide a connection between intermediate filaments of the cell cytoskeletons of adjacent cells. This structure gives strength to tissues.



Desmosomes

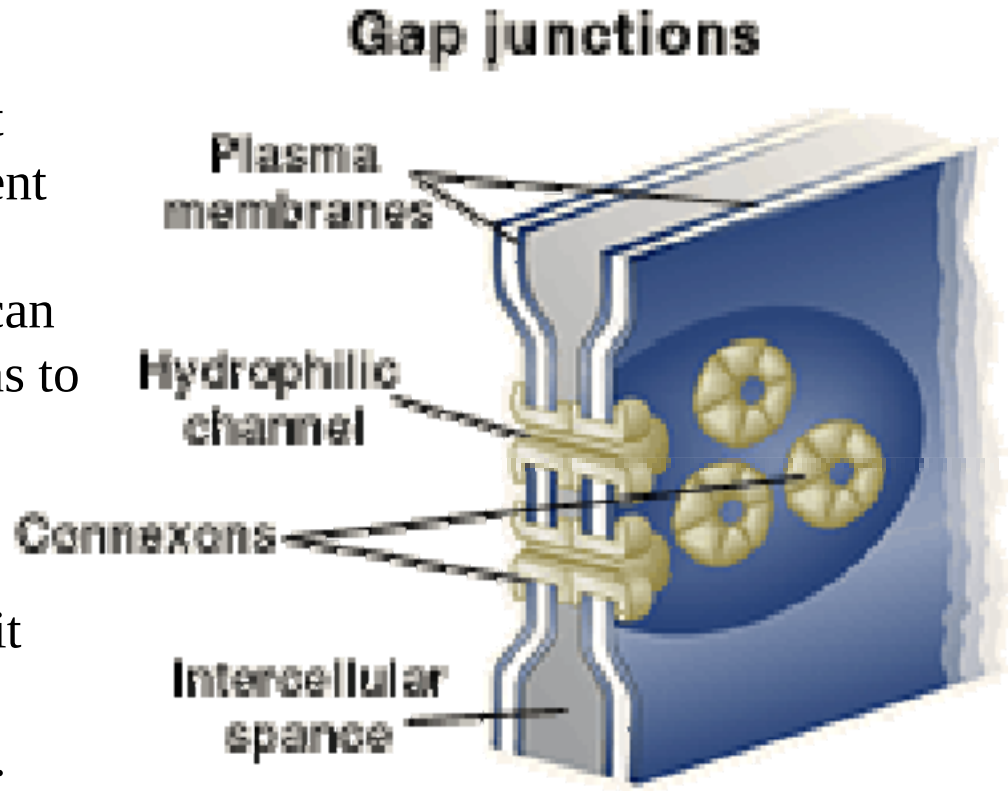





cell membrane
plaque proteins
intermediate filaments
desmogleins
desmocollins

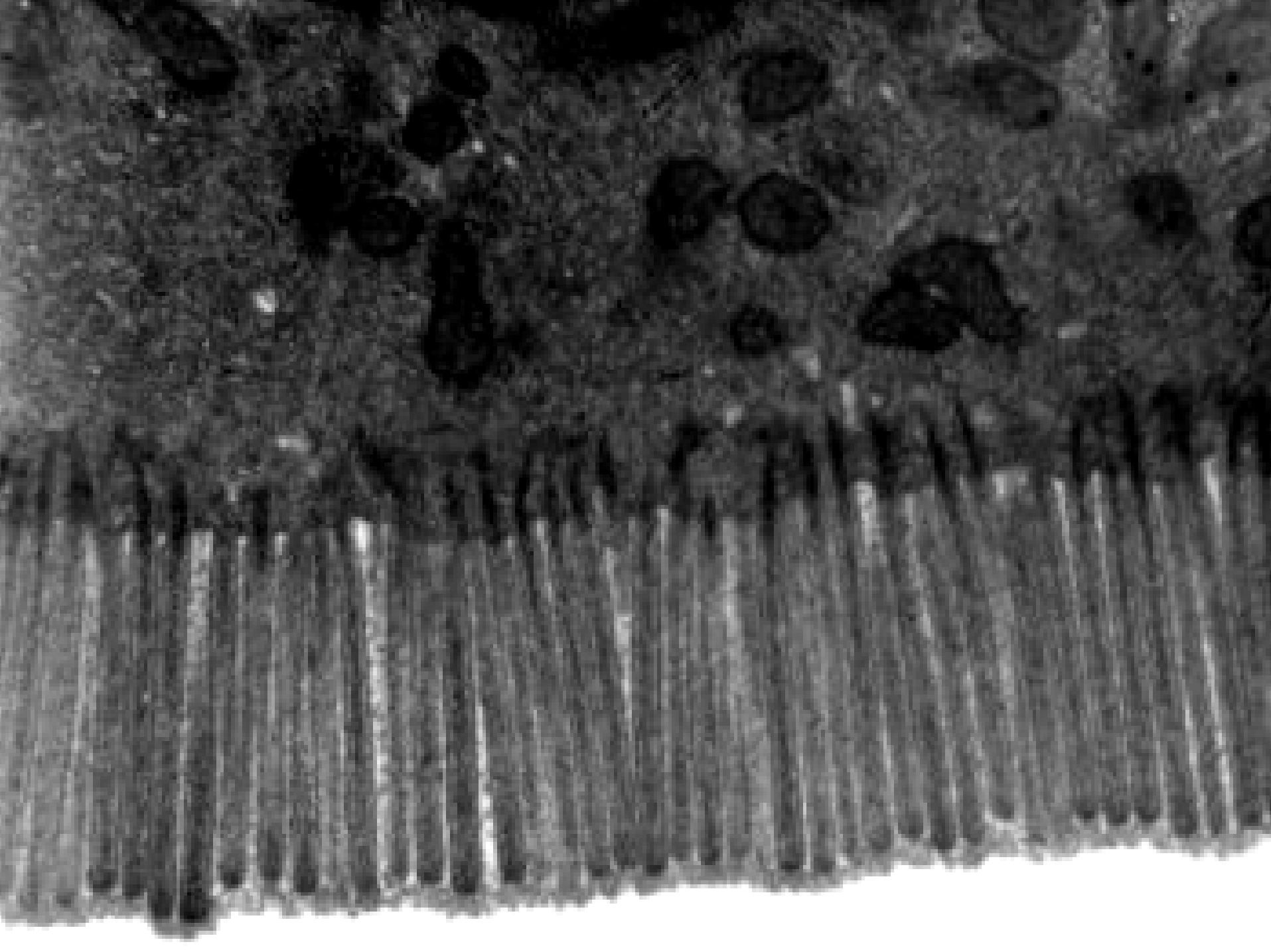
Gap junctions

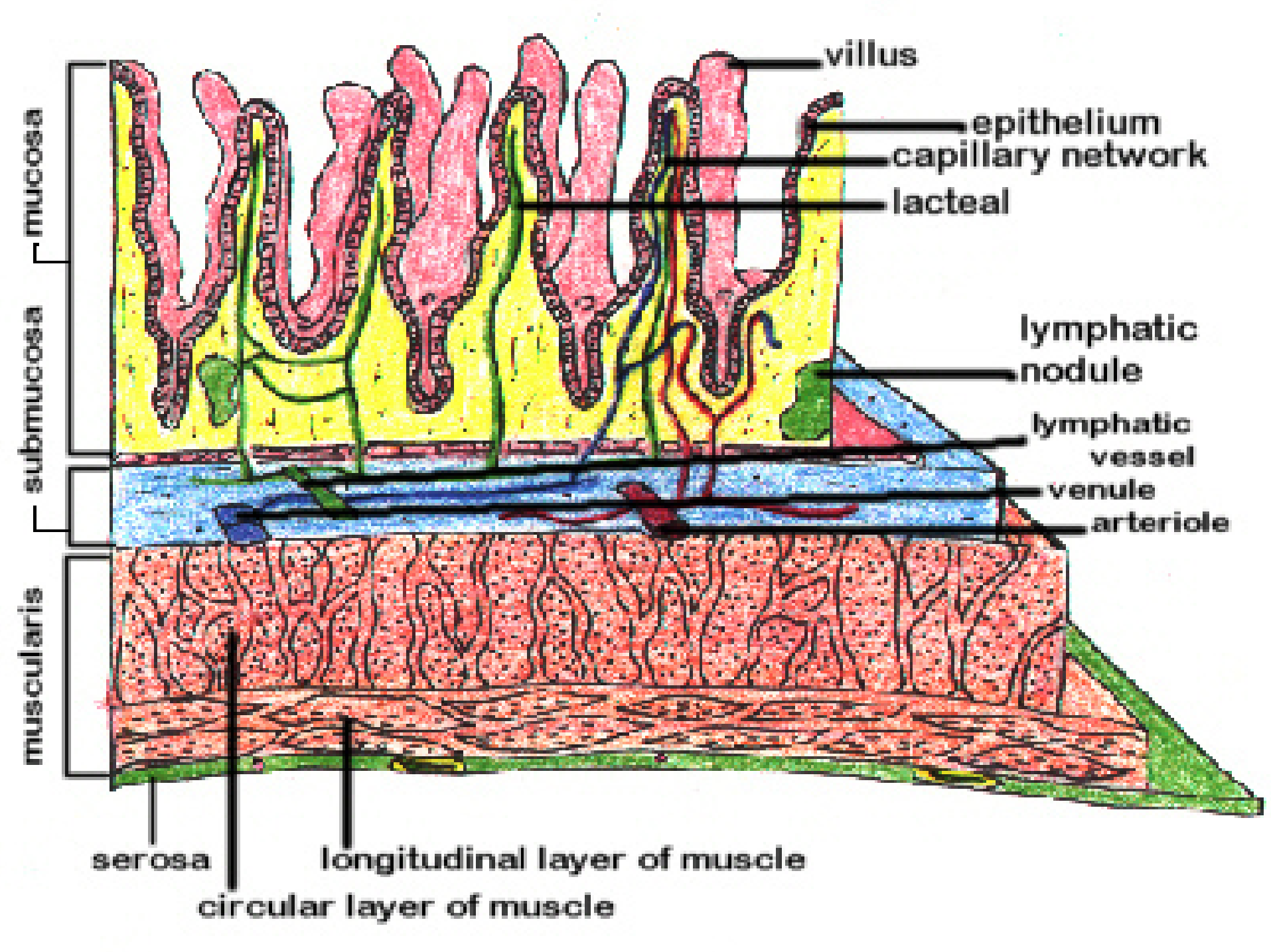
- the need for signaling is a function of gap junctions that form pores connecting adjacent cells. Small molecules and electrical signals in one cell can pass through the gap junctions to adjacent cells. This process allows tissues to coordinate responses to stimuli. For example, gap junctions permit coordinated movements of muscles leading to childbirth.

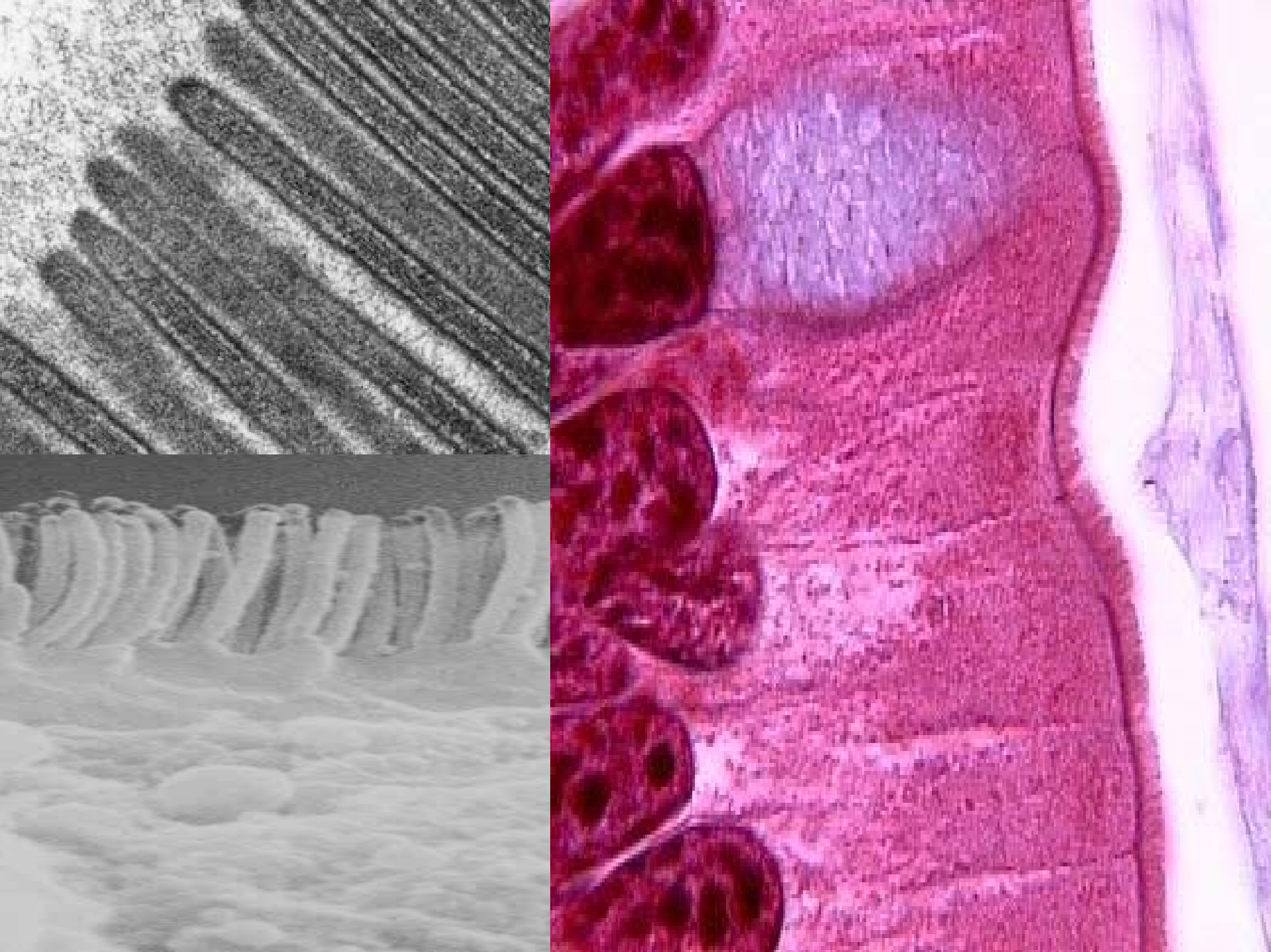


Microvilli

- A **microvillus** (usually not occurring alone, so usually referred to as the plural *microvilli*) is a small (0.08 μm in diameter, 1 μm long) extension of the cell surface of absorptive and secretory epithelial cells, such as kidney and intestinal cells. These structures increase the surface area of cells by approximately 600 fold (human), thus facilitating absorption and secretion. There are several thousand microvilli present on the apical surface of a single cell in human small intestinal cells.
- Microvilli also occur in sensory cells of the inner ear (as stereocilia), in the cells of taste buds, and in olfactory receptor cells. They are observed on the plasma surface of eggs, aiding in the anchoring of sperm cells that have penetrated the extracellular coat of egg cells. Clustering of elongated microtubules around a sperm allows for it to be drawn closer and held firmly so fusion can occur. Microvilli are also of importance on the cell surface of white blood cells, as they aid in the migration of white blood cells.

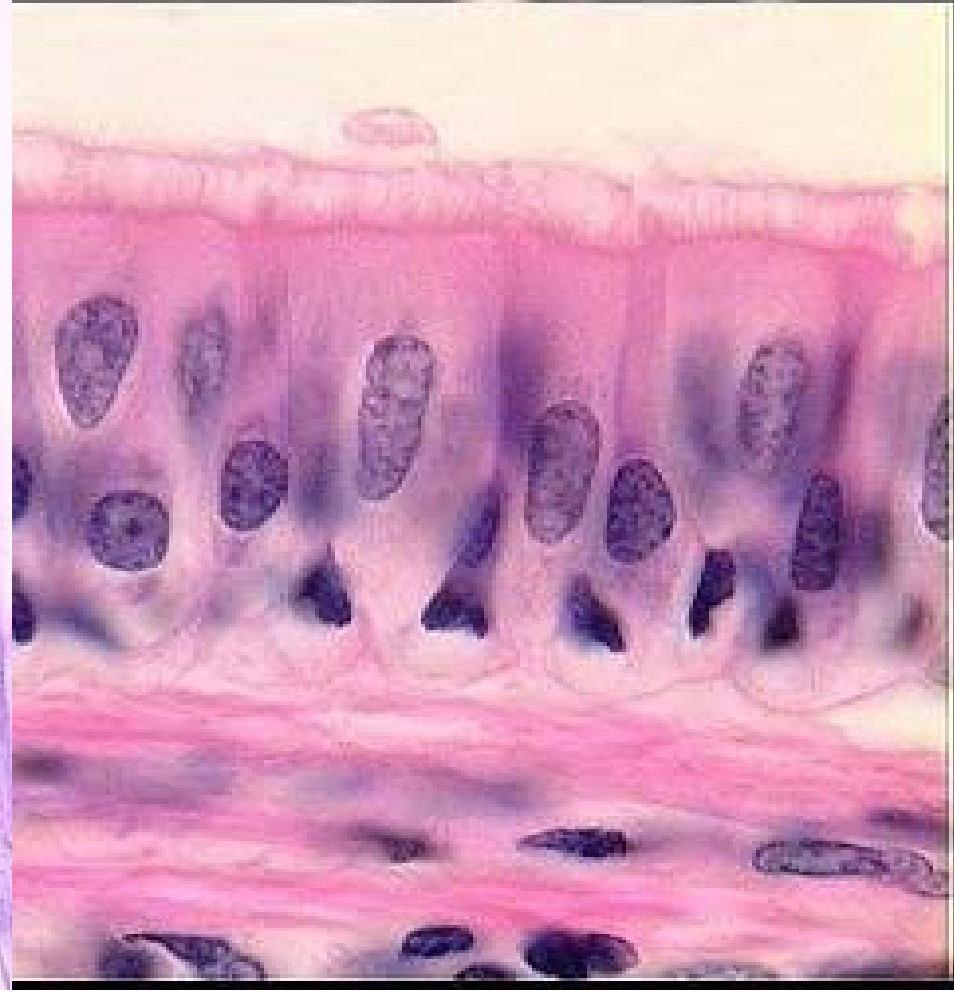



villus
epithelium
capillary network
lacteal
lymphatic nodule
lymphatic vessel
venule
arteriole
mucosa
submucosa
muscularis
serosa
circular layer of muscle
longitudinal layer of muscle



- **Microvilli**

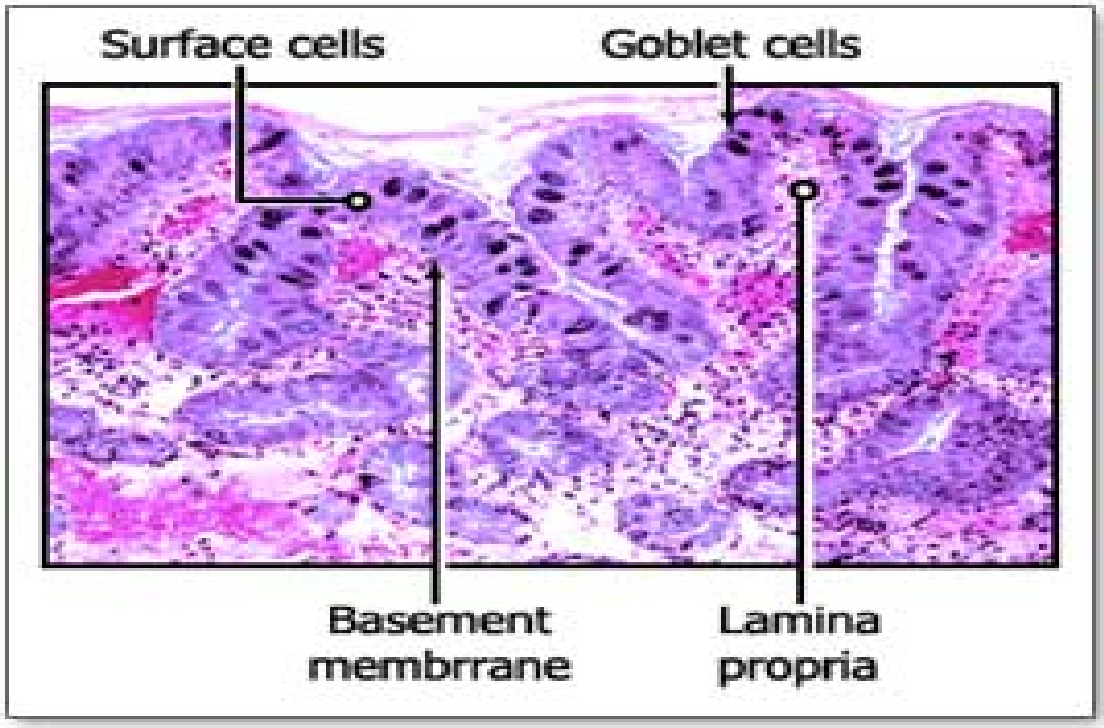
- Microvilli are shorter and more uniform in length. These structures reminded histologists of a brush with bristles viewed from the side. They named this border in the small intestine the "**brush border**". Note, you can't see through the brush border.

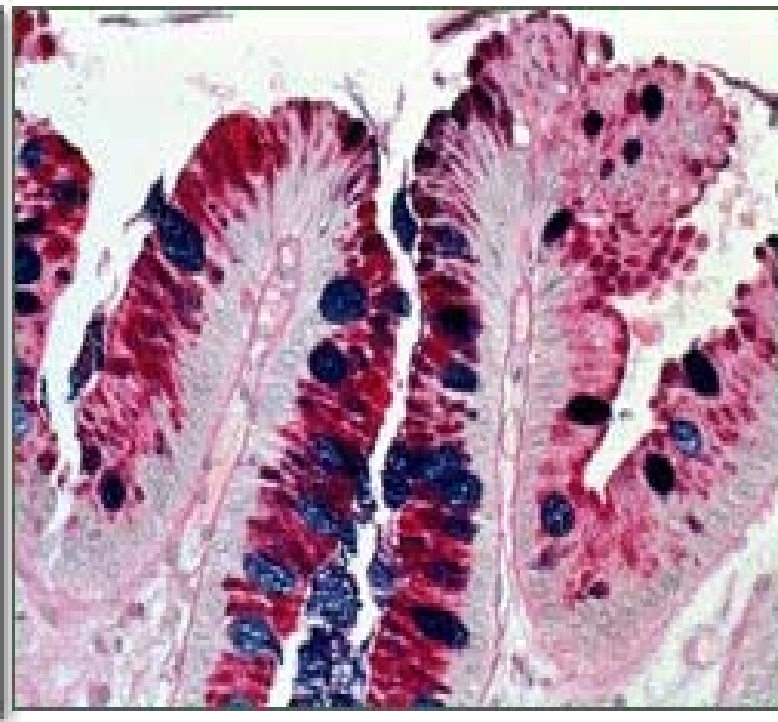


- **Cilia**

- In this view of the epithelium lining the trachea, note the long filamentous cilia along the apical surface. You can usually see through a layer of cilia!

Specialized **goblet cells**





Classification

Epithelial cells are classified by the following three factors:

- ***Shape***
- ***Stratification (number of layers)***
- ***Specialization***

Shape

- **Squamous**:
- **Cuboidal**
- **Columnar**:.
- **Transitional**:

Squamous:

- Squamous cells are flat cells with an irregular flattened shape.
- The one-cell layer of simple squamous epithelium that **forms the**
  - **alveoli of the respiratory membrane,**
  - **and the endothelium of capillaries, and is a minimal barrier to diffusion**.

- Places where squamous cells can be found include the alveoli of the lungs, the filtration tubules of the kidneys, and the major cavities of the body.

- These cells are relatively inactive metabolically, and are associated with the diffusion of water, electrolytes, and other substances.

Cuboidal:

- As the name suggests, these cells have a shape similar to a cube, meaning its width is the same size as its height.

- The nuclei of these cells are usually located in the center

Columnar:

- These cells are taller than they are wide.
- Simple columnar epithelium is made up of a single layer of cells that are longer than they are wide.
- The nucleus is also closer to the base of the cell.
- The small intestine is a tubular organ lined with this type of tissue.
- Unicellular glands called goblet cells are scattered throughout the simple columnar epithelial cells and secrete mucus.
- The free surface of the columnar cell has tiny hairlike projections called microvilli.
- They increase the surface area for absorption

Transitional

- This is a specialized type of epithelium found lining organs that can stretch,
- such as the urothelium that lines the bladder and ureter of mammals.

- Since the cells can slide over each other, the appearance of this epithelium depends on whether the organ is distended or contracted: if distended, it appears as if there are only a few layers; when contracted, it appears as if there are several layers.

Stratification

- **Simple**: There is a single layer of cells.

- **Stratified**: More than one layer of cells. The superficial layer is used to classify the layer. Only one layer touches the basal lamina. Stratified cells can usually withstand large amounts of stress.

- **Pseudostratified with cilia**: This is used mainly in one type of classification (pseudostratified columnar epithelium). There is only a single layer of cells, but the position of the nuclei gives the impression that it is stratified. If a specimen looks stratified, but you can identify cilia, the specimen is pseudostratified ciliated epithelium since stratified epithelium cannot have cilia.

Specializations

- ***Keratinized*** cells contain keratin (a cytoskeletal protein). ***While keratinized epithelium occurs mainly in the skin, it is also found in the mouth and nose***, providing a tough, impermeable barrier.

- ***Ciliated*** cells have apical plasma membrane extensions composed of microtubules capable of beating rhythmically to move mucus or other substances through a duct. ***Cilia are common in the respiratory system and the lining of the oviduct***.

- **Simple squamous**: Found in blood vessels & lymph channels (called endothelium) and body cavities (called mesothelium)

- **Keratinized stratified squamous**: Found in human skin (specifically, the dead superficial layer); also found in masticatory oral mucosa (attached gingiva, dorsum of tongue, hard palate, etc.)

- **Non-Keratinised stratified squamous:** Found in human oesophagus (Oral Mucosa) specfically non-masticatory "movable" mucosa, and vagina

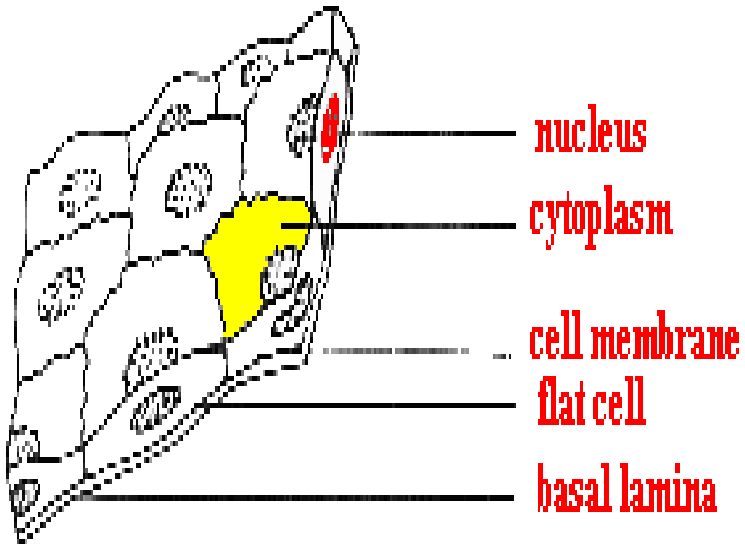
- **Simple cuboidal:** Found in thyroid follicles Exclusively found in sweat gland ducts

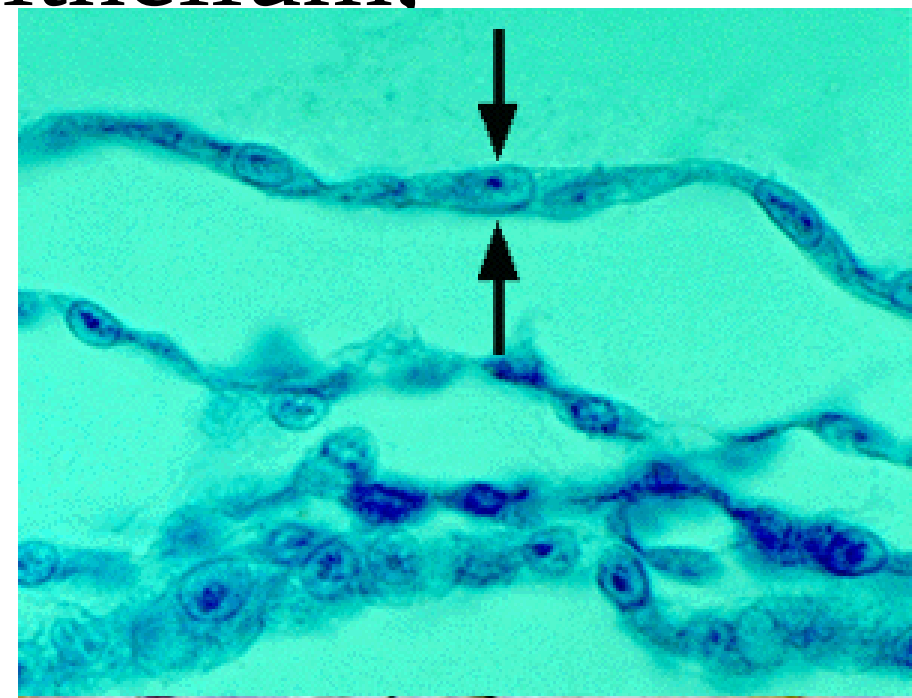
- **Ciliated Stratified cuboidal**: **simple columnar**: Found in intestine and kidney (specifically, proximal convoluted tubule)

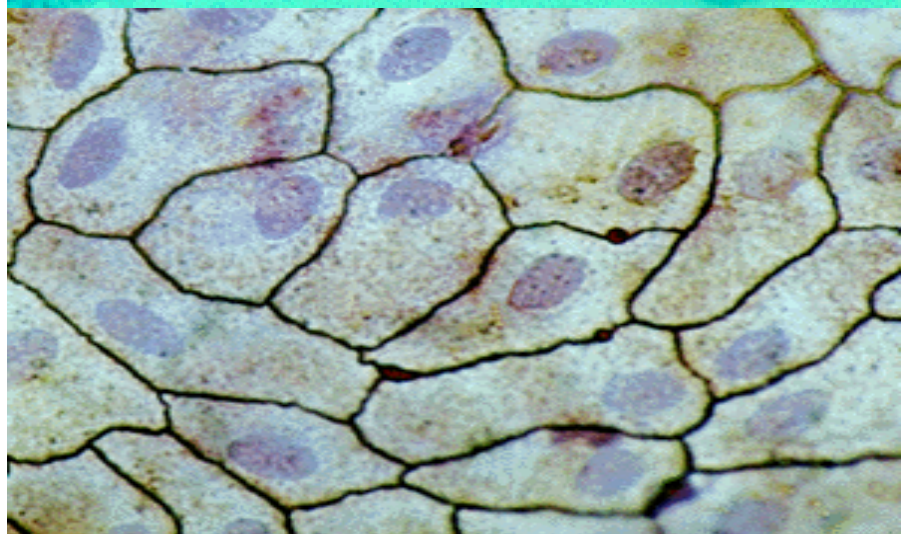
- **Stratified columnar**: Ducts of submandibular glands

- **Transitional**: Specialized to distend (stretch) as the urinary bladder fills

Simple epithelium.

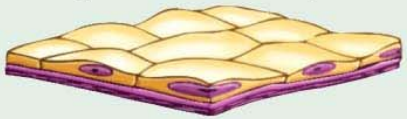






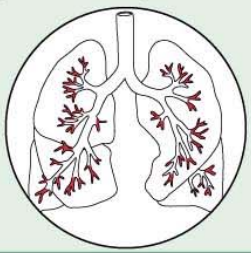
(a) Simple squamous epithelium

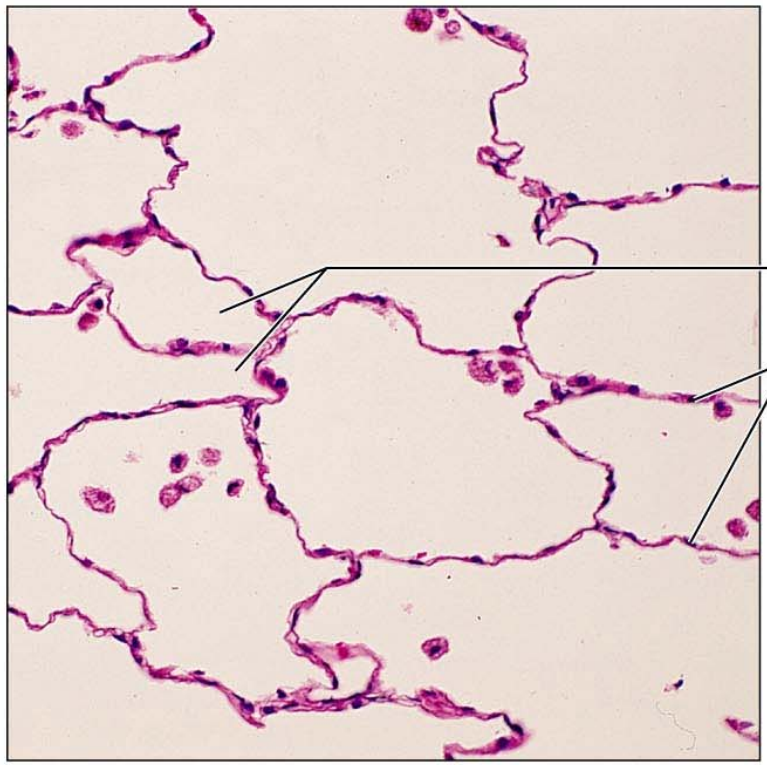
Description: Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.



Function: Allows passage of materials by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosae.

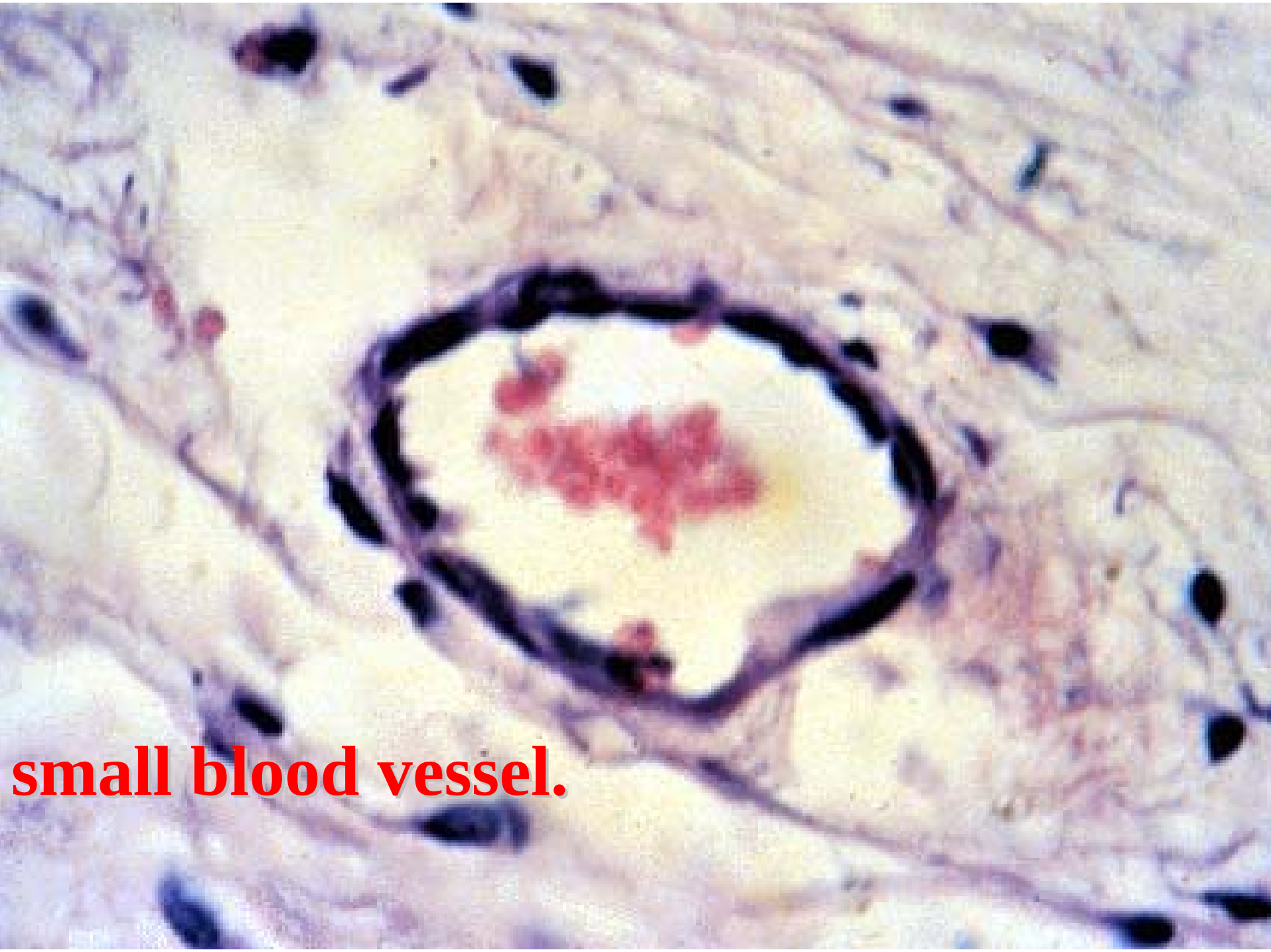
Location: Kidney glomeruli; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosae).



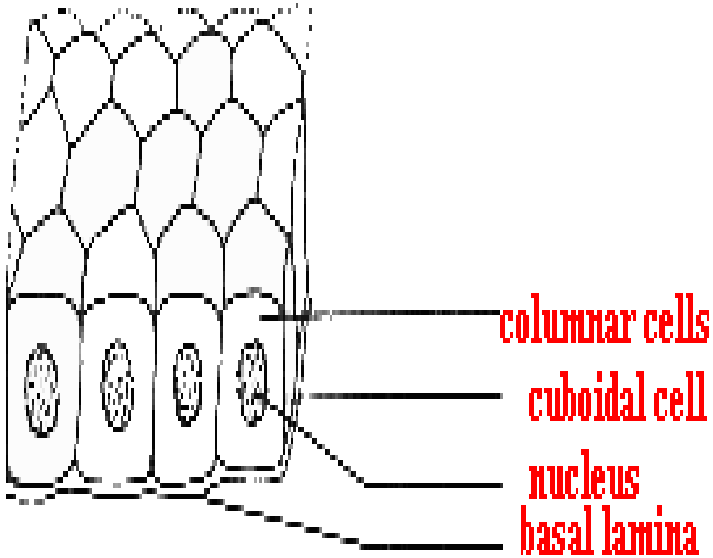


Photomicrograph: Simple squamous epithelium forming part of the alveolar (air sac) walls (400×).

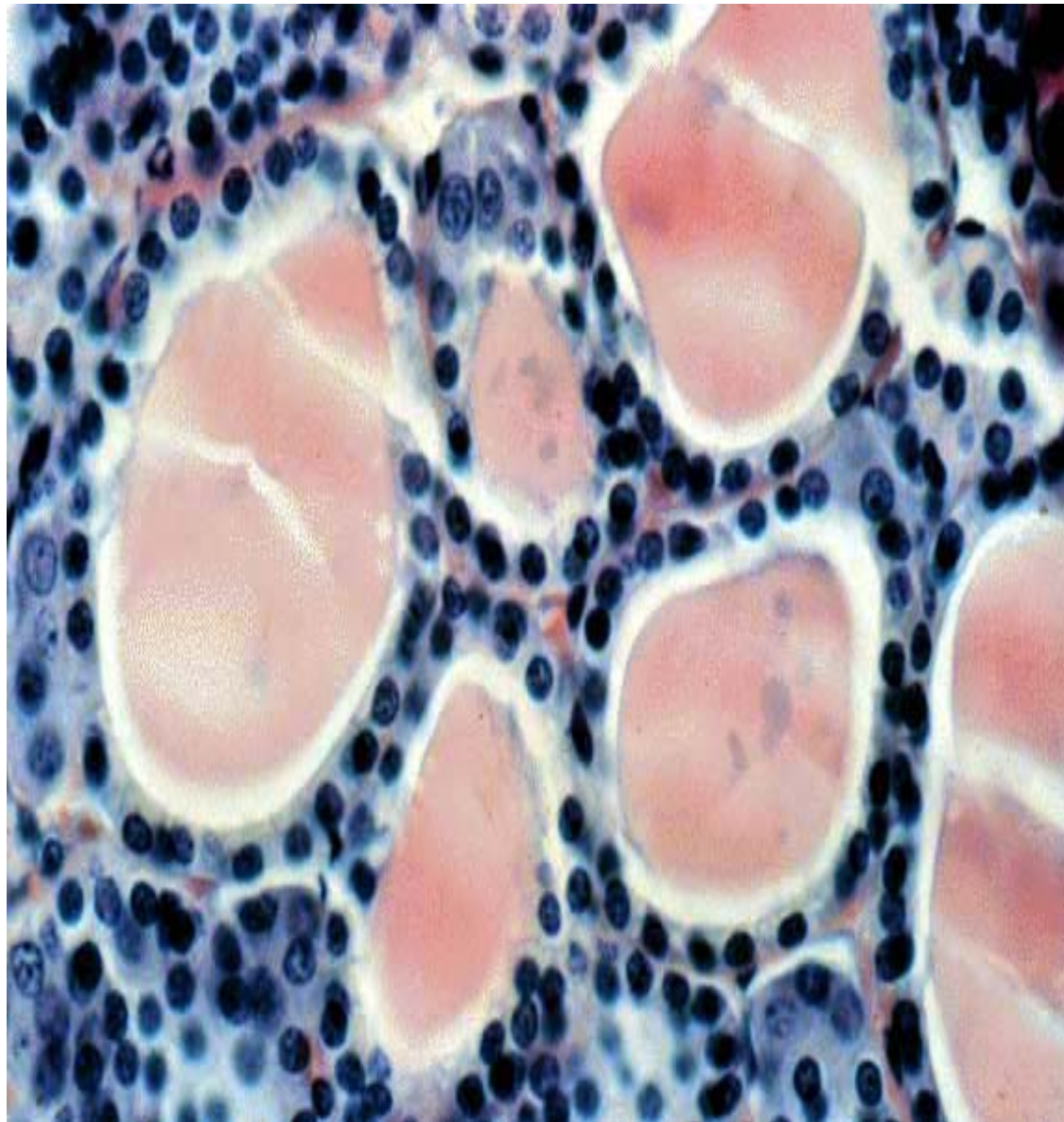
Figure 4.2a


small blood vessel.

Simple cuboidal epithelium

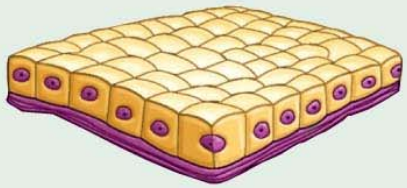


thyroid follicles



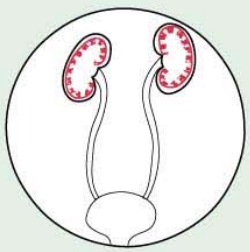
(b) Simple cuboidal epithelium

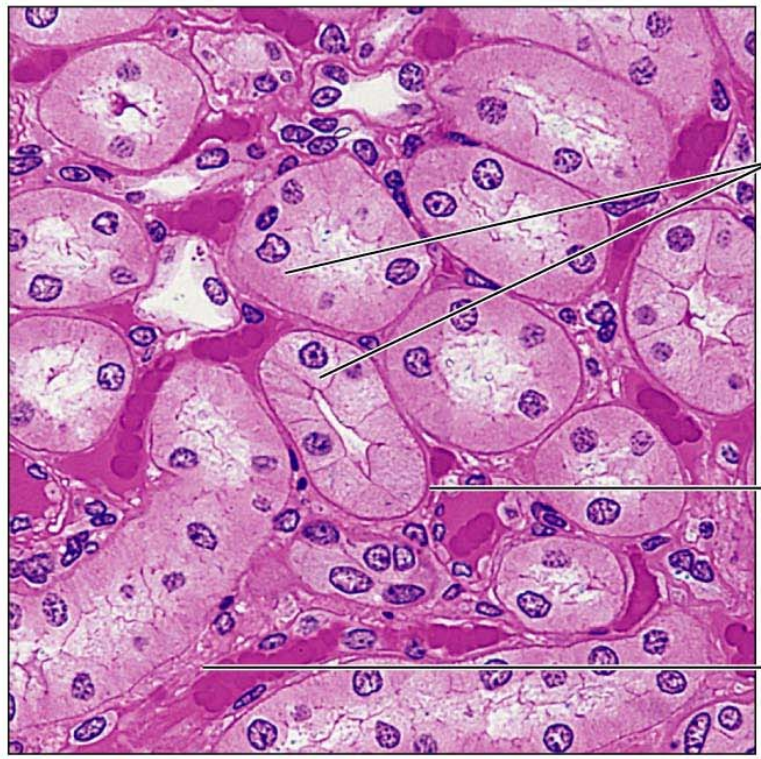
Description: Single layer of cubelike cells with large, spherical central nuclei.



Function: Secretion and absorption.

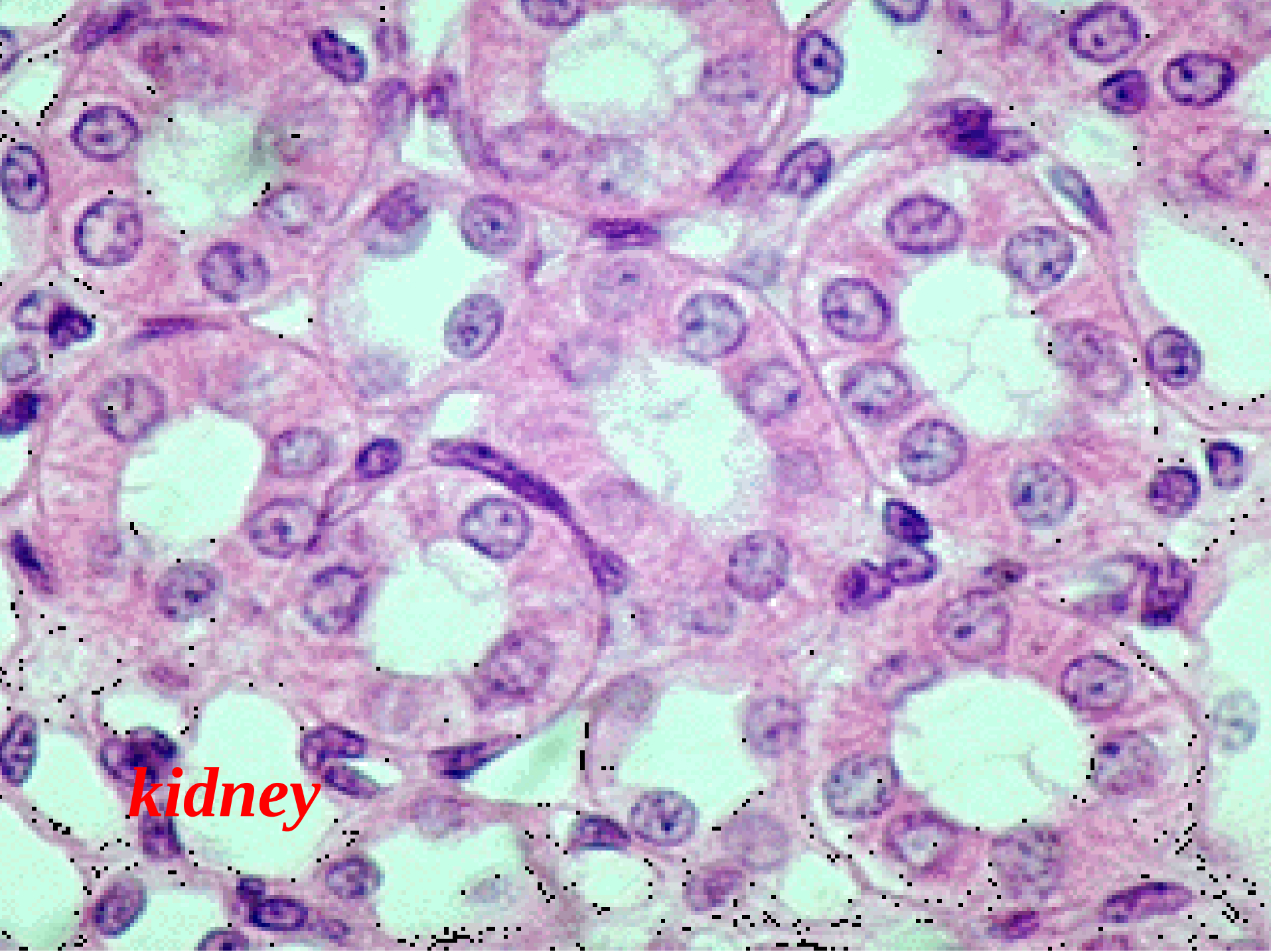
Location: Kidney tubules; ducts and secretory portions of small glands; ovary surface.





Photomicrograph: Simple cuboidal epithelium in kidney tubules (400×).

Figure 4.2b


kidney

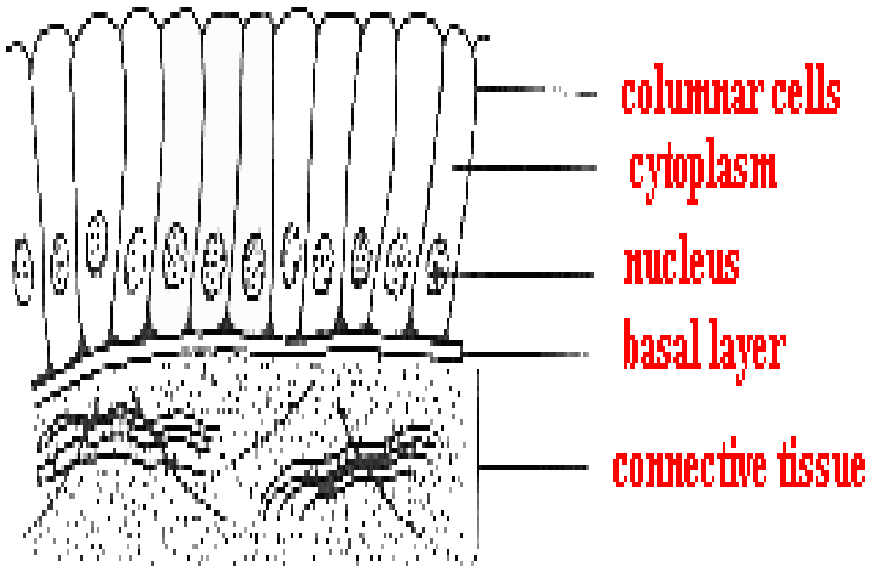
Simple cuboidal eplithelia are cells in a single layer found on the surface of

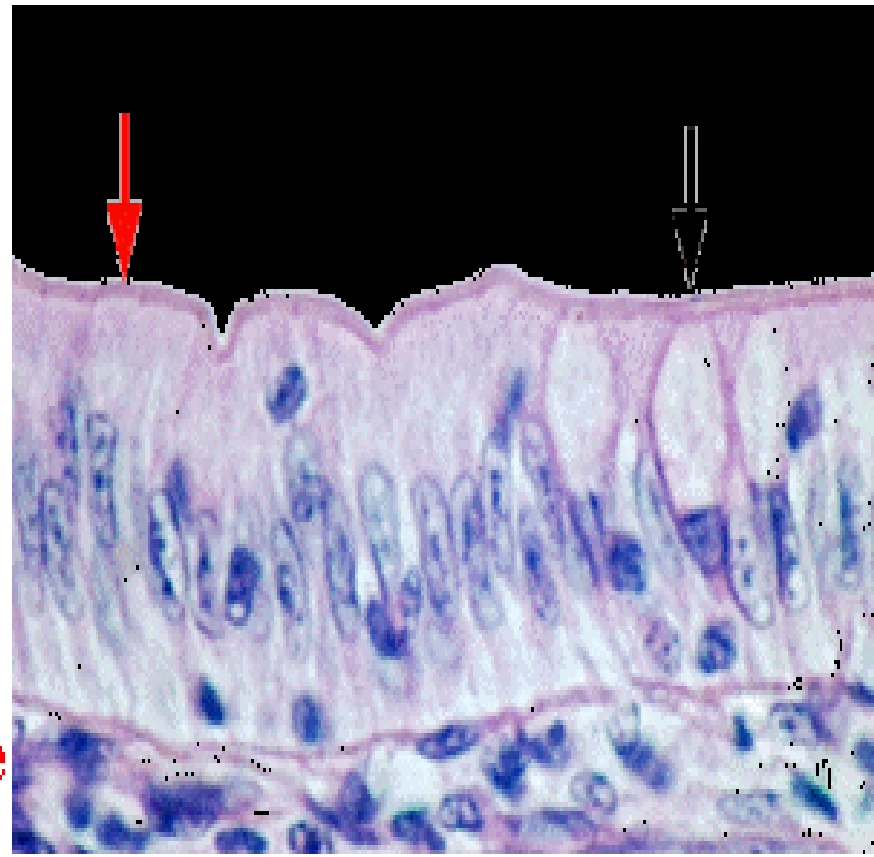
- **ovaries,**
- **the lining of nephrons**
- **parts of the eye**
- **thyroid.**

•On these surfaces, the cells perform secretion and absorption. Stratified cuboidal epithelia are multi-layered.

•They protect such areas as ducts of sweat glands and the male urethra.

columnar

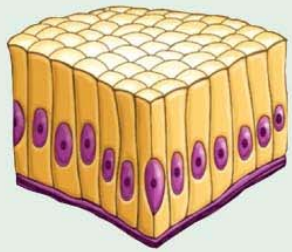




The small intestine

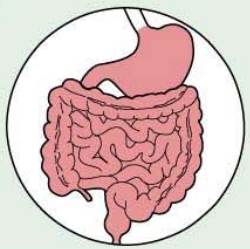
(c) Simple columnar epithelium

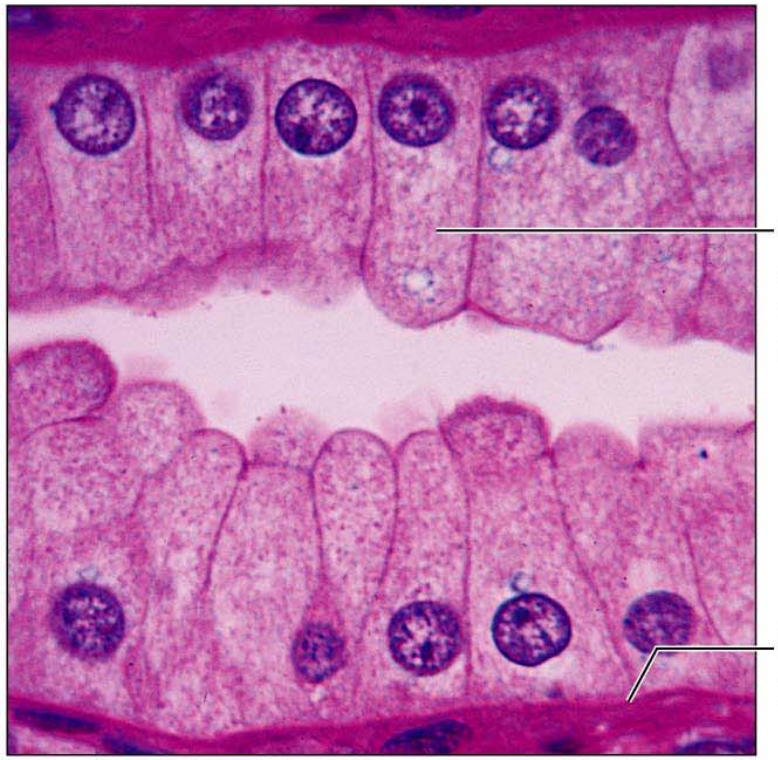
Description: Single layer of tall cells with *round* to *oval* nuclei; some cells bear cilia; layer may contain mucus-secreting unicellular glands (goblet cells).



Function: Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.

Location: Nonciliated type lines most of the digestive tract (stomach to anal canal), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.

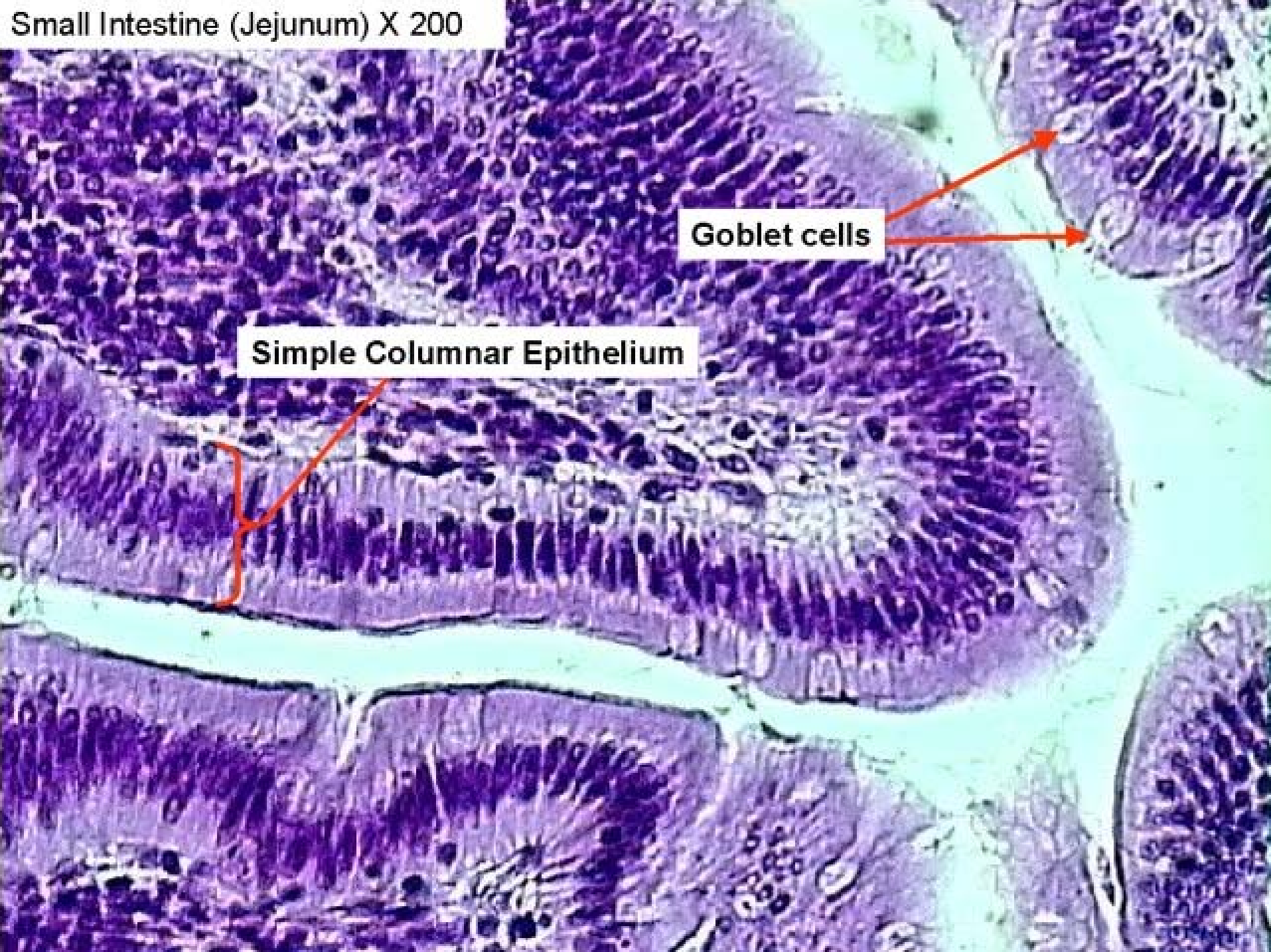




Photomicrograph: Simple columnar epithelium of the stomach mucosa (1300×).

Figure 4.2c


gallbladder


Small Intestine (Jejunum) X 200
Goblet cells
Simple Columnar Epithelium

•Columnar epithelial cells occur in **one or more layers**.
•The cells are **elongated** and **column-shaped**.
•The **nuclei are elongated** and are usually located near the base of the cells.
• Columnar epithelium forms the **lining of the**

•stomach
•and intestines.

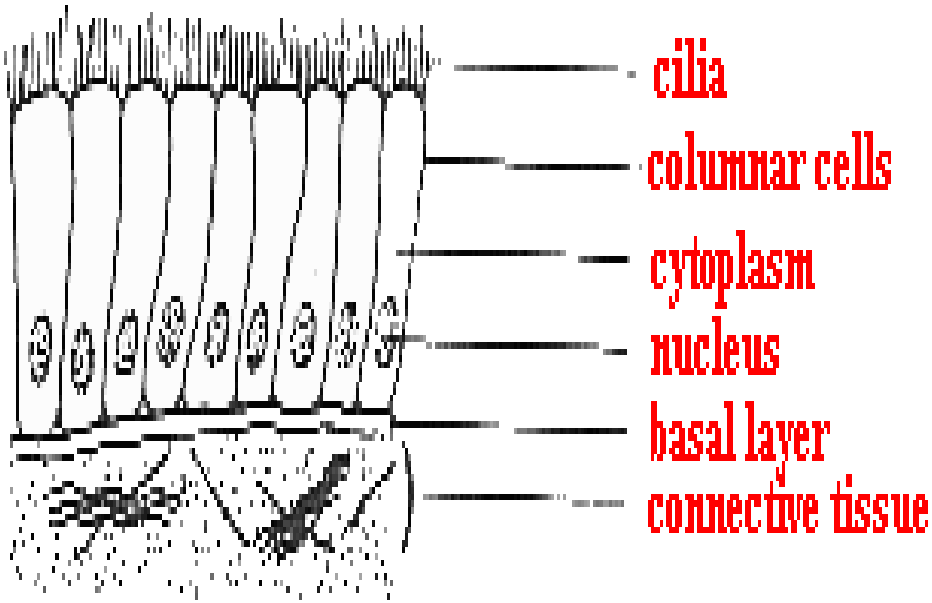
Some columnar cells are **specialised for sensory reception** such as in

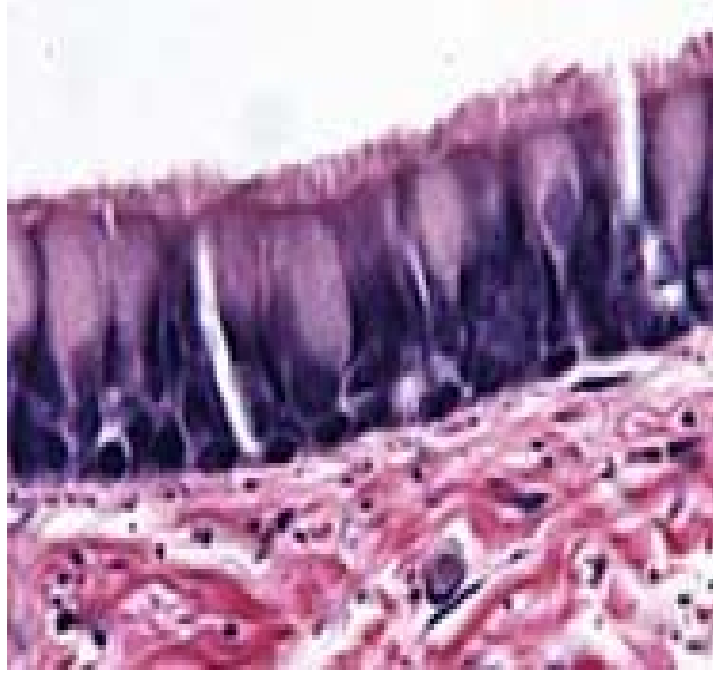
•the nose,
• ears and
•the taste buds of the tongue.

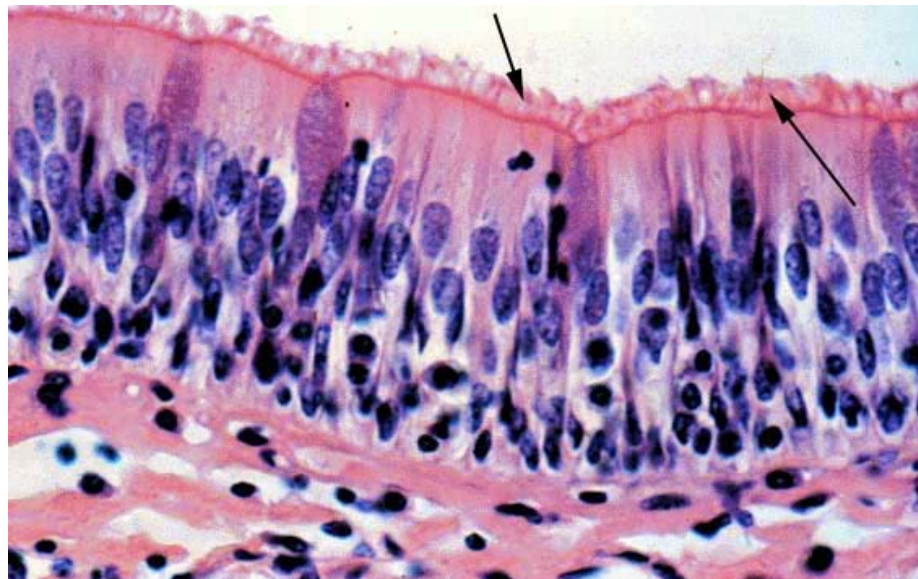
•**Goblet cells** (unicellular glands) are found between the **columnar epithelial cells of the duodenum.**

They **secrete mucus or slime**, a lubricating substance which keeps the surface smooth.

Ciliated Columnar Epithelium

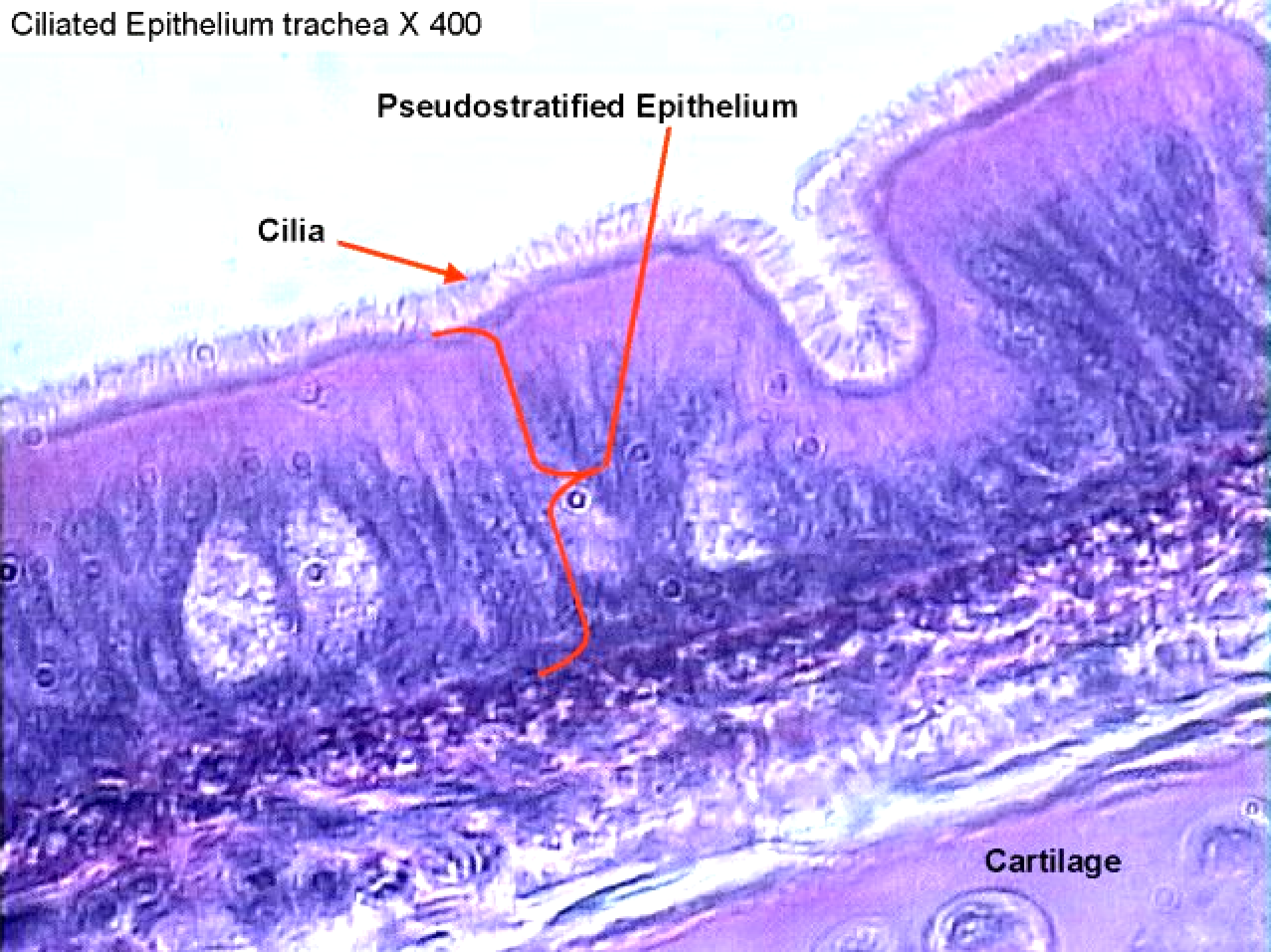






Pseudostratified Ciliated Columnar Epithelium
TRACHEA

Pseudostratified Ciliated Columnar Epithelium


Ciliated Epithelium trachea X 400
Pseudostratified Epithelium
Cilia
Cartilage

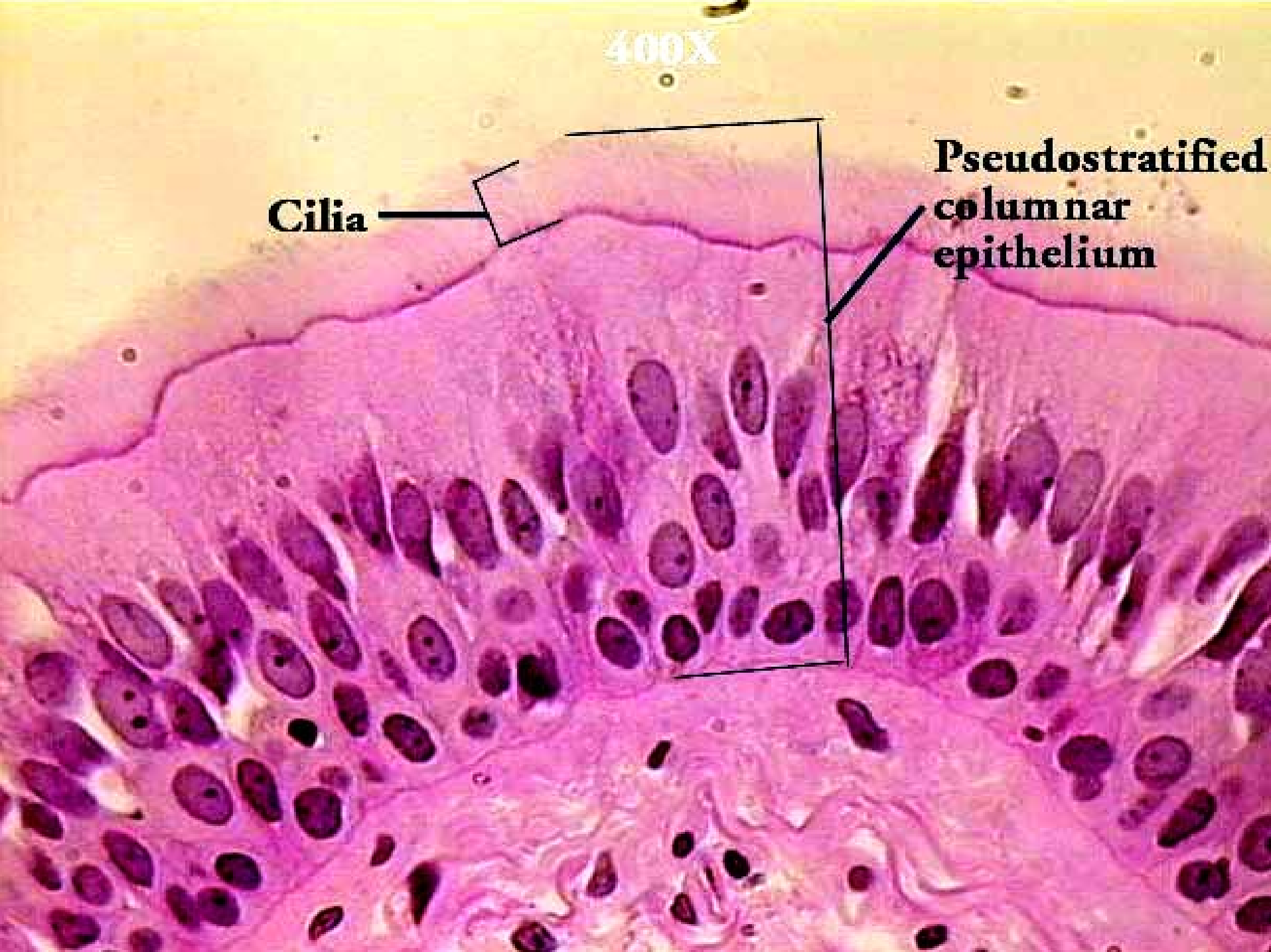
These are **simple columnar epithelial cells**, but in addition, they posses **fine hair-like outgrowths, cilia** on their free surfaces.

These cilia are capable of **rapid, rhythmic, wavelike beatings** in a certain direction.

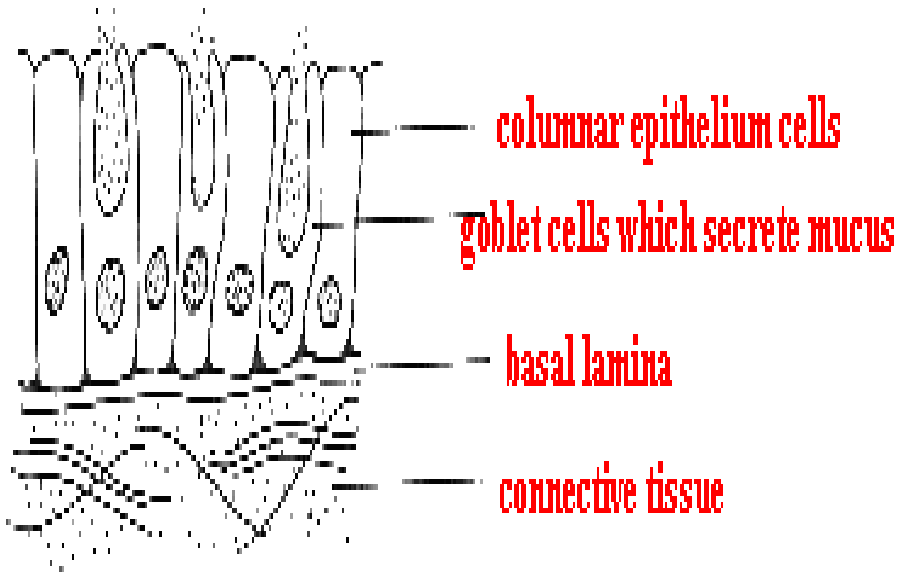
This movement of the cilia in a certain direction causes the mucus, which is secreted by the goblet cells, to move (flow or stream) in that direction.

Ciliated epithelium is usually found in the air passages like the nose. It is also found in the uterus and Fallopian tubes of females.

The movement of the cilia propel the ovum to the uterus.


400X
Cilia
Pseudostratified columnar epithelium

Glandular Epithelium

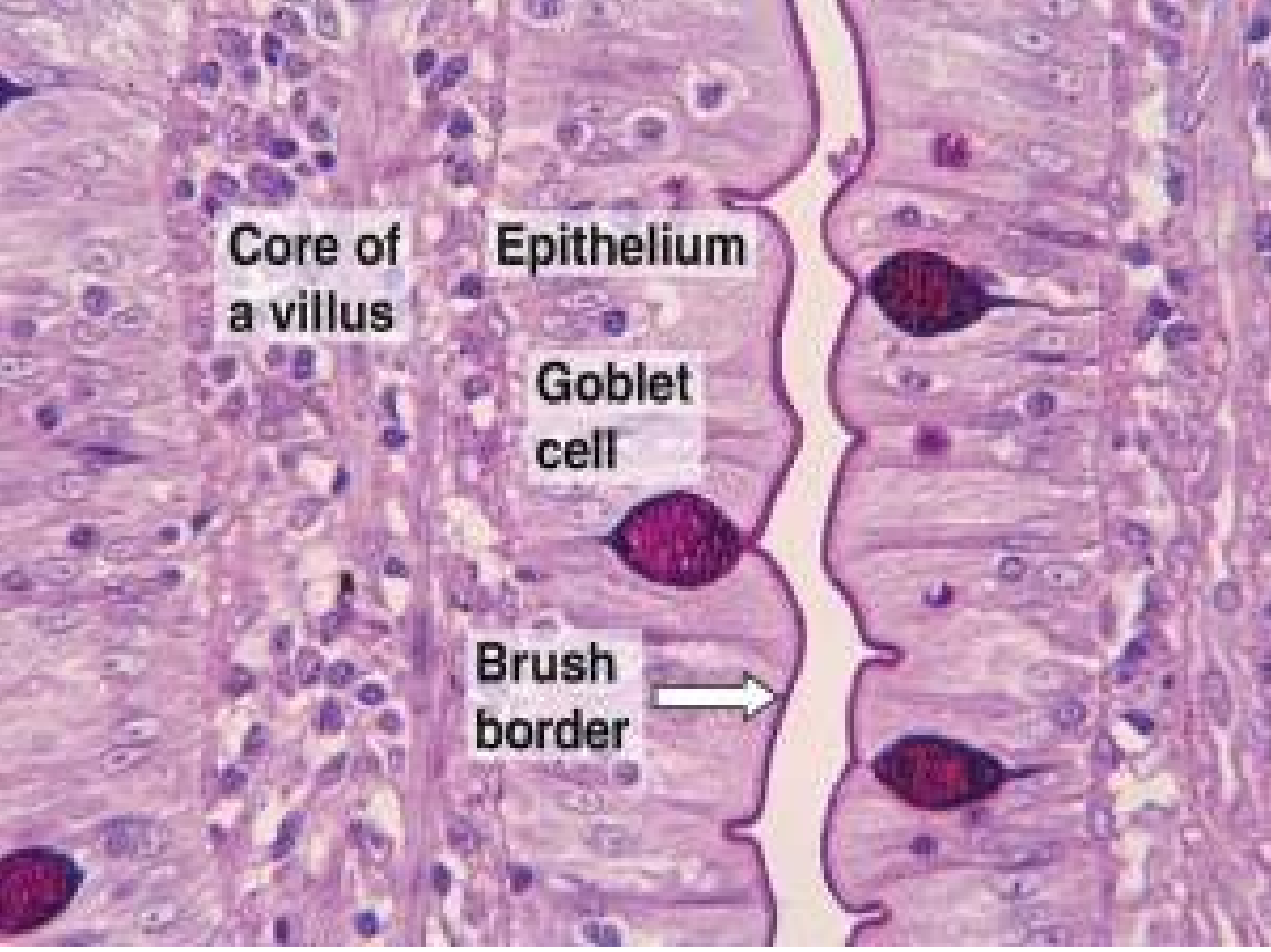


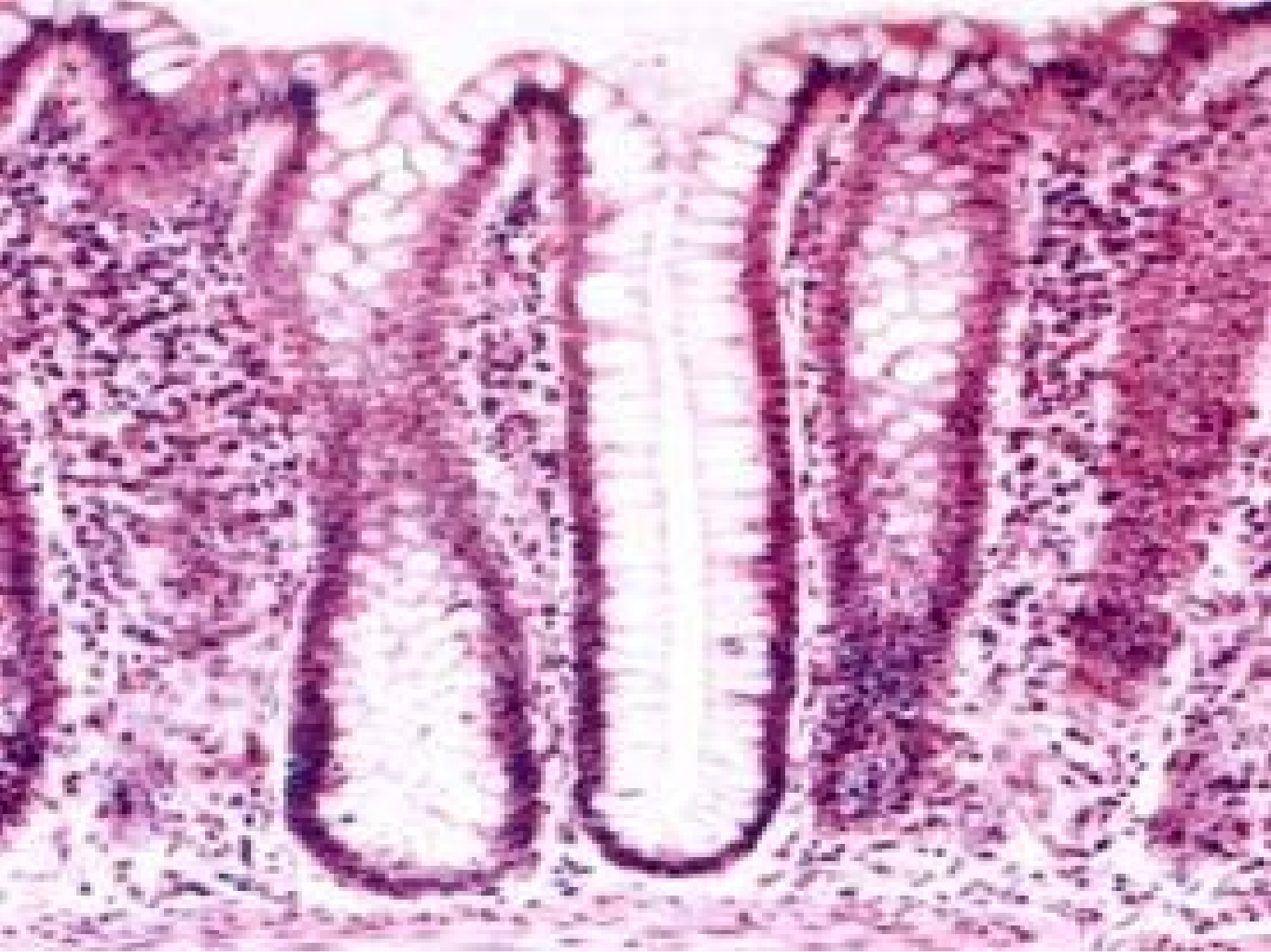
Columnar epithelium **with goblet cells is called glandular epithelium**. Some parts of the glandular epithelium consist of such a **large number of goblet cells** that there are only a few normal epithelial cells left.

Columnar and cuboidal epithelial cells often become specialised as gland cells which are capable of synthesising and secreting certain substances such as enzymes, hormones, milk, mucus, sweat, wax and saliva.

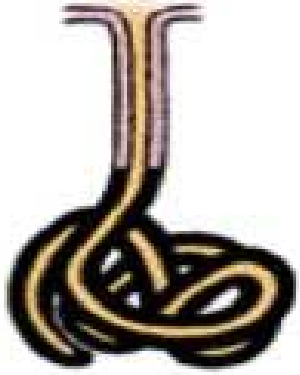
Unicellular glands consist of single, isolated glandular cells such as the goblet cells.
Sometimes a portion of the epithelial tissue becomes invaginated and a **multicellular gland** is formed.

Multicellular glands are **composed of clusters of cells**.
Most glands are multicellular including the the salivary glands

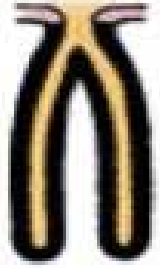

Core of a villus
Epithelium
Goblet cell
Brush border



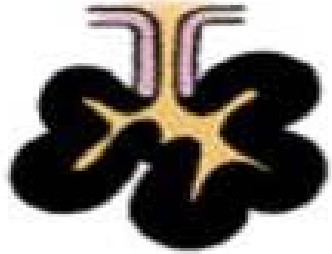
Simple tubular



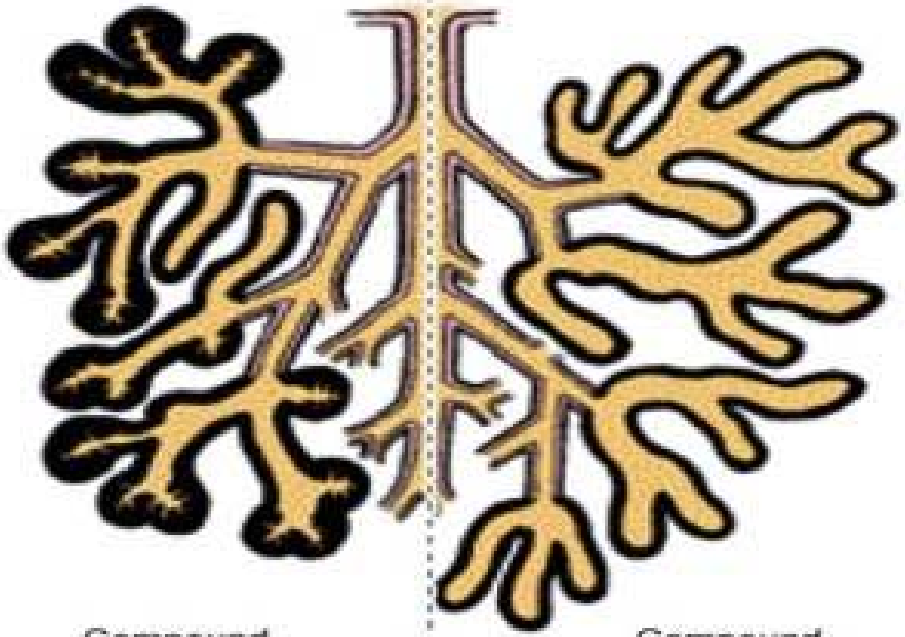
Simple coiled tubular



Simple branched tubular



Simple branched acinar

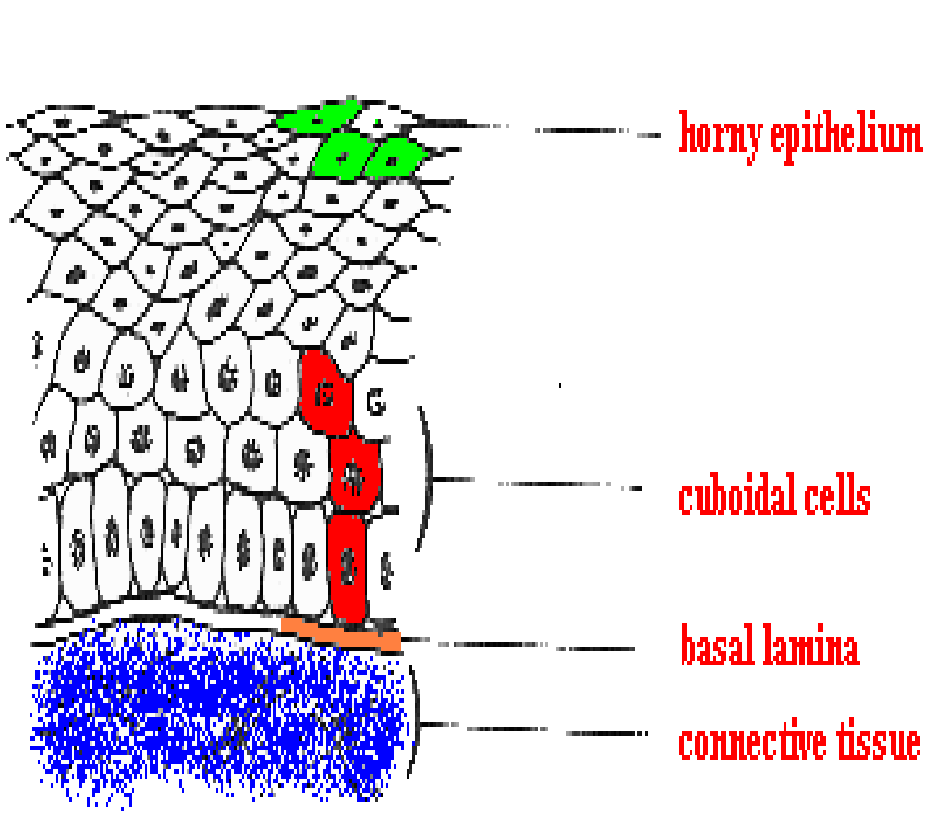


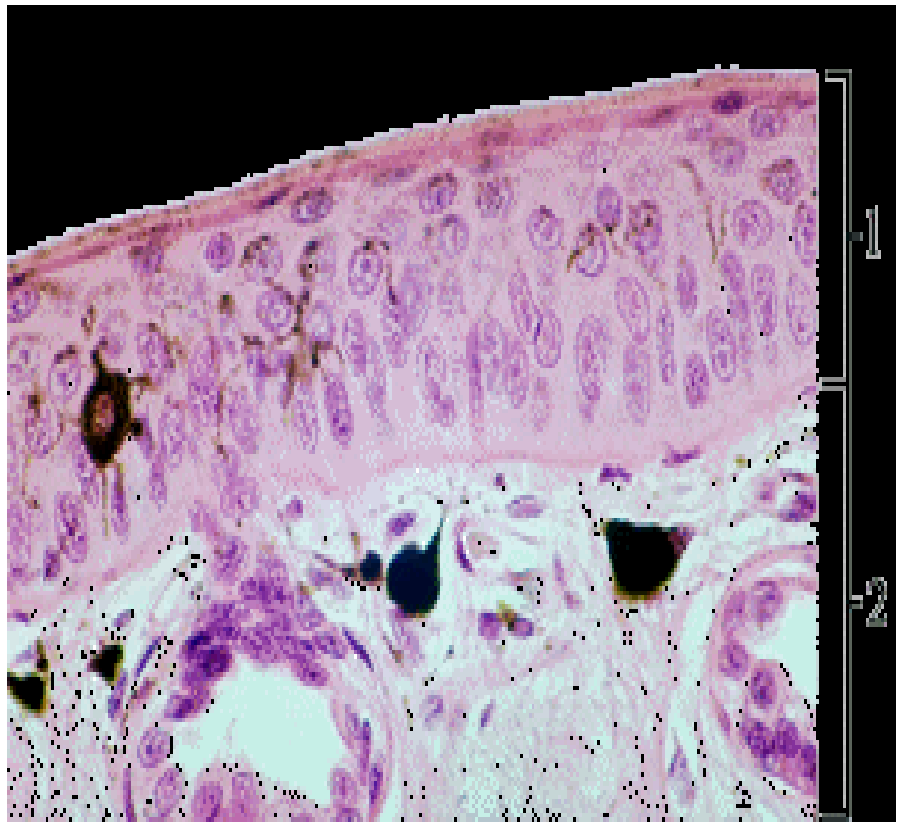
Compound tubuloacinar

Compound tubular

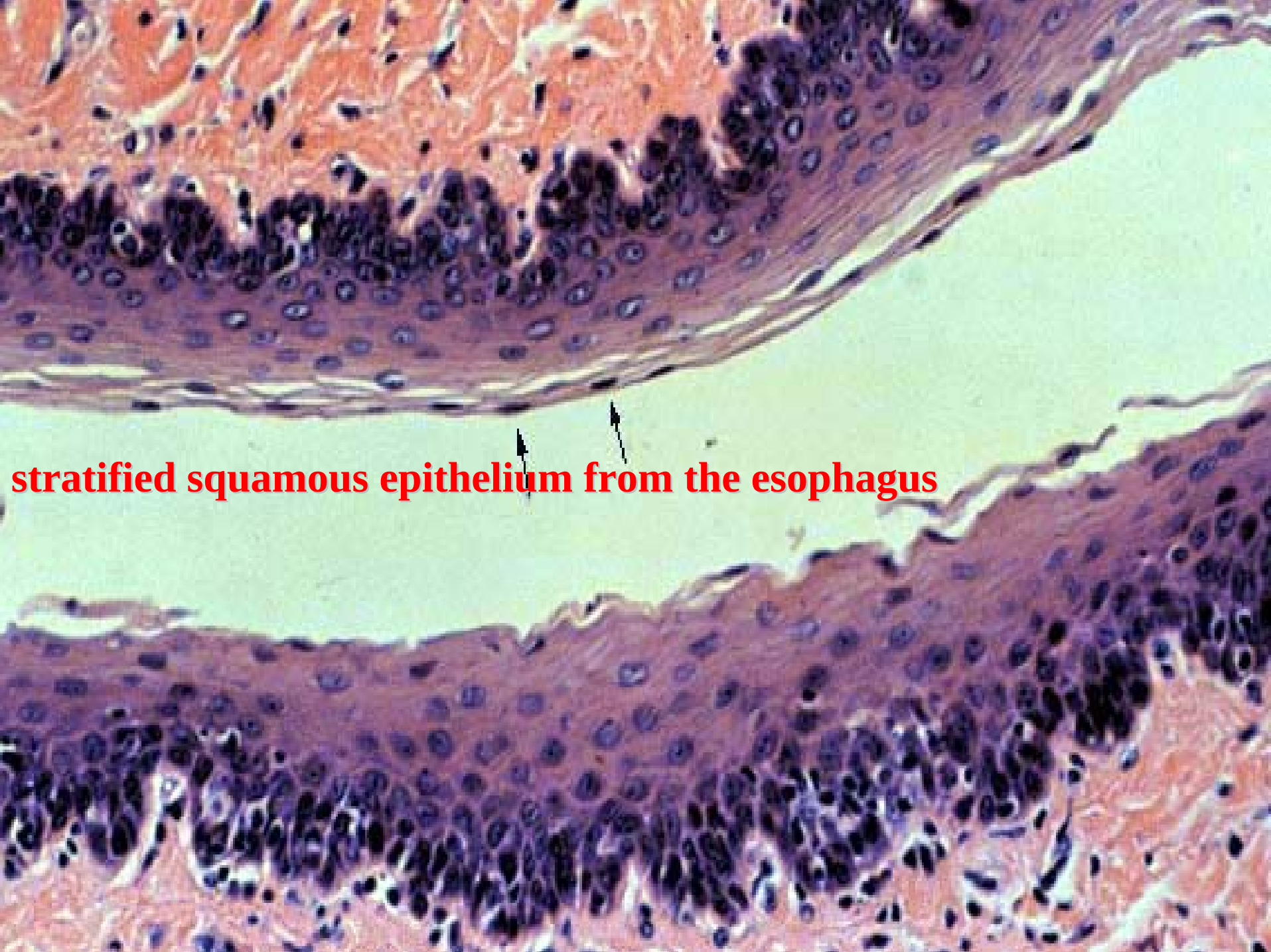
Compound acinar

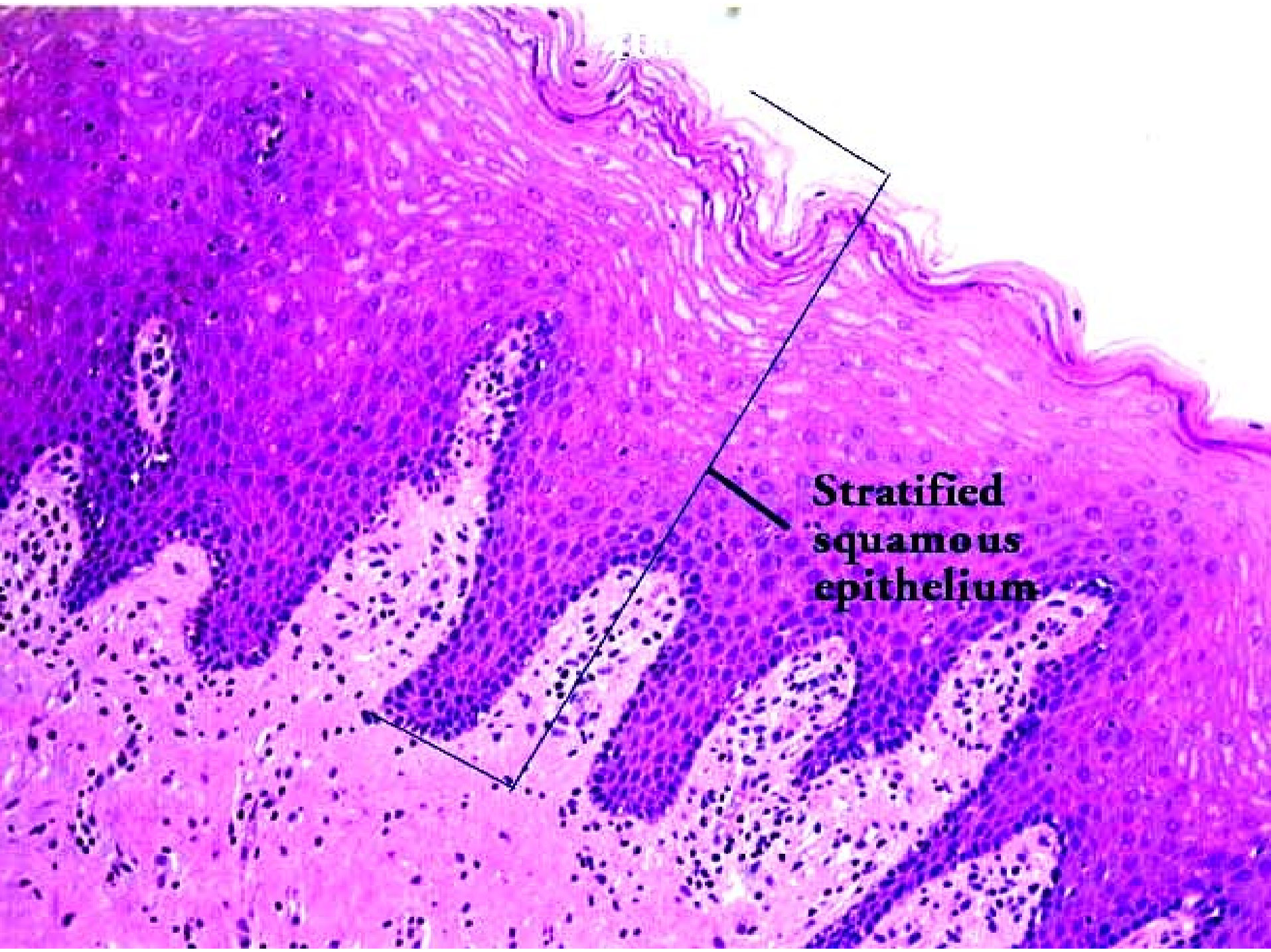
Stratified Epithelium.





epidermis (outer part of the skin), typical stratified squamous epithelium and the dermis showing connective tissue.


stratified squamous epithelium from the esophagus

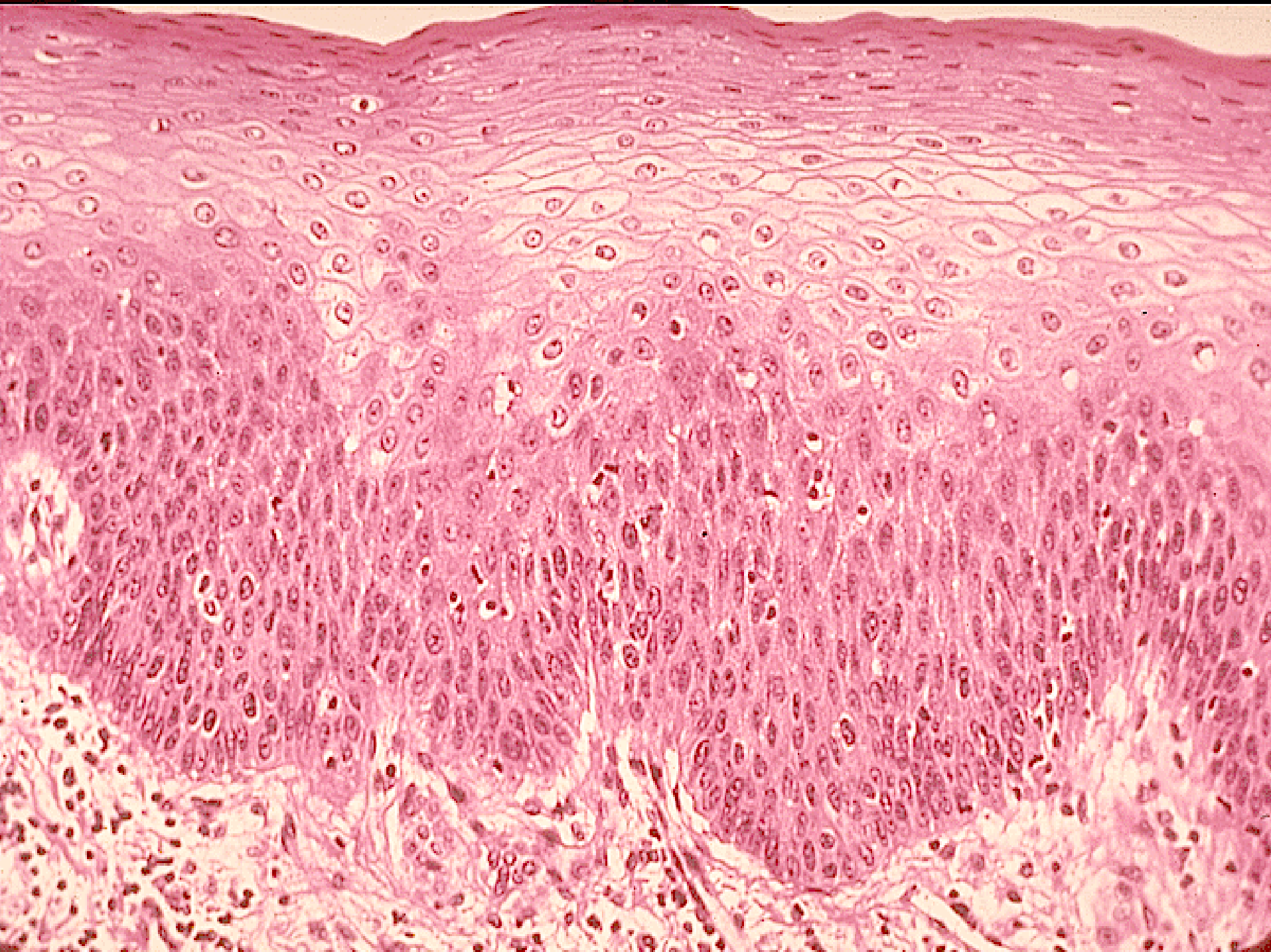

Stratified
squamous
epithelium

Where body linings have to withstand wear and tear, the epithelia are **composed of several layers of cells and are then called compound or stratified epithelium**.

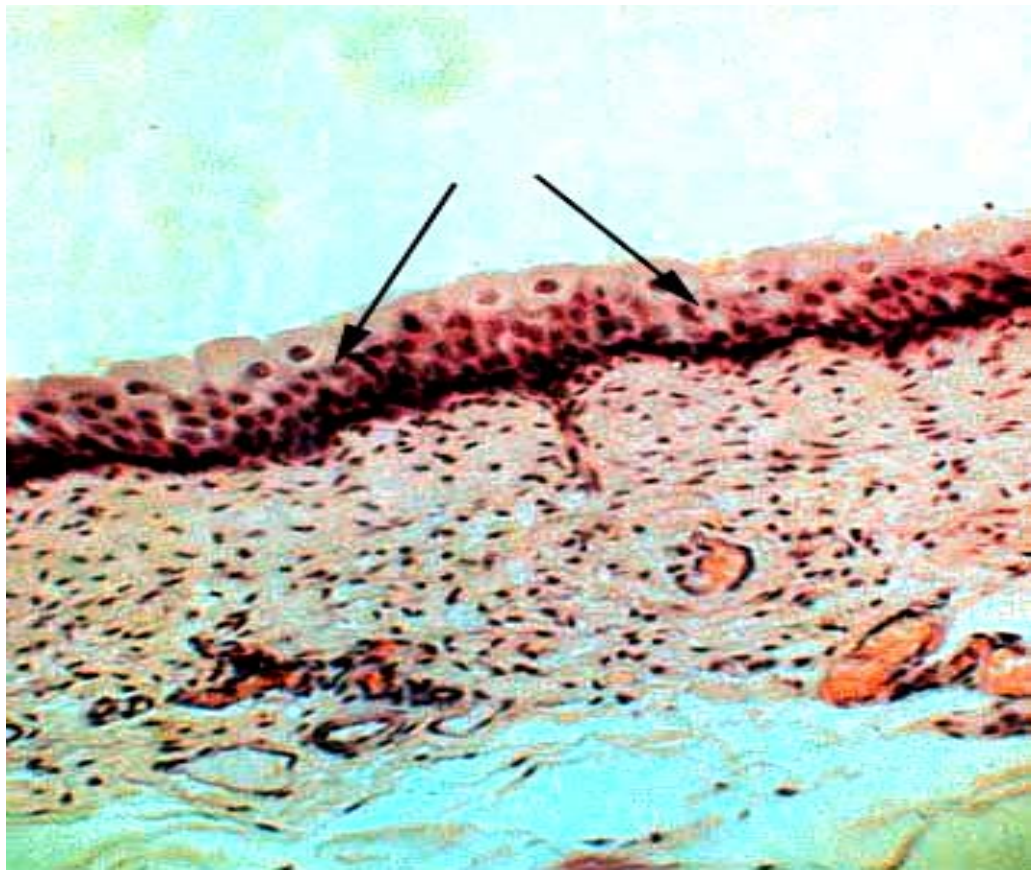
The **top cells** are **flat and scaly** and it may or may not be **keratinised** (i.e. containing a tough, resistant protein called keratin).

The **mammalian skin** is an example of **dry, keratinised, stratified epithelium**.

The lining of the **mouth cavity** is an example of an **unkeratinisied, stratified epithelium.**

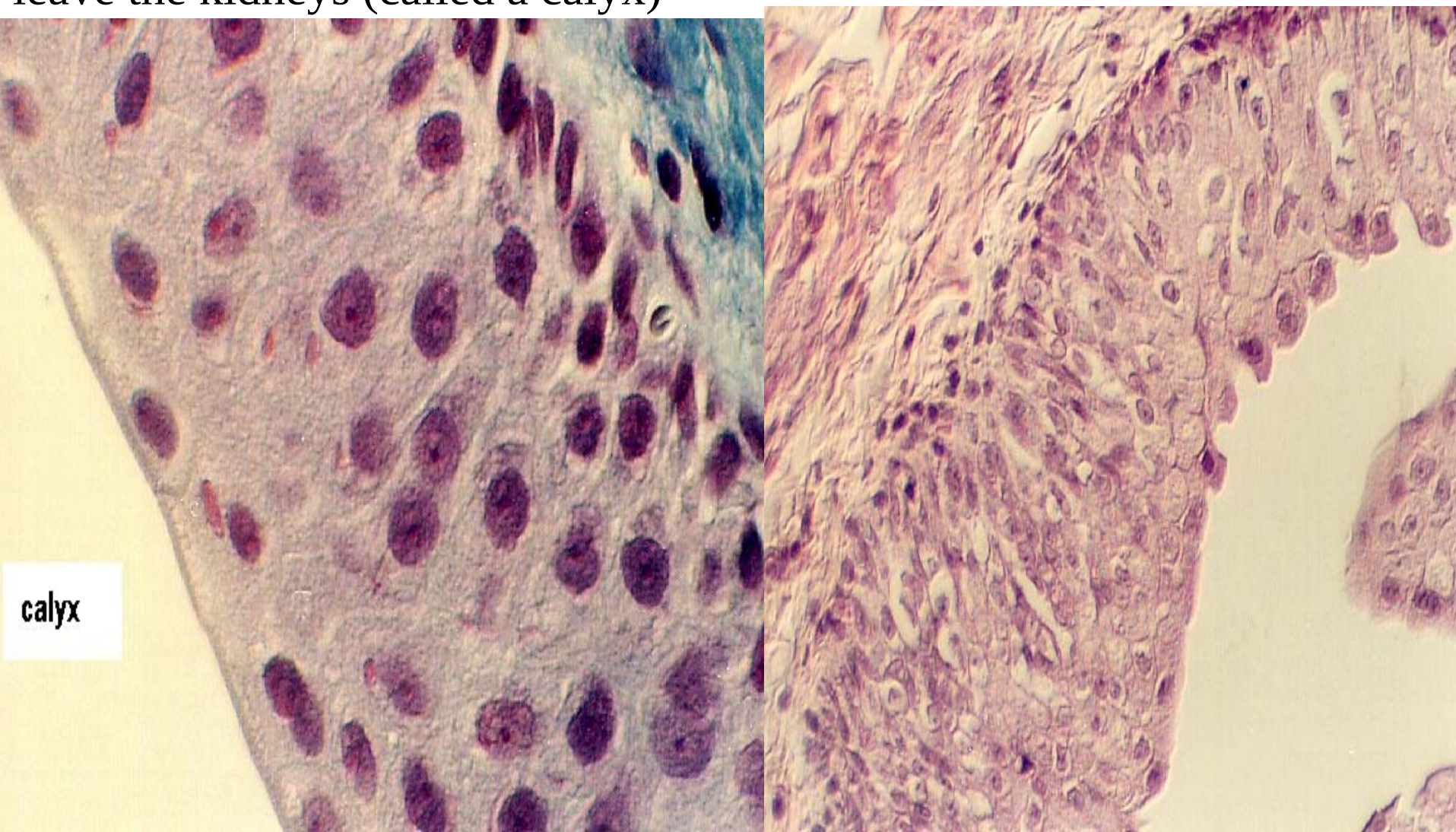


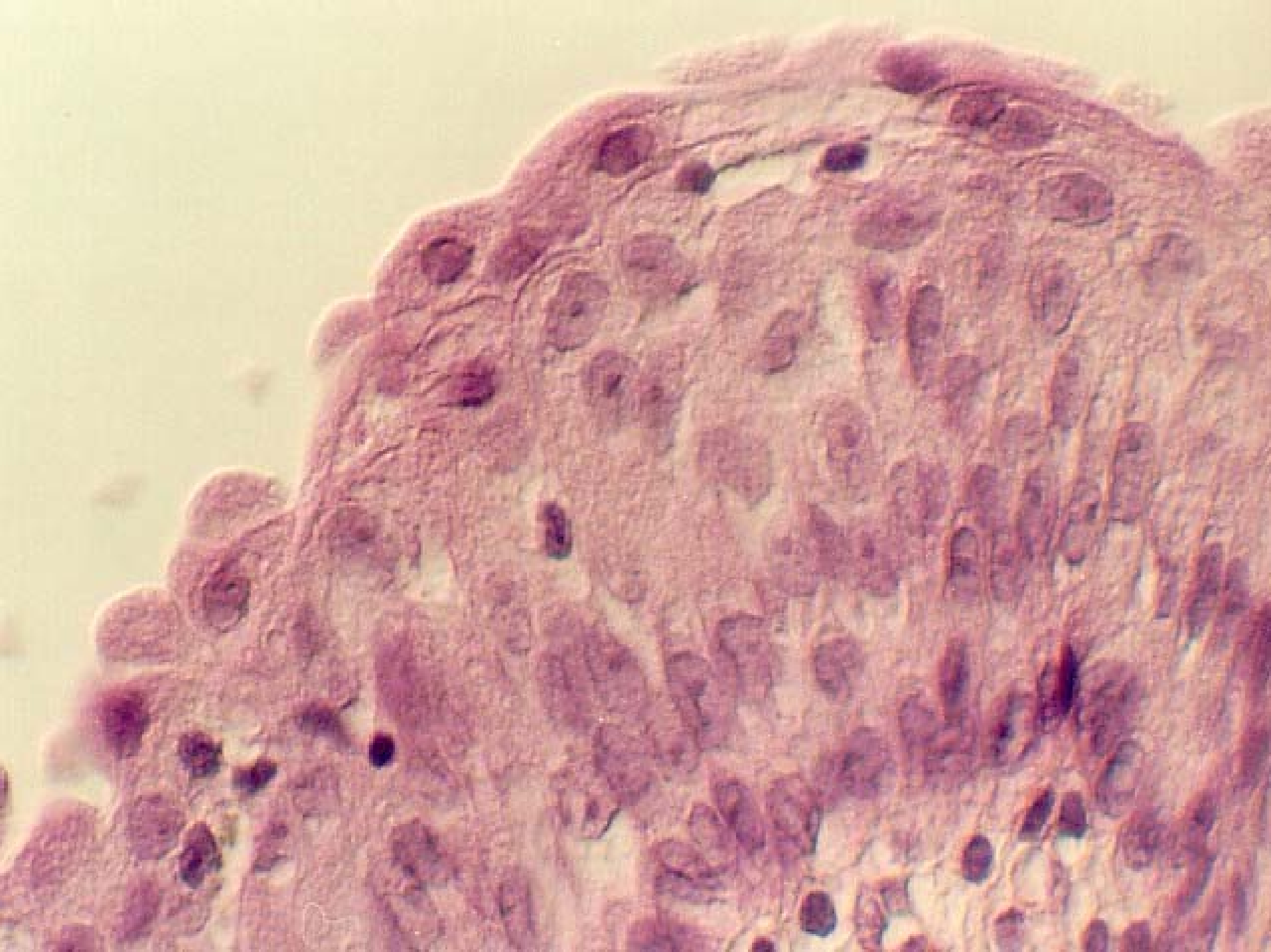
TRANSITIONAL



transitional epithelium from the urinary bladder. The arrows are on the actual transitional cell layer. Below the dark layer of transitional cell nuclei is the subucosa.

Transitional epithelium contains cells that are flattened and cells that are cuboidal; hence the name "transitional". You can find transitional epithelium in the bladder and in the first expansion of the ureters as they leave the kidneys (called a calyx)





TO REVIEW

- **Simple Columnar Epithelium**

- **Colon**
- **Duodenum**
- **Jejunum**

- **Simple cuboidal epithelium**

- **thyroid**
- **kidney tubules**

- **Simple squamous epithelium**

- **spinal cord (capillaries)**
- **kidney glomerulus**

- **Pseudostratified columnar epithelium**

- **olfactory**
- **trachea**

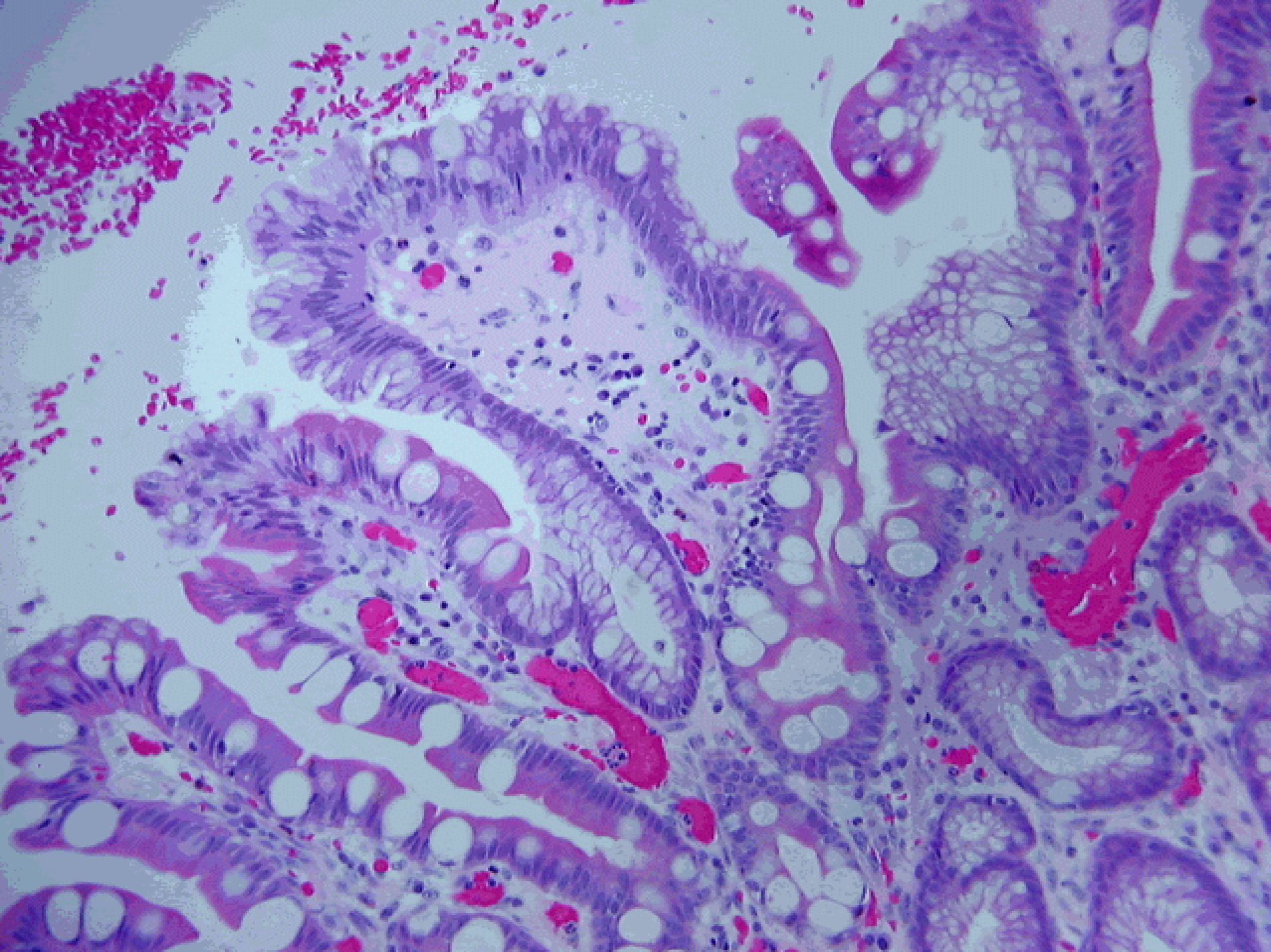
- **Stratified squamous epithelium**
  - **esophagus**
  - **skin**

- **Stratified columnar/cuboidal epithelium**
  - **salivary gland ducts (excretory)**
  - **sweat gland ducts**

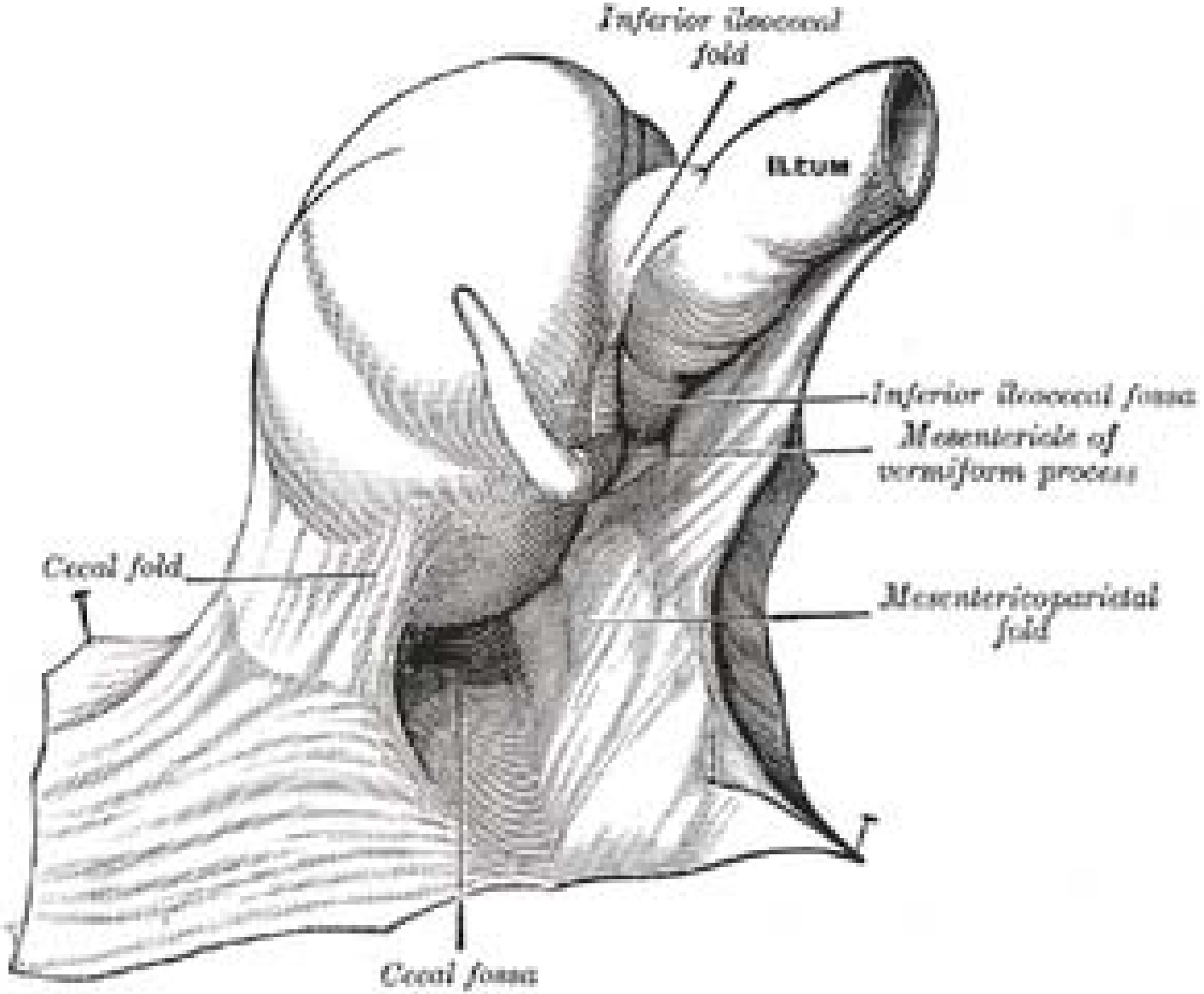
- **Transitional epithelium**
  - **major calyx**
  - **bladder**

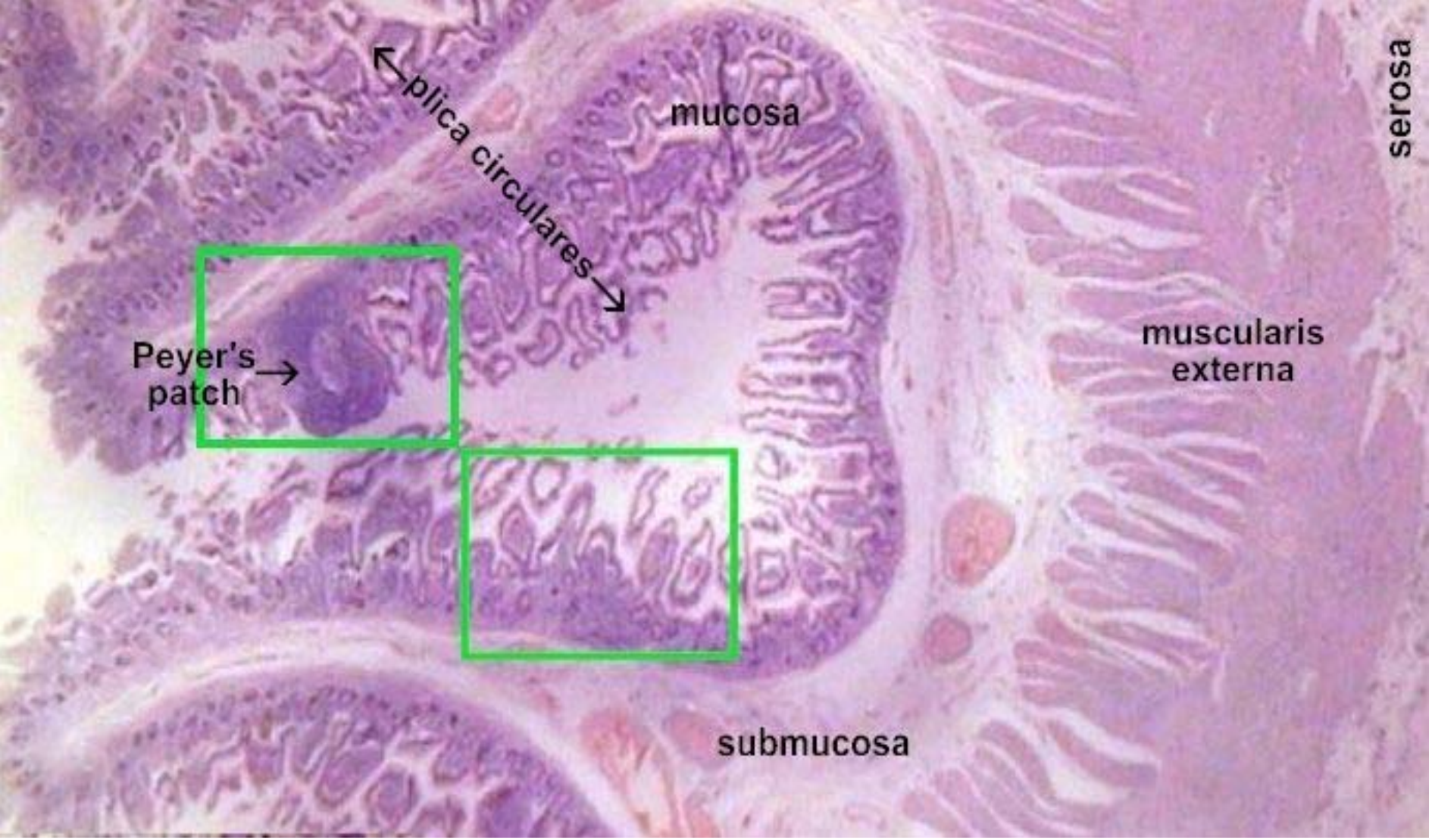
EXERCISE

- WHAT TYPE OF TISSUE, WHERE,ANY GOBLET CELLS



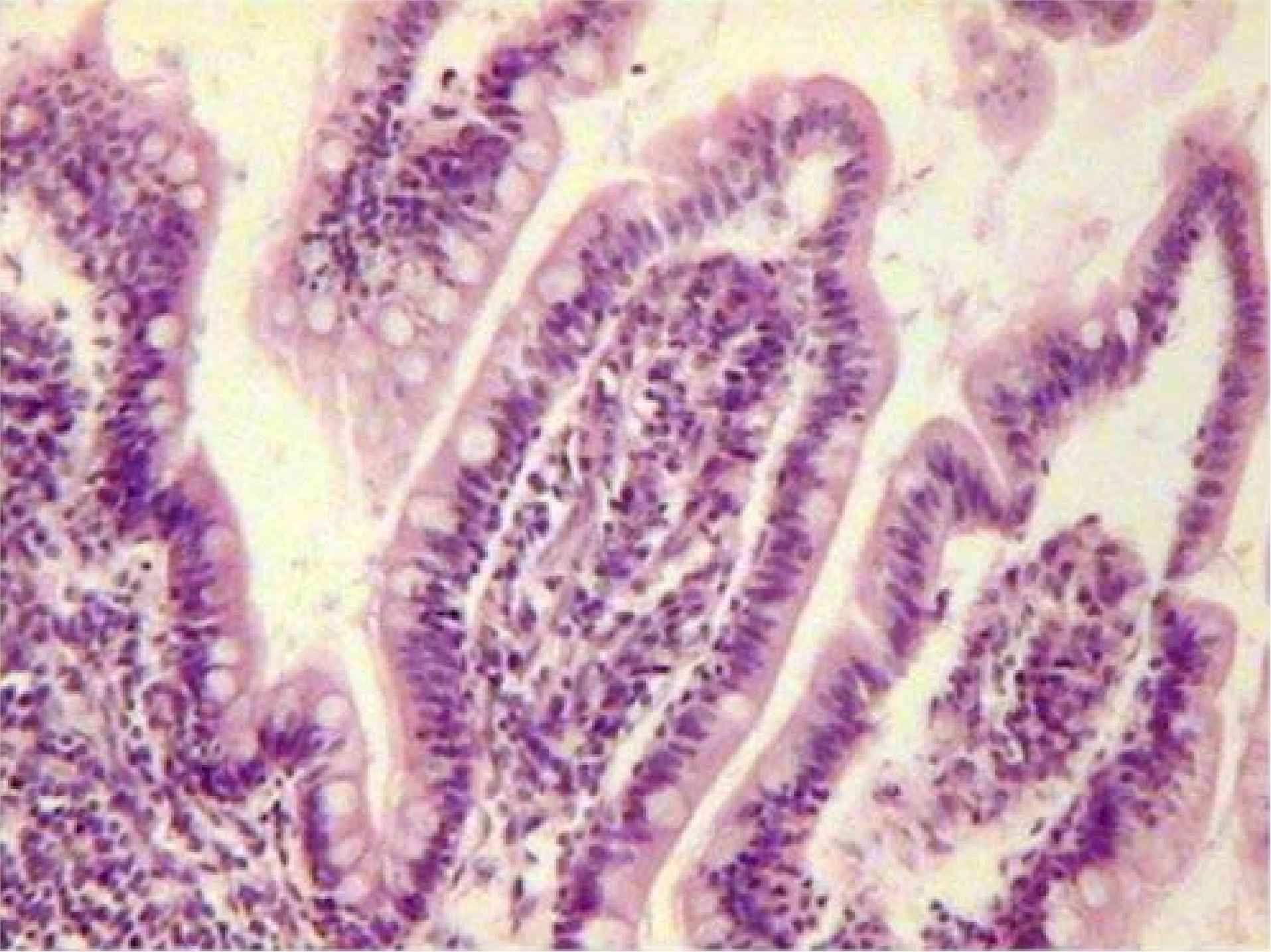
What is the function of the ileum





The **ileum, the last section of the small intestine, is different** from the duodenum and the jejunum by having more goblet cells in the mucosa and lymph nodules called **Peyer's patches**.


villus
Peyer's patch



Absorb vitamin B_{12} and bile salts

The wall itself is made up of folds, each of which has many tiny finger-like projections known as villi, on its surface. In turn, the epithelial cells which line these villi possess even larger numbers of microvilli. Therefore the ileum has an extremely large surface area both for the adsorption (attachment) of enzyme molecules and for the **absorption of products of digestion.** The cells that line the ileum contain the protease and carbohydrase enzymes responsible for the final stages of protein and carbohydrate digestion. These enzymes are present in the cytoplasm of the epithelial cells. The villi contain large numbers of capillaries which take the amino acids and glucose produced by digestion to the hepatic portal vein and the liver.

Connective tissues

- ***Dense connective tissue or Fibrous connective*** tissue forms ligaments and tendons. Its densely packed collagen fibers have great tensile strength.
- ***Loose connective tissue or Areolar connective tissue*** holds organs and epithelia in place, and has a variety of proteinaceous fibers, including collagen and elastin. It is also important in inflammation.
- ***Reticular connective tissue*** is a network of reticular fibers (fine collagen) that form a soft skeleton to support the lymphoid organs (lymph nodes, bone marrow, and spleen.)
- ***Adipose tissue contains adipocytes***, used for cushioning, thermal insulation, lubrication (primarily in the pericardium) and energy storage.
- ***Fiber types as follows***: Collagenous fibers, elastic fibers, retucular fibers

Connective tissues function primarily to **support the body and to bind or connect together all types of tissue.**

This tissue also provide a **mechanical framework (the skeleton)** which plays an important role in **locomotion**.

Unlike epithelial tissue, connective tissue is characterised by the **large amounts of intercellular substance** (also called **ground substance** or the **matrix**) that it contains.

Connective tissue are **relatively few cells** which are widely **seperated** from each other.

These **living cells** are responsible for **secreting** the large amounts of **intercellular ground substance (matrix)**.

The matrix is a **non-living material** which may be **liquid (eg. blood), semi-solid (eg. connective tissue)** or **solid (eg. bone)**.

Embedded in the matrix are a variety of **connecting and supporting fibres**, eg. collagen fibres and elastic fibres.

Classification of the basic connective tissue depends on the **predominant fibre type** present in each

1). binding
2). support
3). binding
4). insulation
5). transportation.

Accordingly, connective tissues are divided among four main classes:

(1) connective tissue proper,

(2) cartilage,

(3) bone,

(4) blood.

Characteristics of Connective Tissues

A). Not adjacent to other cells

B). Extra Cellular Matrix

C). **Common origin in embryonic development**.

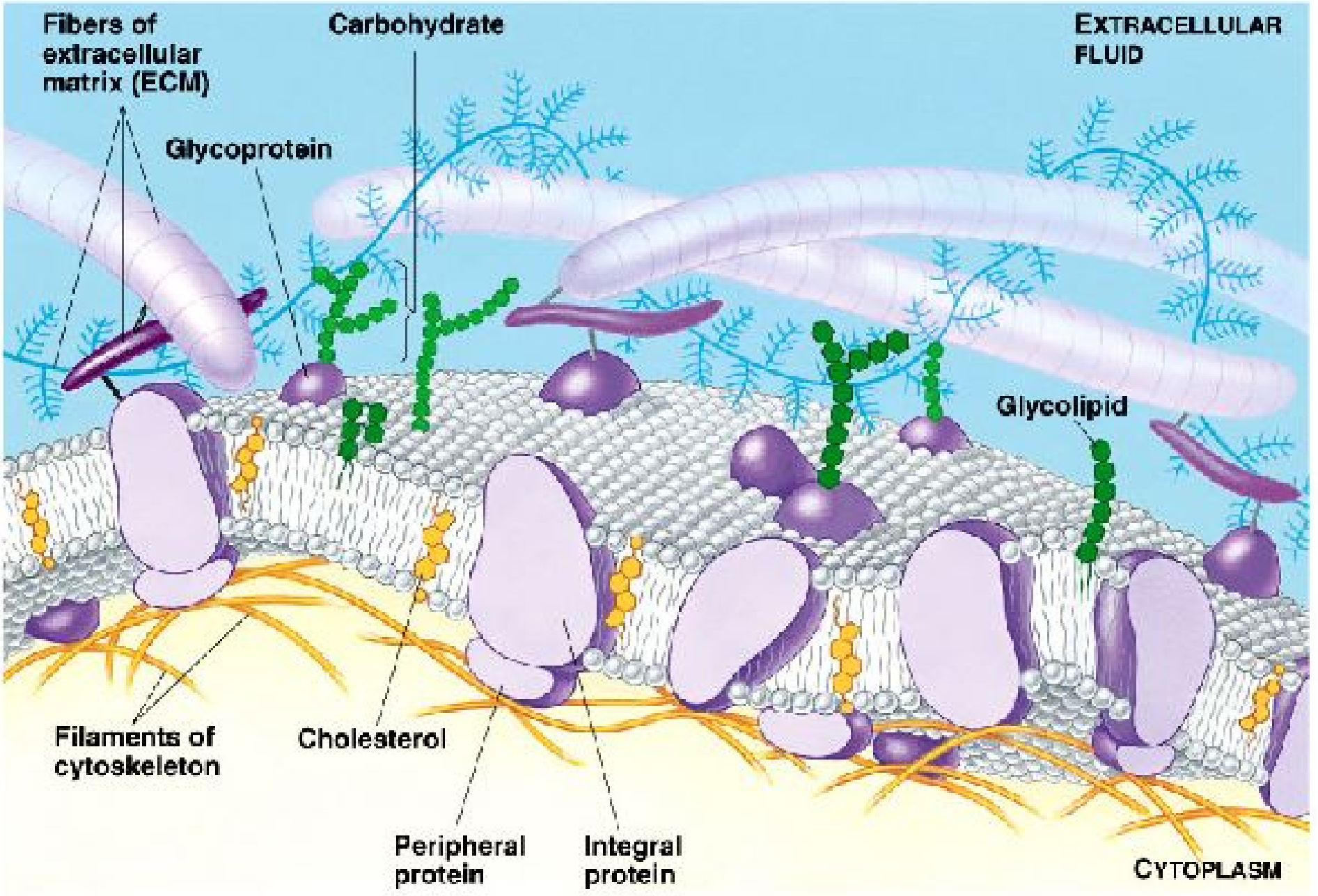
D). **Vary in degrees of vascularity**

All connective tissues have a common origin during embryonic development, and all connective tissues contain **extracellular matrix**.

The extracellular matrix (ECM) is a complex structural entity surrounding and supporting cells that are found within mammalian tissues.
The ECM is often referred to as the connective tissue.
The ECM is composed of 3 major classes of biomolecules:

1. **Structural proteins:** collagen and elastin.
2. **Specialized proteins:** e.g. fibrillin, fibronectin, and laminin.
3. **Proteoglycans:** these are composed of a protein core to which is attached long chains of repeating disaccharide units termed of glycosaminoglycans (GAGs) forming extremely complex high molecular weight components of the ECM.

Figure 8.5 The detailed structure of an animal cell's plasma membrane, in cross



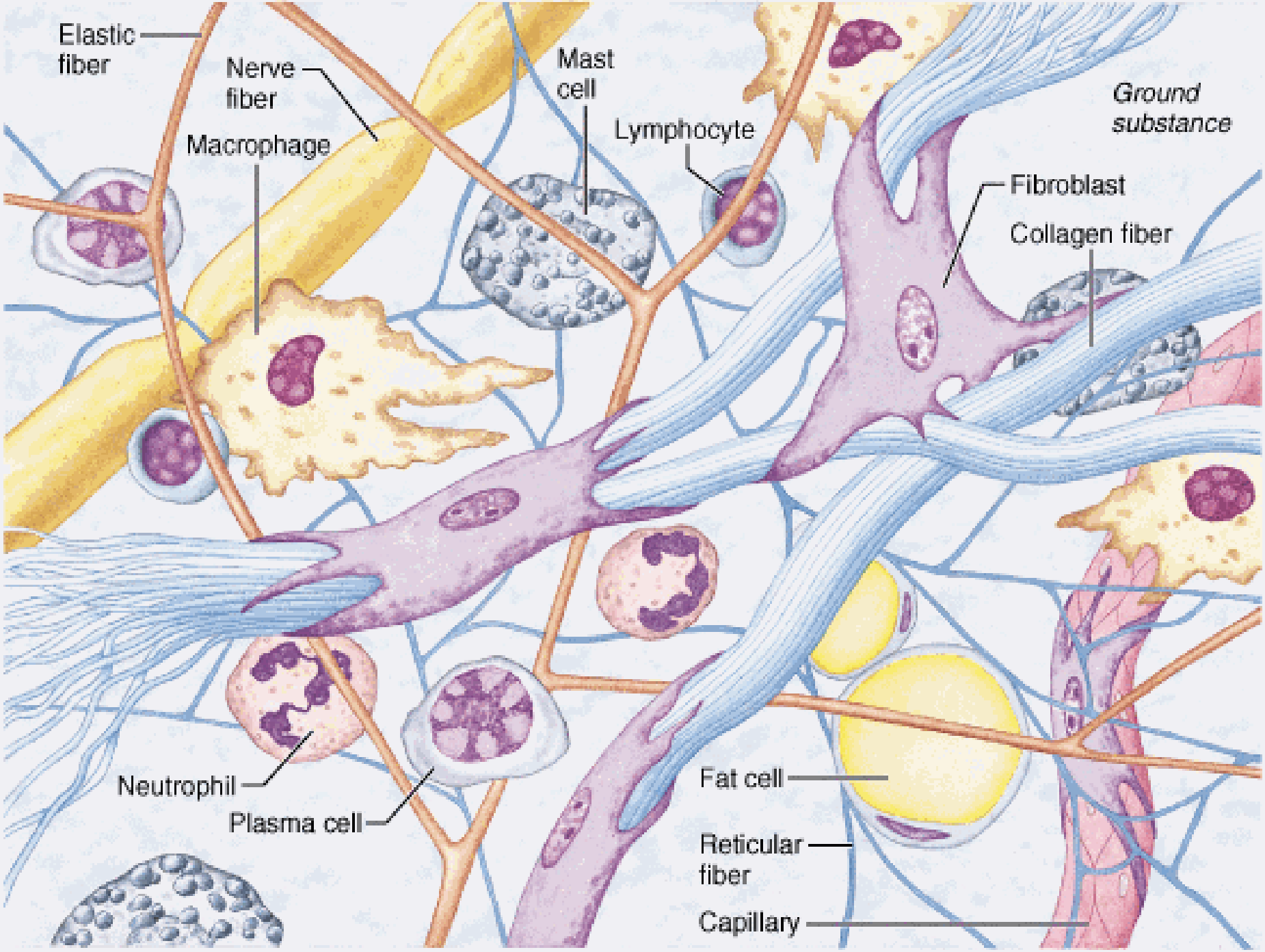
Areolar connective tissue is found throughout the body underlying epithelial tissues, surrounding organs, and wrapped around blood vessels and nerves .You may think of it as the body's packing material.

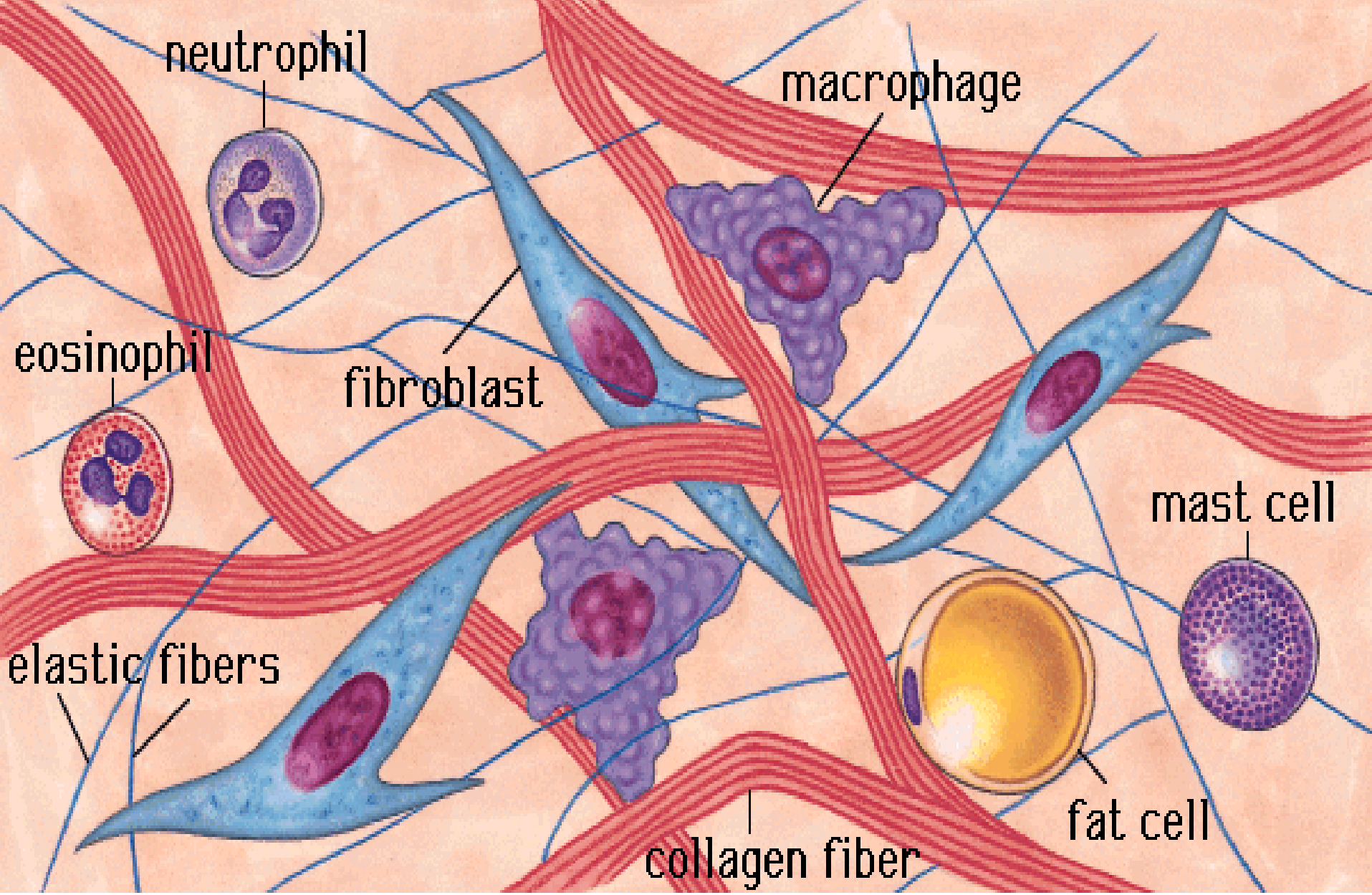
The predominant cell type in areolar connective tissue is the **fibroblast**, which secretes fibers into the extracellular matrix.

Macrophages and **mast cells** are also present, and they act as parts of the immune system to protect the body.

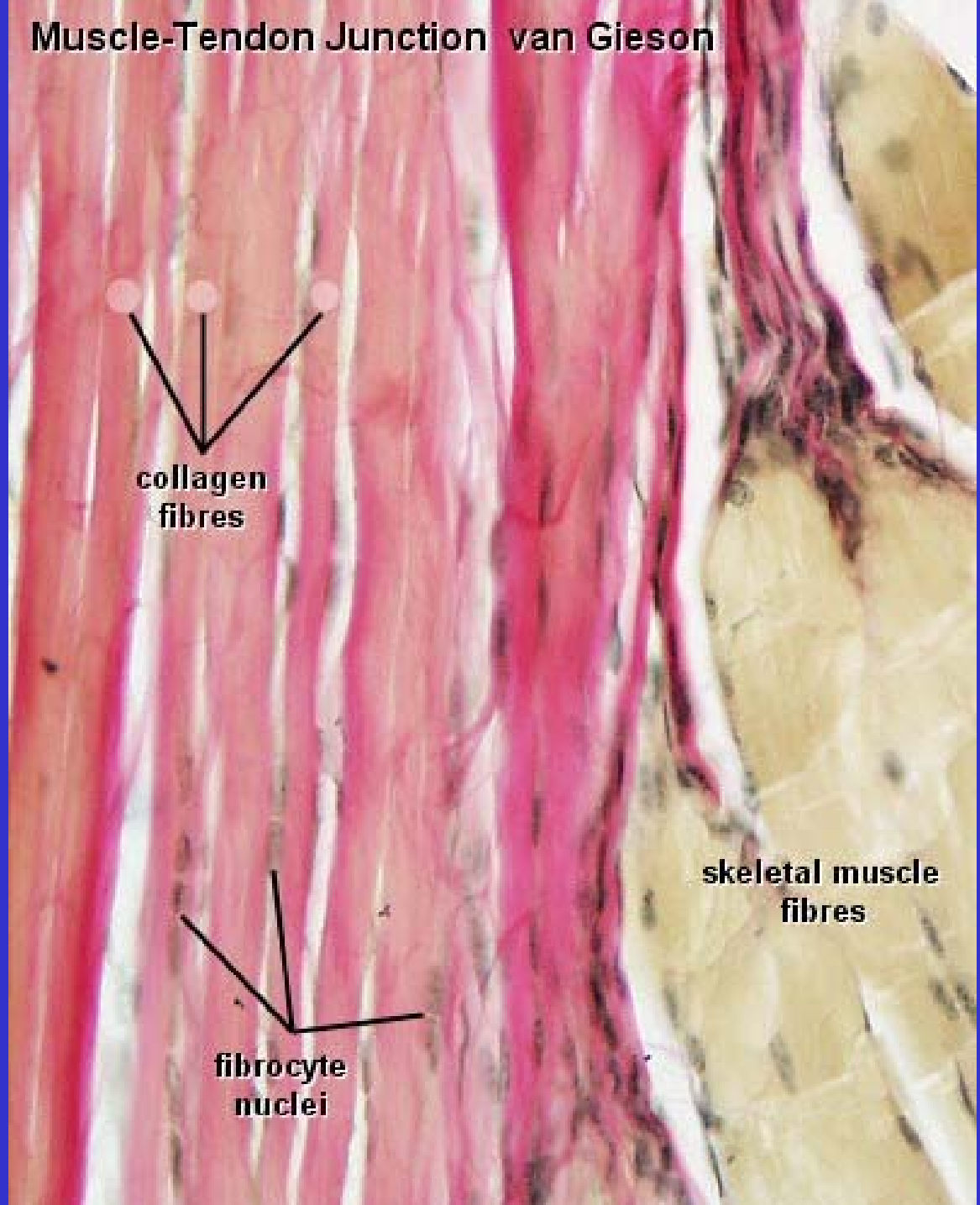
Three types of fibers can be found in the matrix of areolar connective tissue:

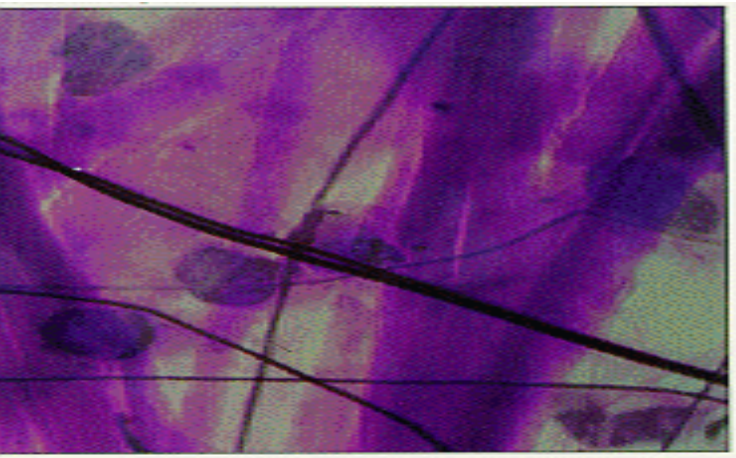
- **Collagen fibers** provide strength,
- **elastic fibers** can stretch and recoil,
- and **reticular fibers** may help connect the tissue to organs or other types of tissue.

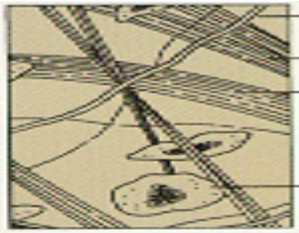

Elastic fiber
Nerve fiber
Mast cell
Lymphocyte
Ground substance
Macrophage
Fibroblast
Collagen fiber
Neutrophil
Plasma cell
Fat cell
Reticular fiber
Capillary



loose connective tissue


Muscle-Tendon Junction van Gieson
collagen fibres
skeletal muscle fibres
fibrocyte nuclei

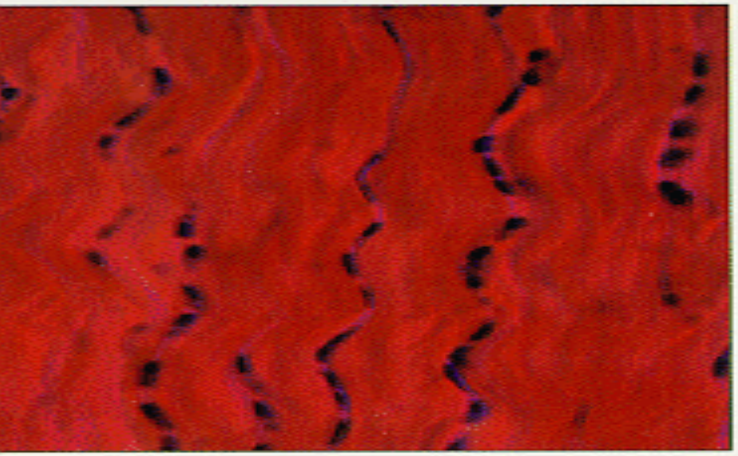


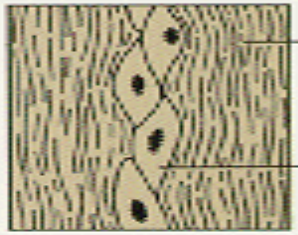


TYPE: Loose

COMMON LOCATIONS:
Under skin, most epithelia

FUNCTION: Support, elasticity

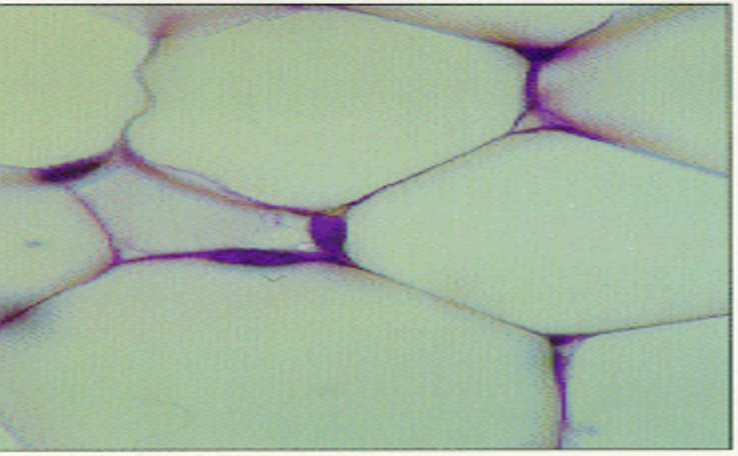


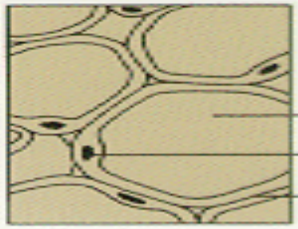


TYPE: Dense, regular

COMMON LOCATIONS:
Tendons, skin, kidney capsule

FUNCTION: Support, elasticity

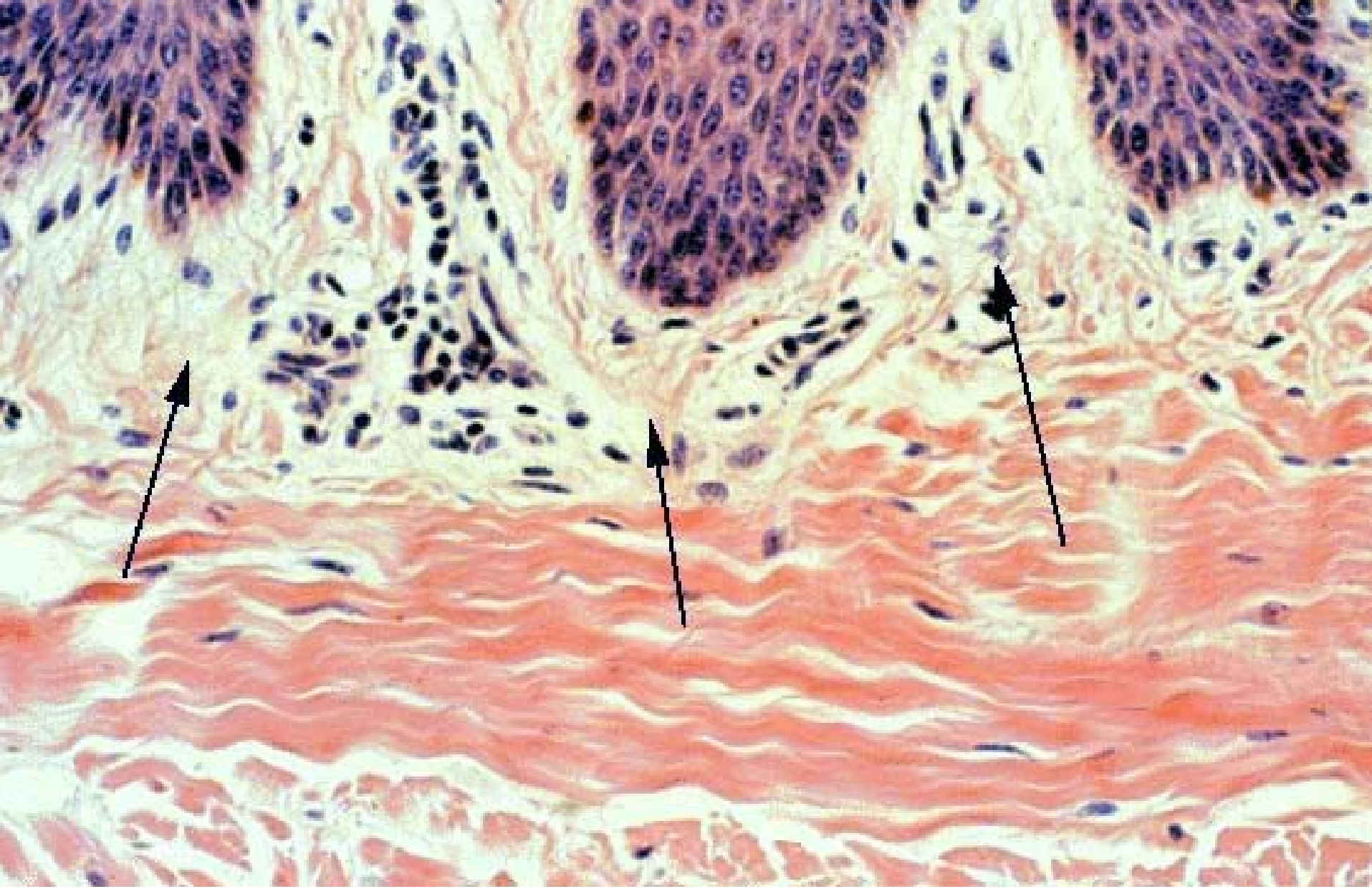




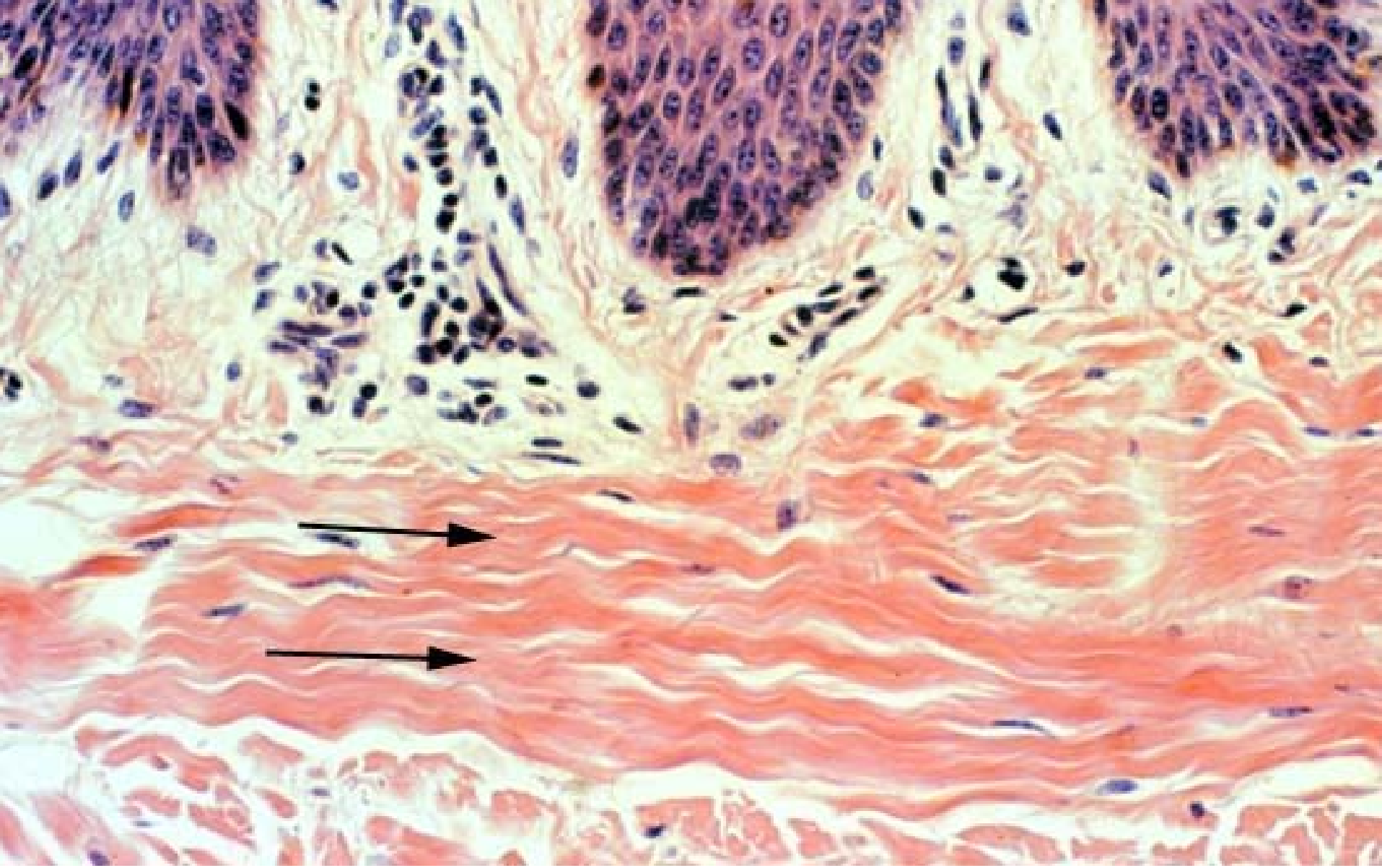
TYPE: Adipose

COMMON LOCATIONS: Under skin, around kidneys, heart

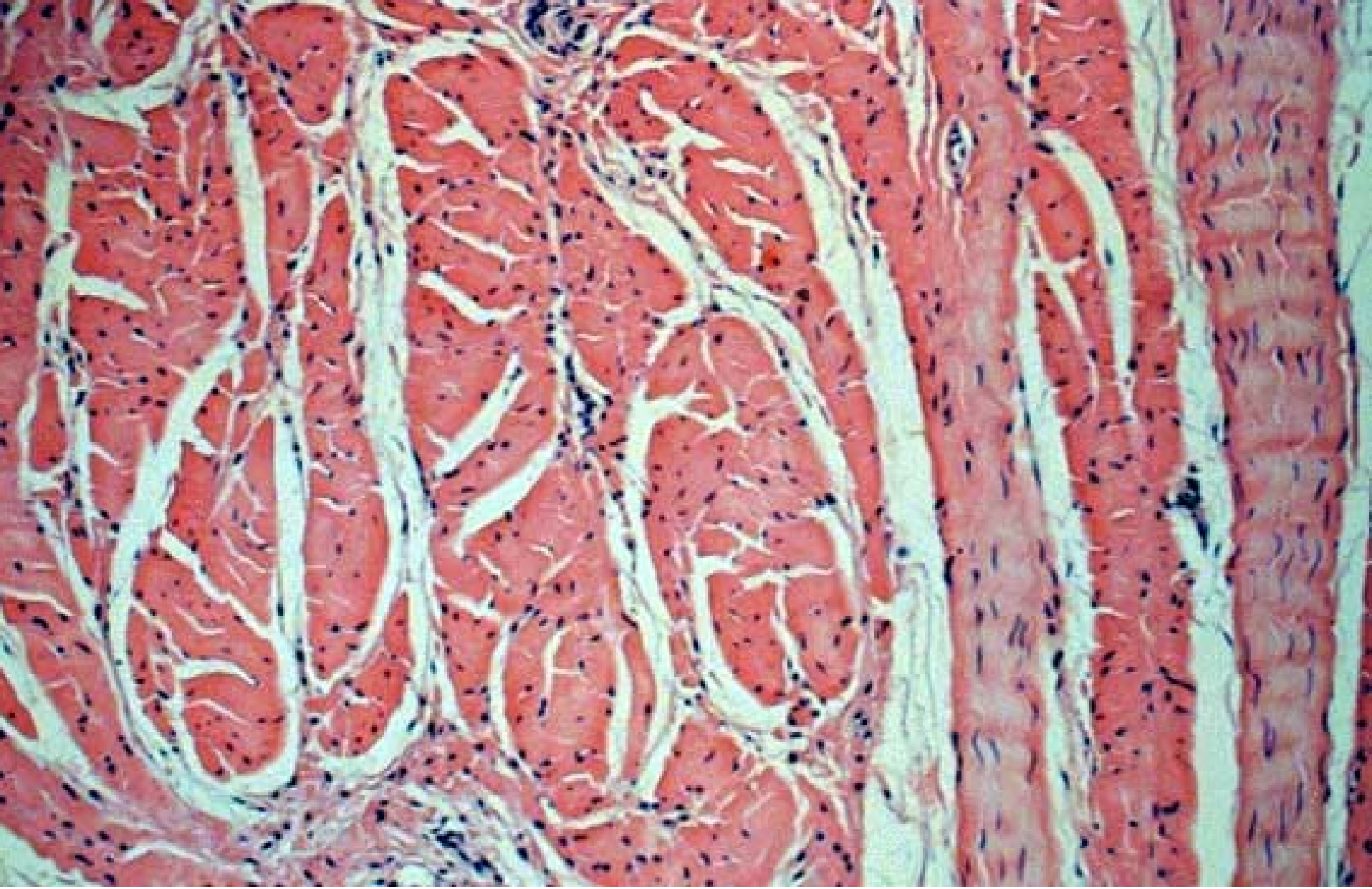
FUNCTION: Energy reserve, insulation, padding



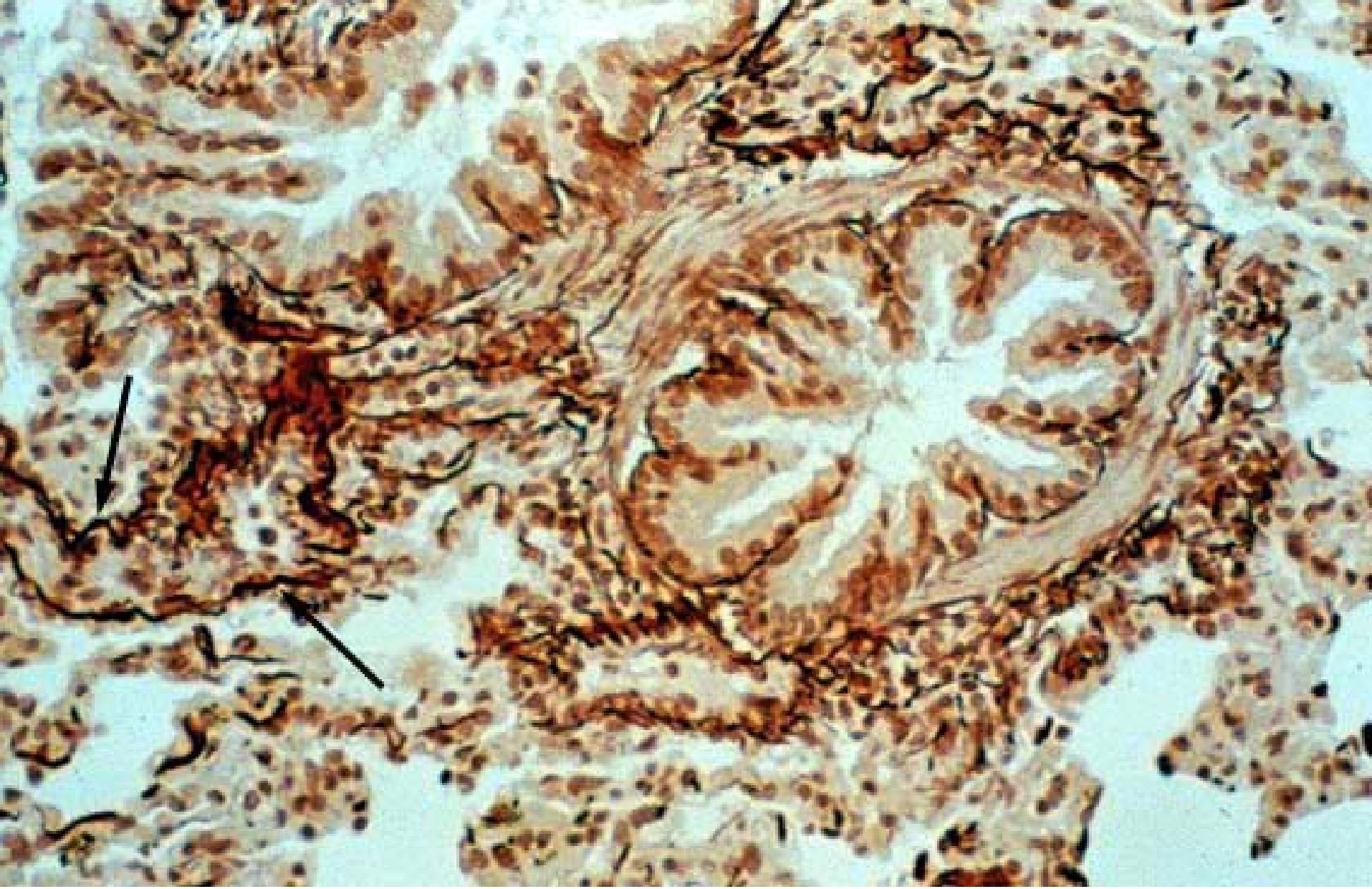
loose connective tissue



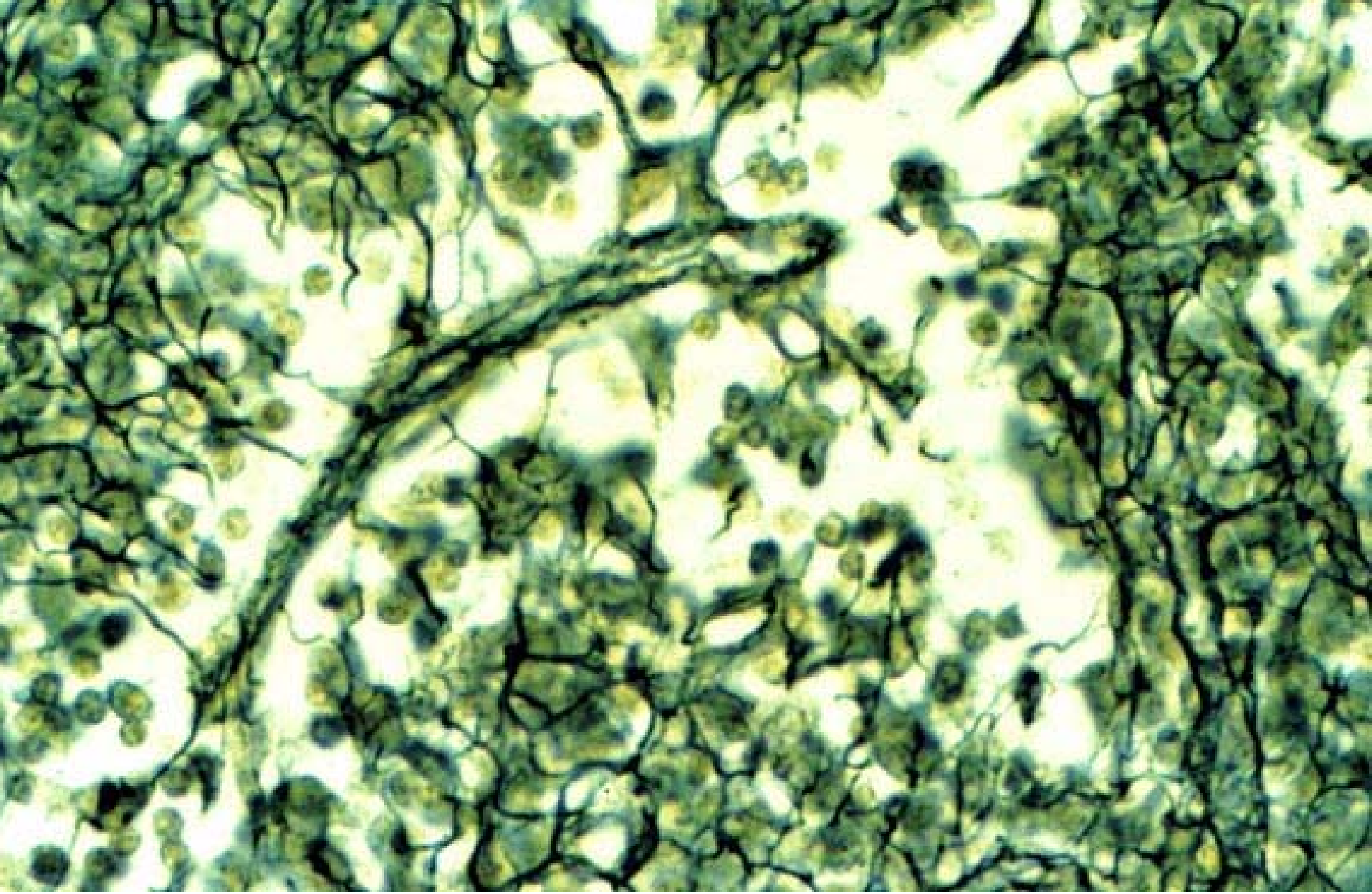
dense irregular CT



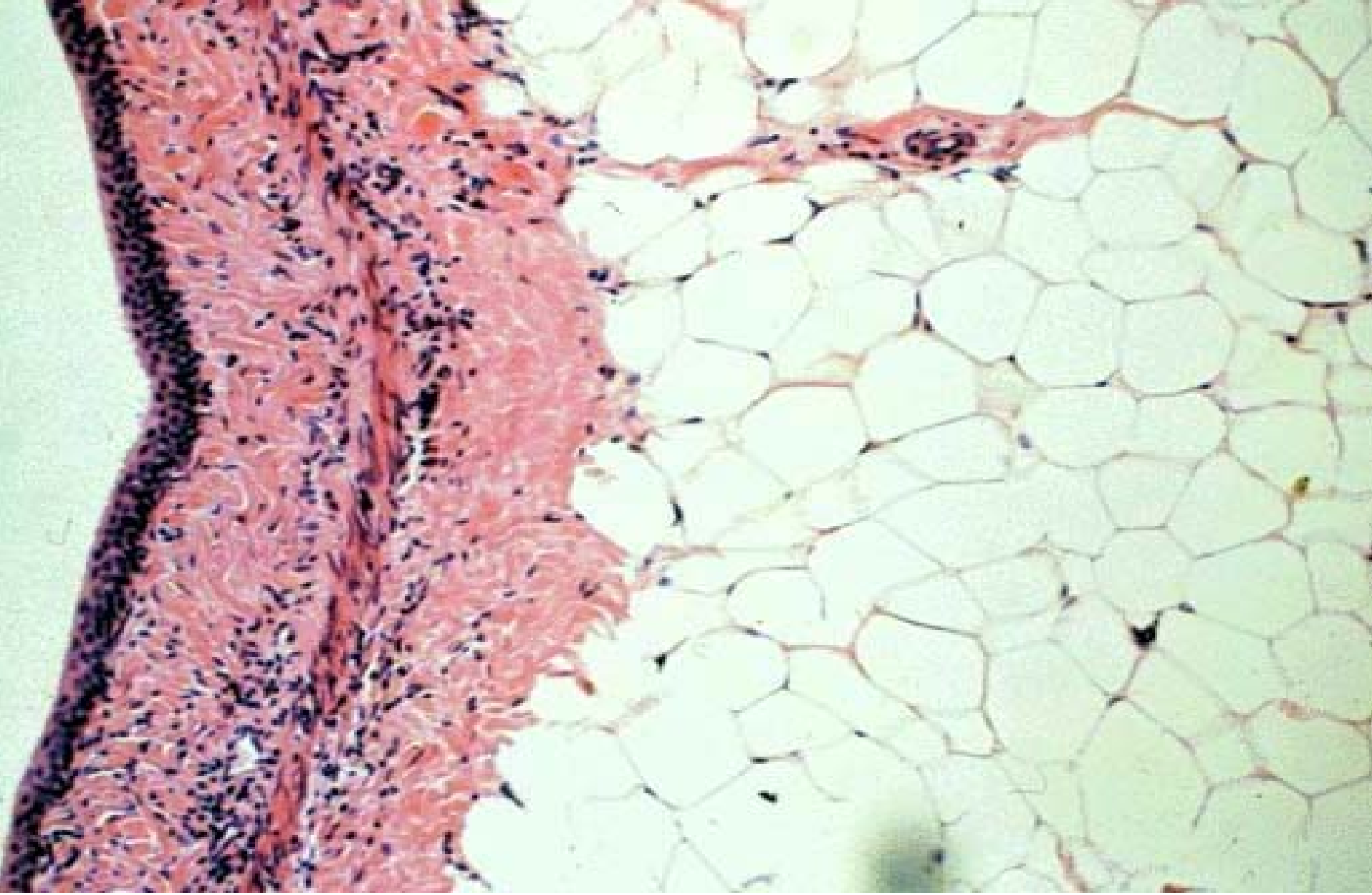
dense regular CT from a tendon.



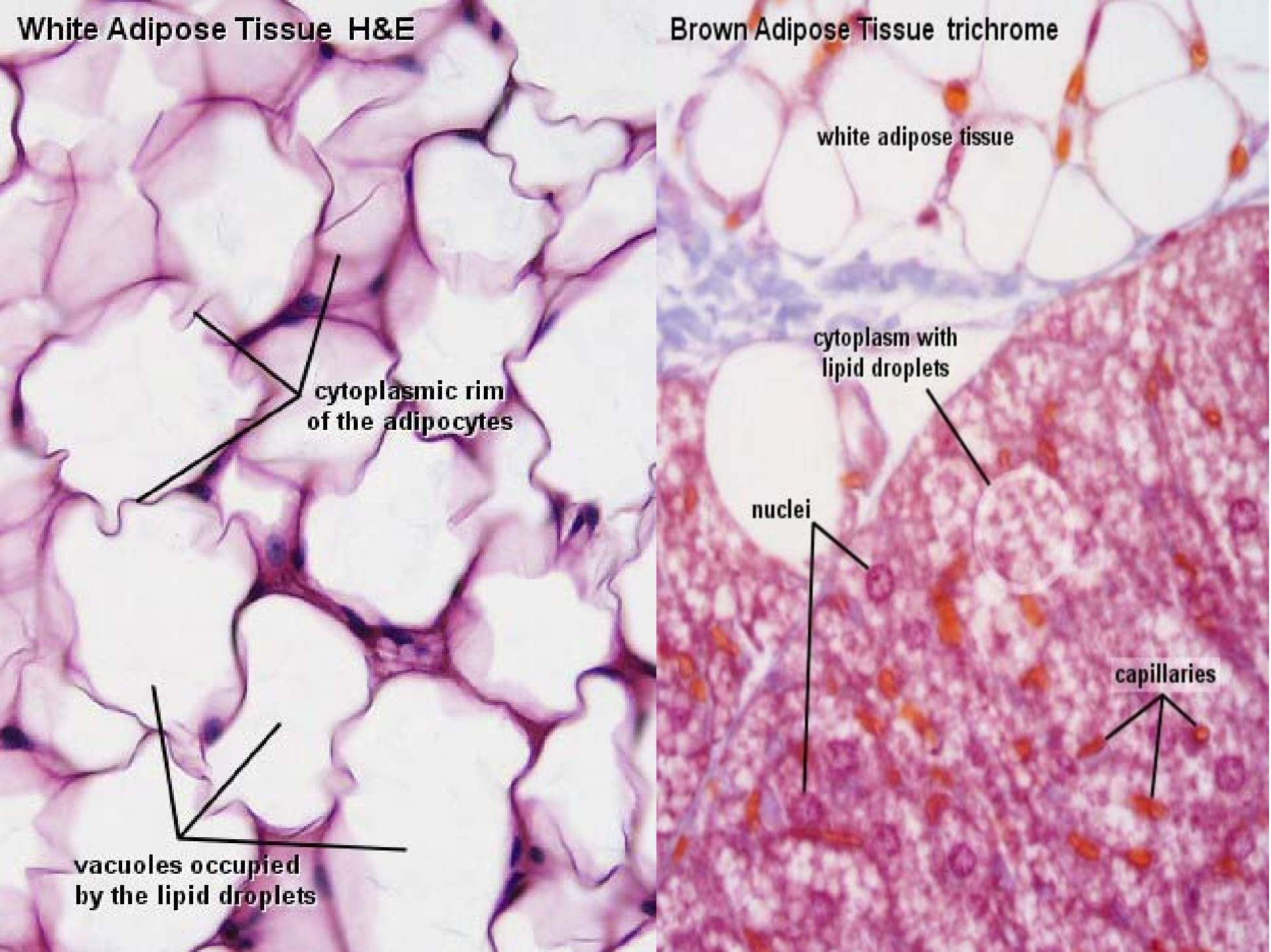
Bronchioles: the elastic CT is stained black and is arranged in loose lines around the open spaces as indicated by the arrows.



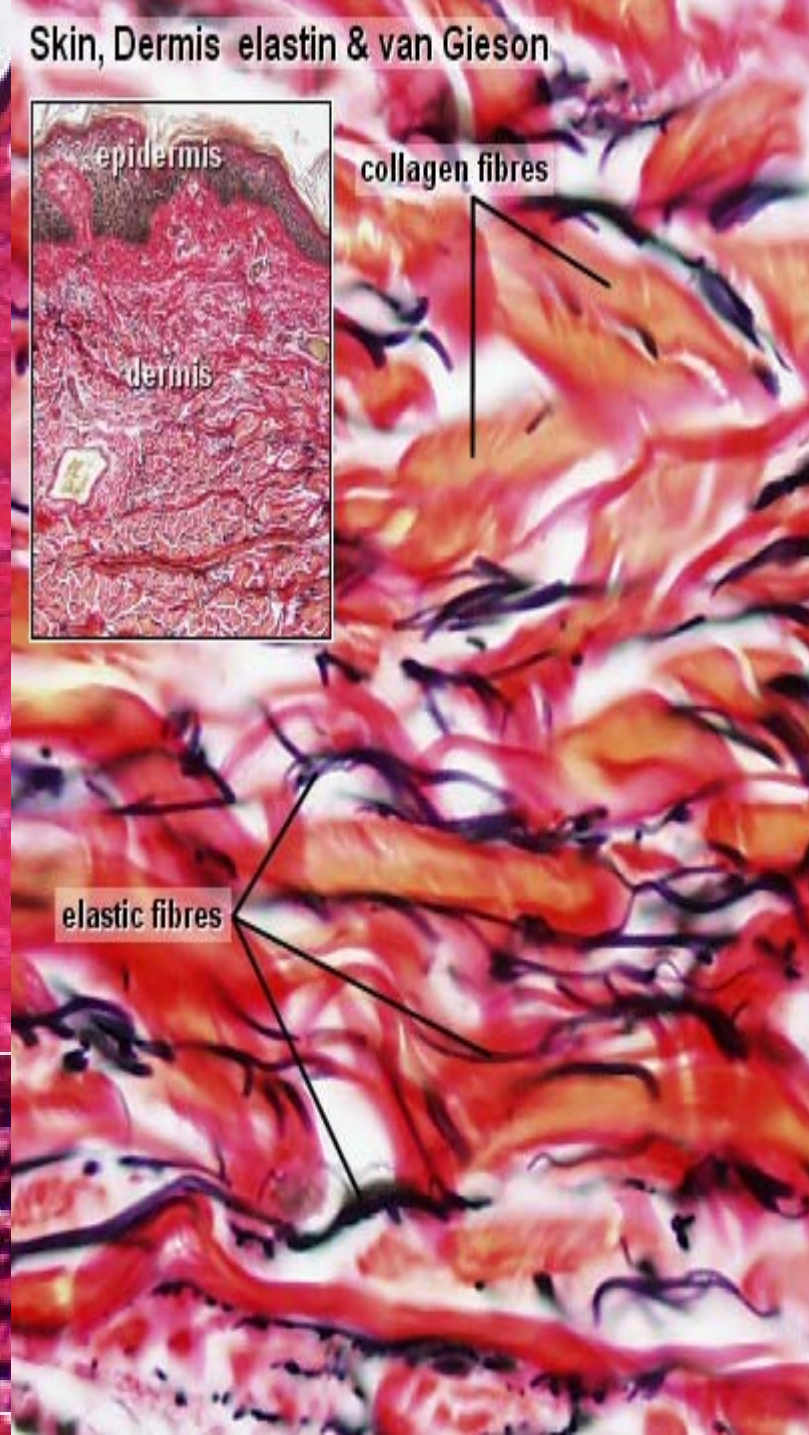
This silver stain of a lymph node stains the stromal reticular fibers black.

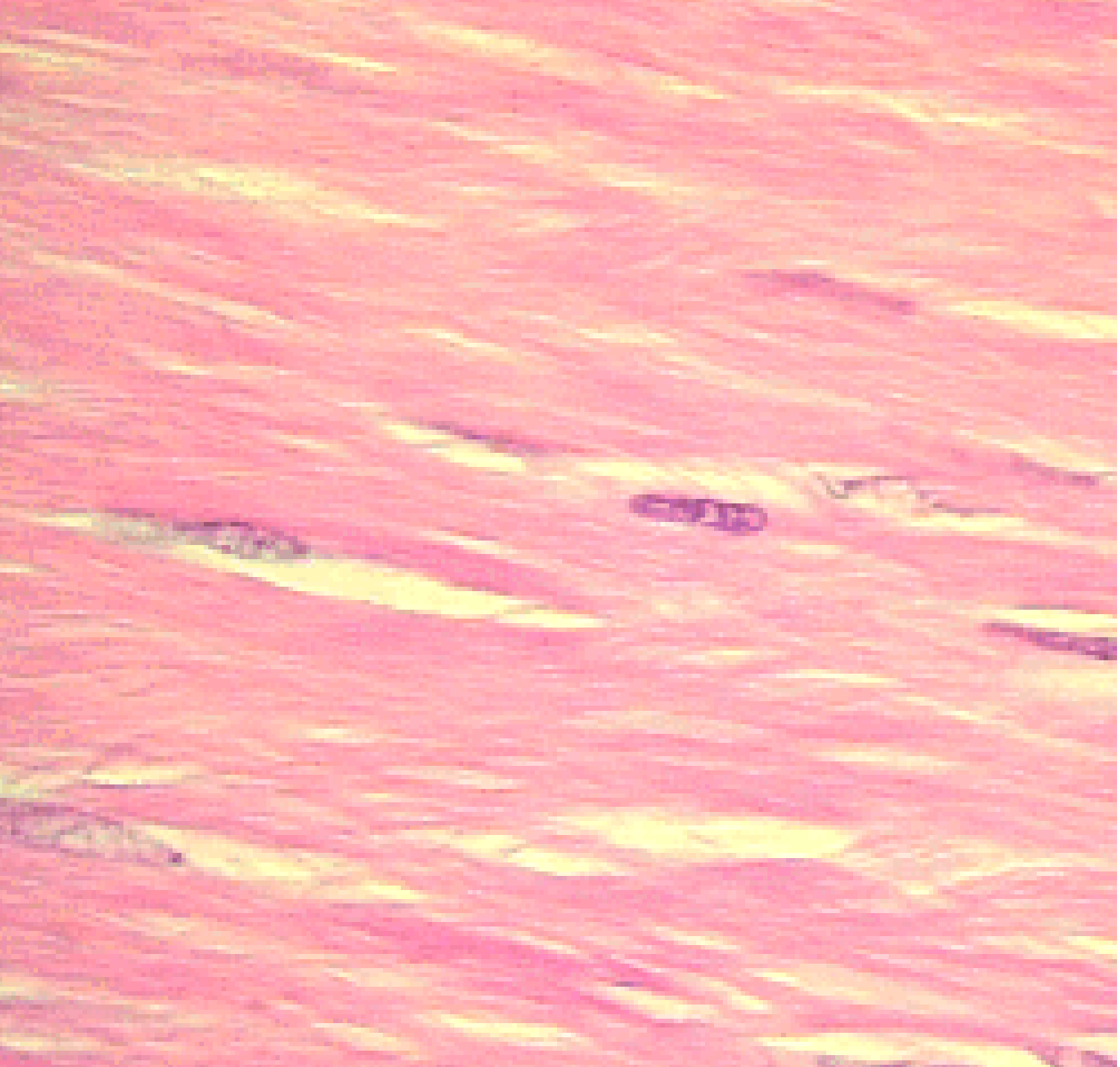


Adipose tissue in the renal pelvis. The adipocytes are the large lipid-filled cells


White Adipose Tissue H&E
cytoplasmic rim
of the adipocytes
vacuoles occupied
by the lipid droplets
Brown Adipose Tissue trichrome
white adipose tissue
cytoplasm with
lipid droplets
nuclei
capillaries


Artery elastin & eosin
elastic lamina
fine elastic fibres
coarse elastic fibres


Skin, Dermis elastin & van Gieson
epidermis
dermis
collagen fibres
elastic fibres



Irregular Dense Collagenous Connective Tissue - Human Dura mater


hyaline cartilage

The type of protein fiber embedded within the matrix of cartilage determines the cartilage type.

In hyaline cartilage protein fibers are large and predominantly collagen

Hyaline cartilage is **semi-transparent** and appears **bluish-white in colour**. It is extremely **strong**, but very **flexible and elastic**. Hyaline cartilage consists of living cells, **chondrocytes**, which are situated far apart in fluid-filled spaces, the **lacunae**. There is an extensive amount of rubbery **matrix** between the cells and the matrix contains a number of **collagenous fibres**. Hyaline cartilage occurs in **trachea**, the **larynx**, the tip of the **nose**, in the connection between the **ribs and the breastbone** and also the **ends of bone** where they form **joints**. Temporary cartilage in **mammalian embryos** also consists of hyaline cartilage.

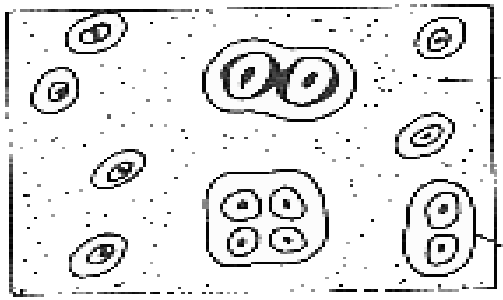
Functions

- **Reduces friction at joints.**
  - By virtue of the smooth surface of hyaline cartilage, it provides a *sliding area* which reduces friction, thus facilitating bone movement.
- **Movement**
  - Hyaline cartilage joins bones firmly together in such a way that a certain amount of *movement* is still possible between them.
- **Support**
  - The c-shaped cartilagenous rings in the windpipes (trachea and bronchi) assist in *keeping* those tubes open.
- **Growth**
  - Hyaline cartilage is responsible for the *longitudinal growth* of bone in the neck regions of the long bones.

White fibrocartilage is an **extremely tough tissue**. The orientation of the **bundles** depends upon the **stresses acting on the cartilage**. The collagenous bundles take up a **direction parallel** to the cartilage. Fibrocartilage is found as **discs between the vertebrae between the pubic bones** in front of the **pelvic girdle** and around the **edges of the articular cavities** such as the **glenoid cavity in the shoulder joint**.

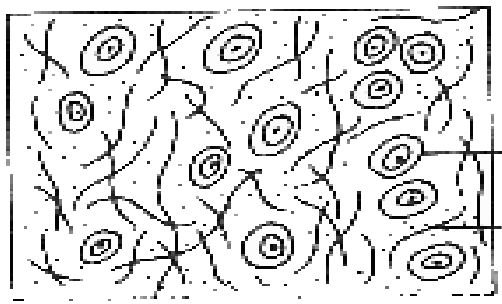
Functions

- **Shock absorbers.**
  - The cartilage between the adjacent vertebrae *absorbs the shocks* that will otherwise damage and jar the bones while we run or walk.
- **Provides sturdiness without impeding movement.**
  - The white fibrocartilage forms a firm joint between bones but still *allows for a reasonable degree of movement*.
- **Deepens sockets.**
  - In articular cavities (such as the ball-and-socket joints in the hip and shoulder regions) white fibrocartilage *deepens the sockets to make dislocation less possible*.



ground substance

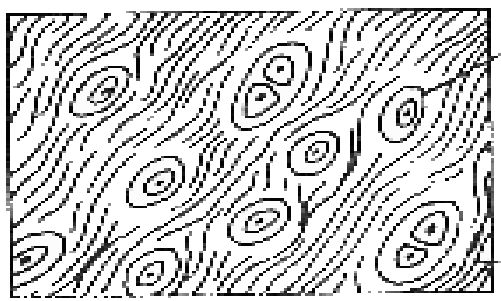
Hyaline Cartilage



Cartilage cells

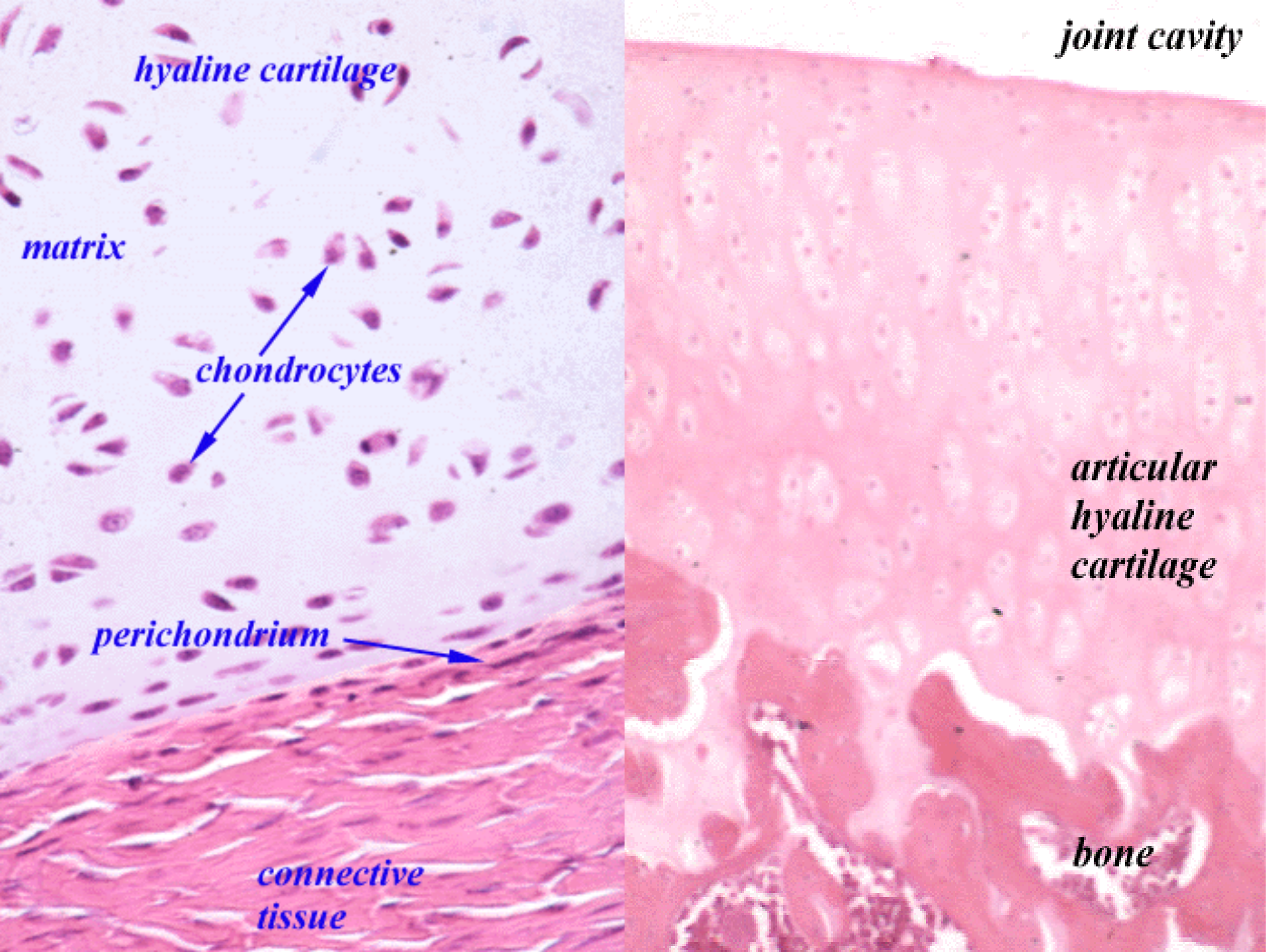
ground substance
with non-elastic
collagen fibres

Fibrous Cartilage



ground substance with
yellow elastic fibres

Elastic Cartilage

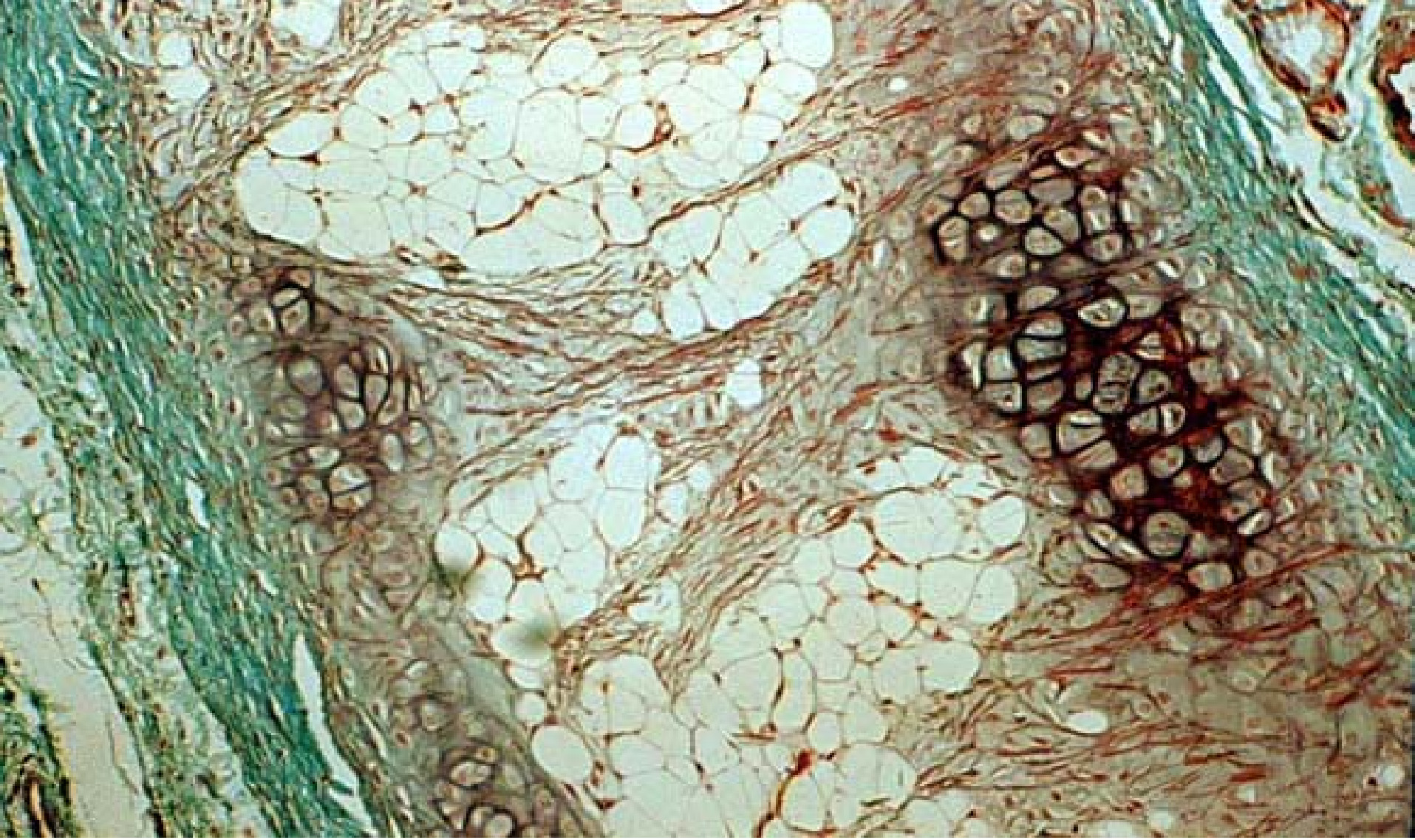

hyaline cartilage
matrix
chondrocytes
perichondrium
connective tissue
joint cavity
articular hyaline cartilage
bone

Elastic cartilage.

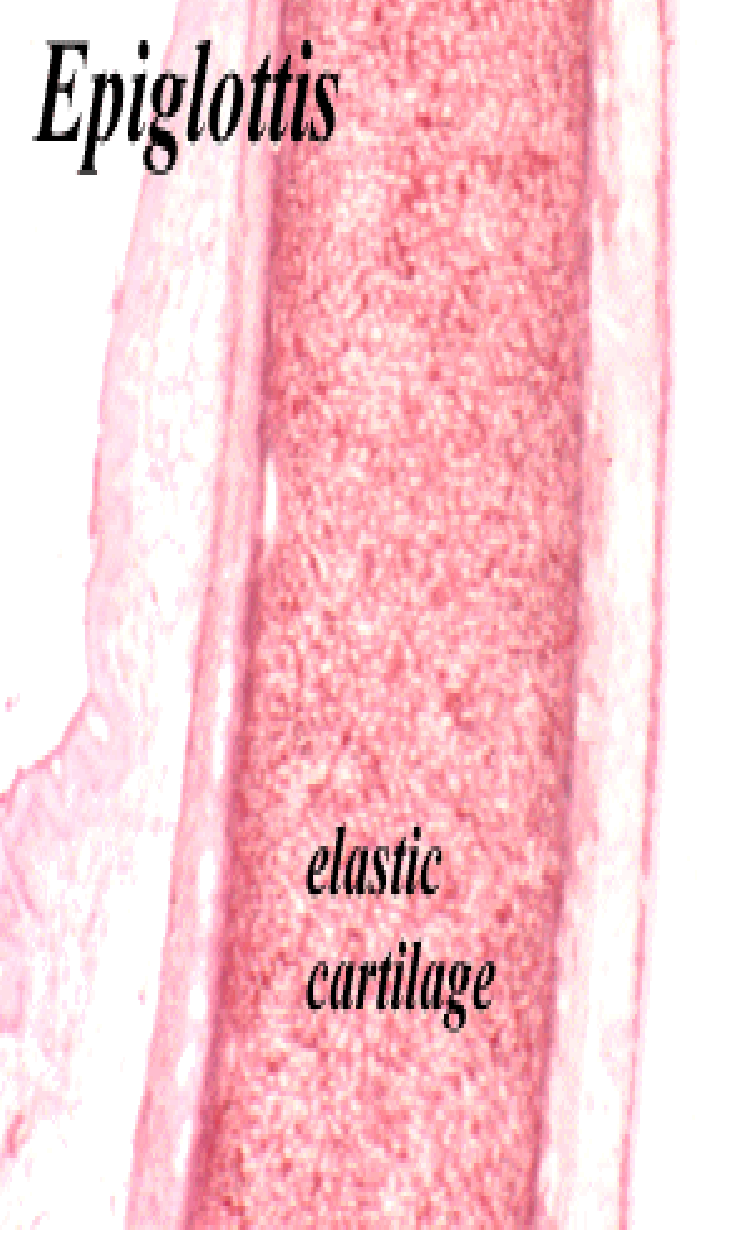
Basically elastic cartilage is **similar to hyaline cartilage**, but in addition to the collagenous fibres, the matrix of the elastic also contains an **abundant network of branched yellow elastic fibres**. They run through the matrix in all directions. This type of cartilage is found in the **lobe of the ear**, the **epiglottis** and in **parts of the larynx.**

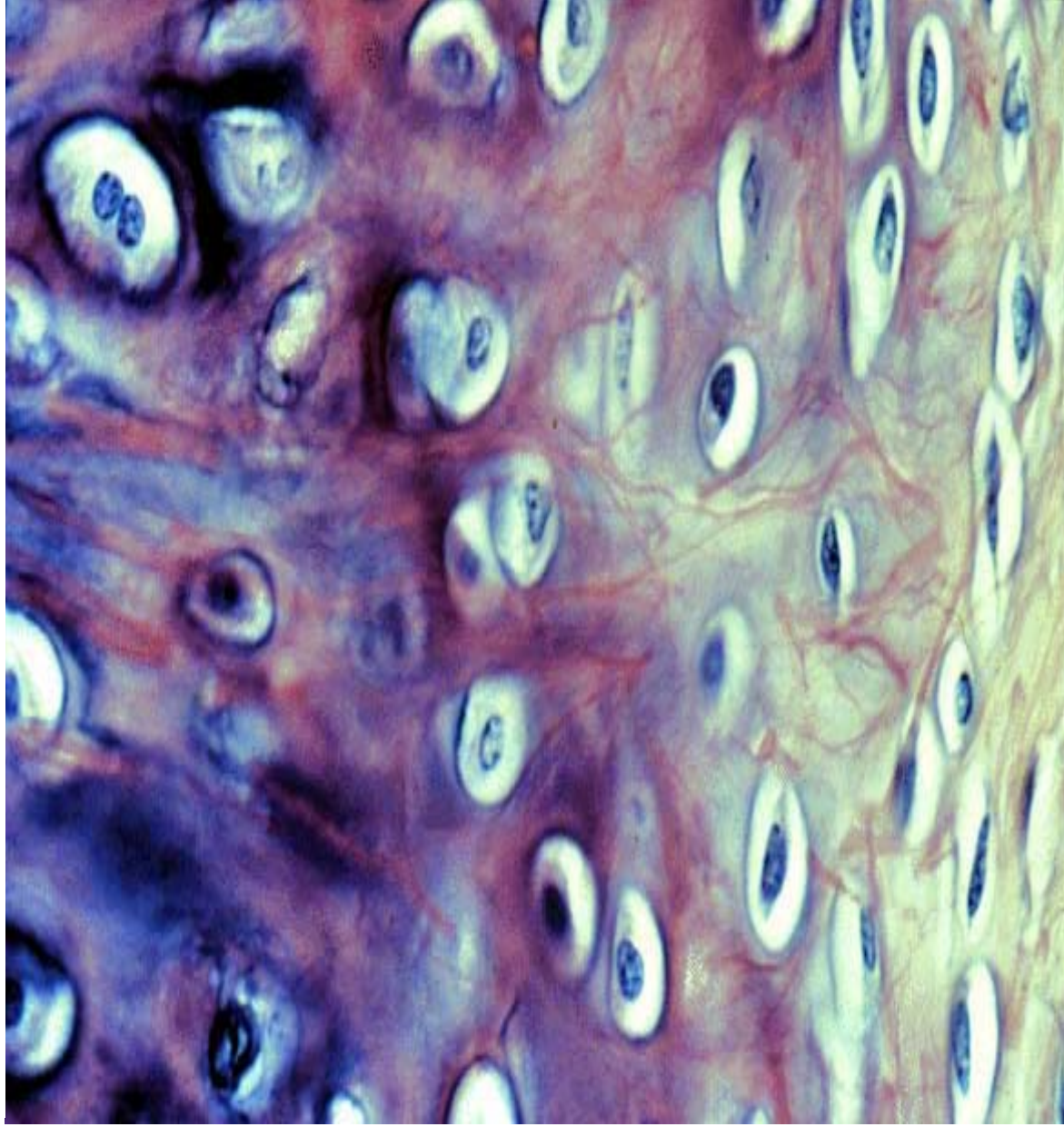
Functions

- **Maintain shape.**
  - In the ear, for example, elastic cartilage *helps to maintain the shape and flexibility of the organ*.
- **Support**
  - Elastic cartilage also *strengthens and supports* these structures.

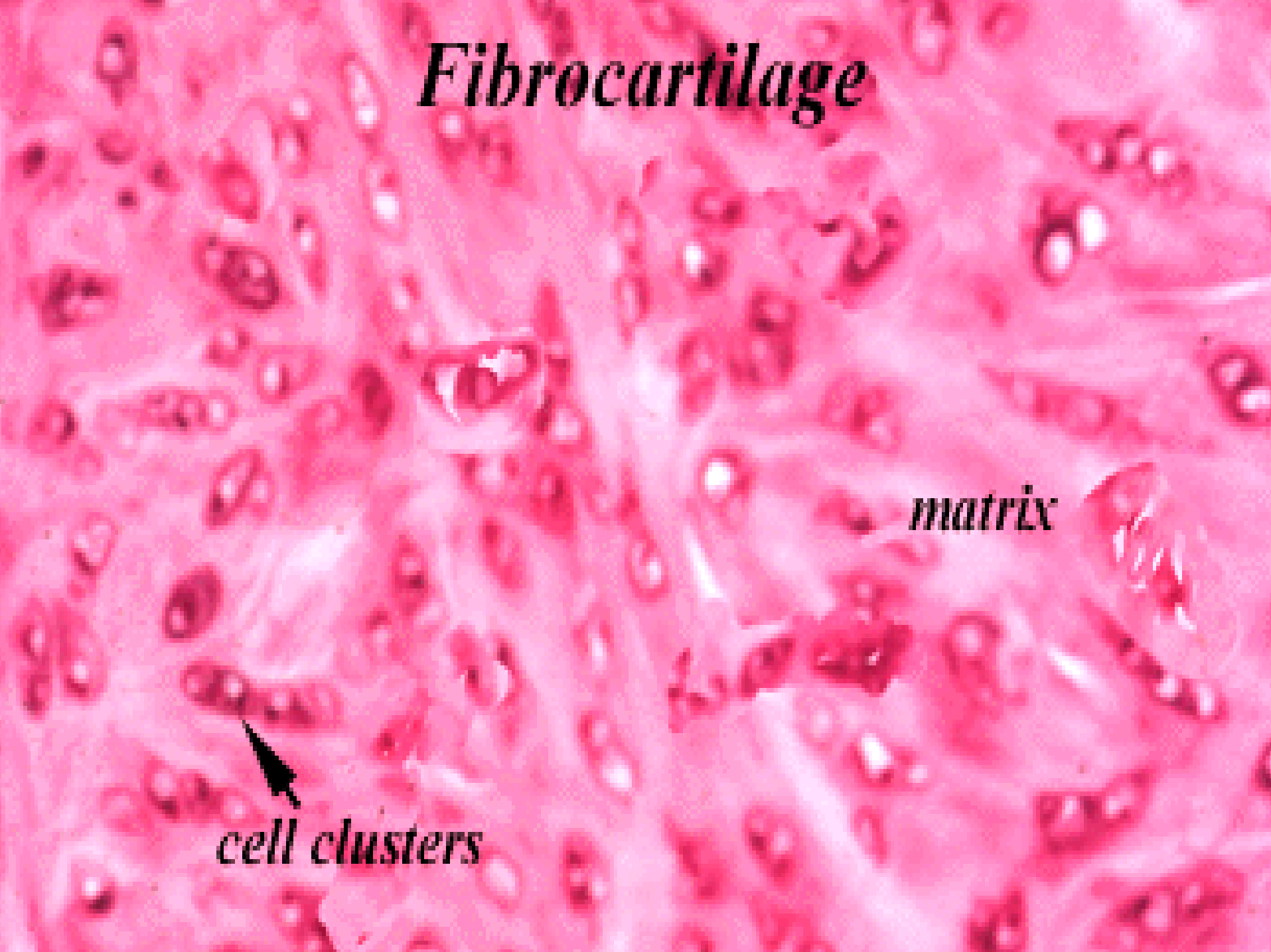


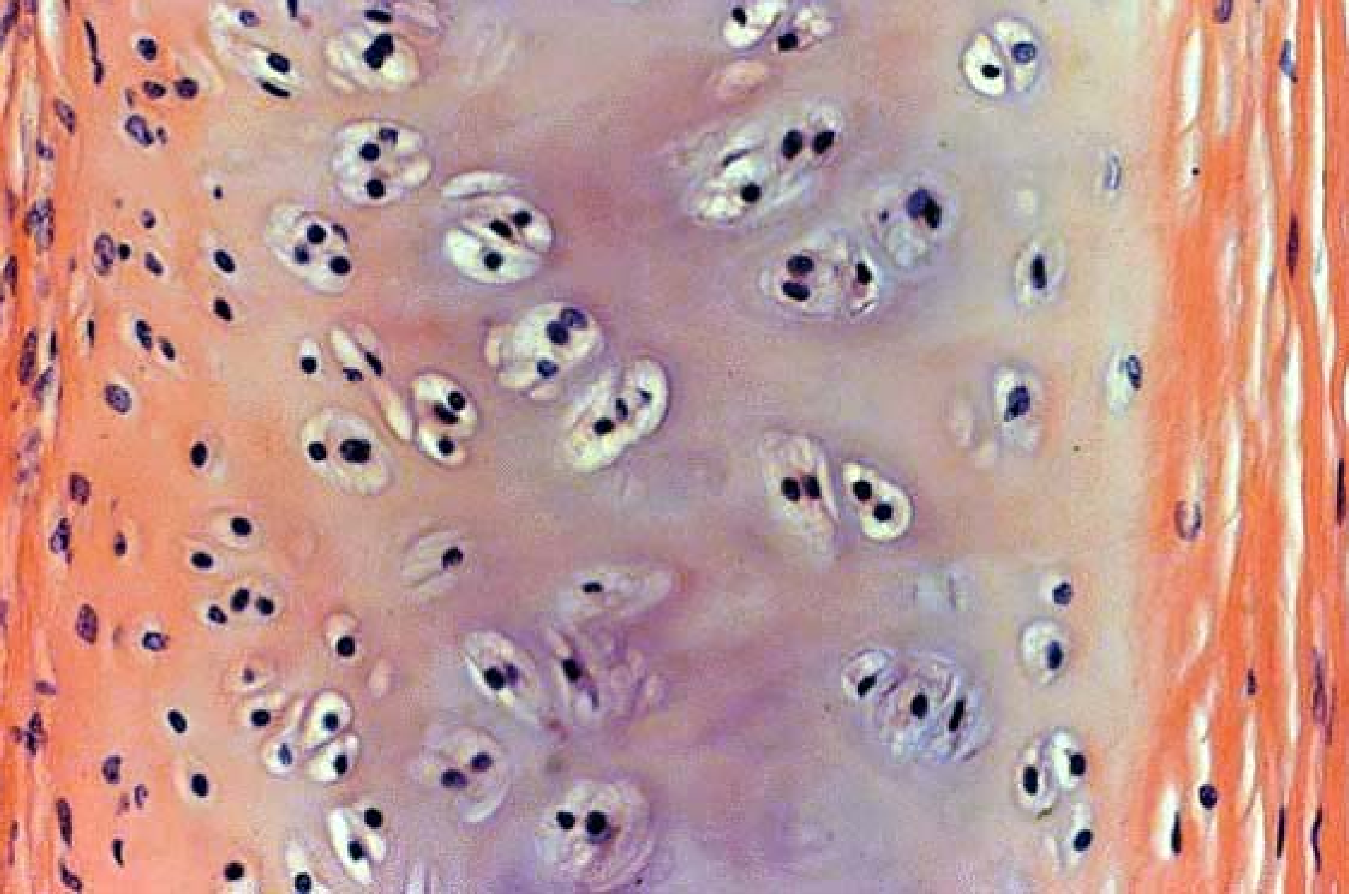
elastic.



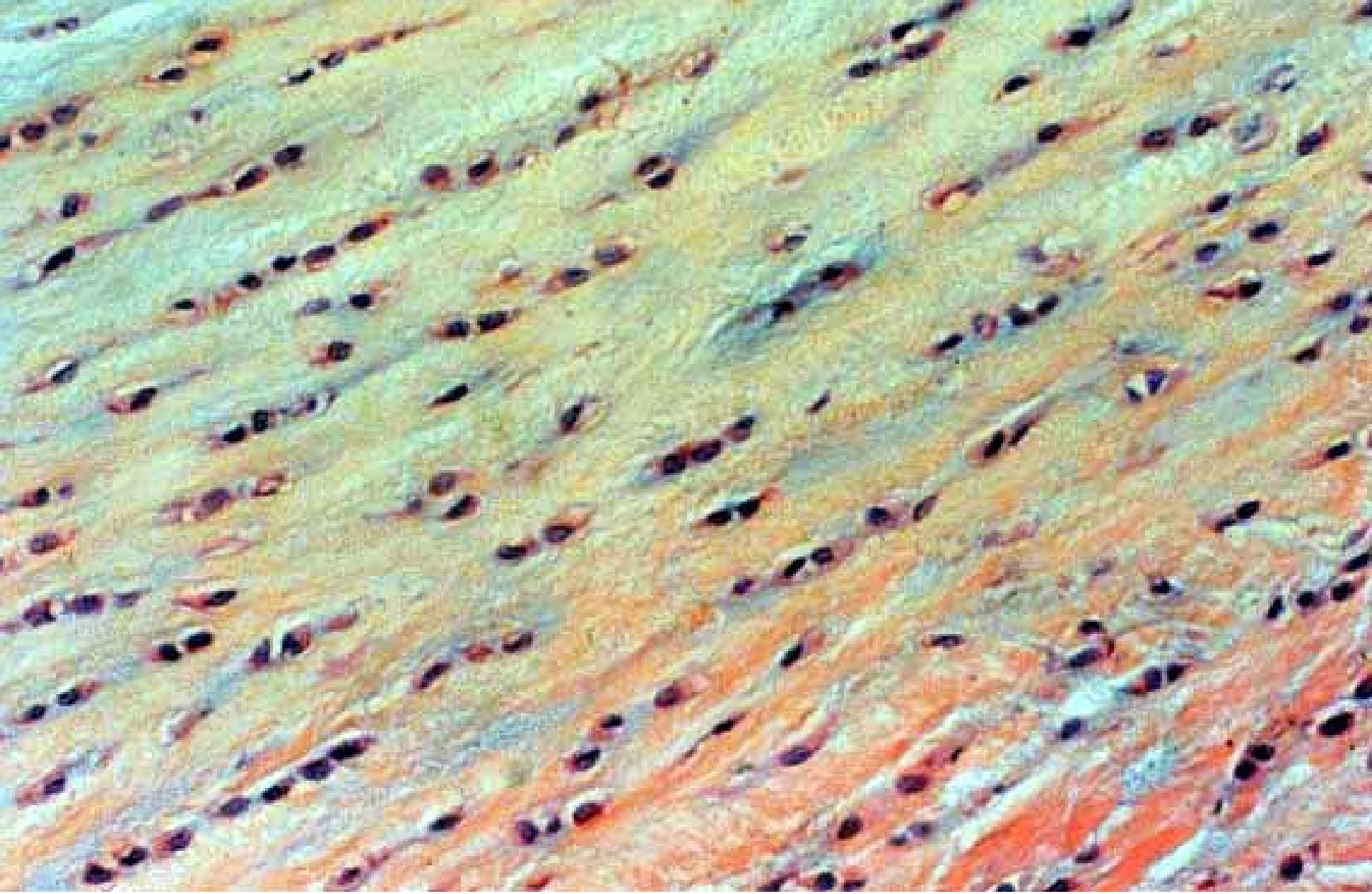


Epiglottis have elastic cartilage

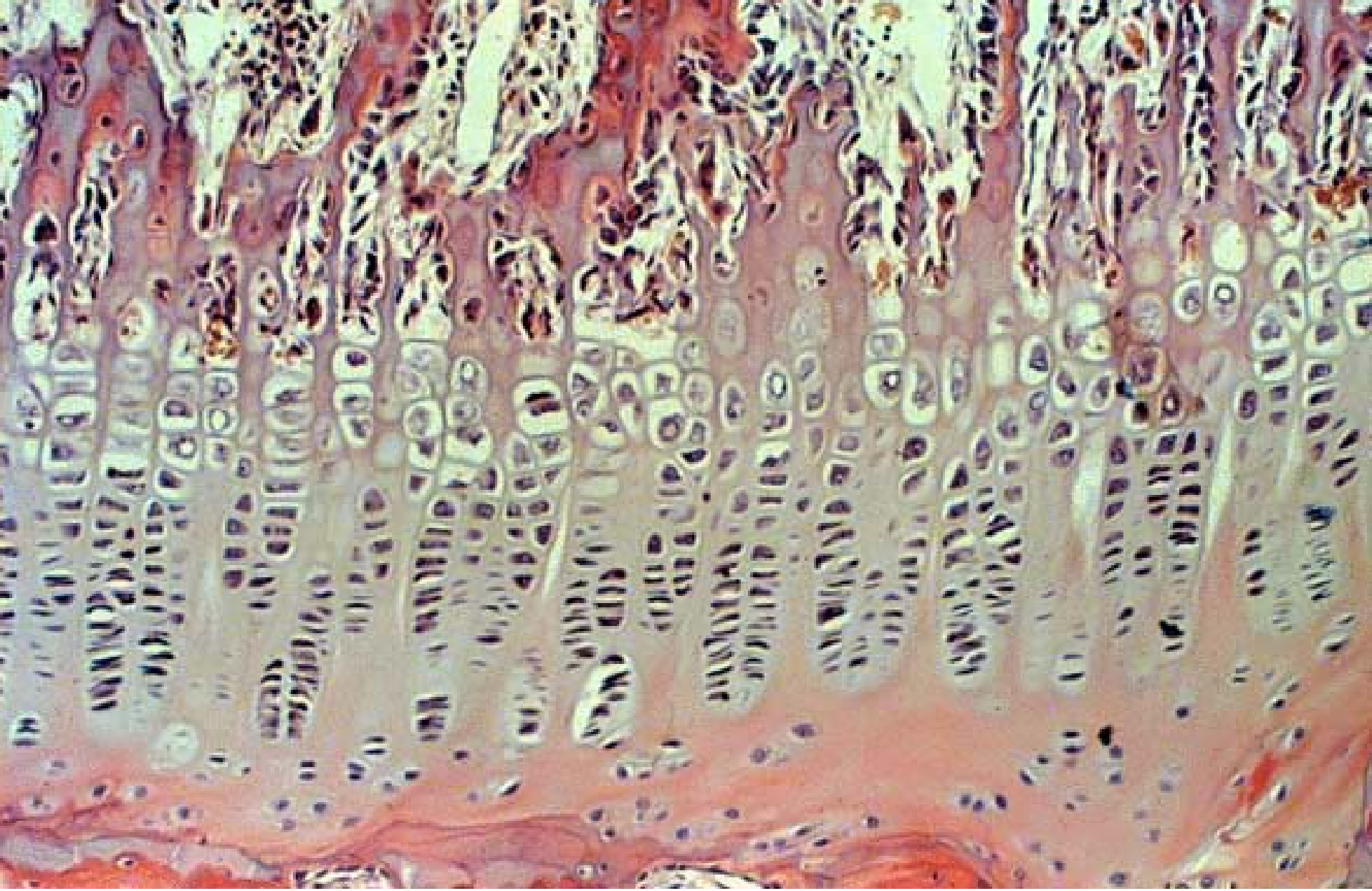

Fibrocartilage
matrix
cell clusters



hyaline cartilage from a trachea. Notice the lacunae. Try saying "lacunae" 10 times in a row really fast



Fibrocartilage



The cartilage starts at the bottom and develops into trabecular bone towards the top

Blast suffix

- bud or germ
- Examples: osteoblast (osteo-blast) - a cell from which bone is derived

Cyte suffix = New Latin -*cyta*, from Greek *kutos*, hollow vessel.
used to form cell names and classifications

- adipocyte
- astrocyte
- blastocyte
- choanocyte
- coenocyte
- erythrocyte
- gametocyt

Disorders of connective tissue

Various connective tissue conditions have been identified; these can be both inherited and environmental.

- •Marfan syndrome - a genetic disease causing abnormal fibrillin.
- •Scurvy - caused by a dietary deficiency in vitamin C, leading to abnormal collagen.
- •Ehlers-Danlos syndrome - a genetic disease causing progressive deterioration of collagens, with different EDS types affecting different sites in the body, such as joints, heart valves, organ walls, arterial walls, etc.
- •Osteogenesis imperfecta (brittle bone disease) - caused by insufficient production of good quality collagen to produce healthy, strong bones.
- •Spontaneous pneumothorax - collapsed lung, believed to be related to subtle abnormalities in connective tissue.
- •Sarcoma - a neoplastic process originating in connective tissue.