
بسم الله الرحمن الرحيم


NO
CELL PHONES!

The purpose of education is to replace an empty mind with an open one.

Malcolm S. Forbes

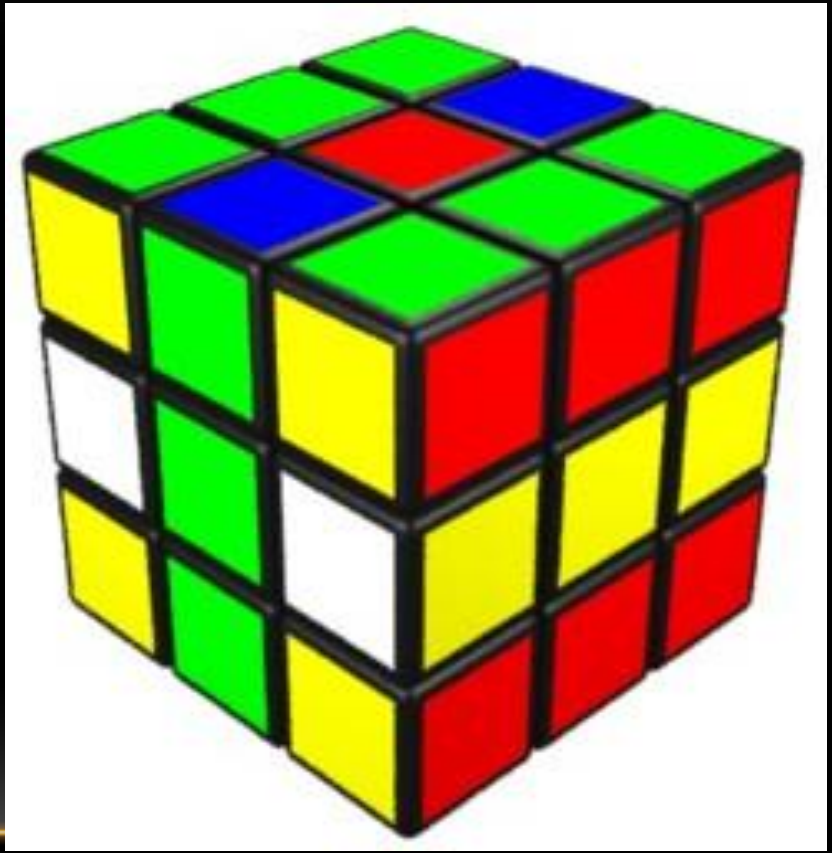
لا يسمح بالخول بعد بدء المحاضرة أو تغيير الشعبة لأي سبب كان.

لايسمح بتسجيل المحاضرات.

سيحرم من الامتحان النهائي كل من يتجاوز غيابه 15% من المحاضرات

Remember !!!!!

Histology is a 2 dimensional study of a 3 dimensional reality.



Epithelium

Why??

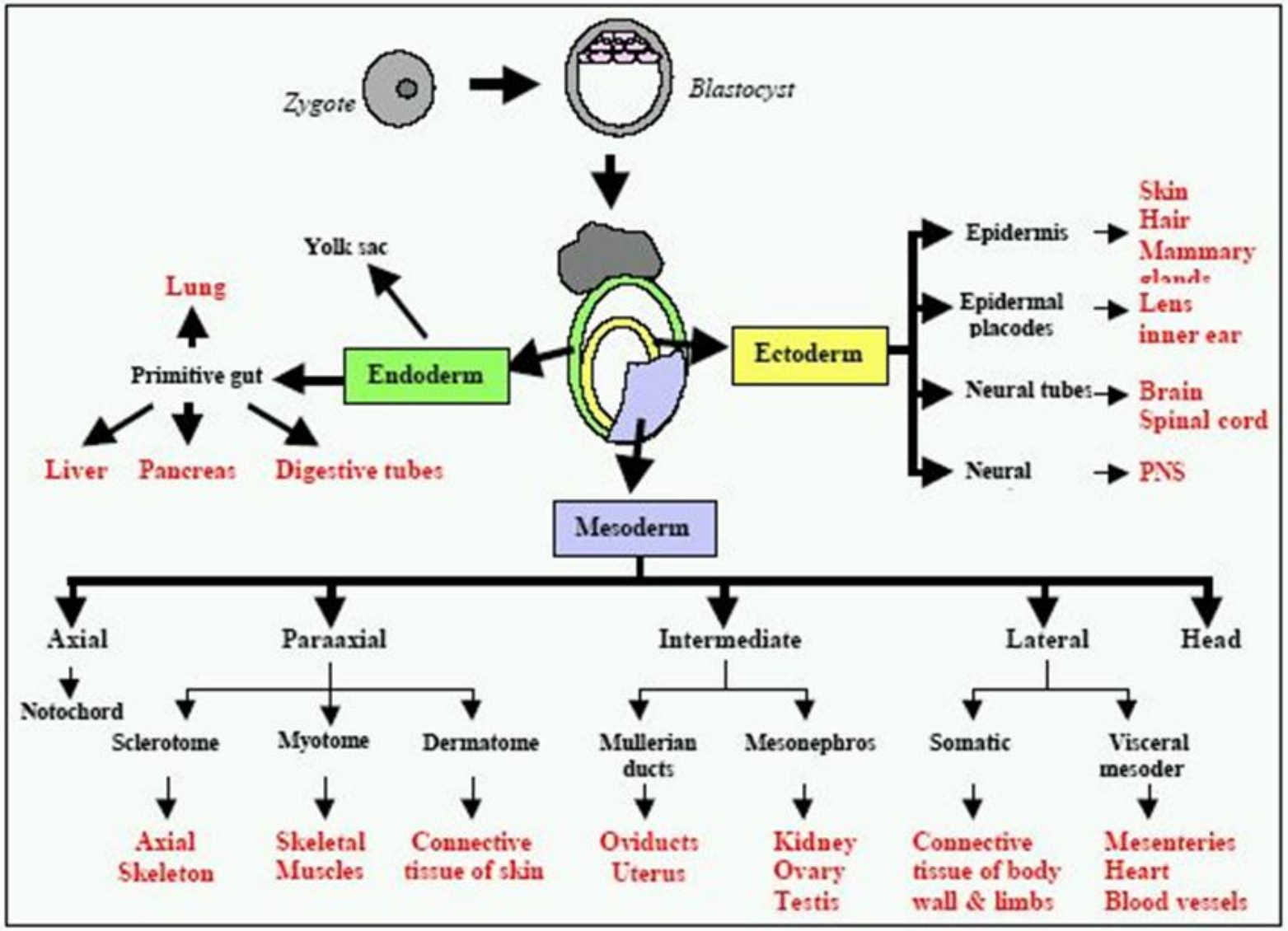
It is the interface between all tissues and the external and internal environment of the body.

Features

Features .. 1

Always on top: covers a surface OR lines a cavity

Features .. 2



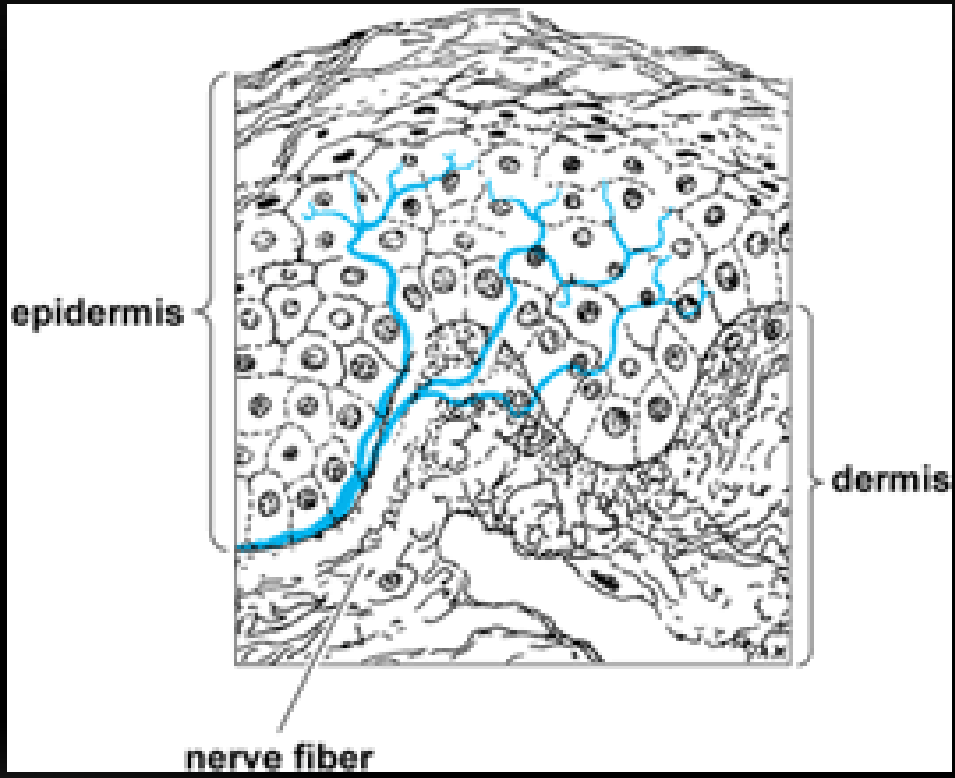
Originates from any of the three embryonic layers.

Features .. 3

Avascular and depends in its nutrition on perfusion from the underlying connective tissue.

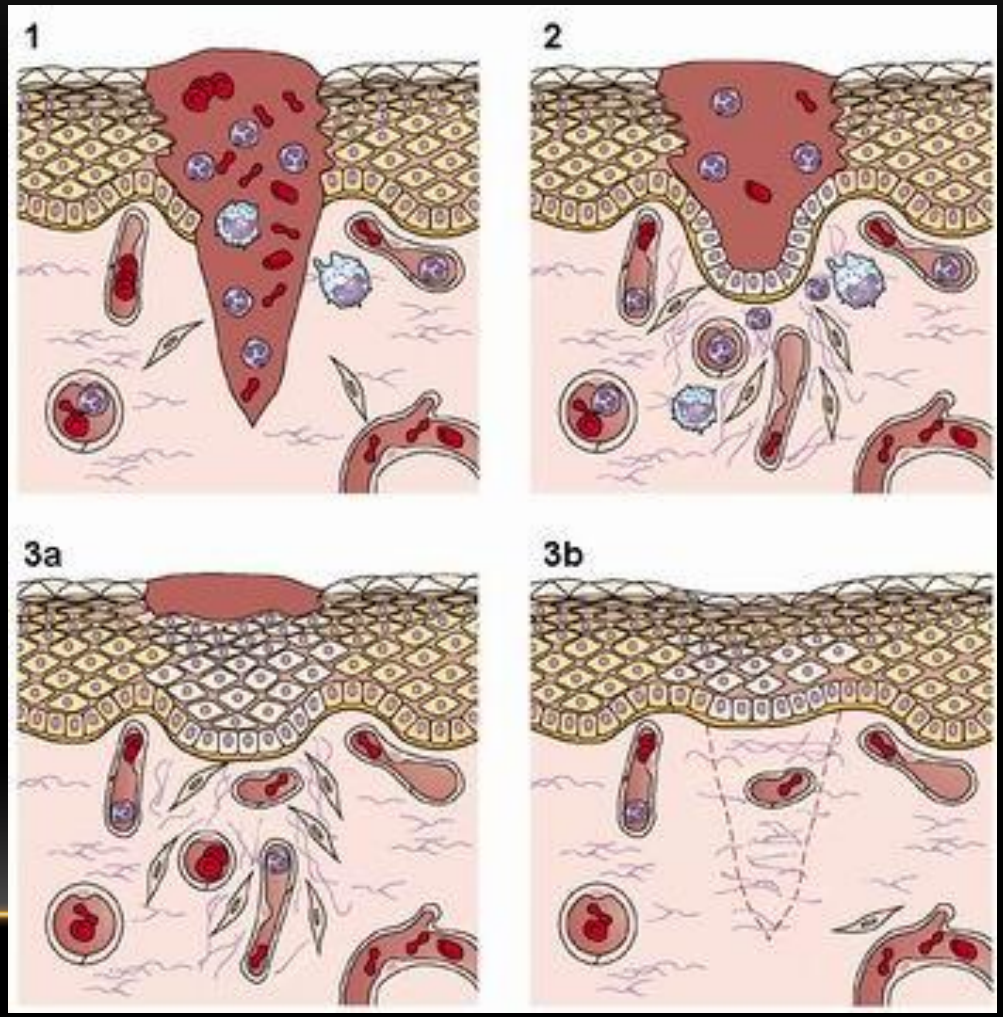
Features .. 4

Richly innervated. Free nerve endings can be seen between epithelial cells.



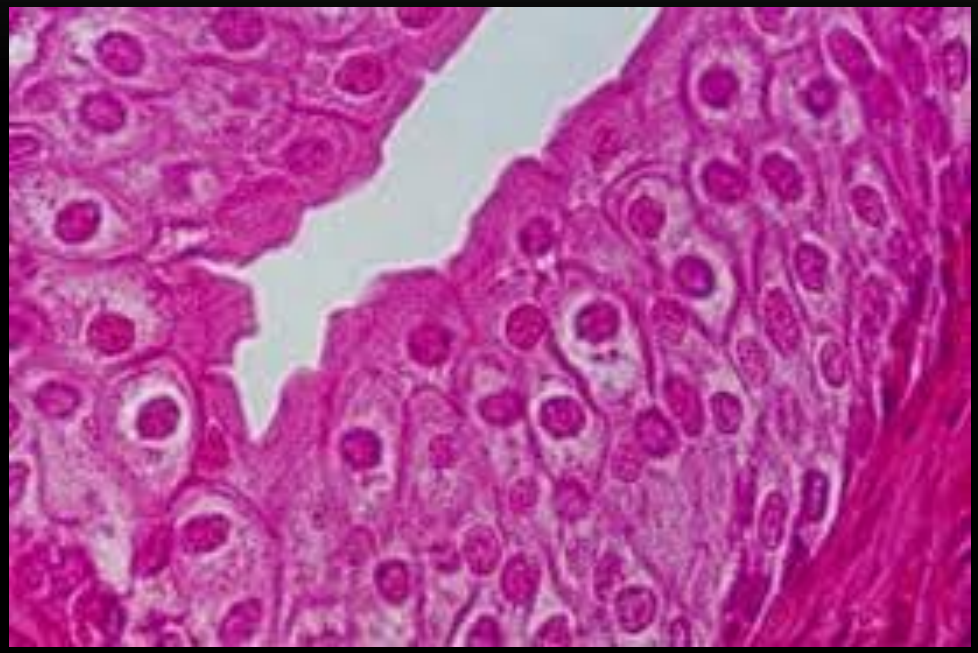
Features .. 5

Has a high regenerative power.



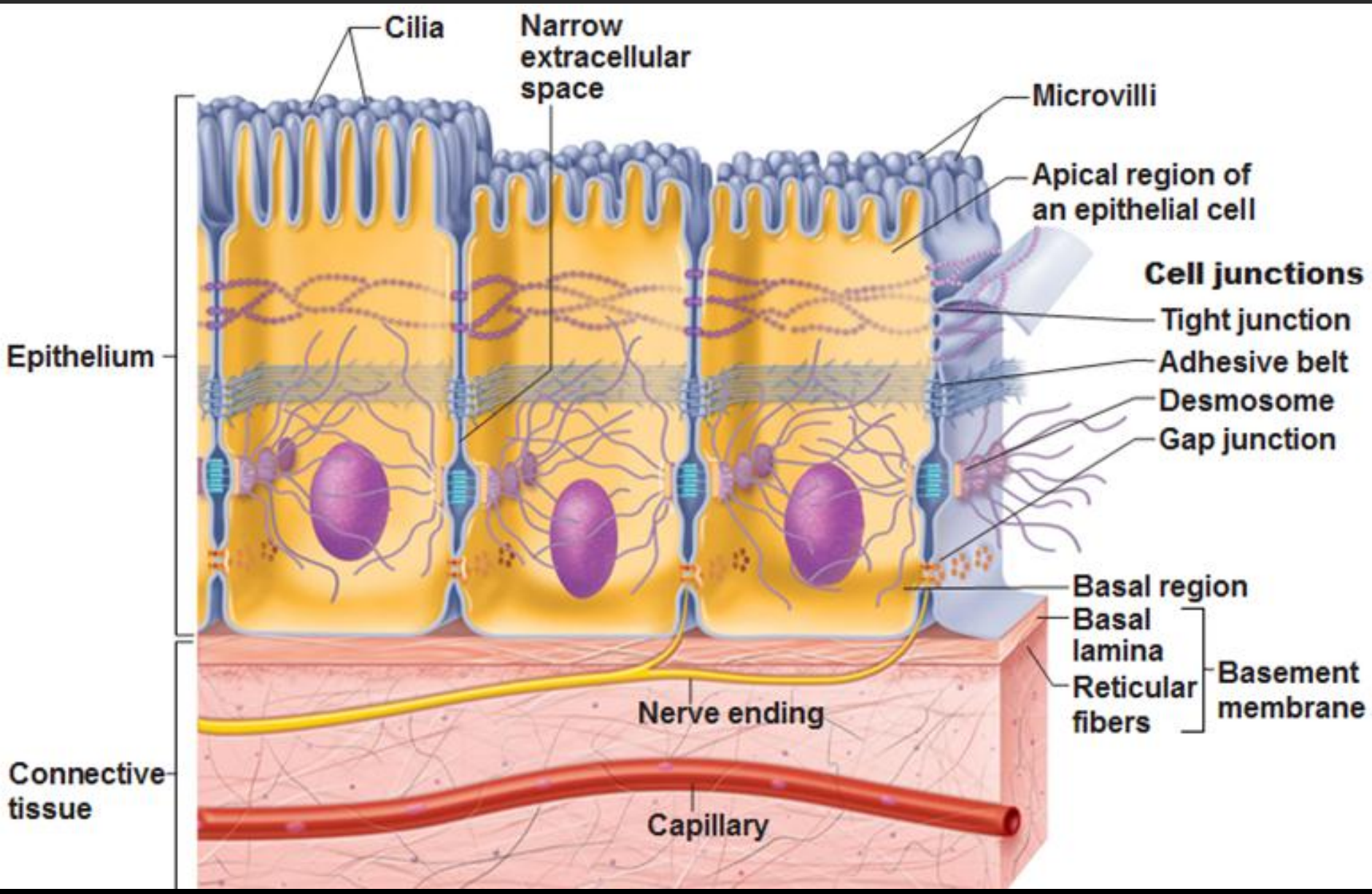
Features .. 6

Cells are closely packed forming sheets or membranes.



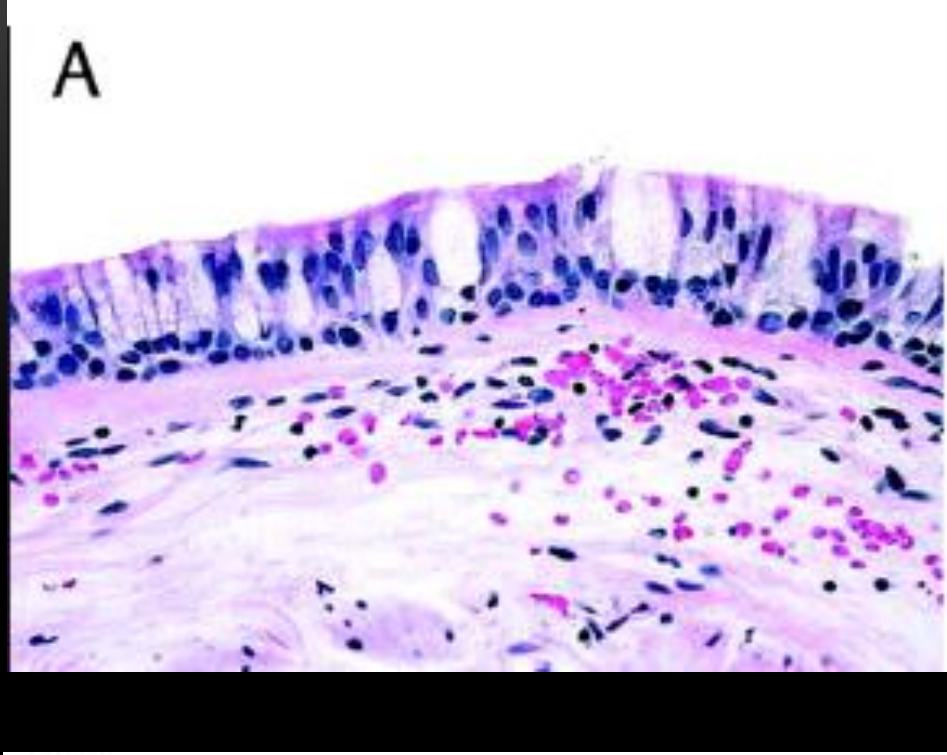
Features .. 7

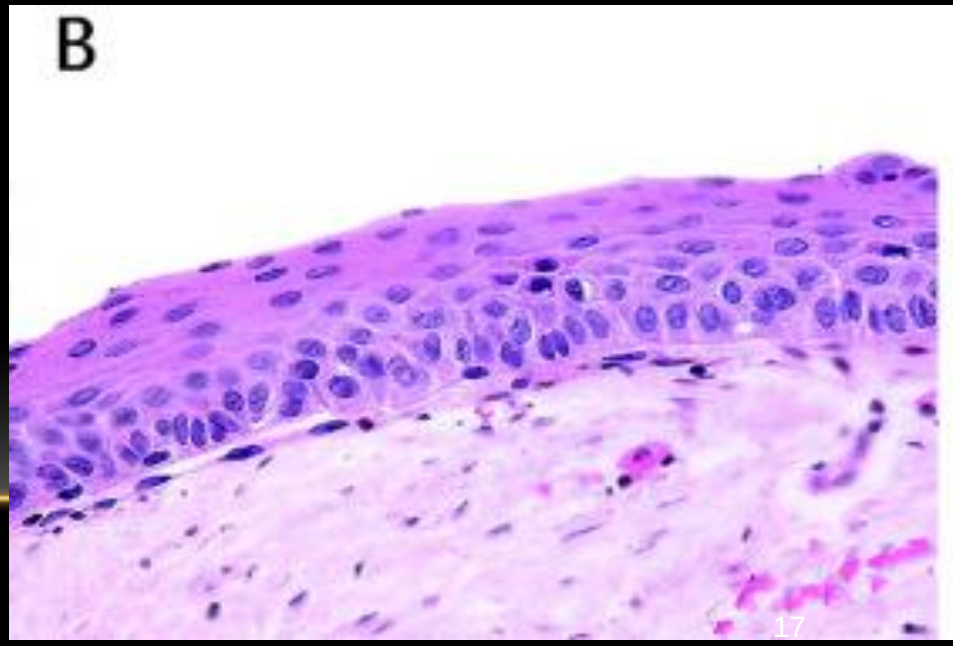
Cells show polarity; organelles are collected at the site of function.


Cilia
Narrow extracellular space
Microvilli
Apical region of an epithelial cell
Cell junctions
Tight junction
Adhesive belt
Desmosome
Gap junction
Epithelium
Basal region
Basal lamina
Reticular fibers
Basement membrane
Nerve ending
Connective tissue
Capillary

Feature 8

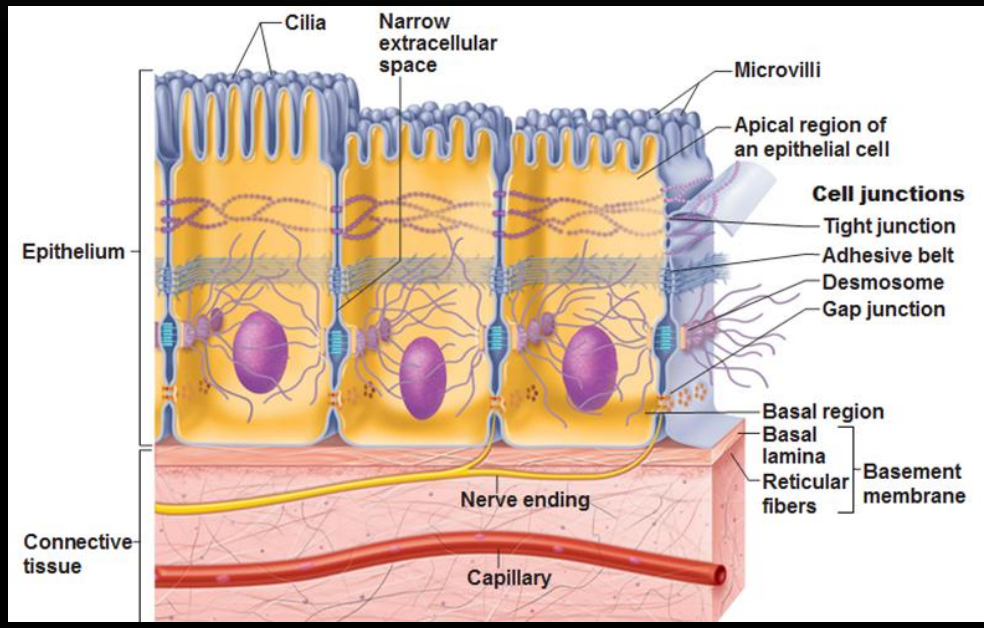
Metaplasia = reversible change of one type of epithelium to another in response to a stimulus





Feature 9

Always rests on a "Basement Membrane or Basal Lamina"



Lecture 2

You do not have to burn books to destroy a culture. Just get people to stop reading them.
Ray Bradbury

Basal Laminae & Basement Membrane

Basal Lamina

Only visible with E.M

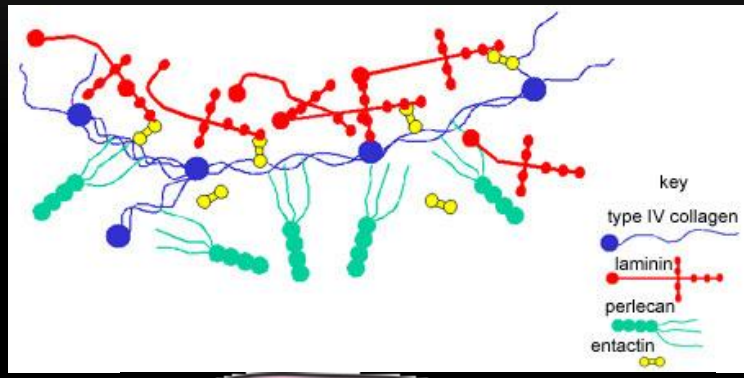
Found also in other tissues

Components are secreted by epithelium, connective tissue, muscle, Schwann cell

Layers of Basal Lamina

Layers of the Basal Lamina

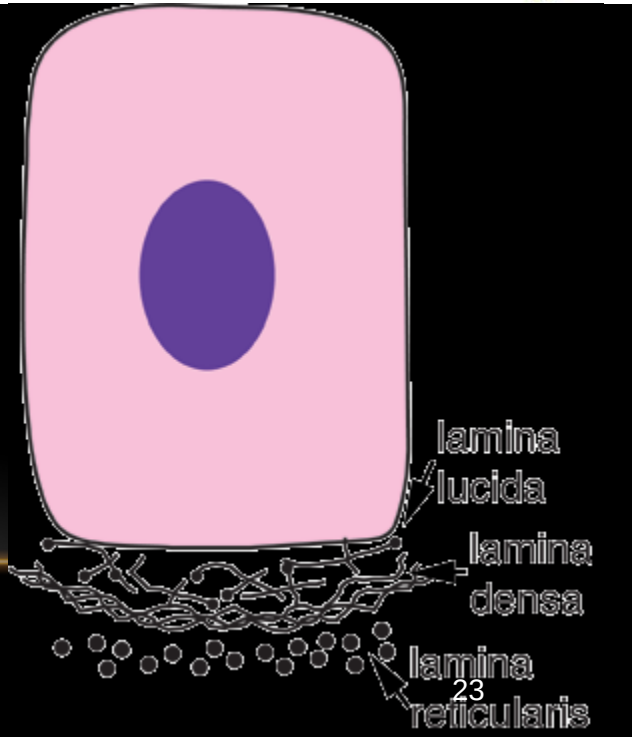
- Lamina Lucida
- Lamina Densa



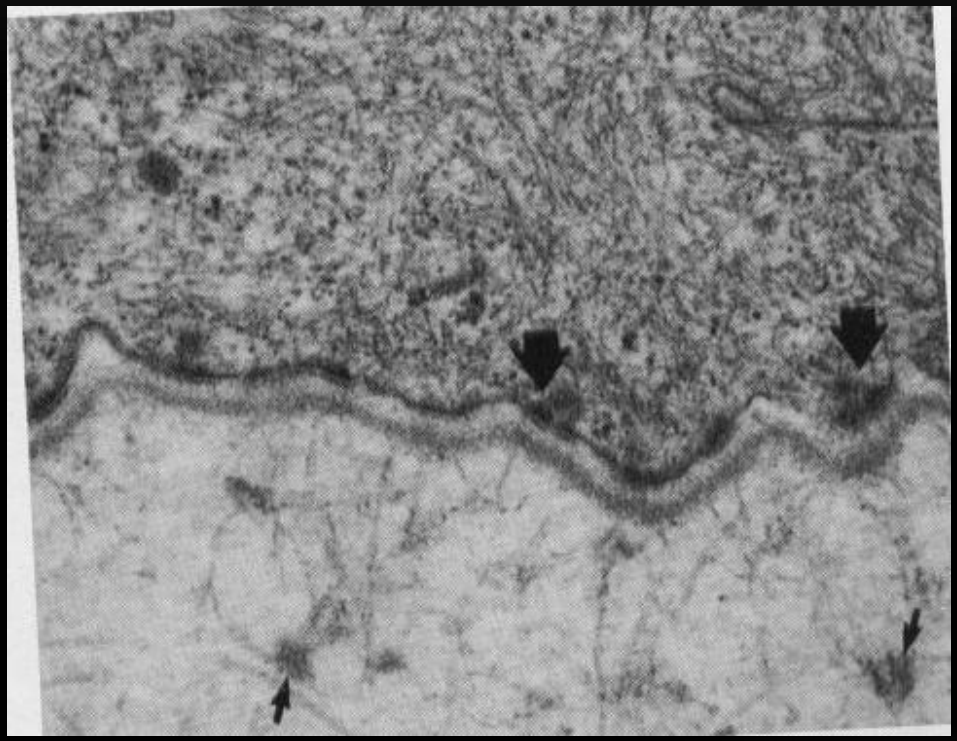
Lamina Reticularis: not part of the basal lamina

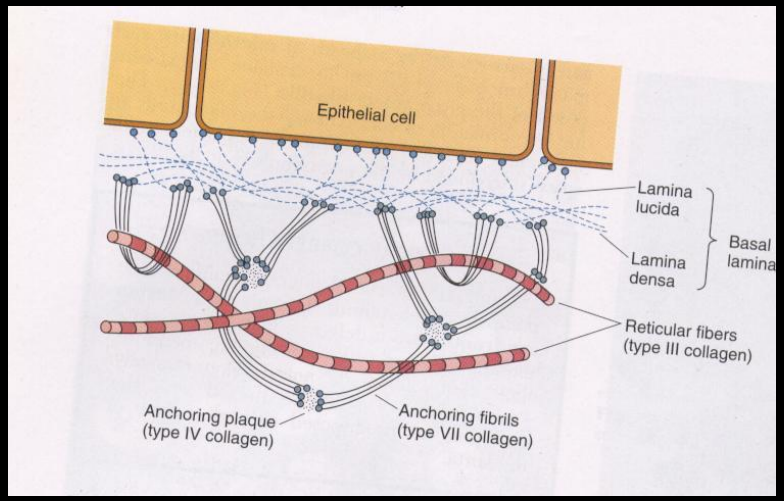
<u>Molecular components are variable but include:</u>

- type IV collagen,
- Glycoproteins (Laminin, entactin…)
- Proteoglycans (Perlecan)



E.M of Basal Lamina





Functions of Basal lamina

- Support
- Selective barrier
- Influencing cell polarity
- Regulation of proliferation and growth
- Affect cellular metabolism
- Affect cell-cell interaction

Clinical Importance of Basal Lamina

Tissue culture

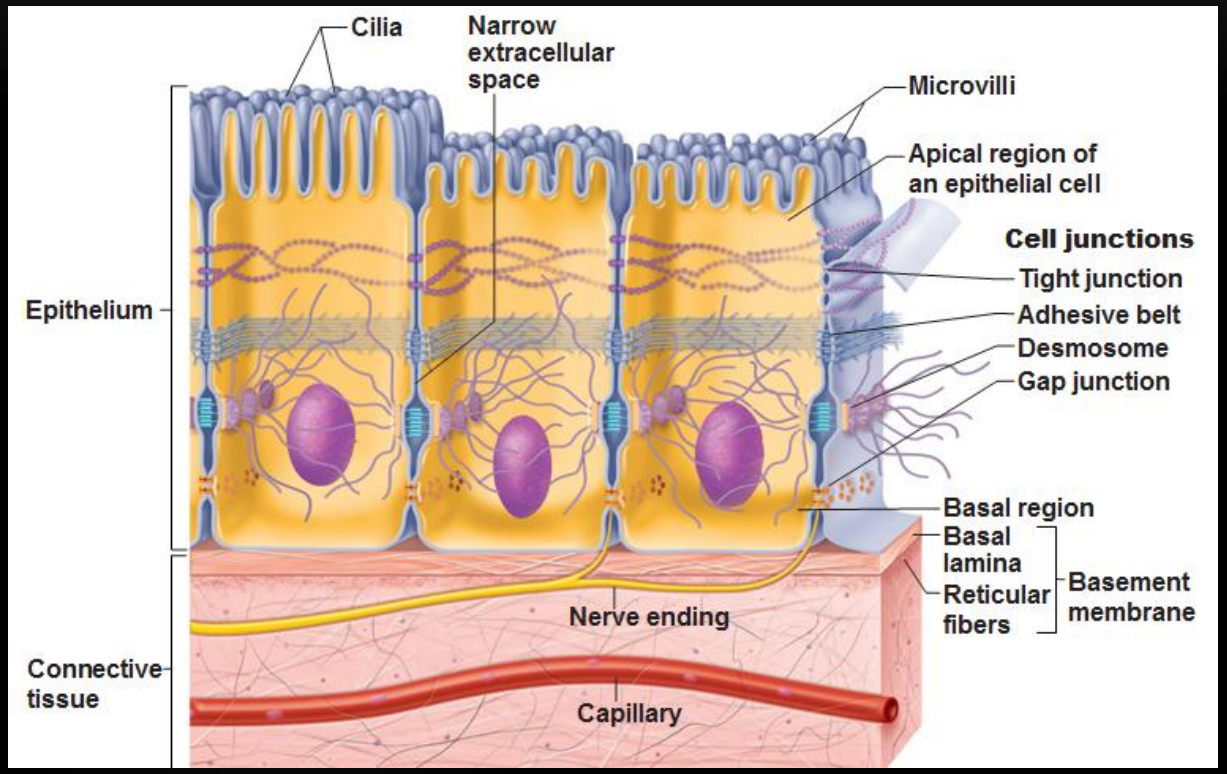
Tumor grading

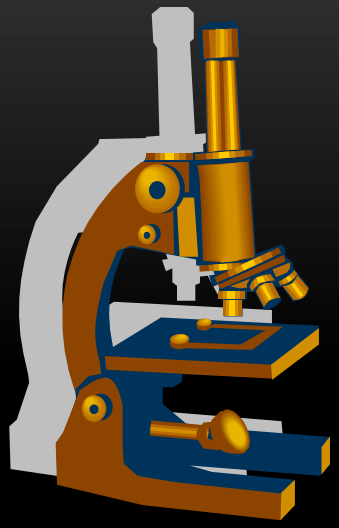
The epithelial cell

Shown to have the following domains:

- Apical
- Baso-lateral

Each domain shows modifications to suit its functions.





Fact….
Most of the tumors after the age of 45 are of epithelial origin.

Functions of Epithelium

- Protection:
- Transcellular transport:
- Secretion:
- Absorption:
- Selective permeability:
- Detection of sensations:

Classification of Epithelium

According to the number of cell layers above the basal lamina epithelium is classified into:

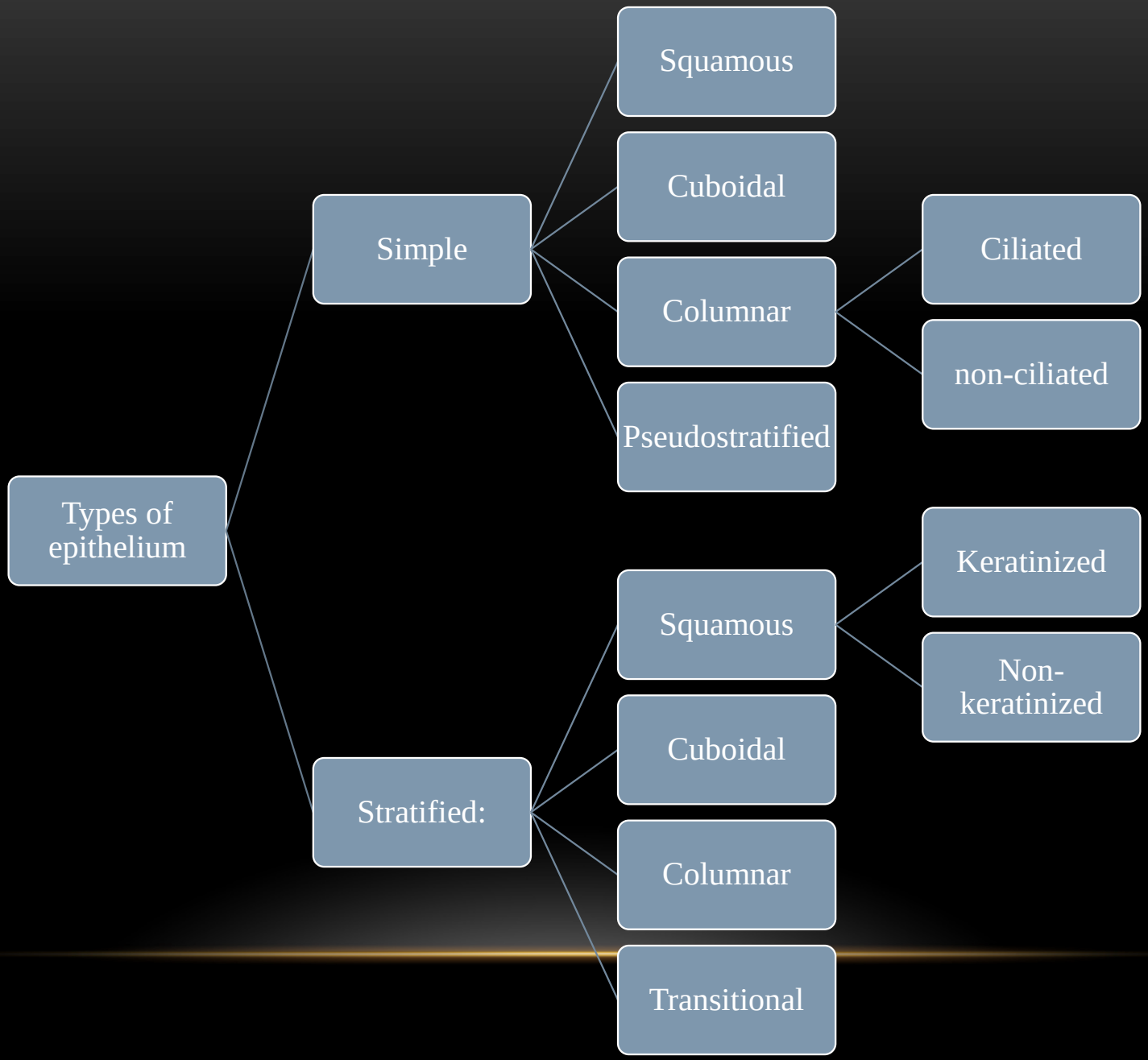
- simple, or
- stratified

Simple epithelium is named according to the shape of its cells.

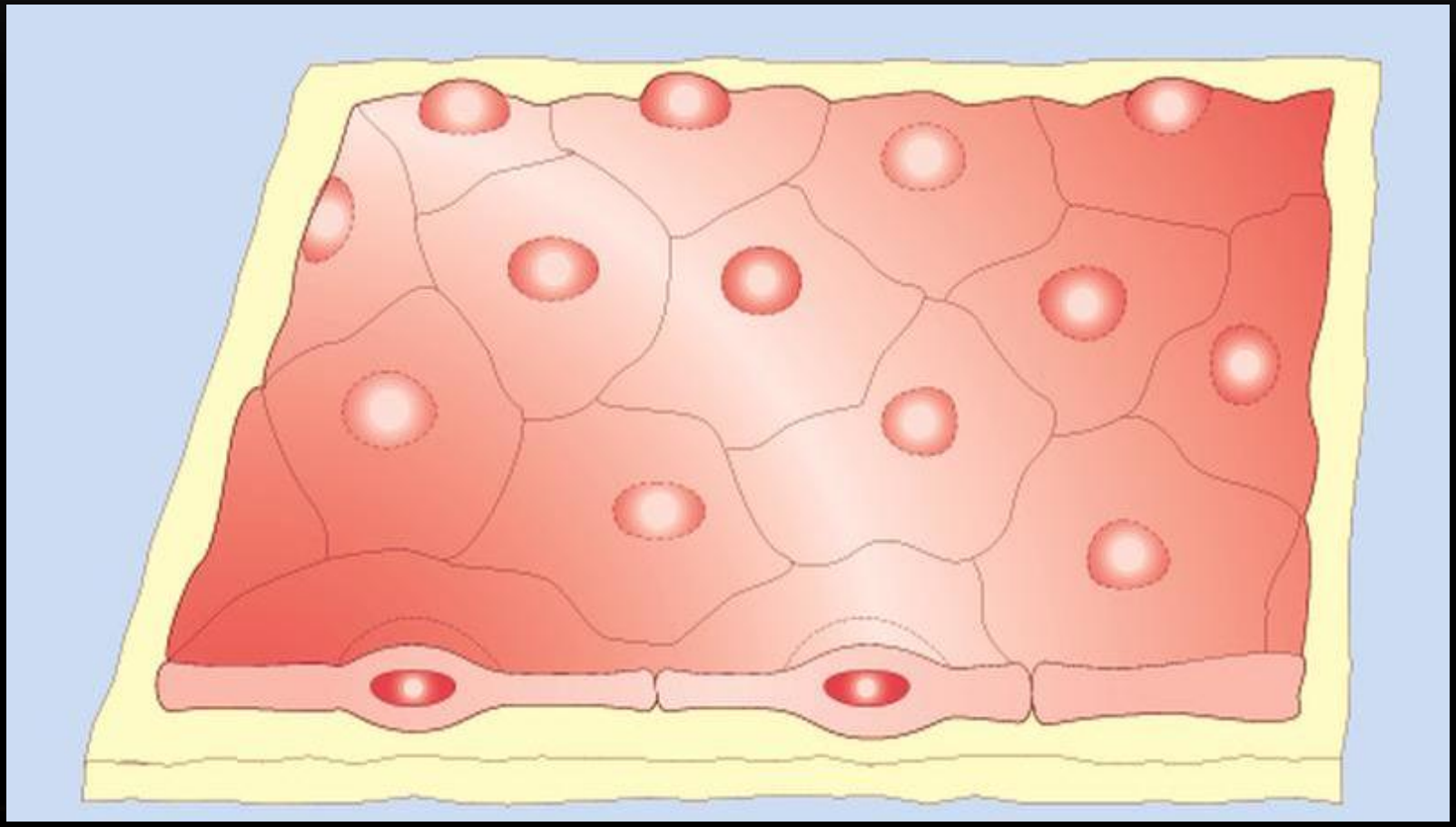
Stratified epithelium is named according to the shape of the cells in the outermost layer.

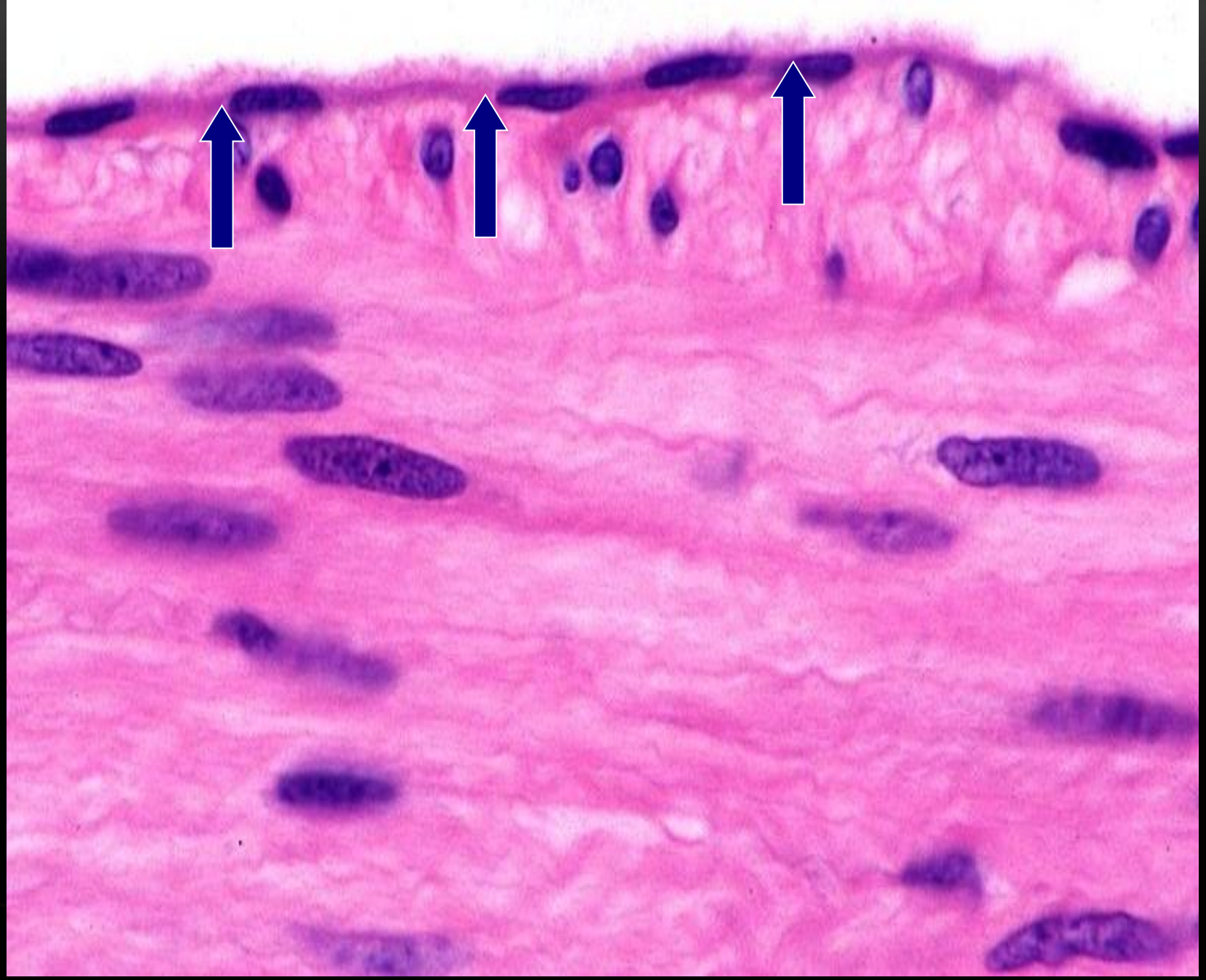
Today a reader, tomorrow a leader.

Margaret Fuller

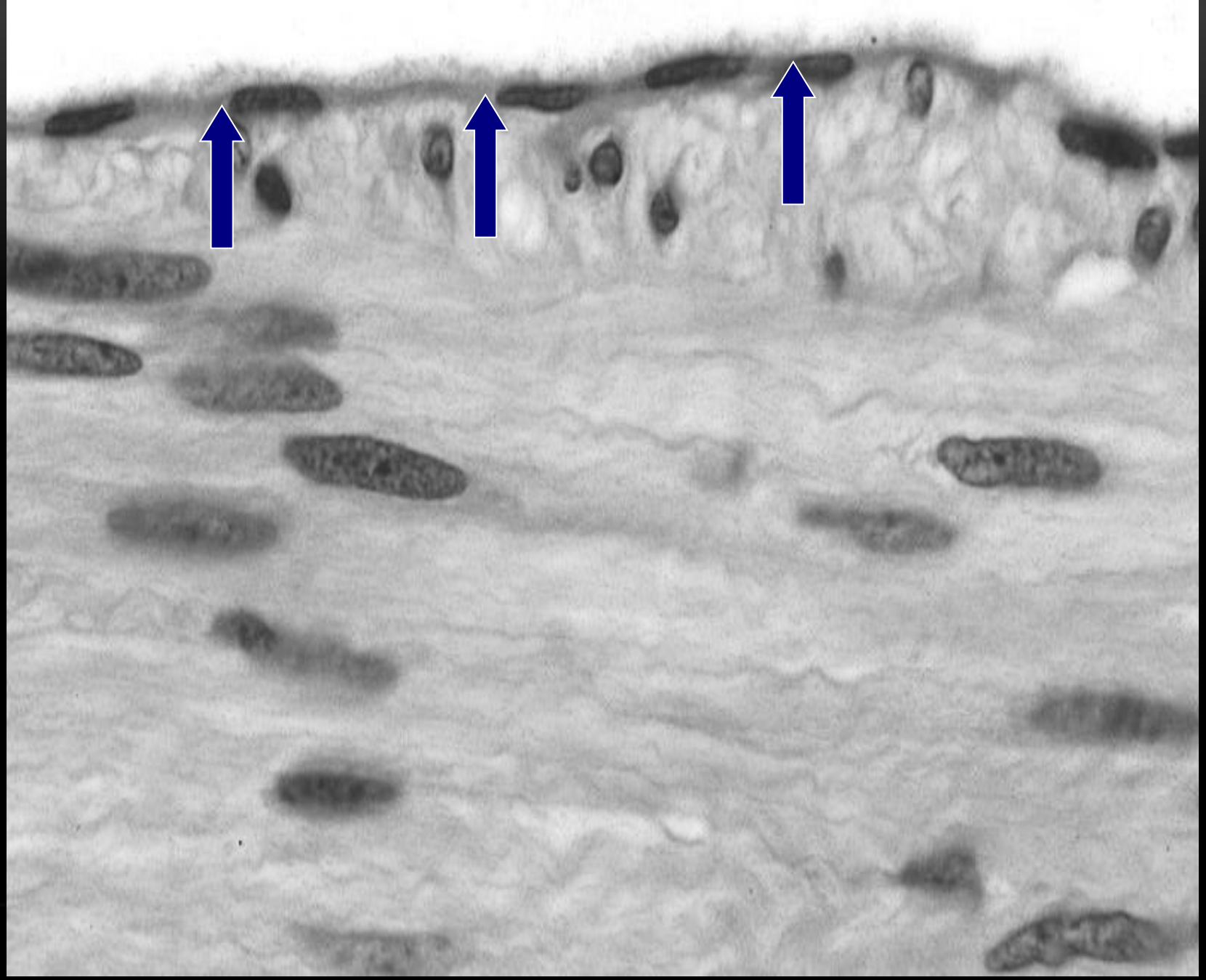

Types of epithelium
Simple
Squamous
Cuboidal
Columnar
Ciliated
non-ciliated
Pseudostratified
Stratified:
Squamous
Keratinized
Non-keratinized
Cuboidal
Columnar
Transitional

Simple Squamous Epithelium



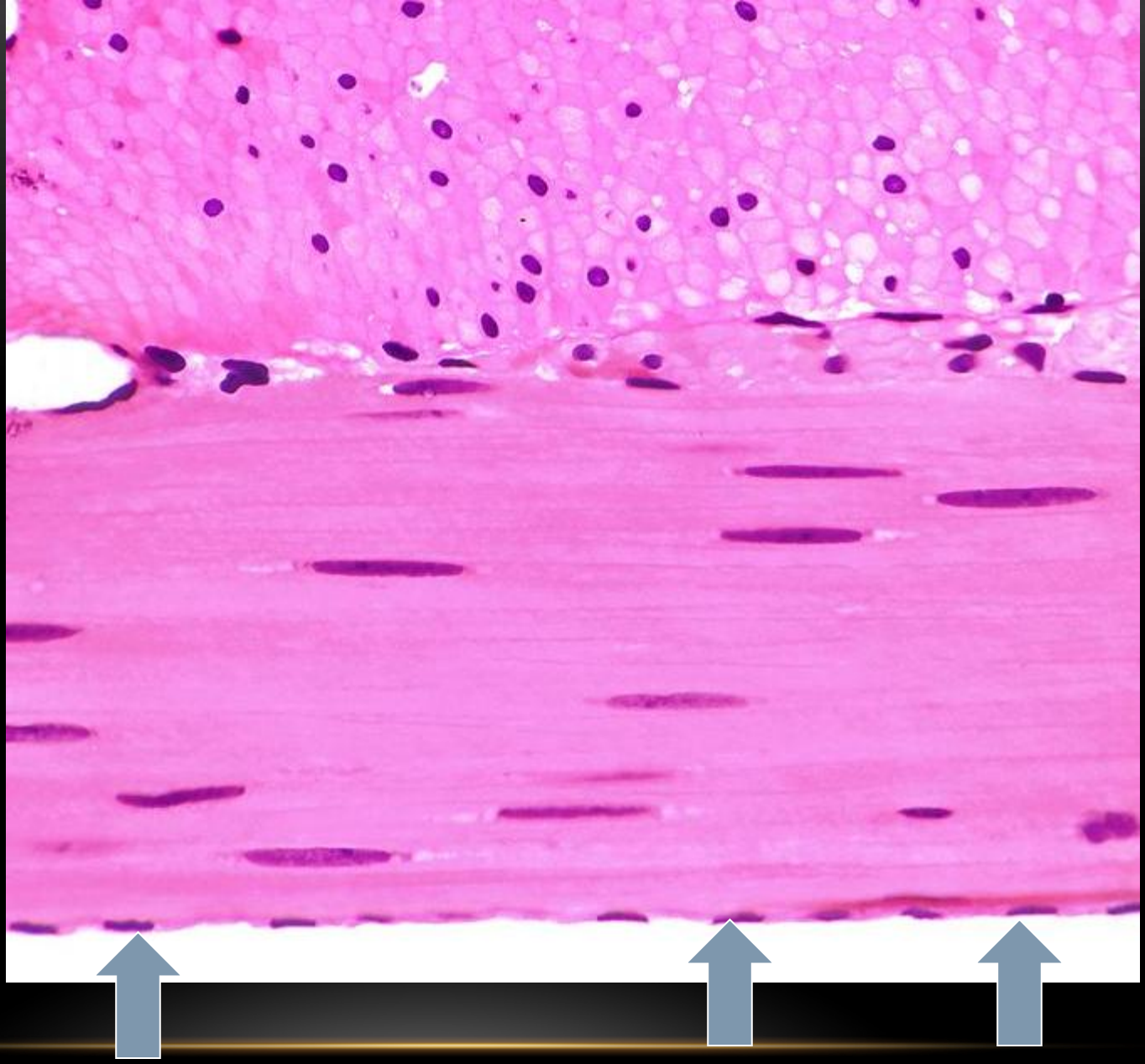


Mesothelium

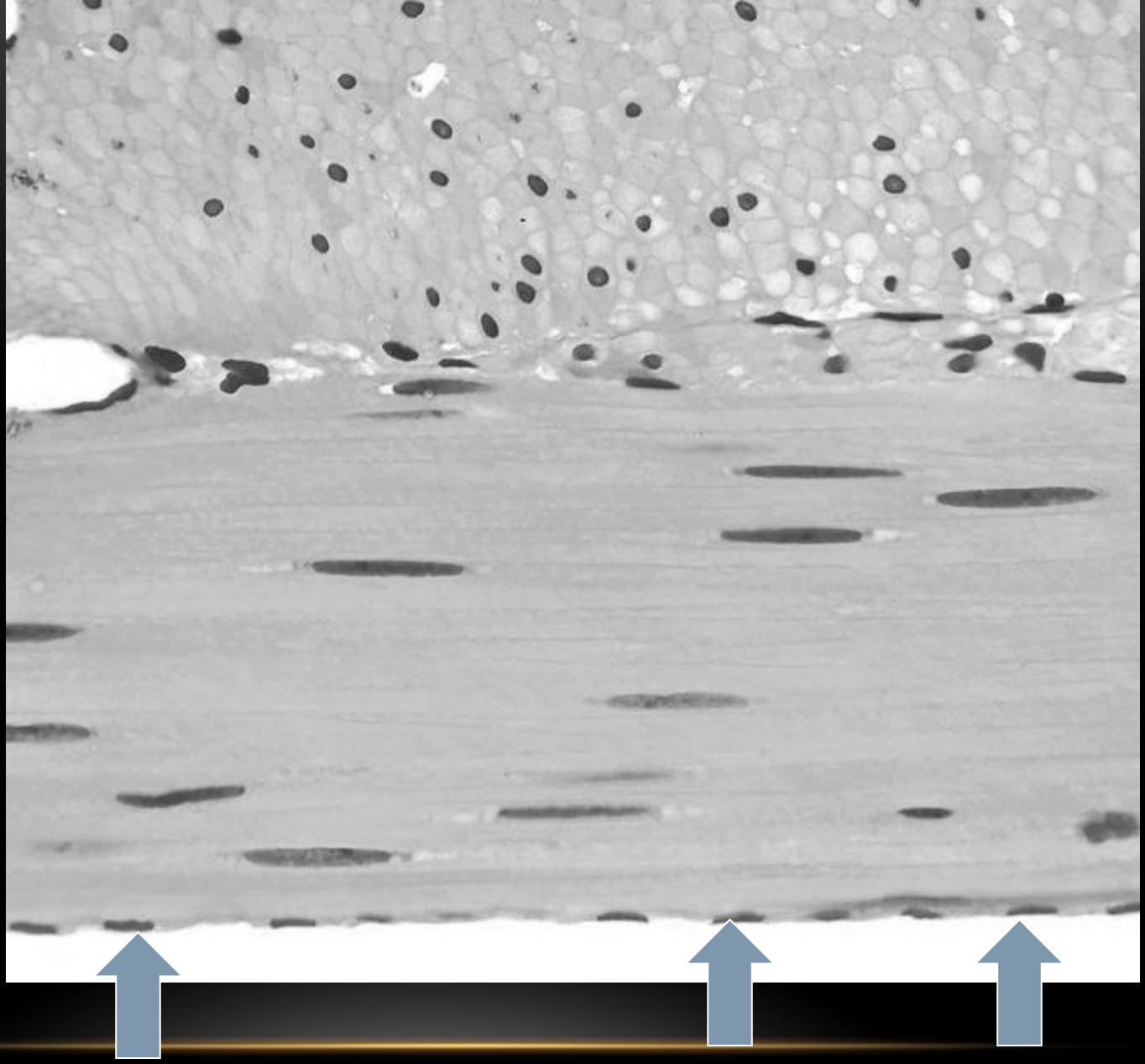


Mesothelium

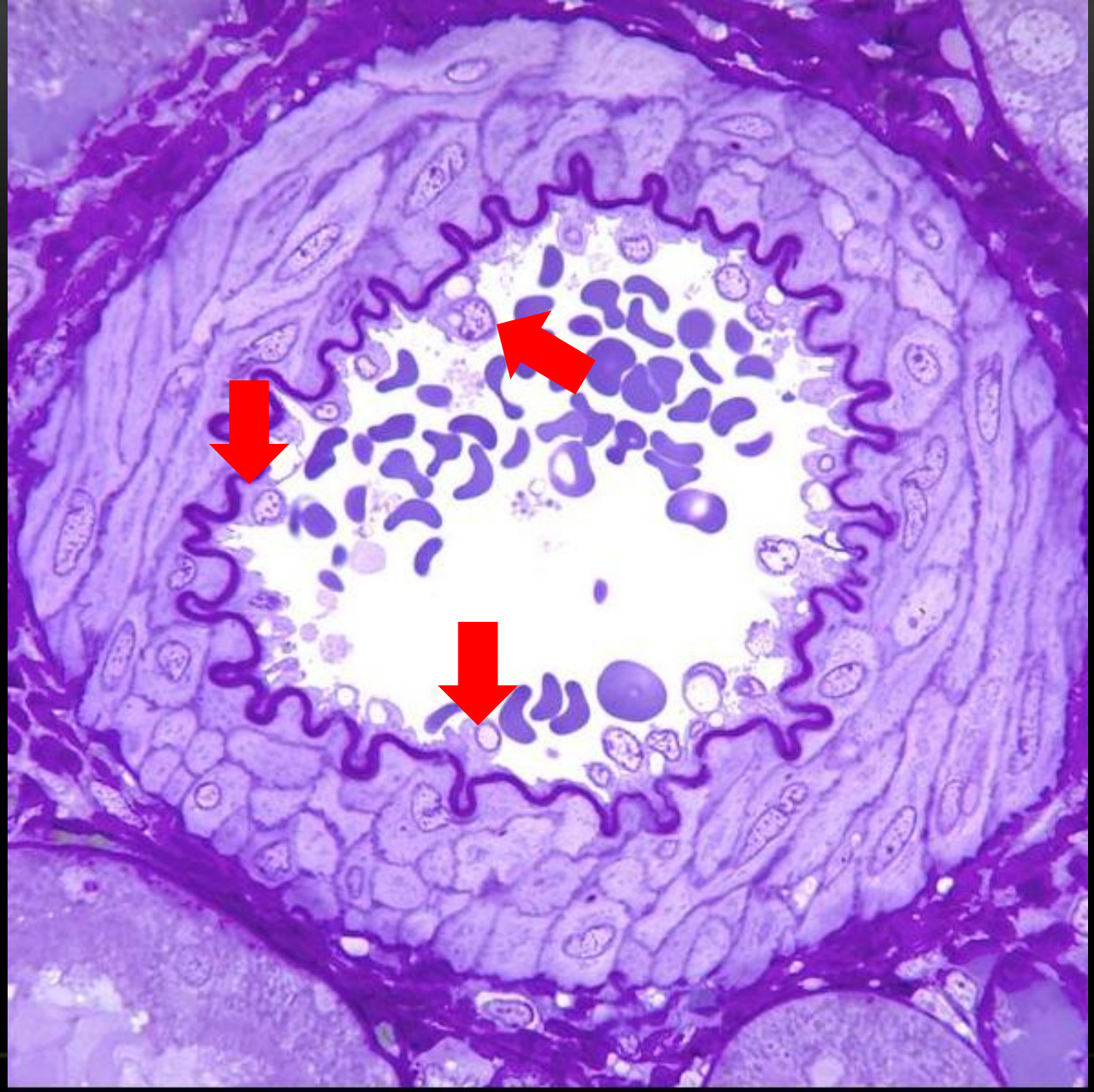
Mesothelium



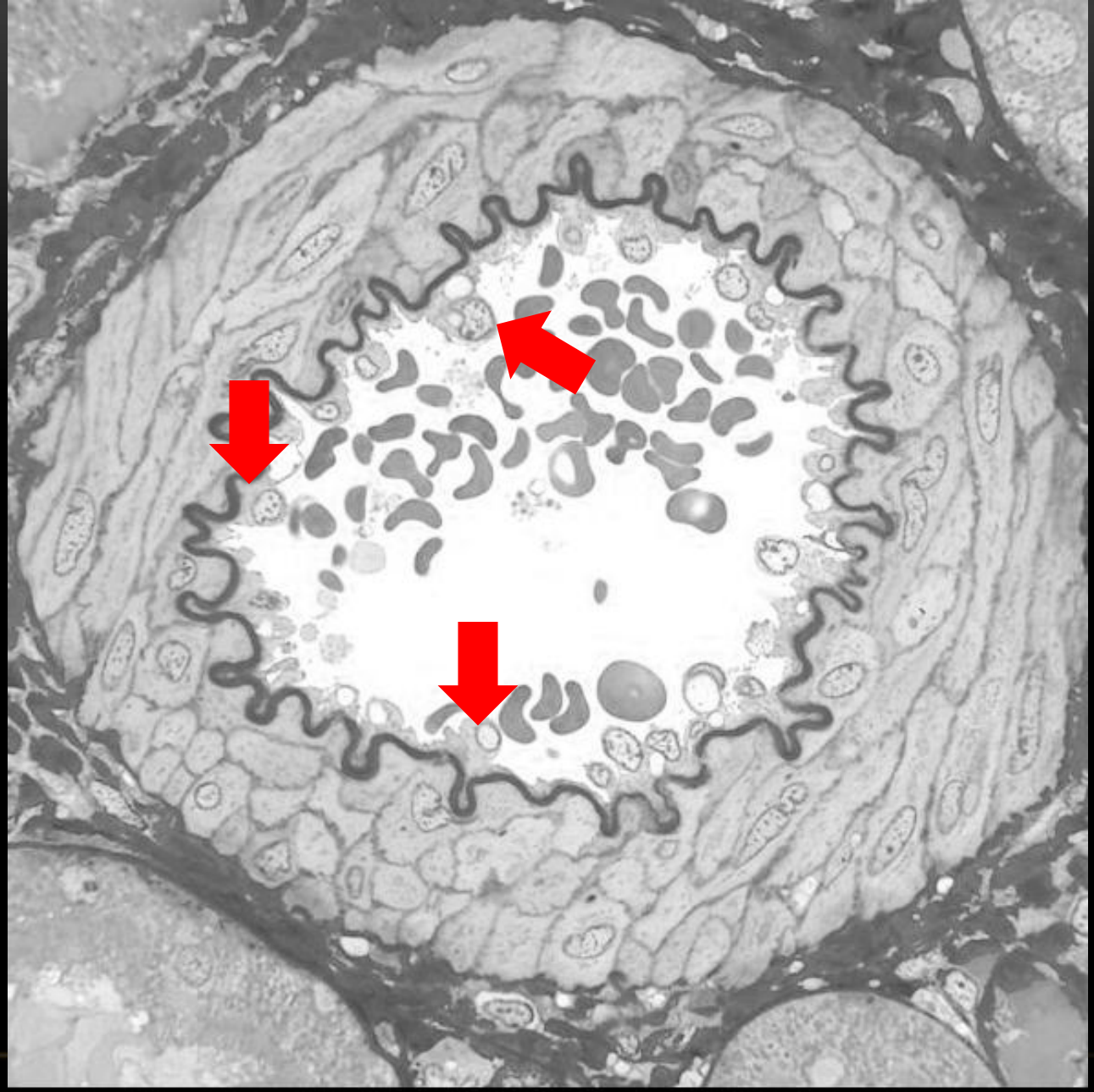
Mesothelium



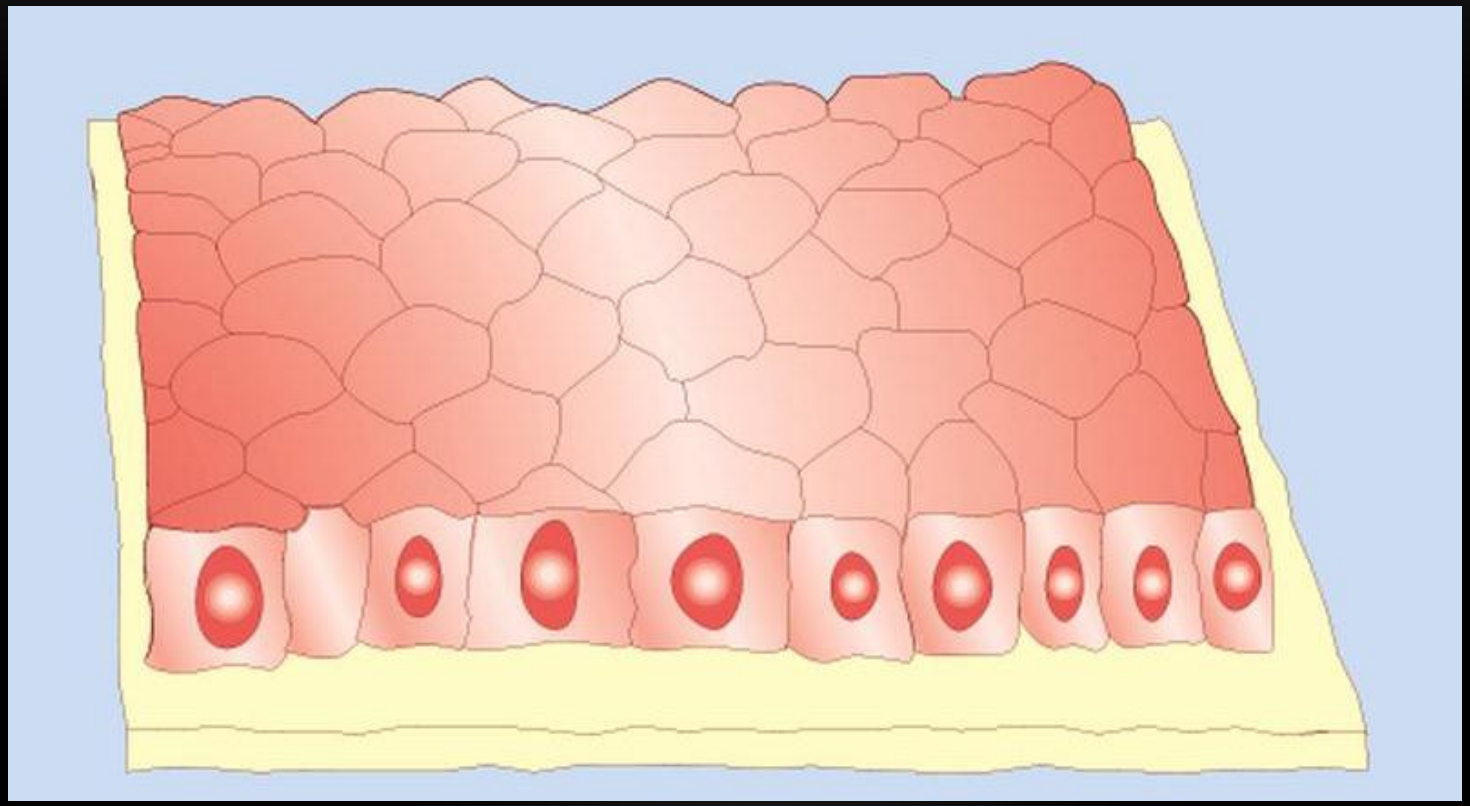
Endothelium

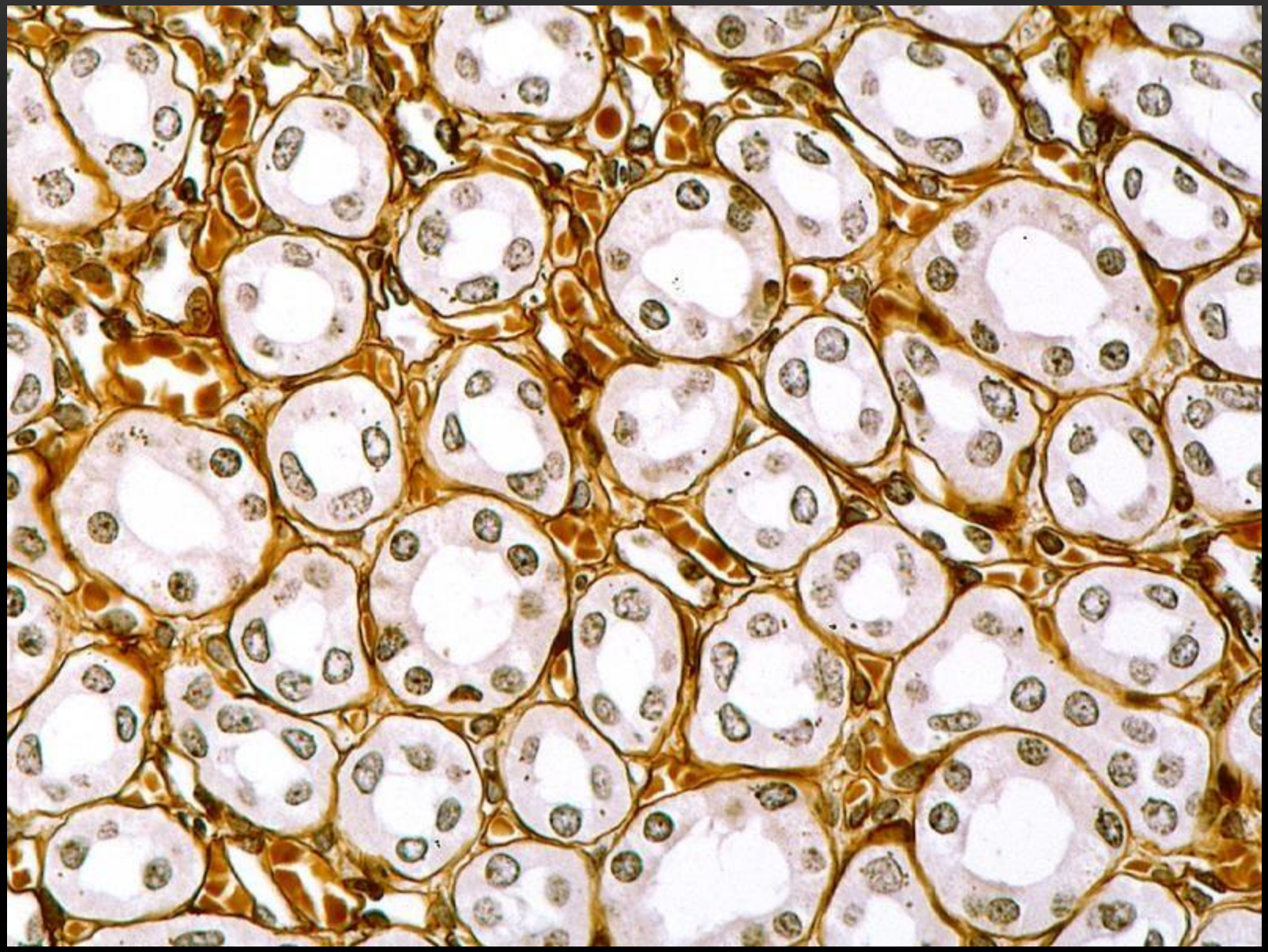


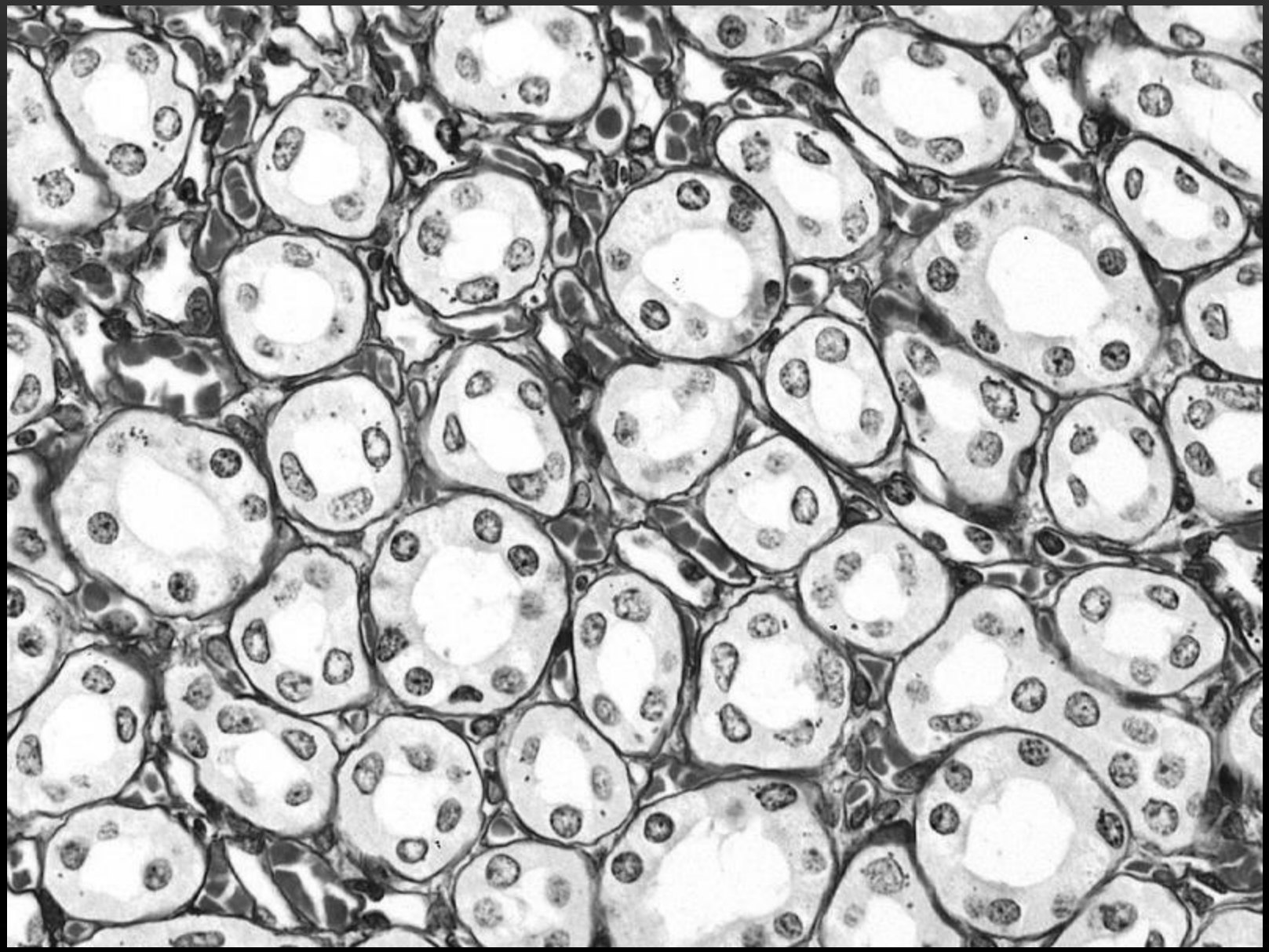
Endothelium

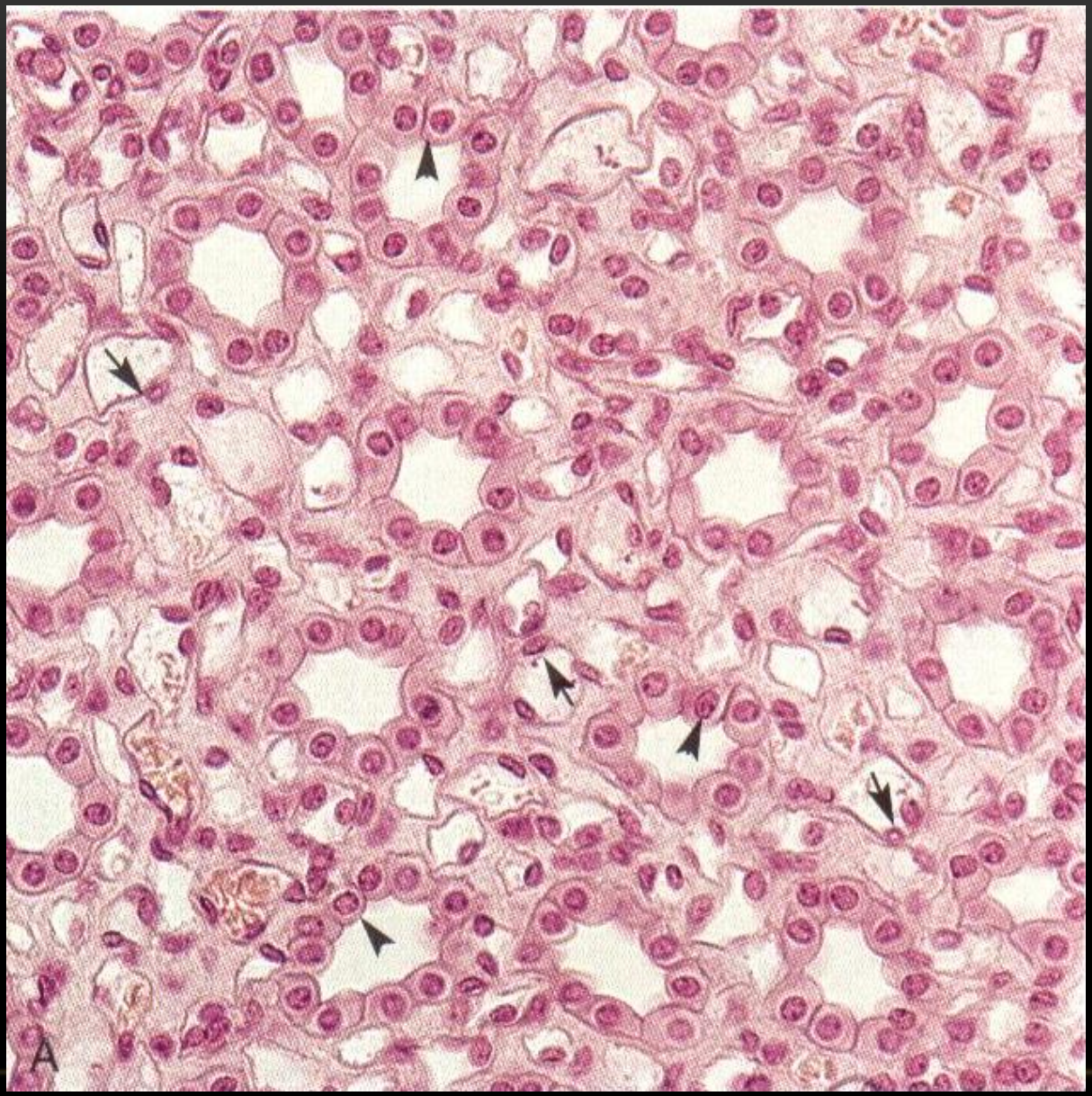


Simple Cuboidal

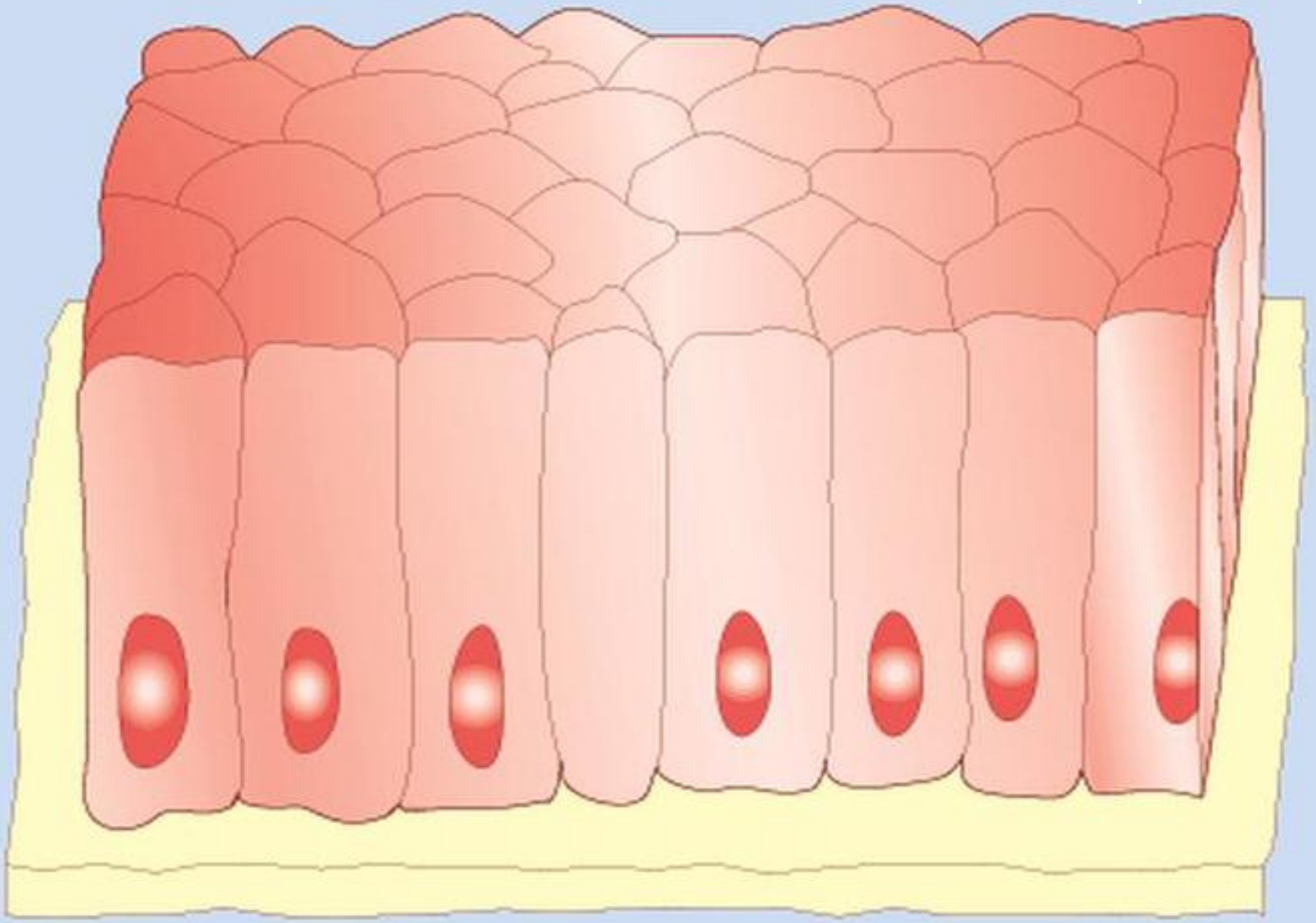


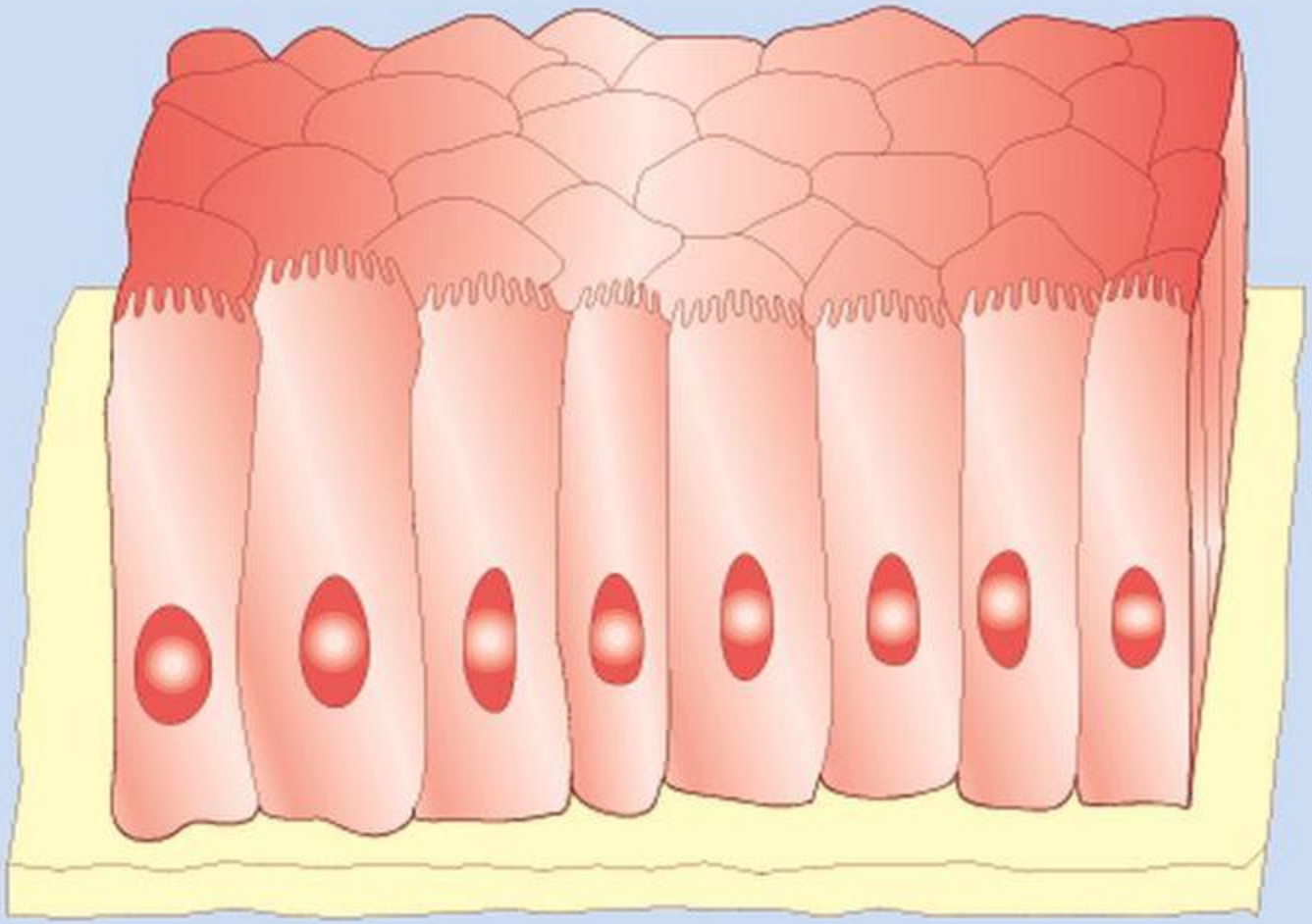




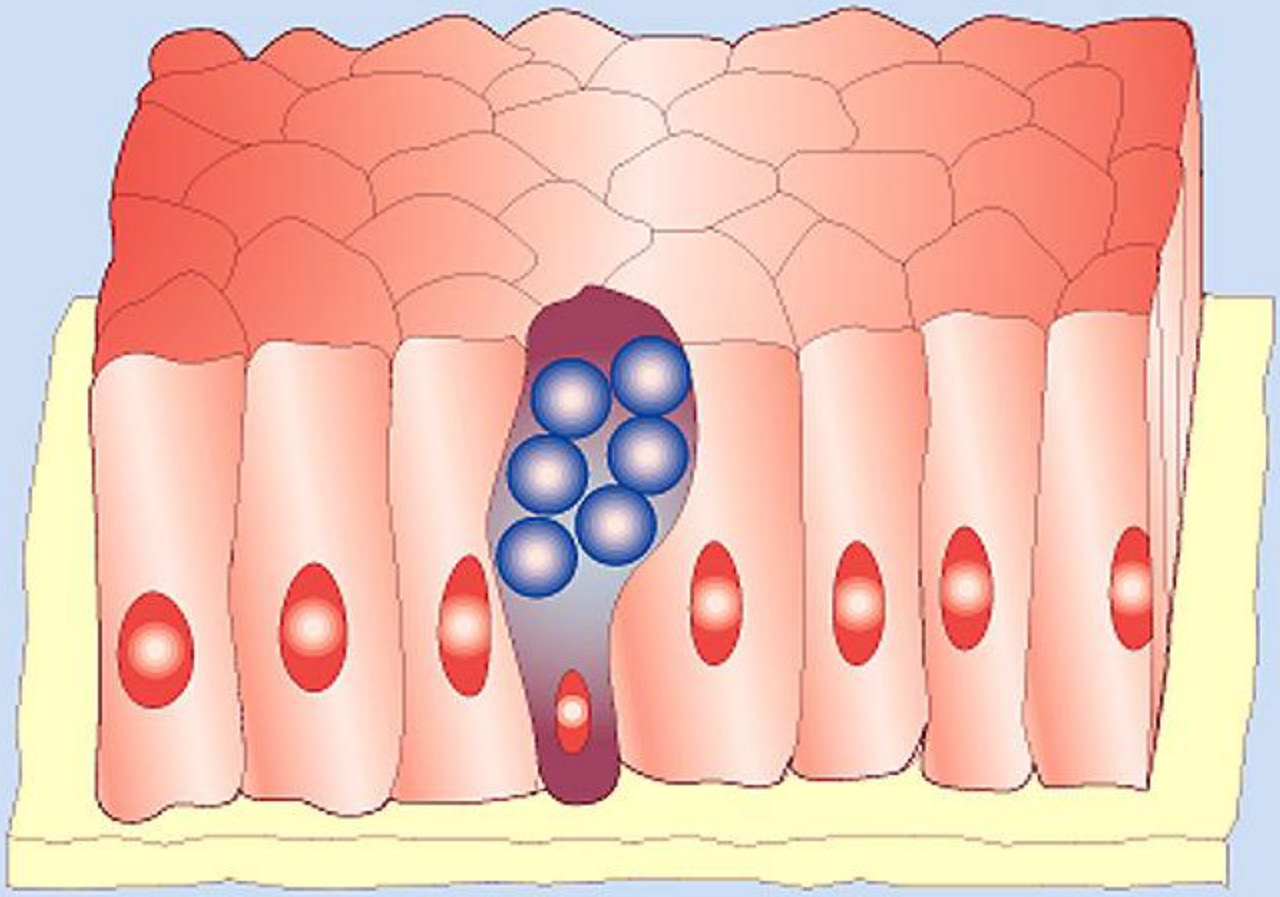

A

Simple columnar

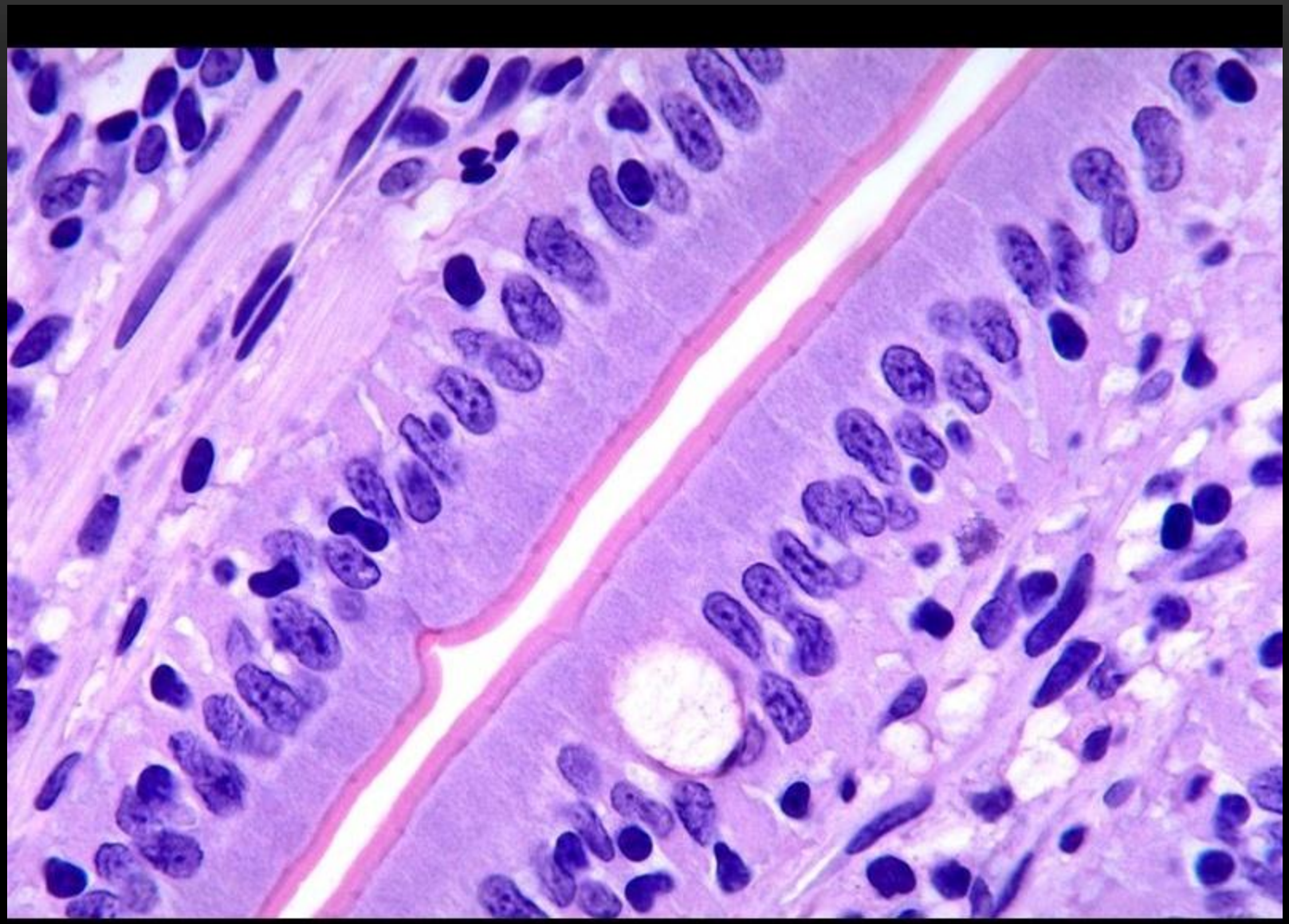


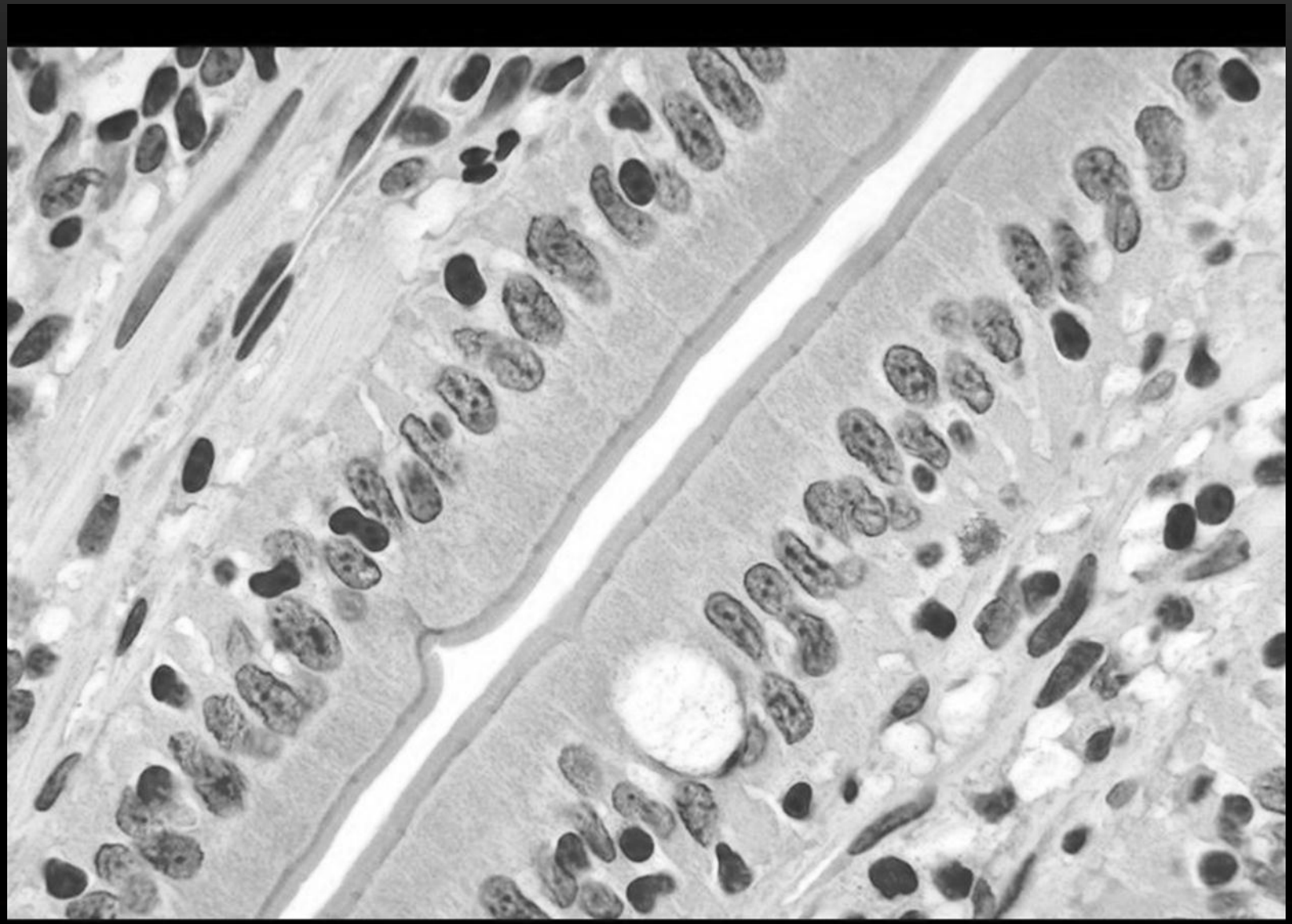


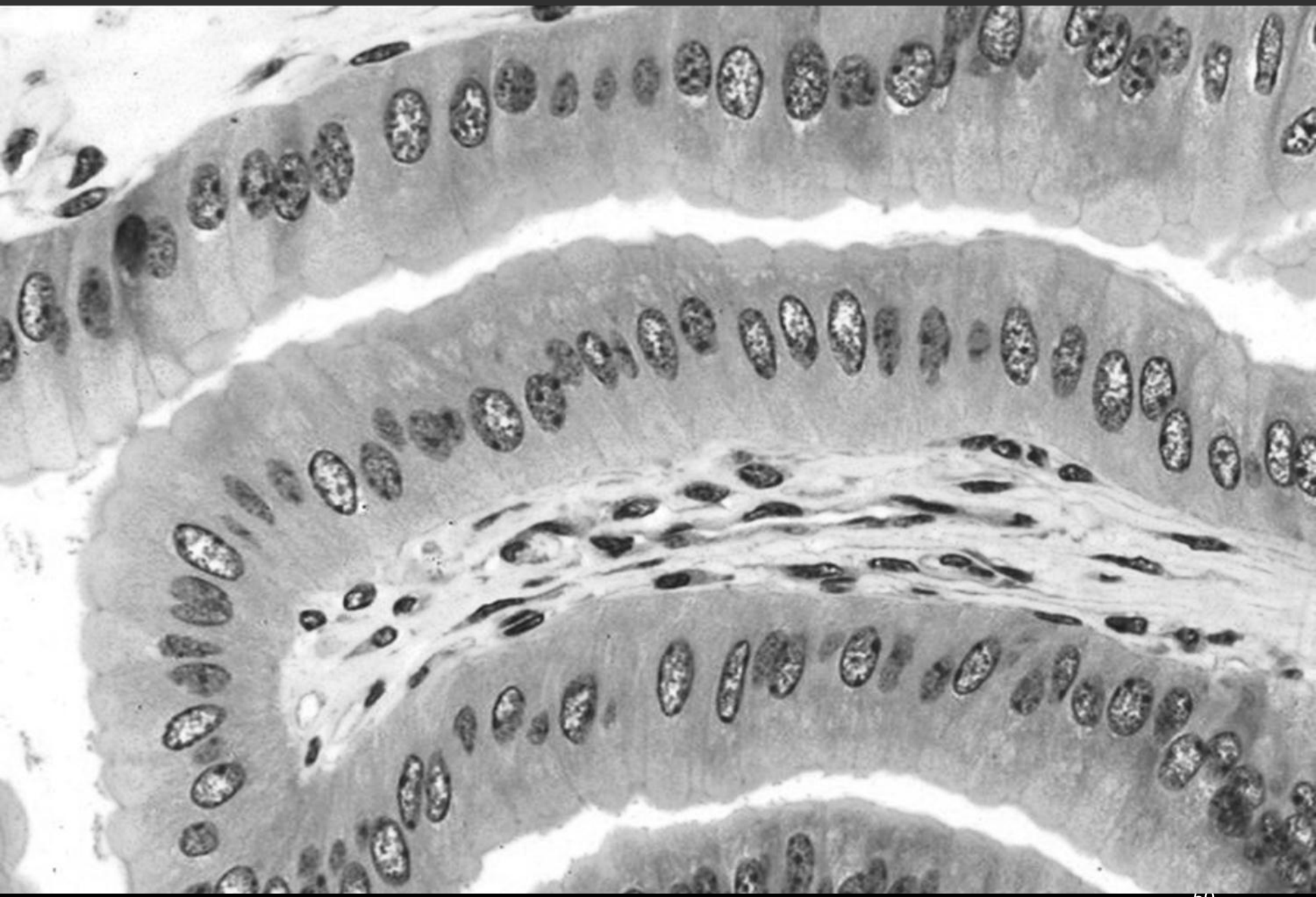
Simple columnar with microvilli

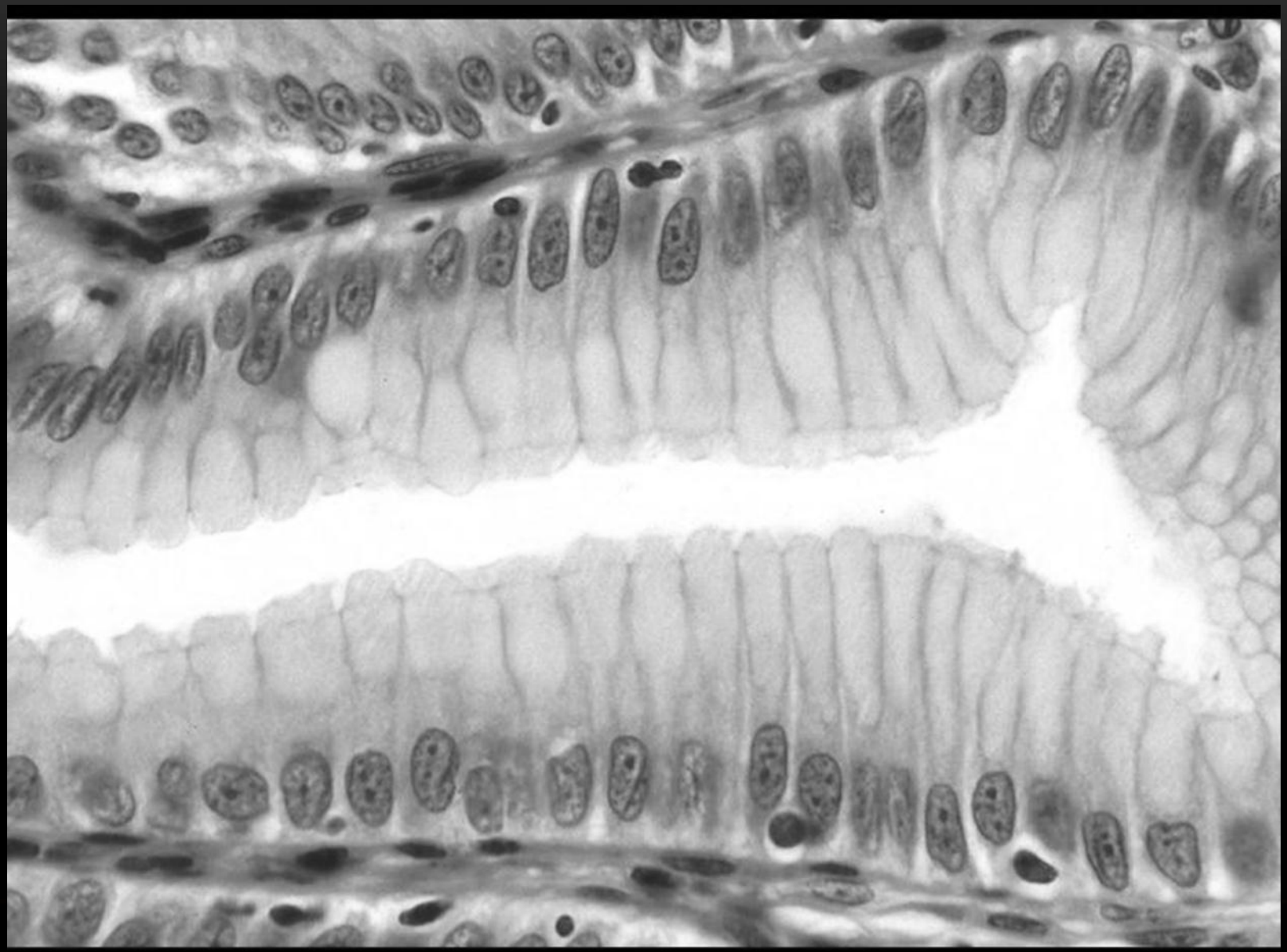


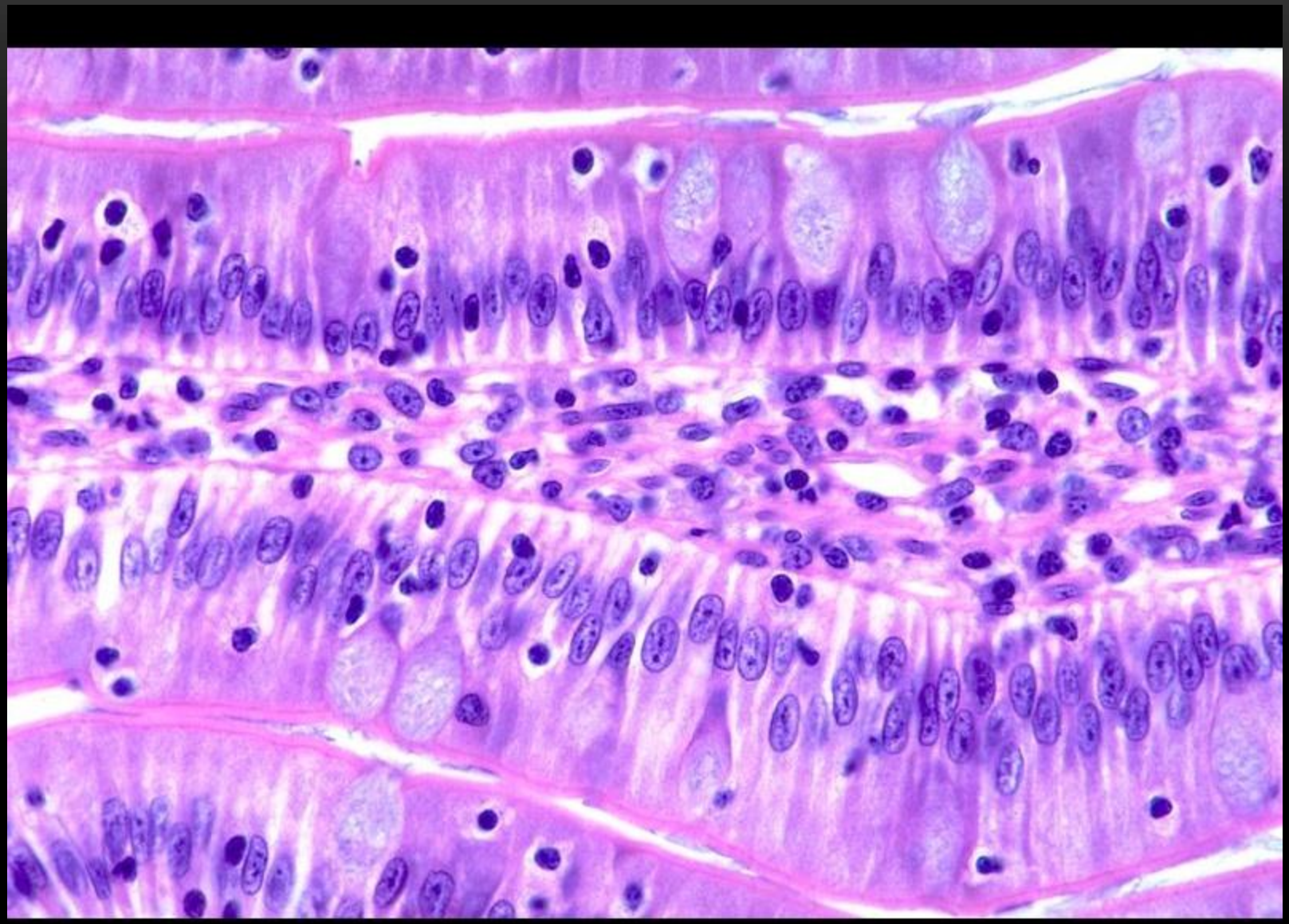
Simple columnar with goblet cells

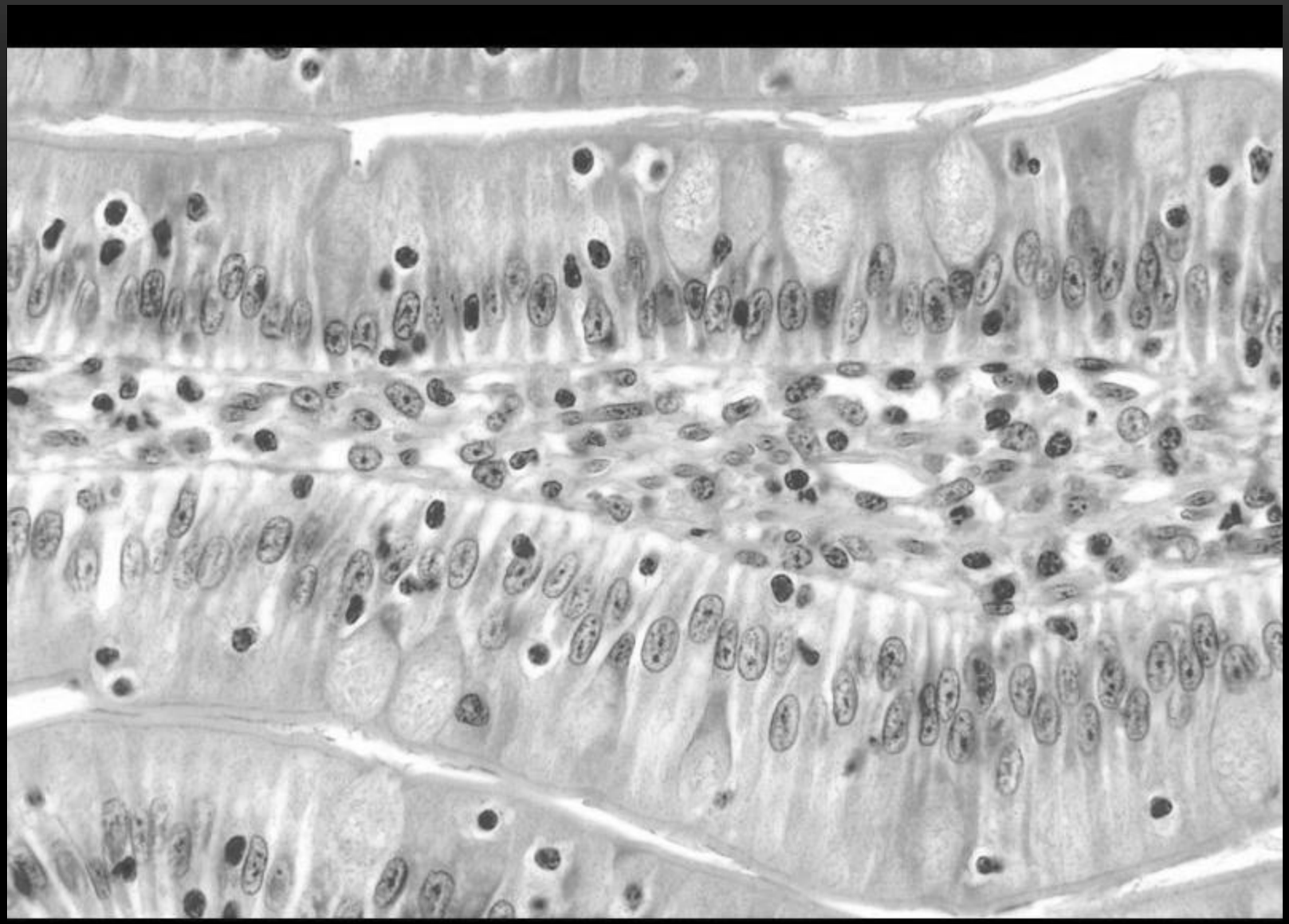


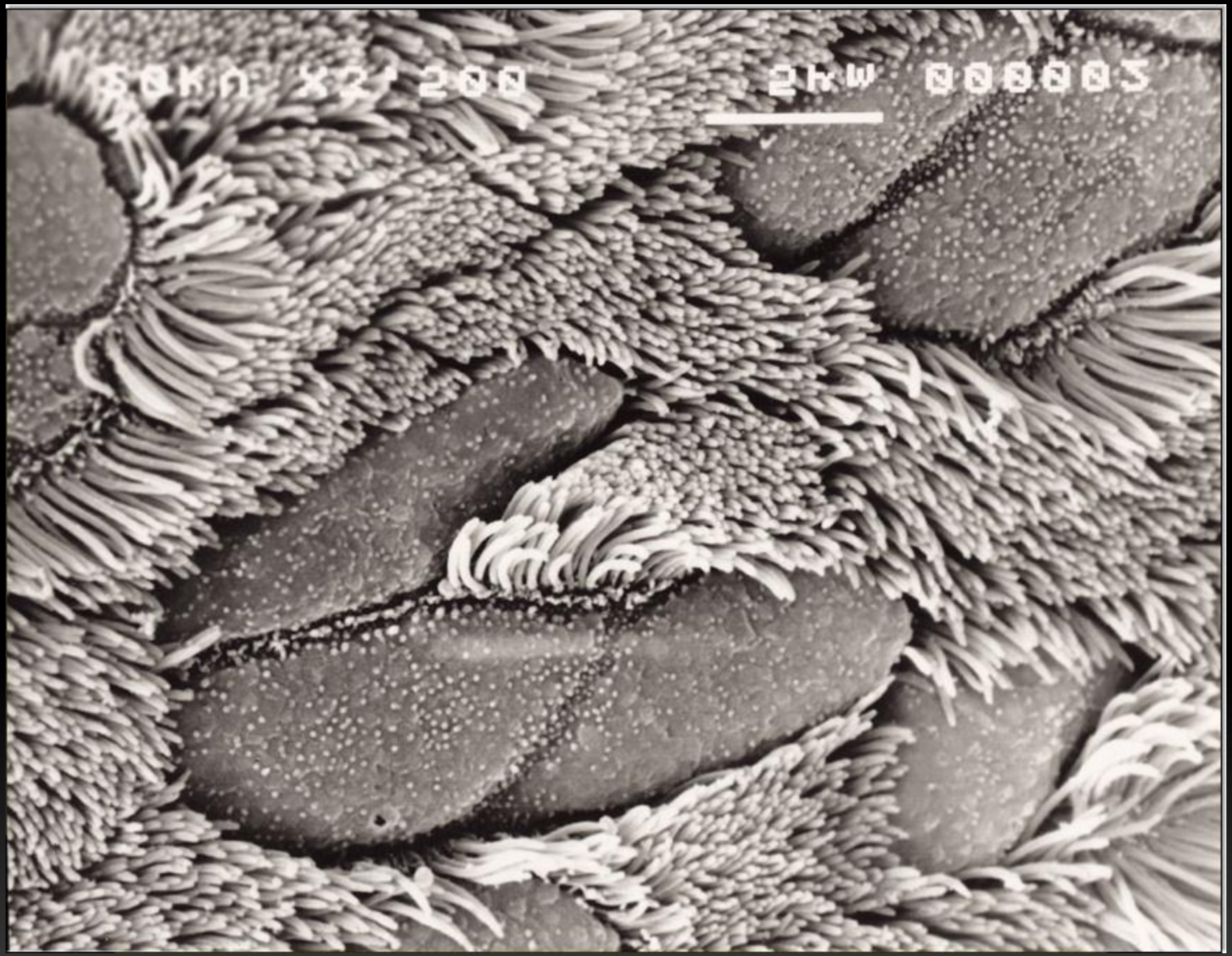








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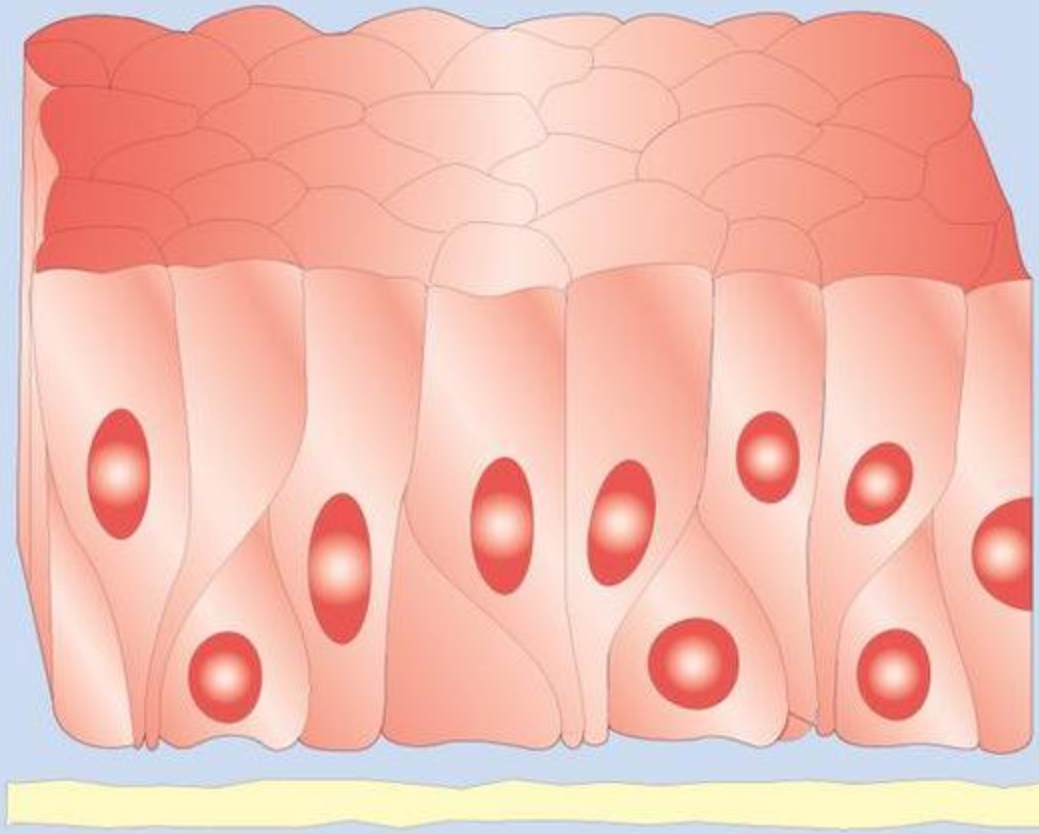
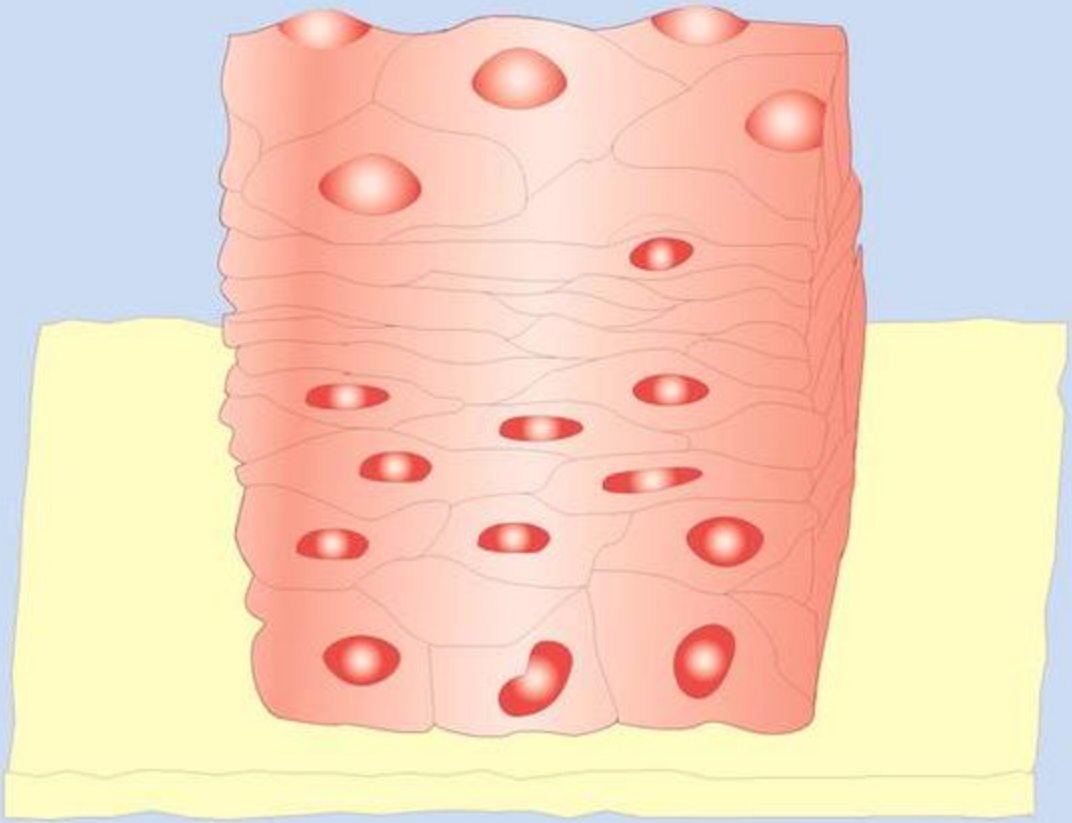


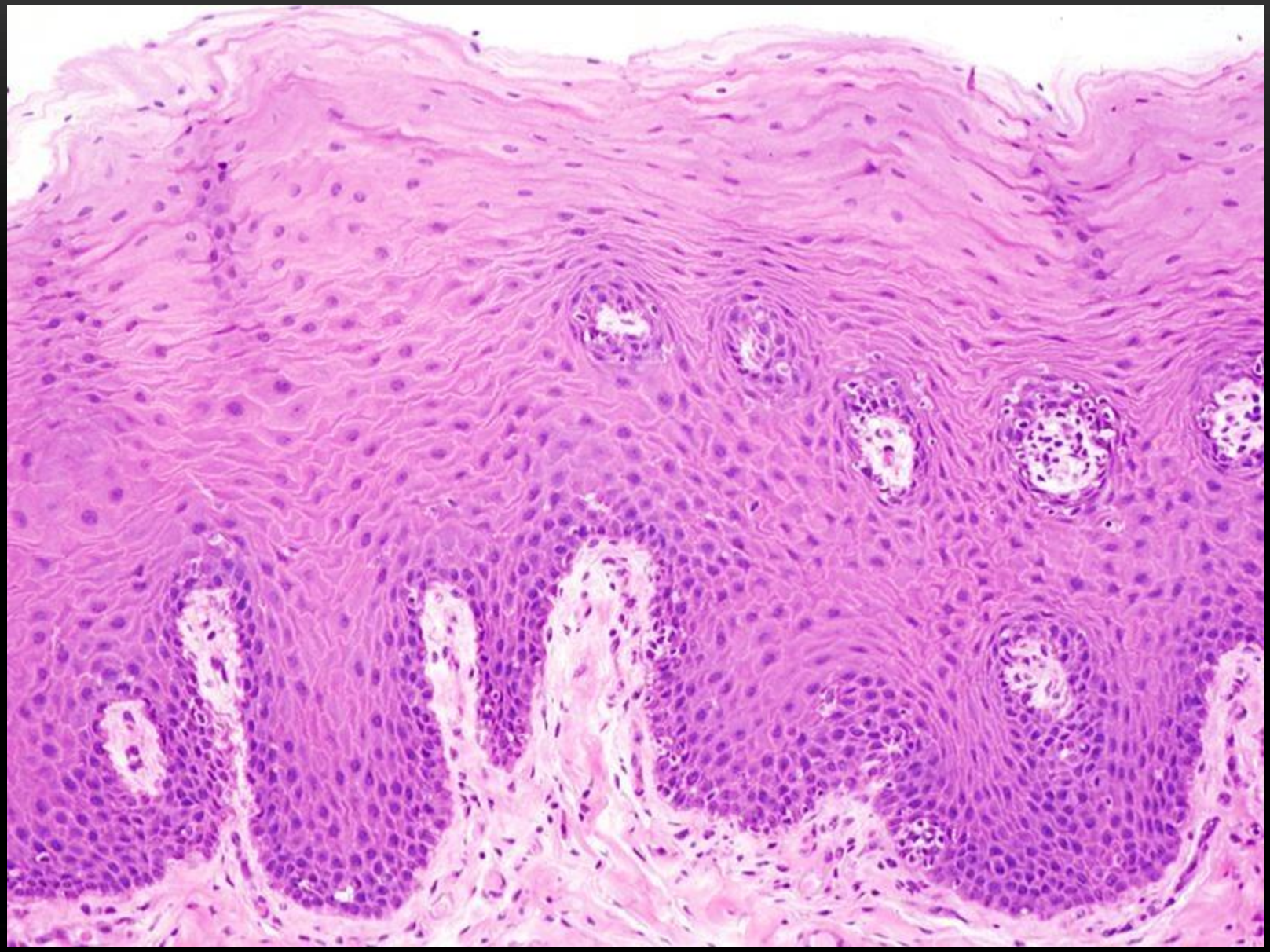
Pseudostratified

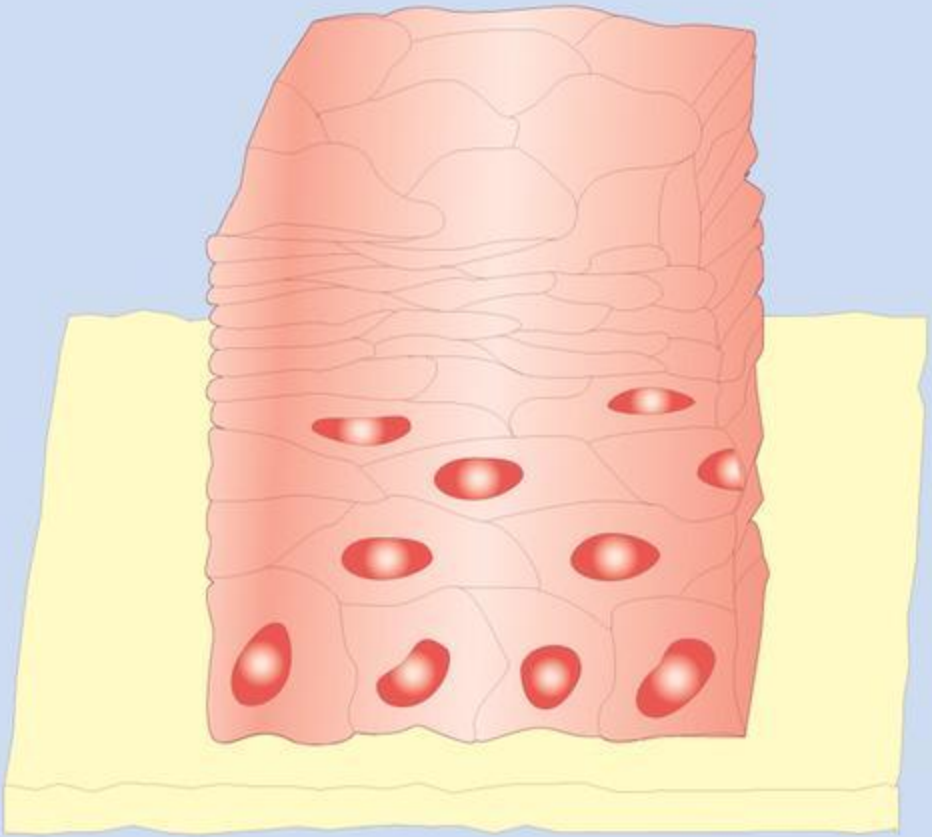
People call it luck when you've acted more sensibly than they have.

Ann Tyler

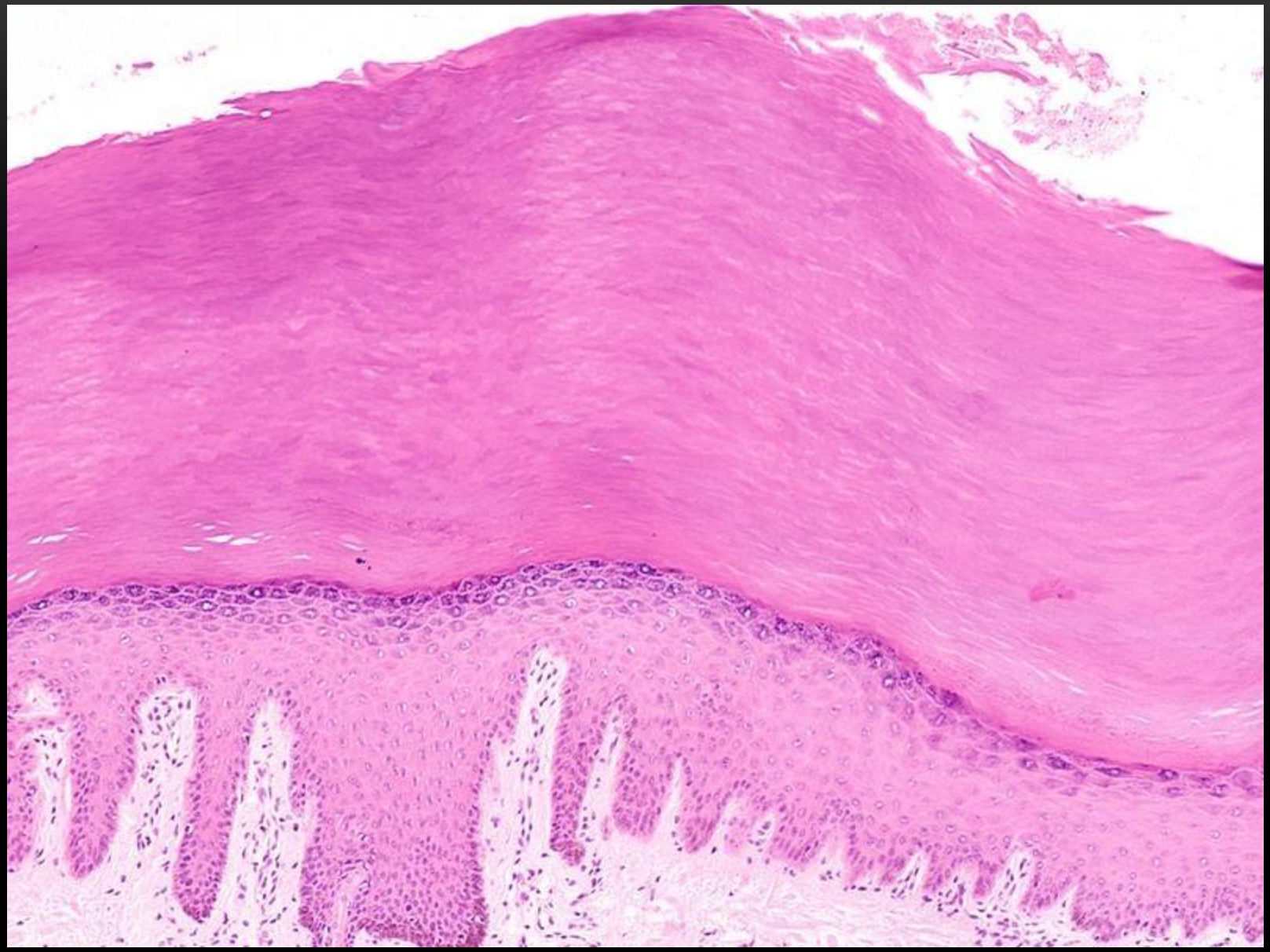


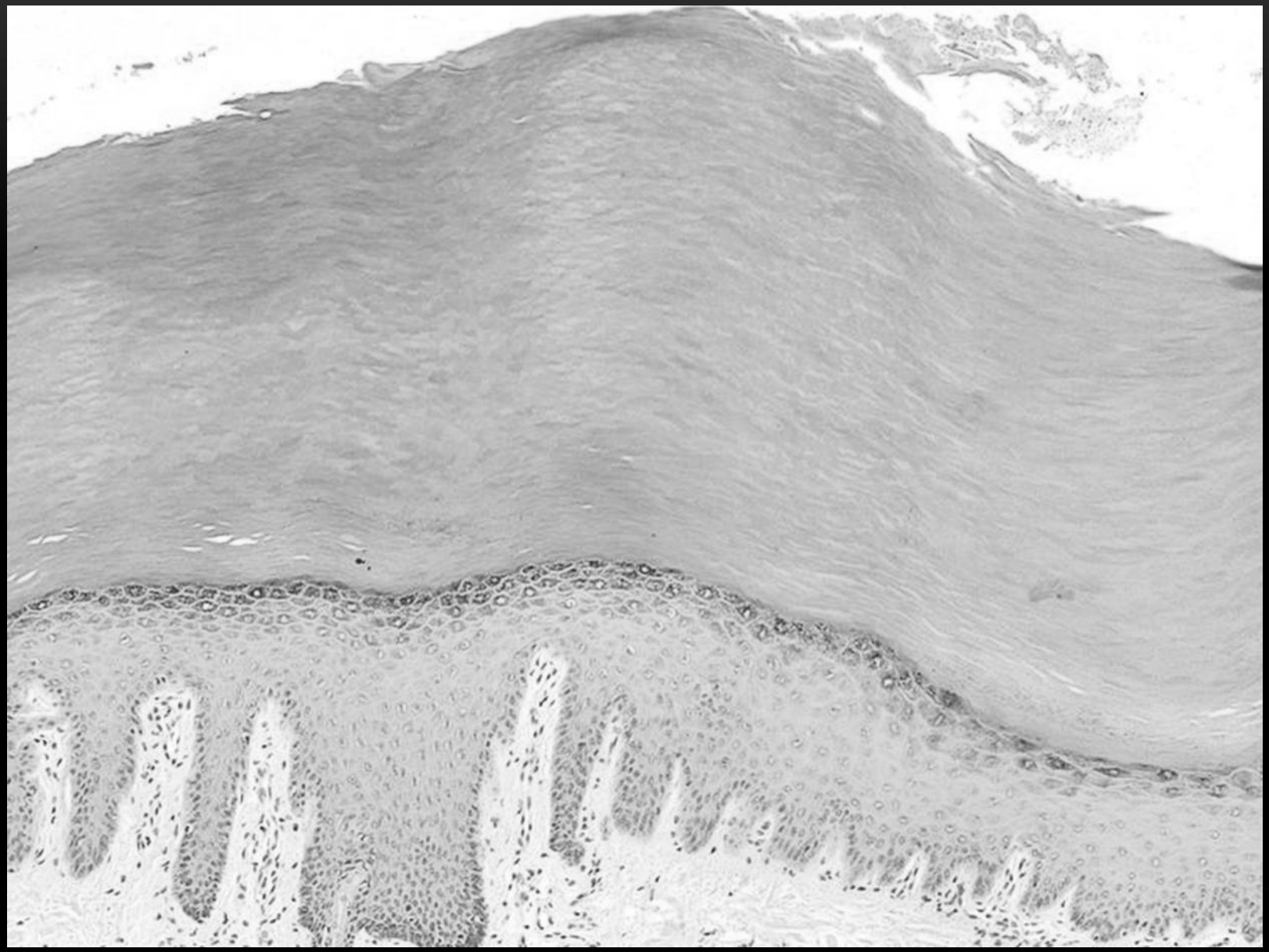
Stratified squamous epithelium



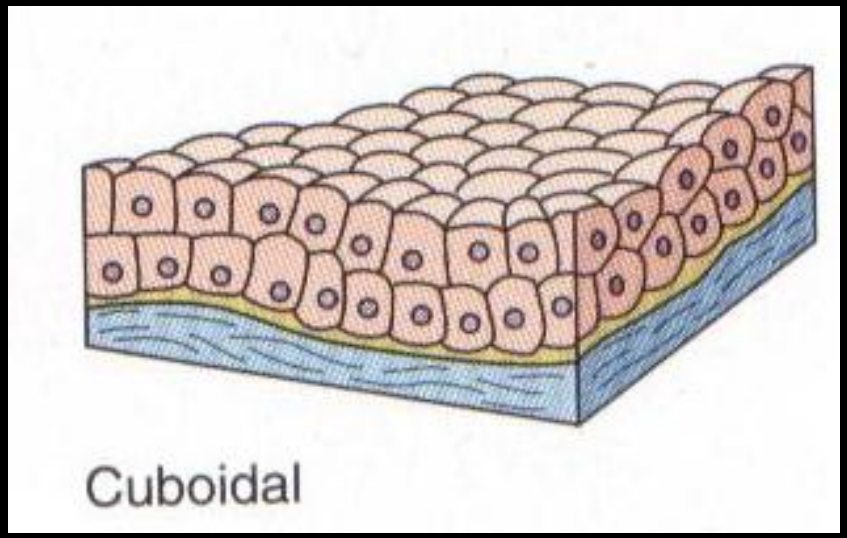


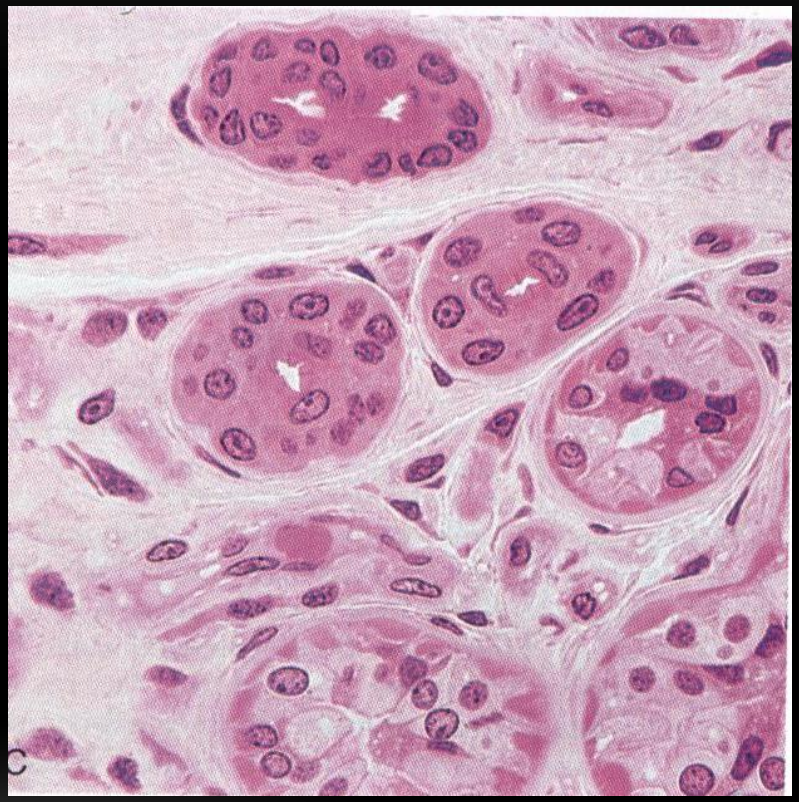
Keratinized stratified squamous epithelium



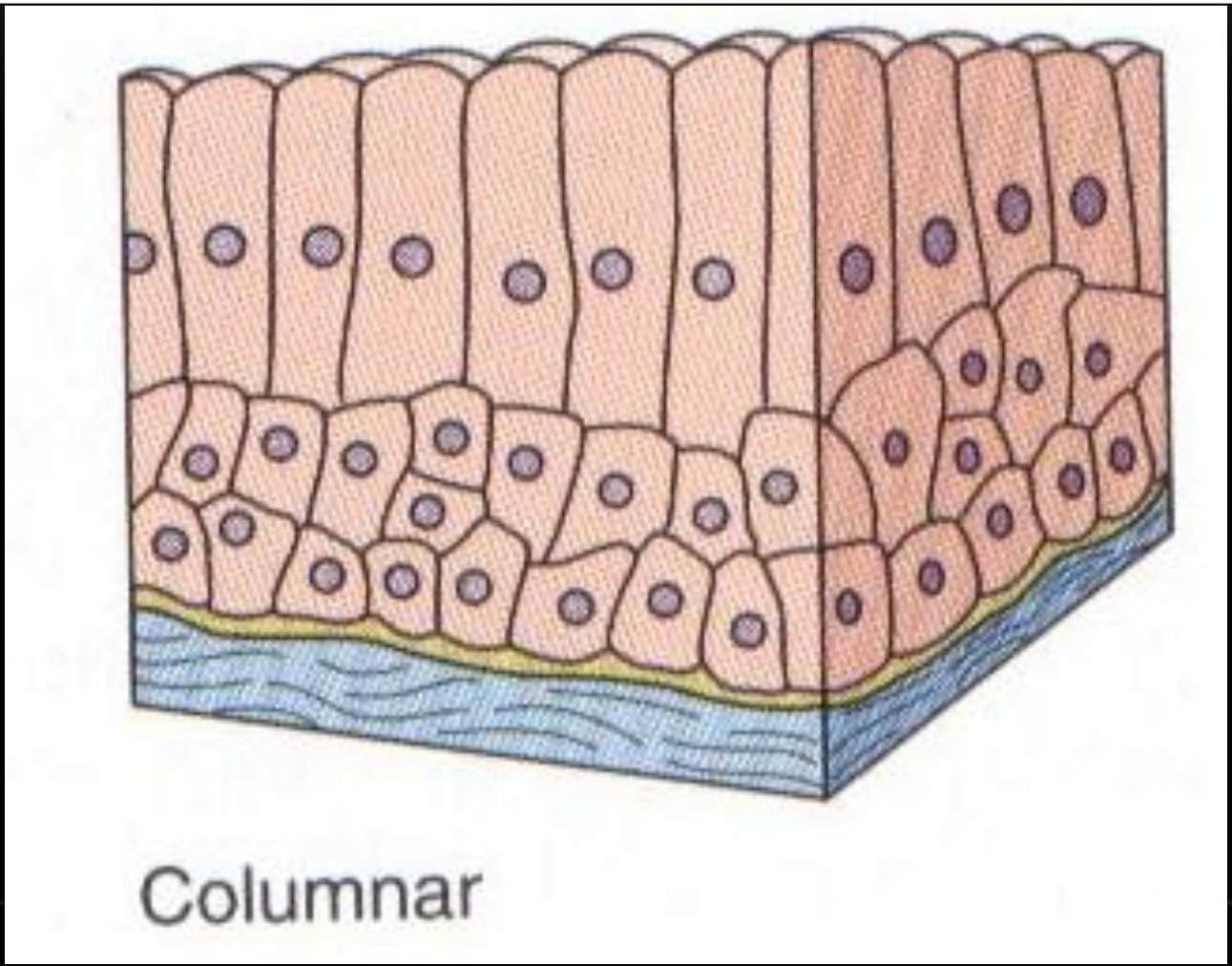


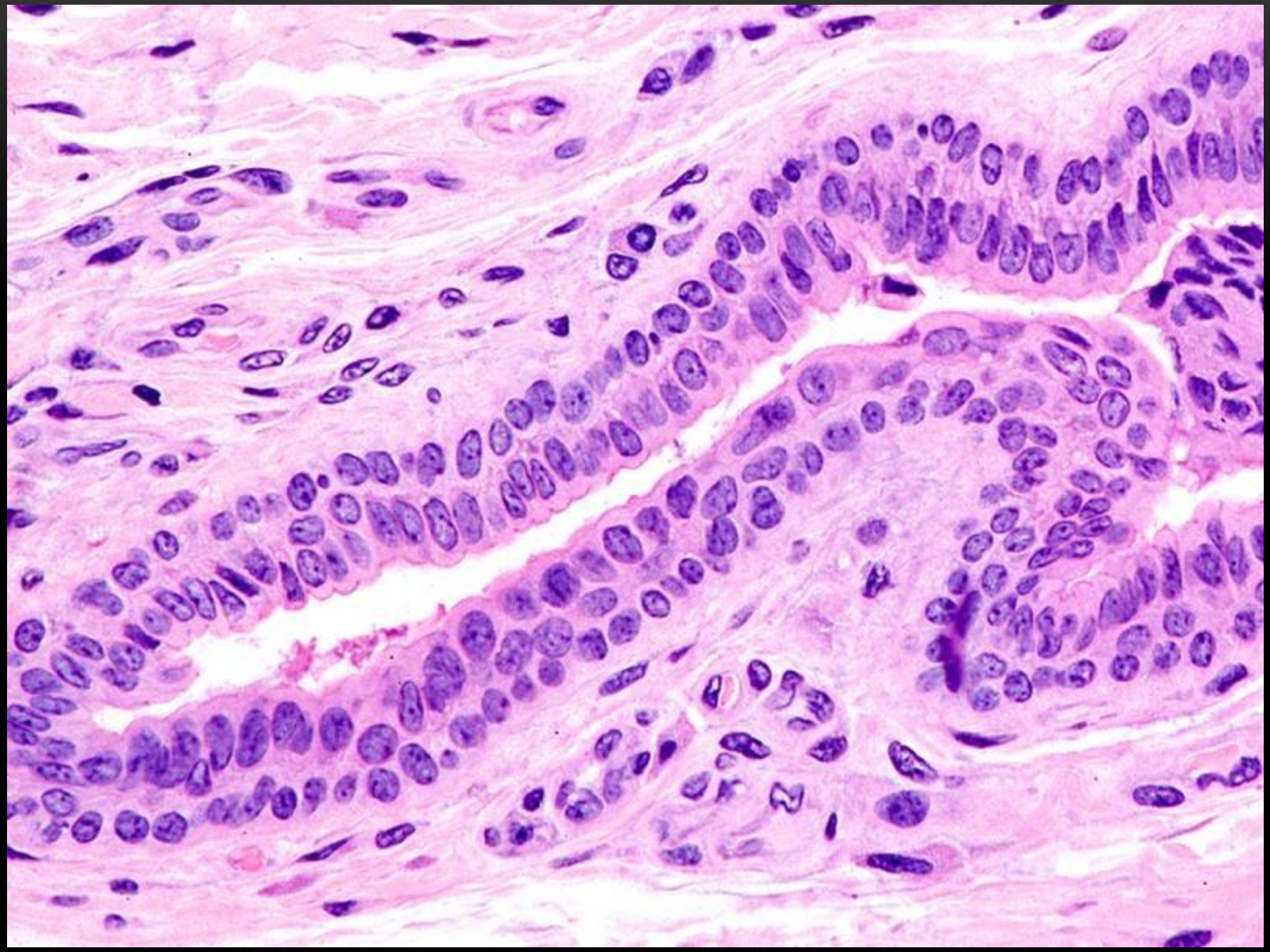
Stratified Cuboidal Epithelium

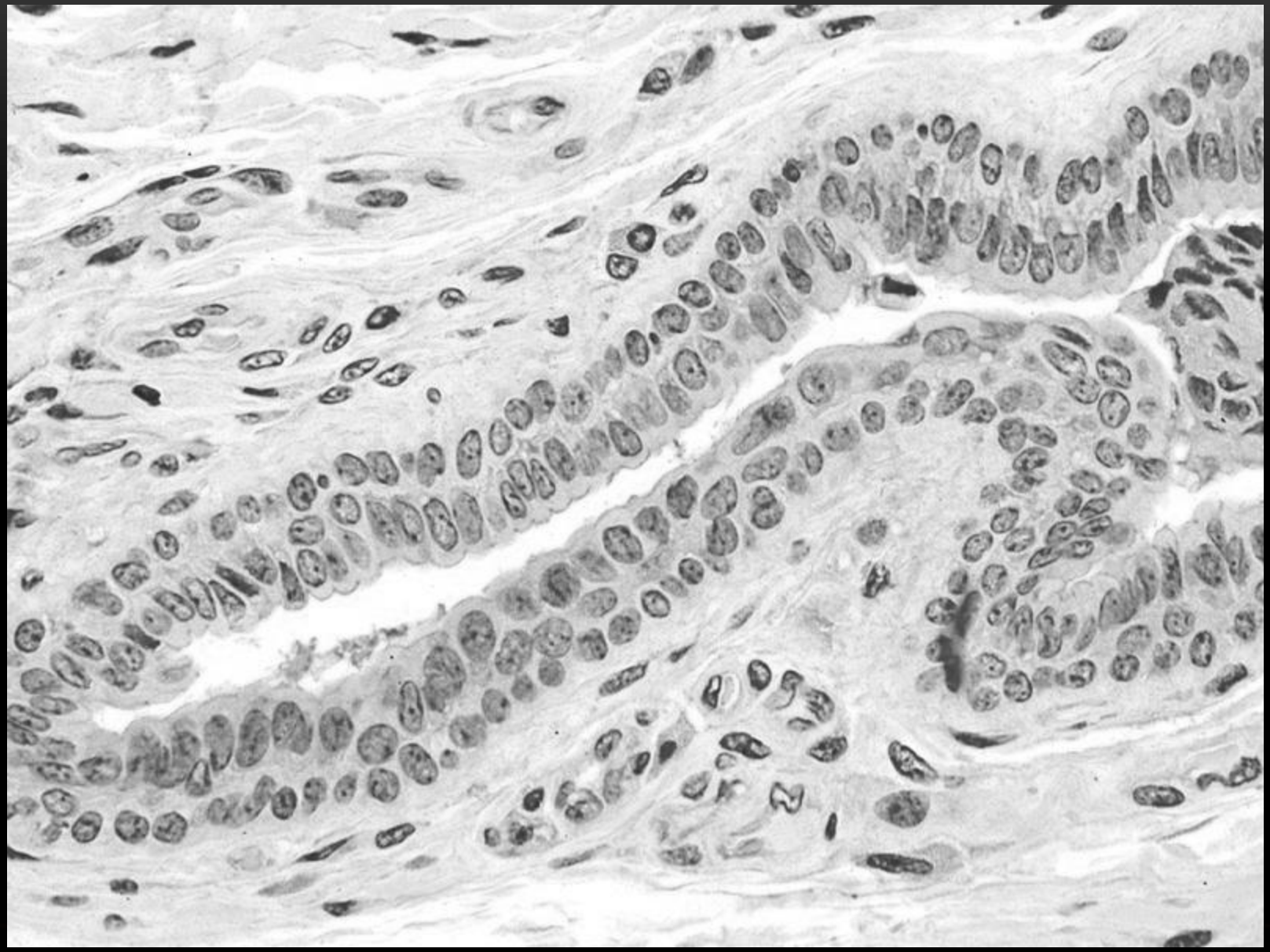


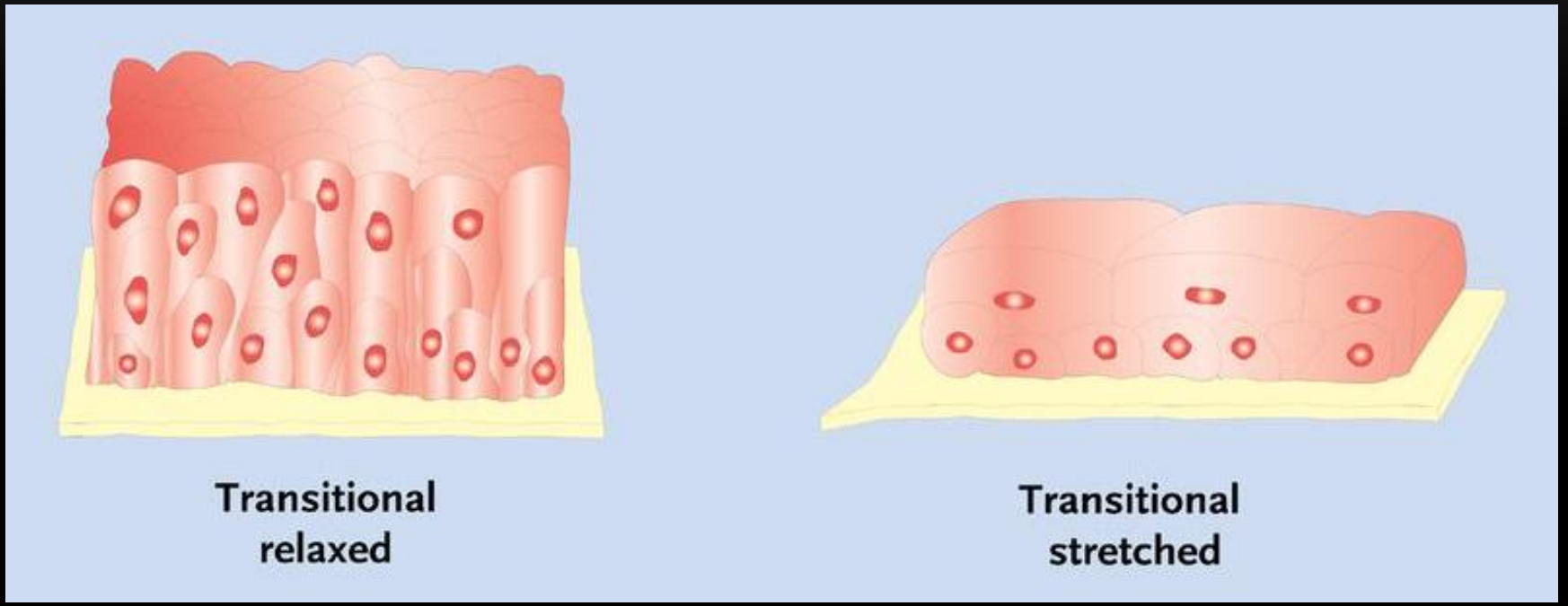


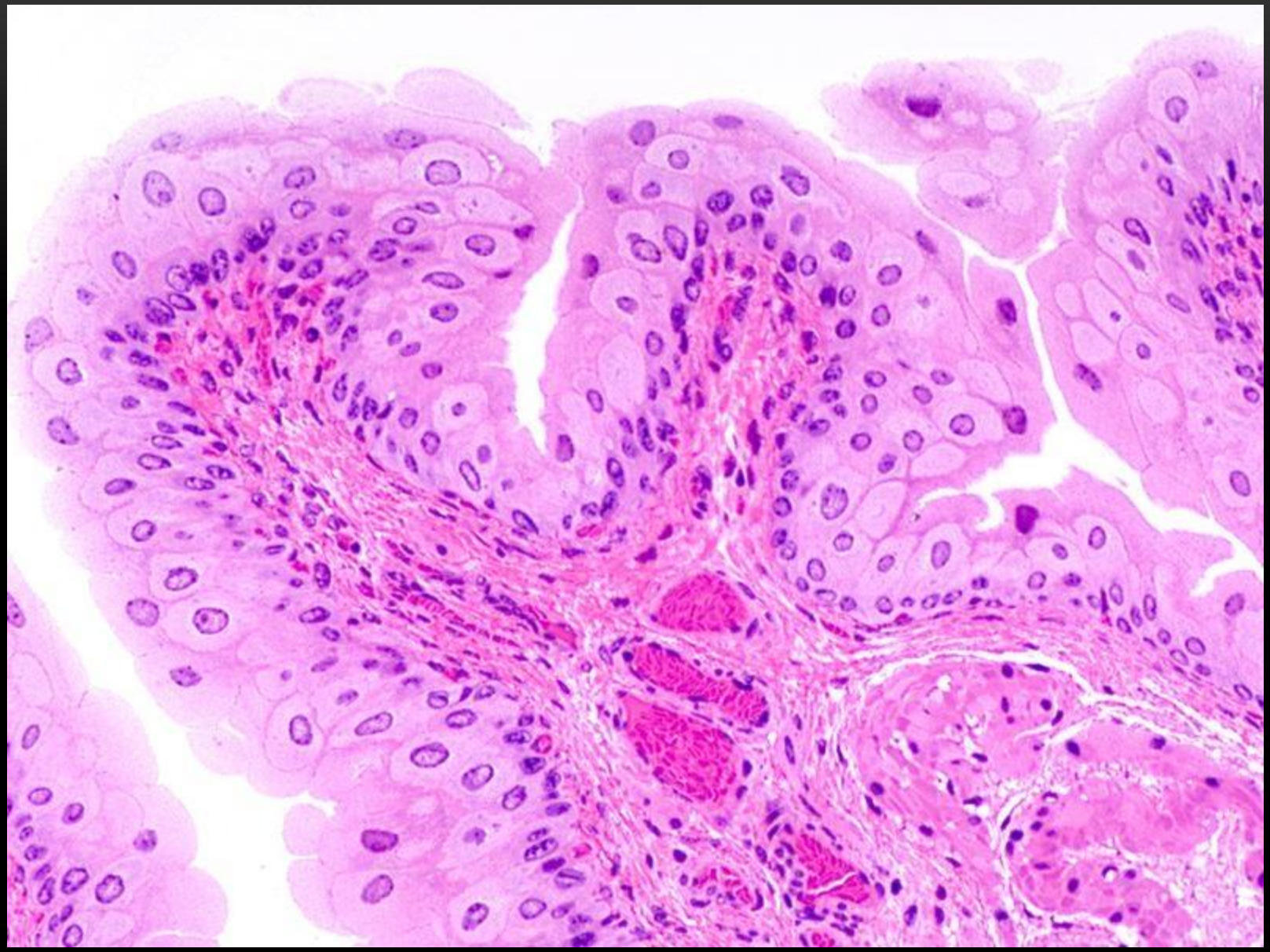
Stratified Columnar Epithelium

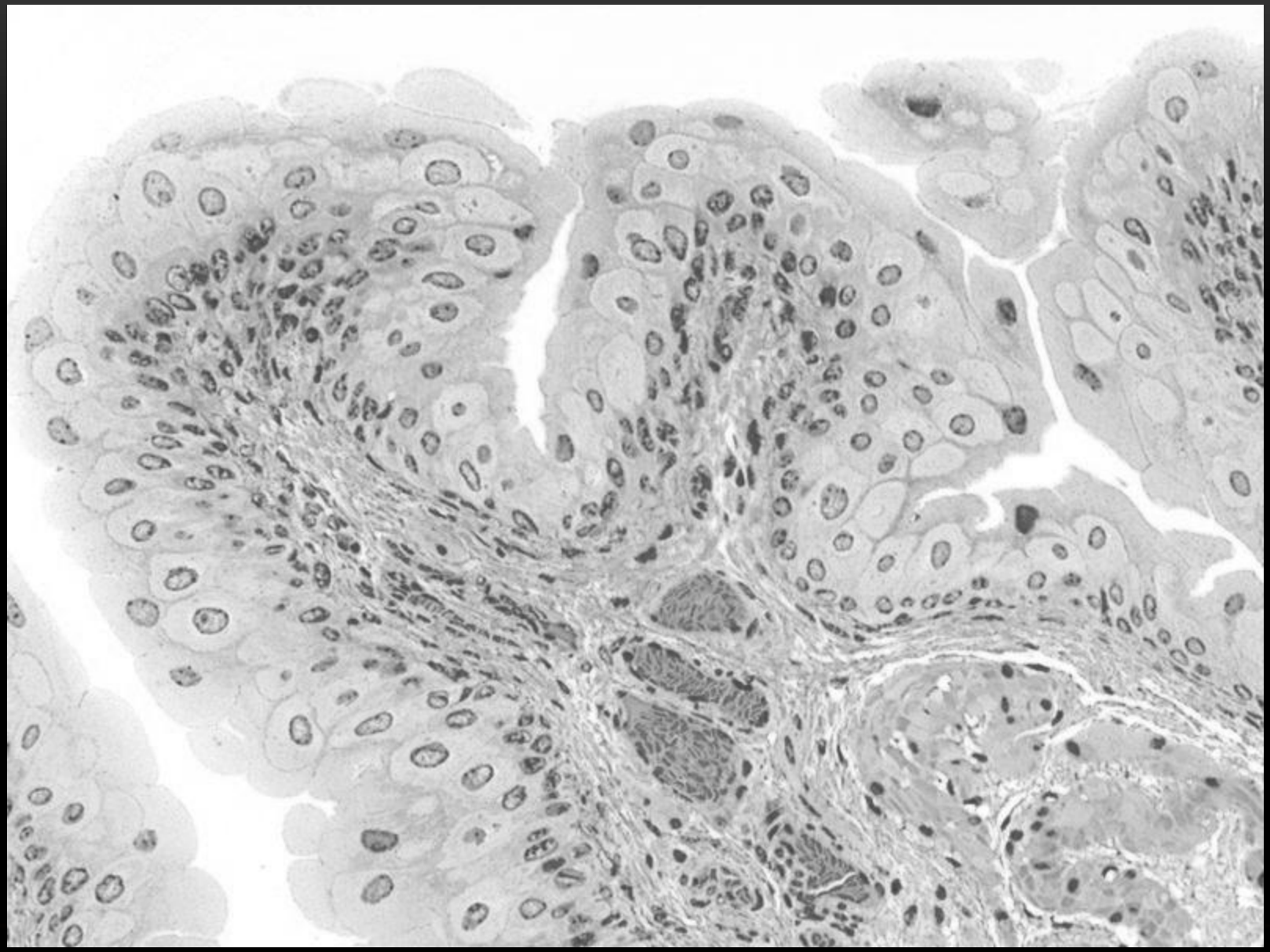


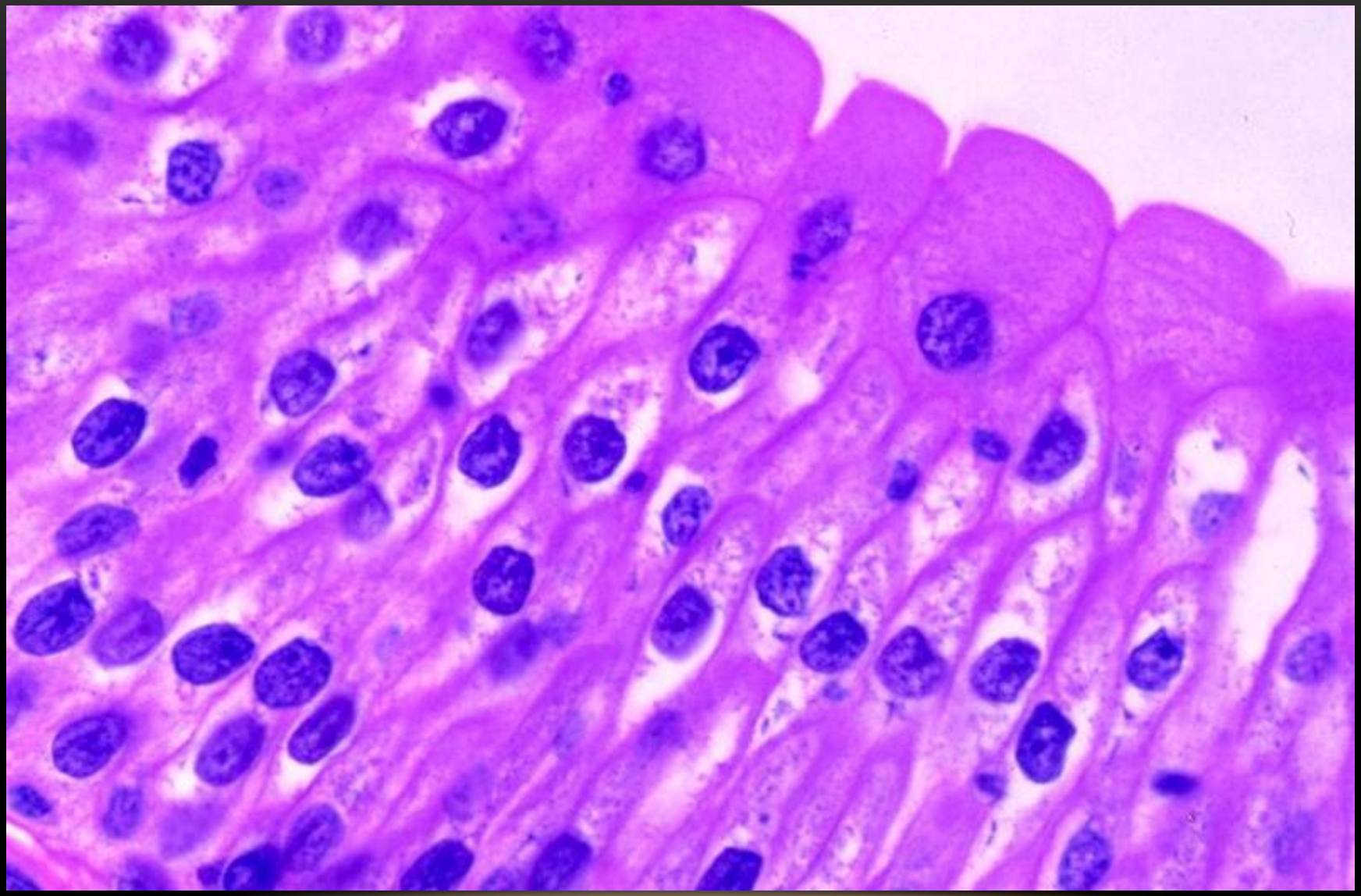


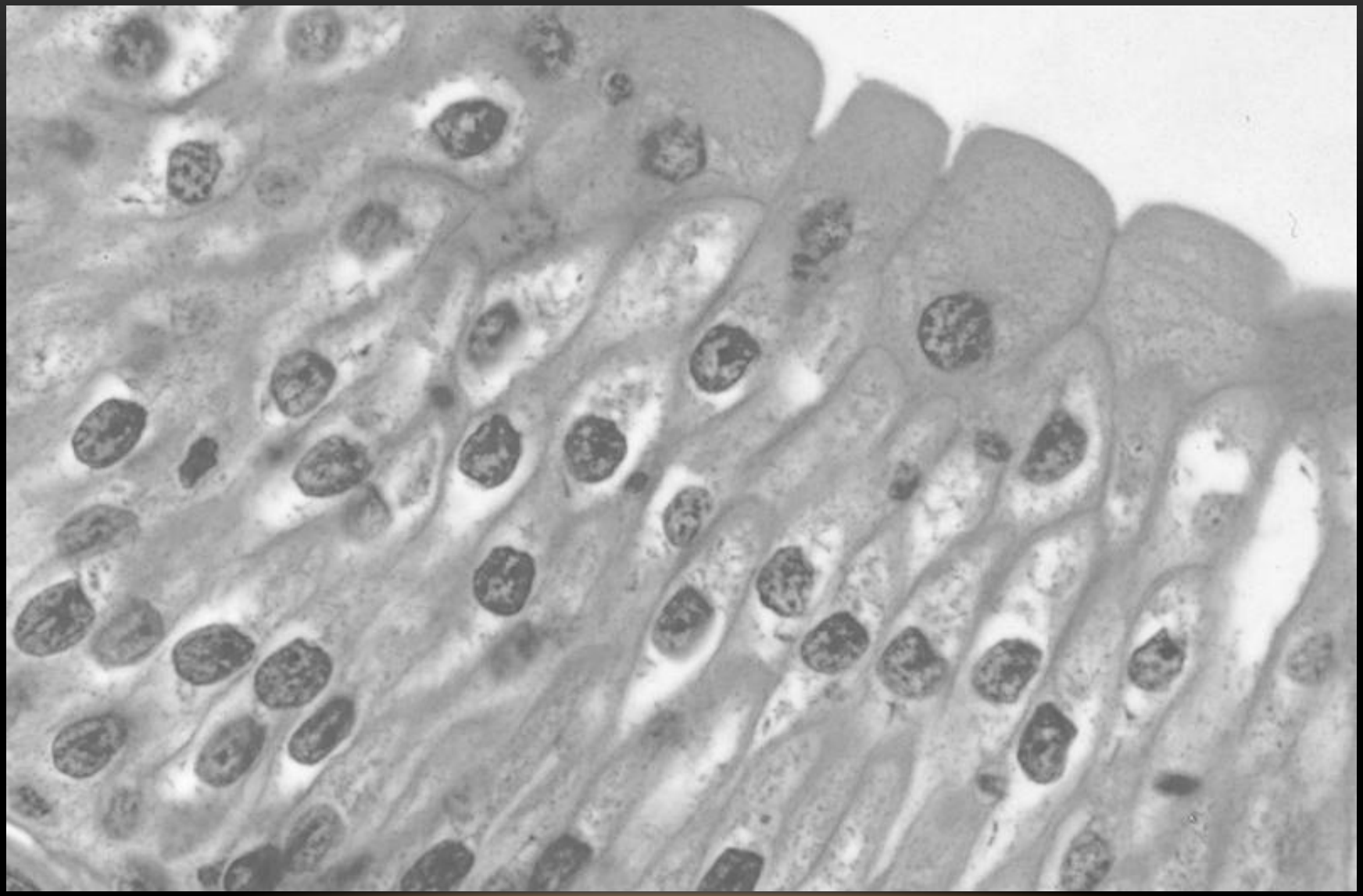



Transitional
relaxed
Transitional
stretched









The saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom.

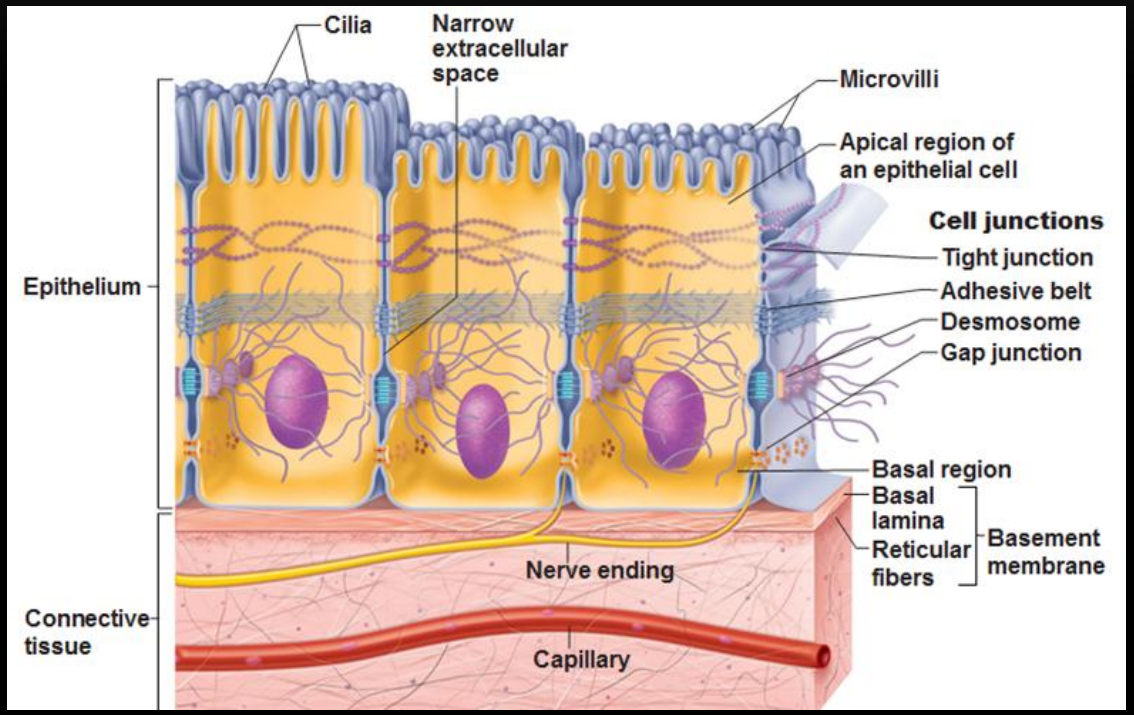
Isaac Asimov

Apical Domain

It is the part of the cell that faces the lumen (the free surface of the cell).

It is rich in ion channels, carrier proteins and hydrolytic enzymes.

The apical modifications are:



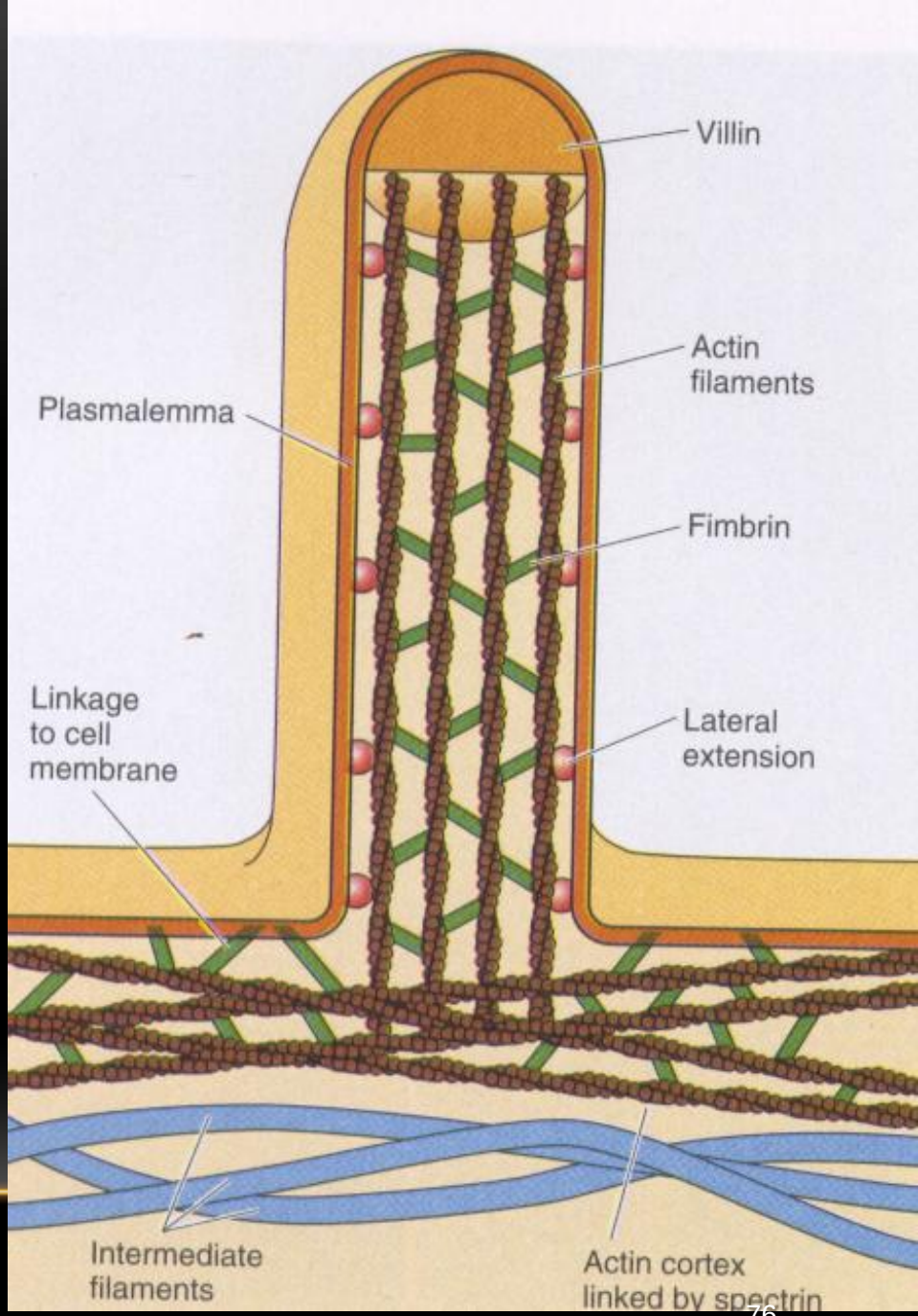
- Microvilli.
- Stereocilia.
- Cilia.
- Flagella.

Microvilli

Present mainly in absorptive cells.

Their number and size vary according to the degree of activity of the cell.

They are usually crowded on the cell apex forming the ***striate border*** in the intestine and the ***brush border*** in the kidney.



Structure of the Microvillus

The microvillus is 1- 2µ in length.

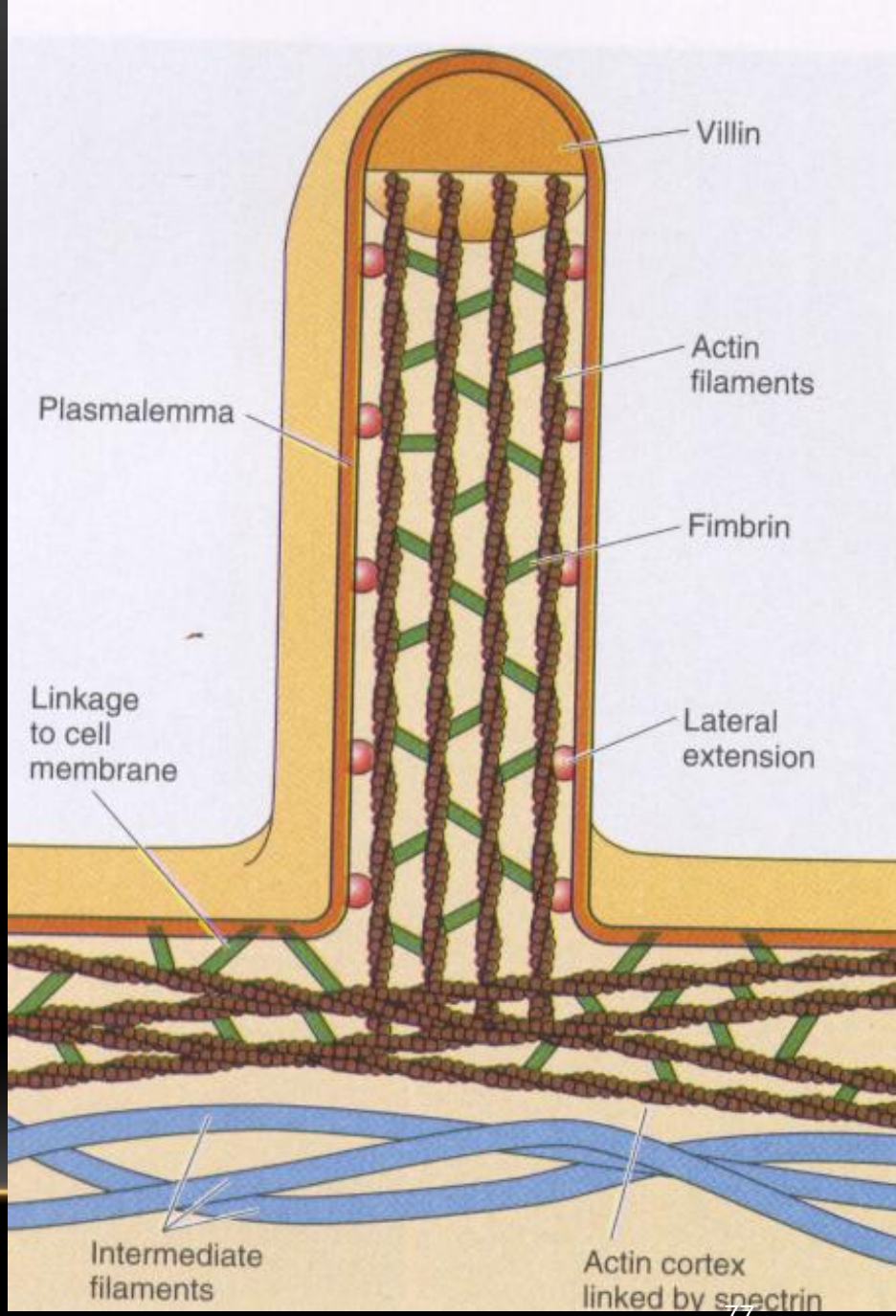
Contains a core of 25-30 actin filaments.

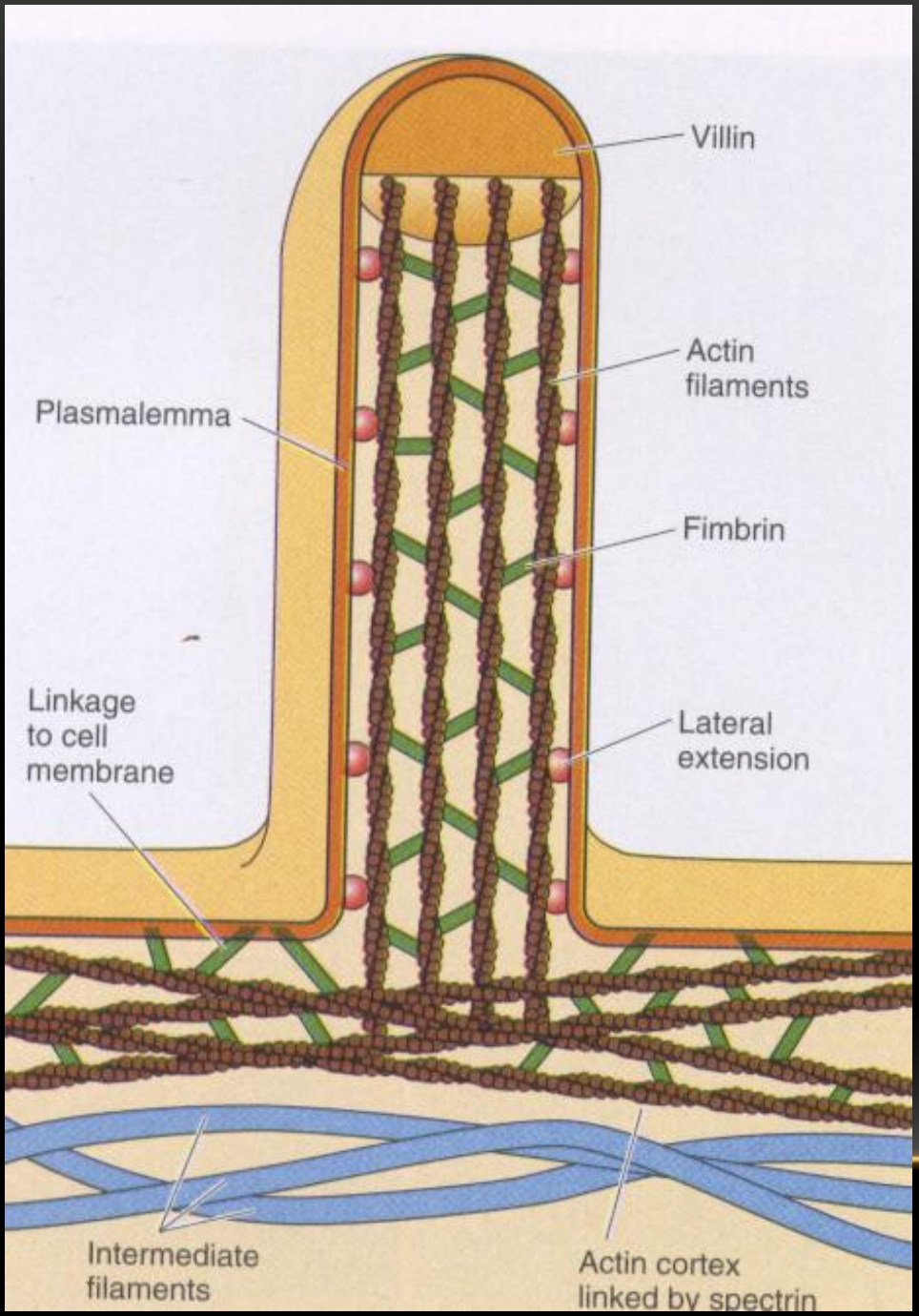
Actin filaments are cross-linked with villin.

The actin filaments are inserted into the ***terminal web***.

The terminal web is a network of actin and spectrin supported by myosin, IF, and camodulin in the apical part of the cell.

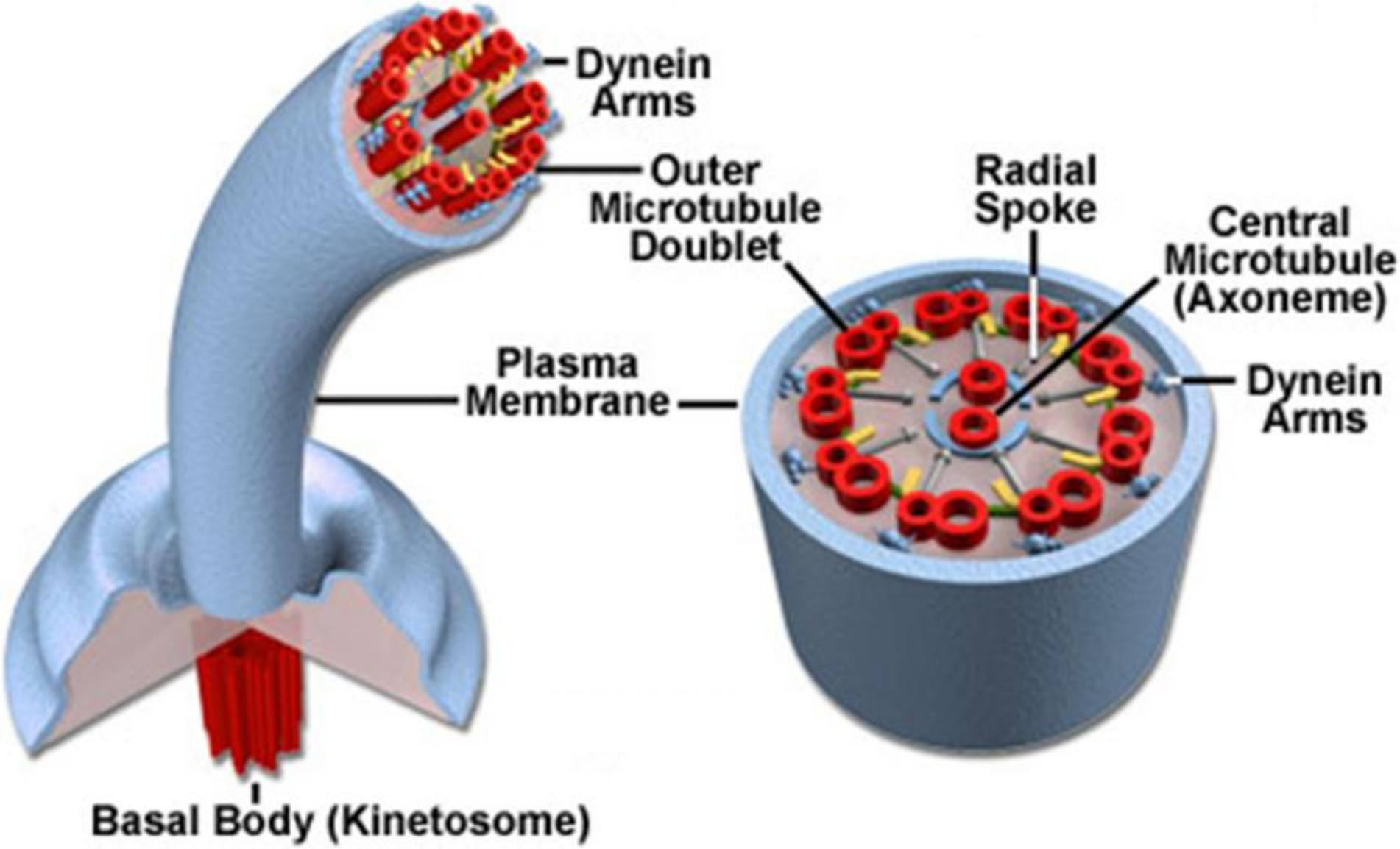
The microvillus is covered by ***glcocalyx;*** it gives PAS +ve reaction




Villin
Actin filaments
Plasmalemma
Fimbrin
Linkage to cell membrane
Lateral extension
Intermediate filaments
Actin cortex linked by spectrin


TERMINAL WEB

Stereocilia are long immotile microvilli present in the epididymis and inner ear. They have special functions in these places.


Dynein Arms
Outer Microtubule Doublet
Radial Spoke
Central Microtubule (Axoneme)
Plasma Membrane
Dynein Arms
Basal Body (Kinetosome)

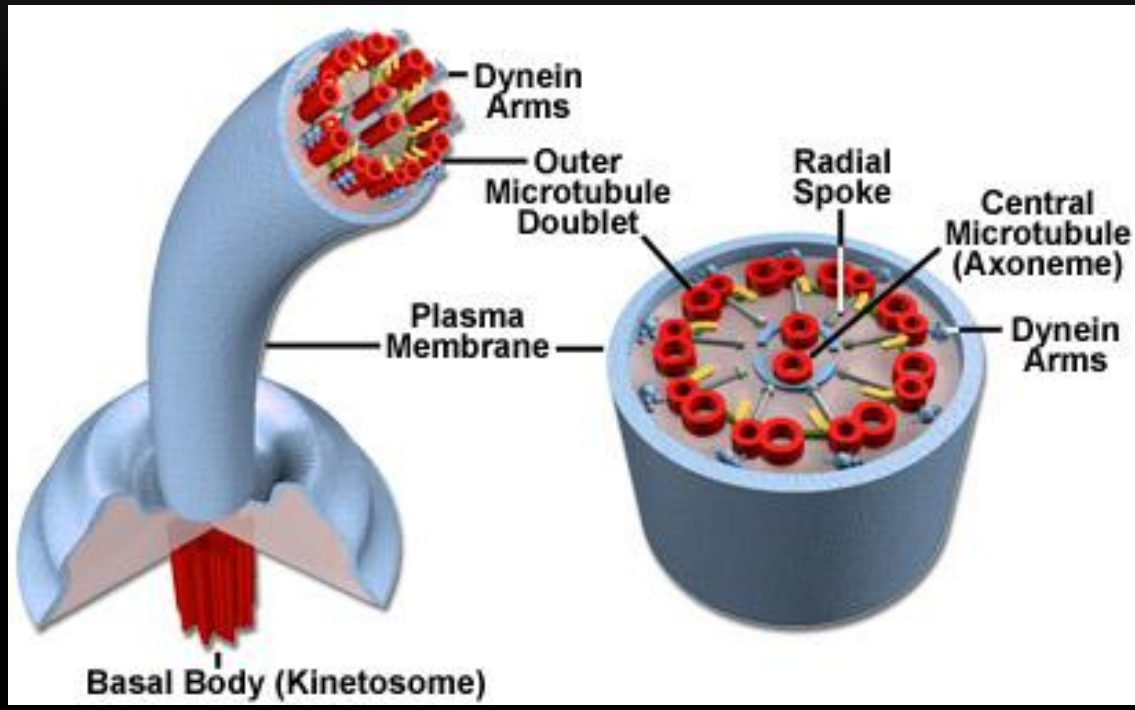
Cilia

Motile cytoplasmic hair like projections capable of moving fluid and particles along epithelial surfaces.

Measurements: length 7-10μ, diameter 0.2 μ.

Number of cilia/cell is variable and ranges 1-300 cilium/cell.

They move rhythmically and rapidly in one direction.



The core of the cilium is called ***axoneme***.

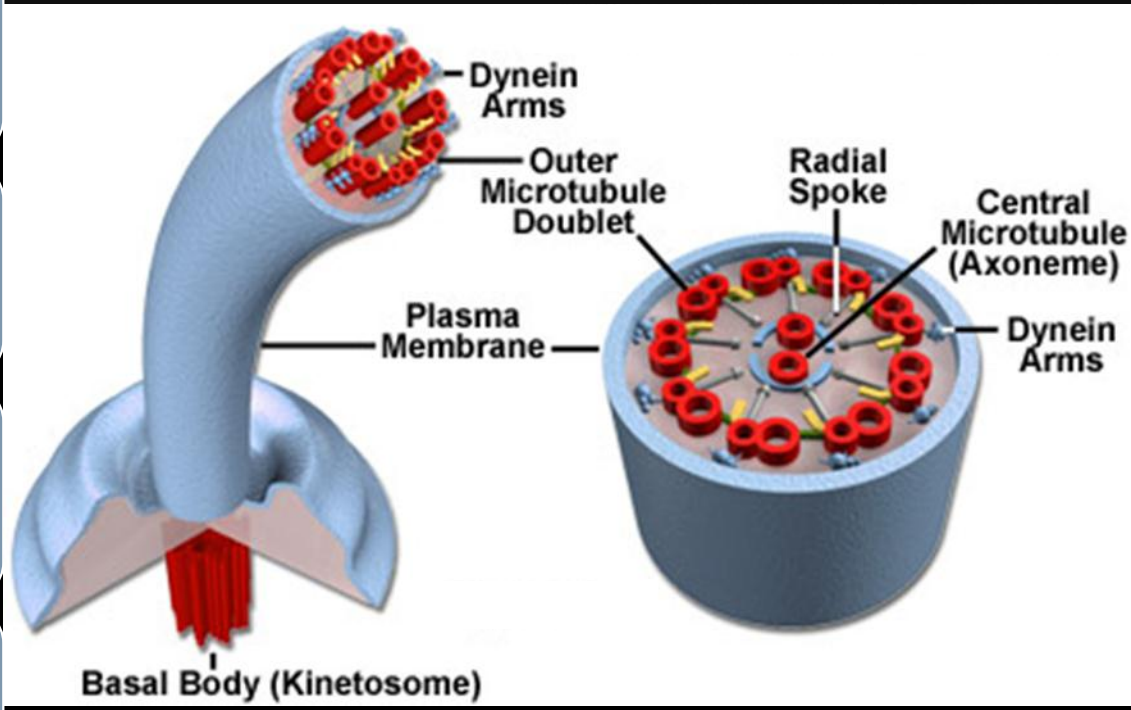
The axoneme consists of longitudinal microtubules arranged as 9 (doublets) peripheral surrounding 2 (singlets) central (9+2).

The singlets are separated by 13 protofilaments.

The doublets are composed of 2 subunits A & B.

Subunit A is formed of 13 protofilaments.

Subunit B is formed of 10 protofilaments.



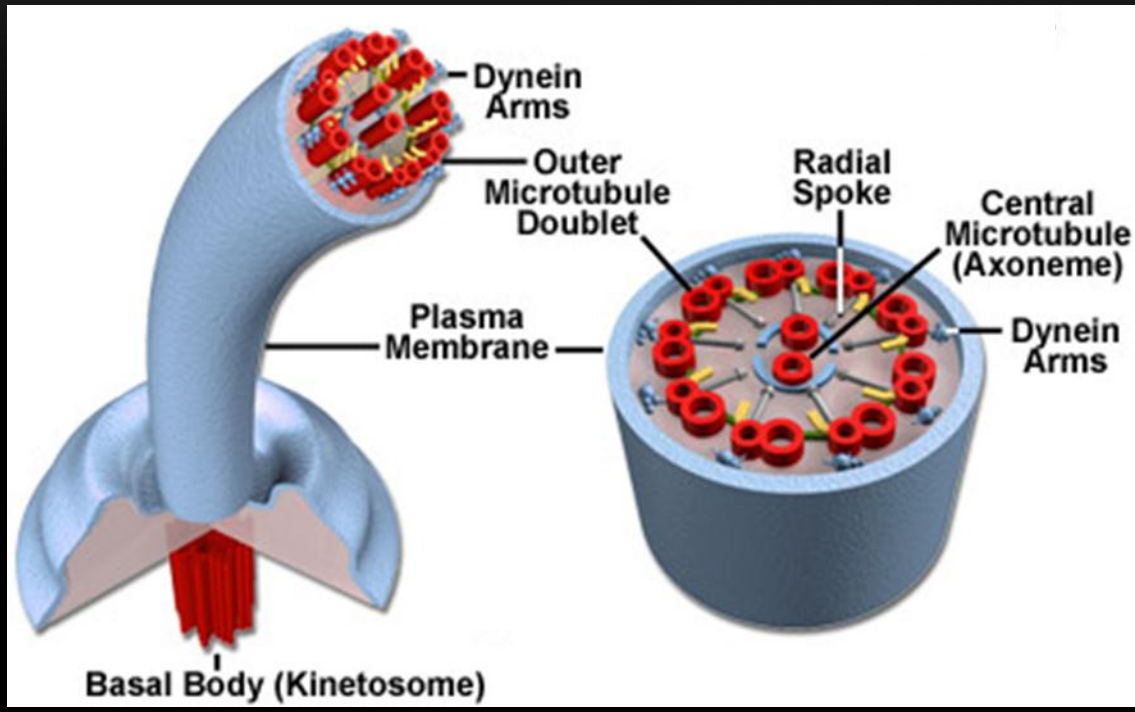
Neighboring doublets are connected by nexin.

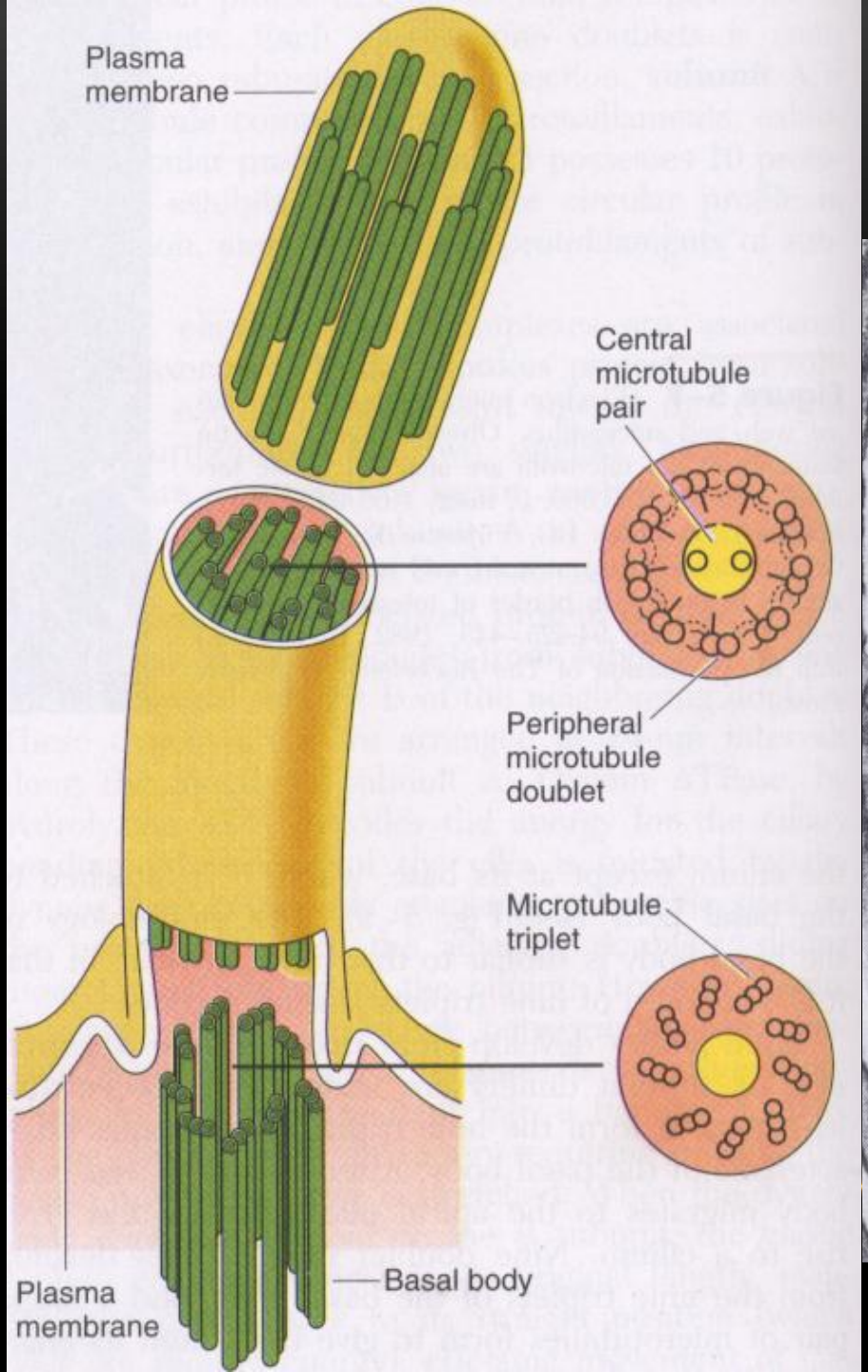
Doublets are connected to the singlets by ***radial spokes***.

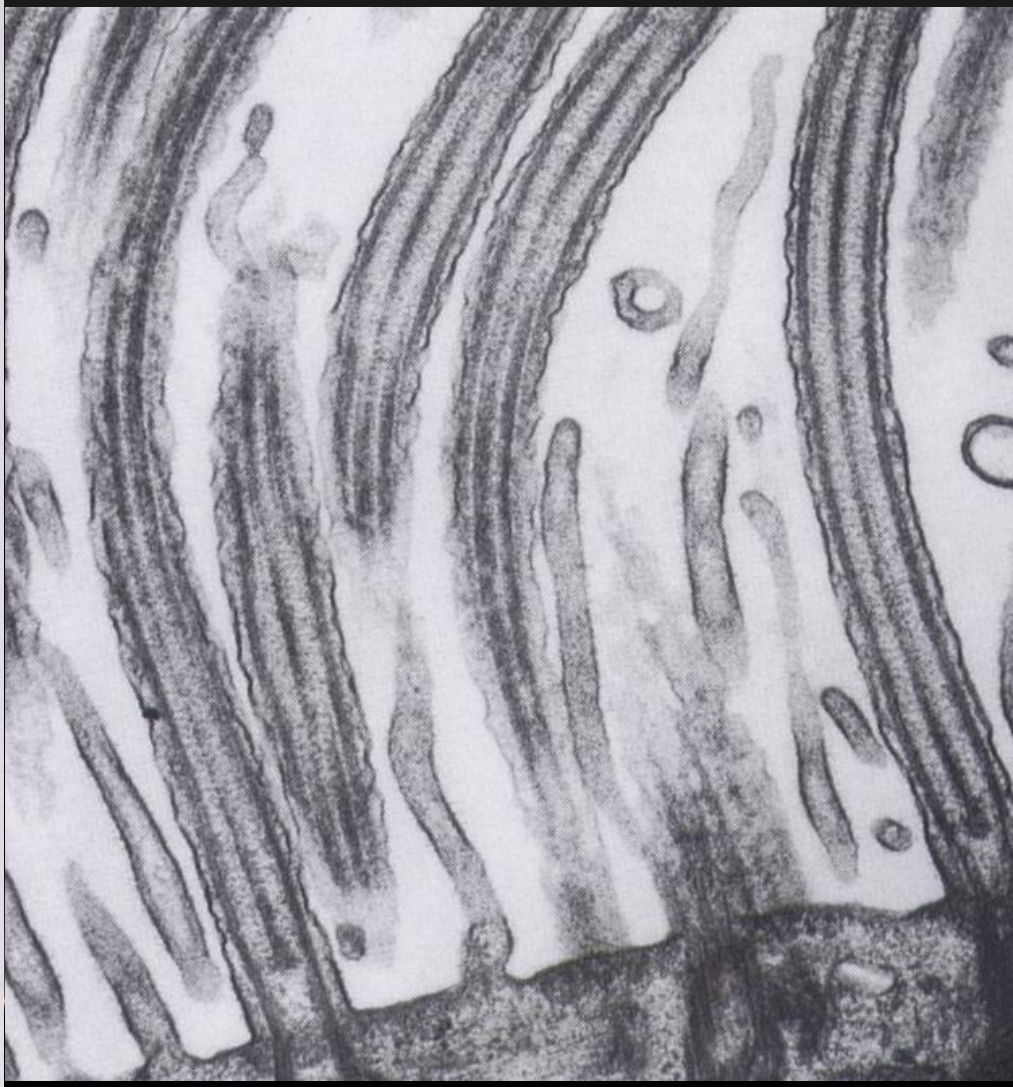
Dynein radiates form subunit A to subunit B.

Dynein has ATPase activity.

Cilia are attached to basal bodies similar in structure to centrioles.




Plasma membrane
Central microtubule pair
Peripheral microtubule doublet
Microtubule triplet
Plasma membrane
Basal body



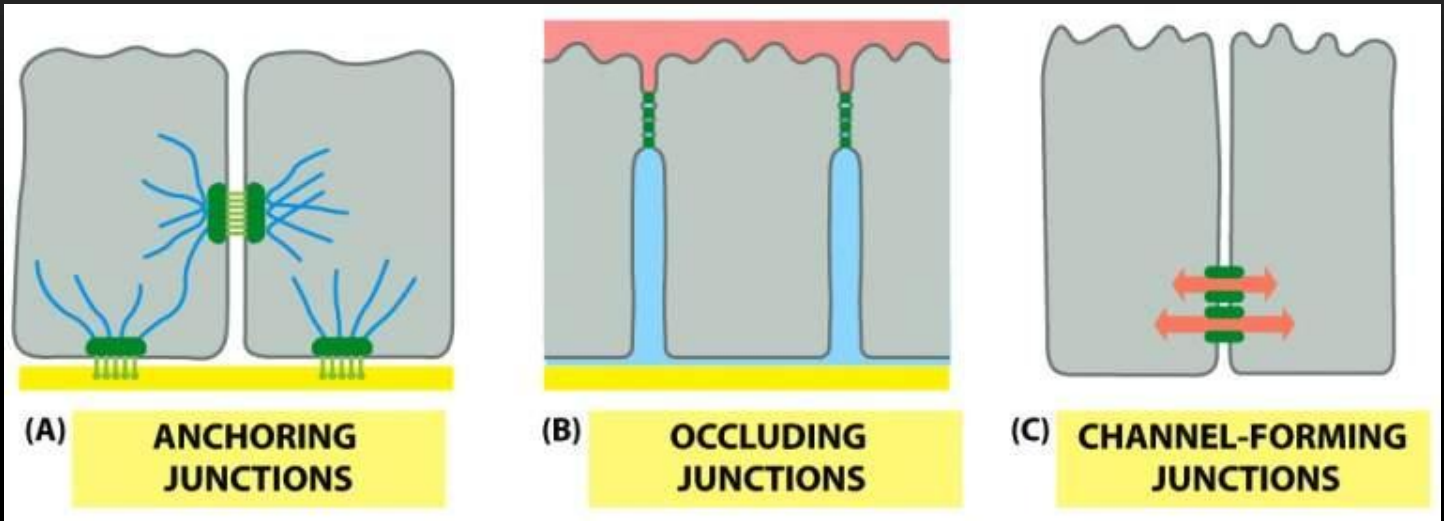
Baso-Lateral Domain

Terminal bars are light microscopic structures at the site of contact of cells.

E.M revealed that the terminal bar is a junctional complex composed of:

- Occluding junctions.
- Anchoring junctions.
- Communicating junctions.

Cell Junctions

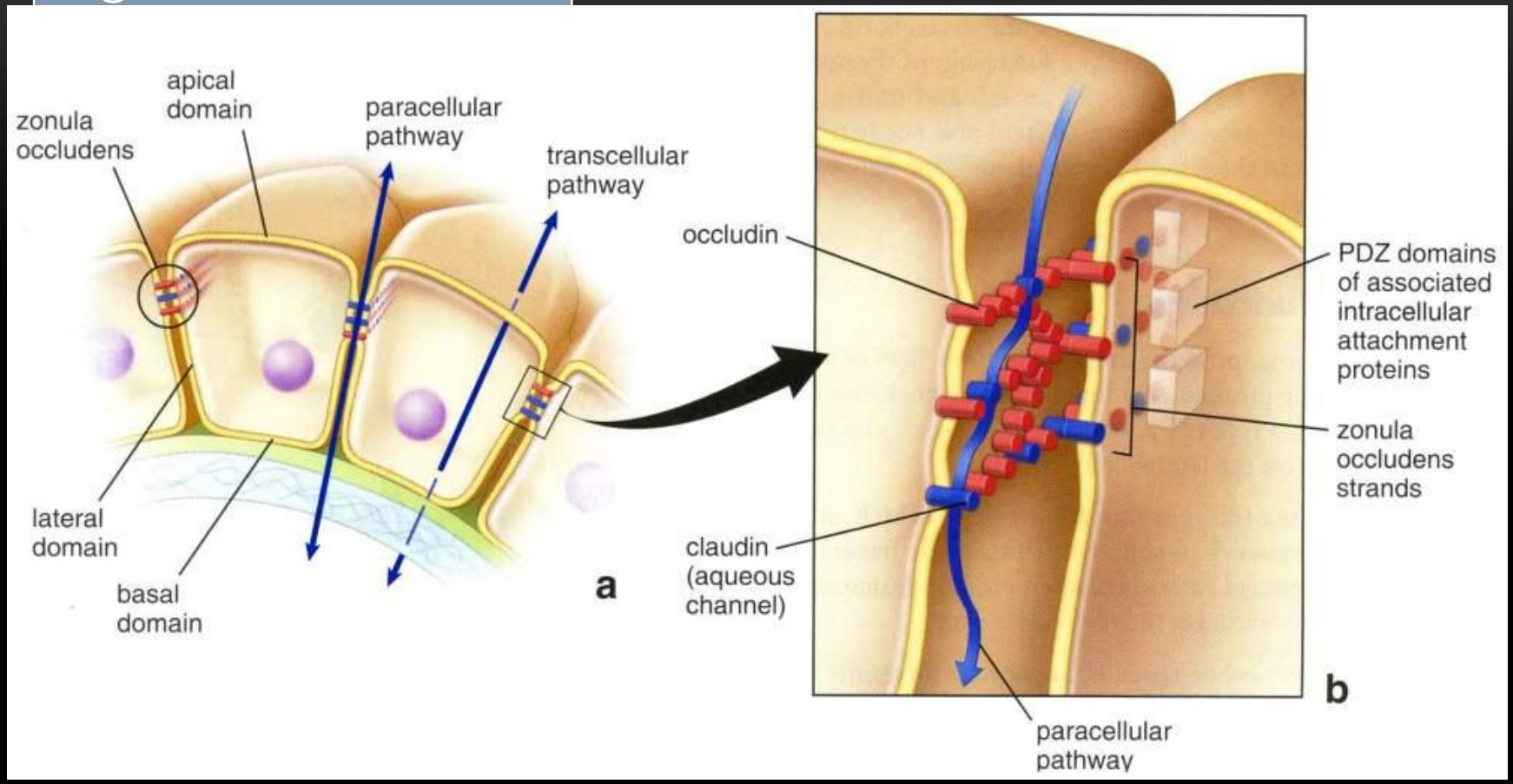


Anchoring (Desmosomes and Macula adherentes) - mediate cell-cell and cell-matrix adhesions; linked to cytoskeleton to transmit and distribute stress

Occluding (Zonula Ocludentes) - form seals between epithelial cells; block or regulate (paracellular) permeability between cells

Channel-forming (Gap Junction) - allow diffusion of small molecules

Tight Junctions

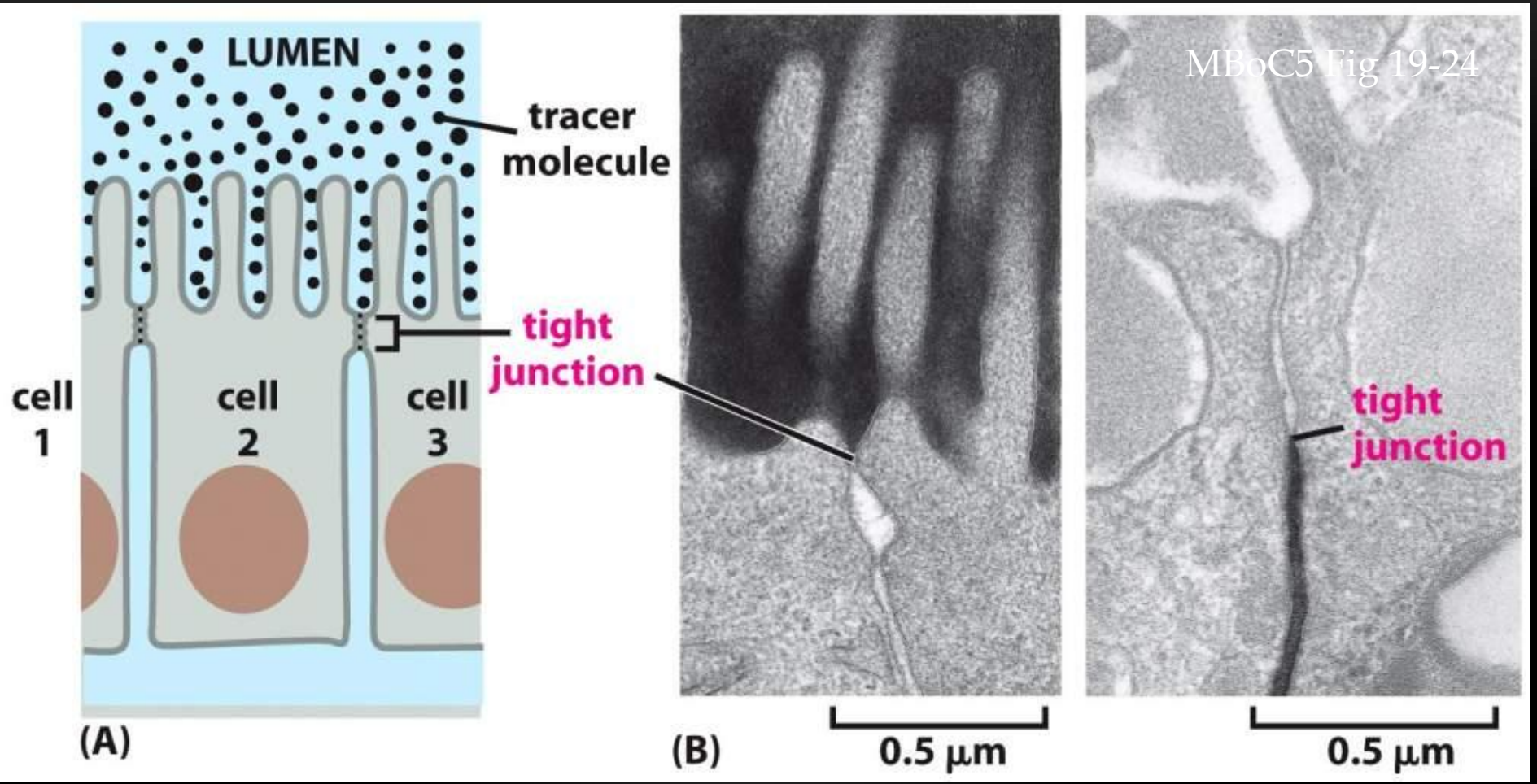


Occluding junction (encircles epithelial cells)

Barrier to diffusion between cells (paracellular pathway)

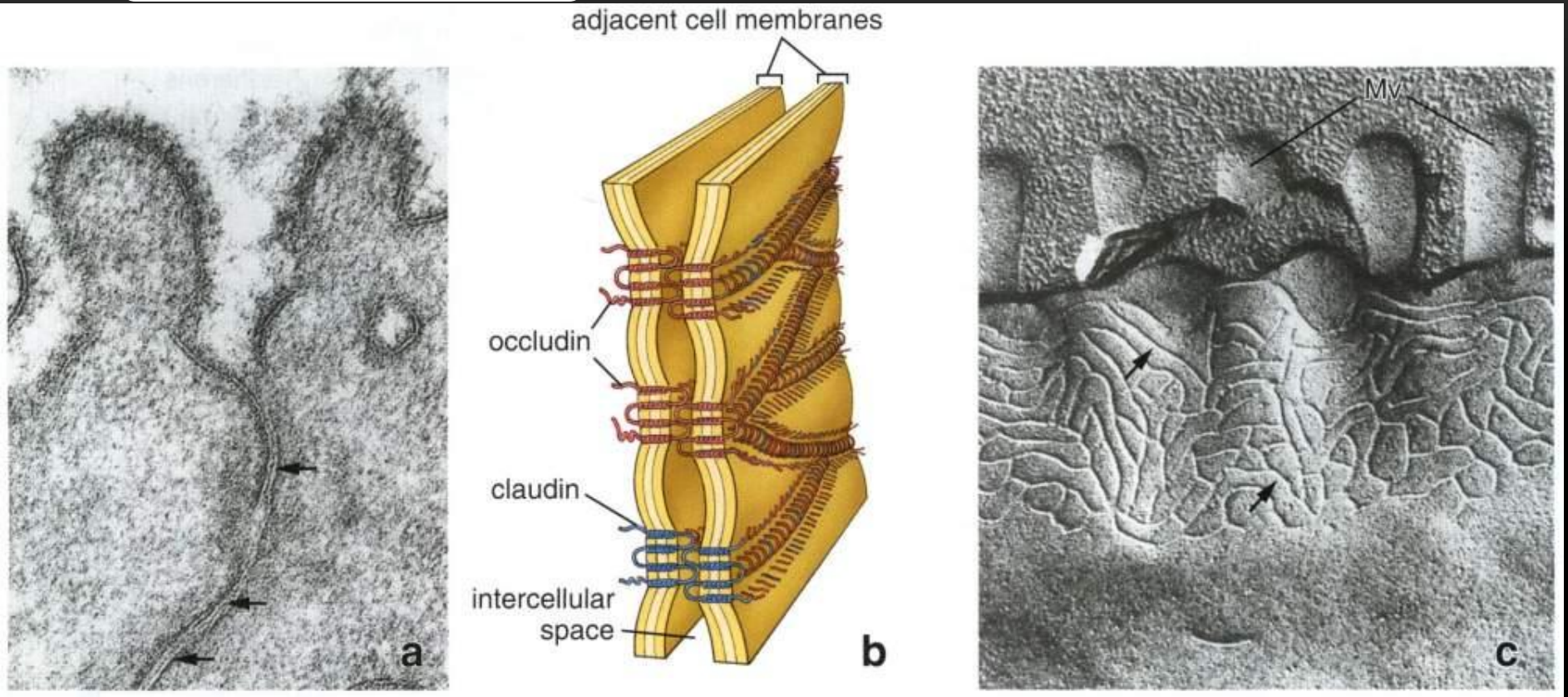
Separates apical and basolateral plasma membranes, the outer layers of 2 adjacent plasmalemma fuse together.

Tight Junctions



Tight junction blocks diffusion of soluble tracer molecules added to either the apical or basolateral compartment.

Tight Junction



TEM: is the most apical junction

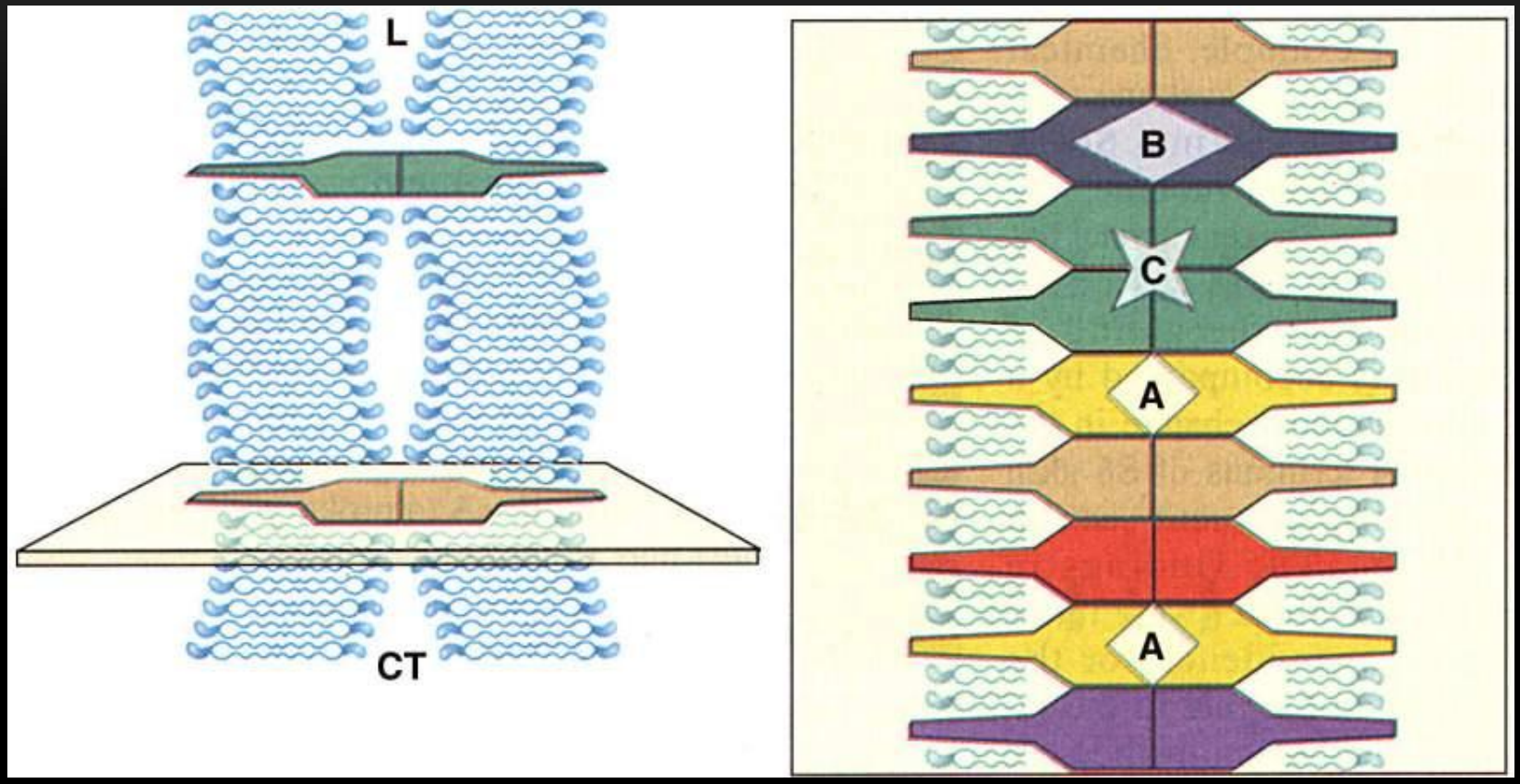
Freeze fracture of TJ reveals ridges in membranes that correspond to sites of contact between cells

Ridges are linear arrays of occludin and claudin proteins

Tight Junction Permeability

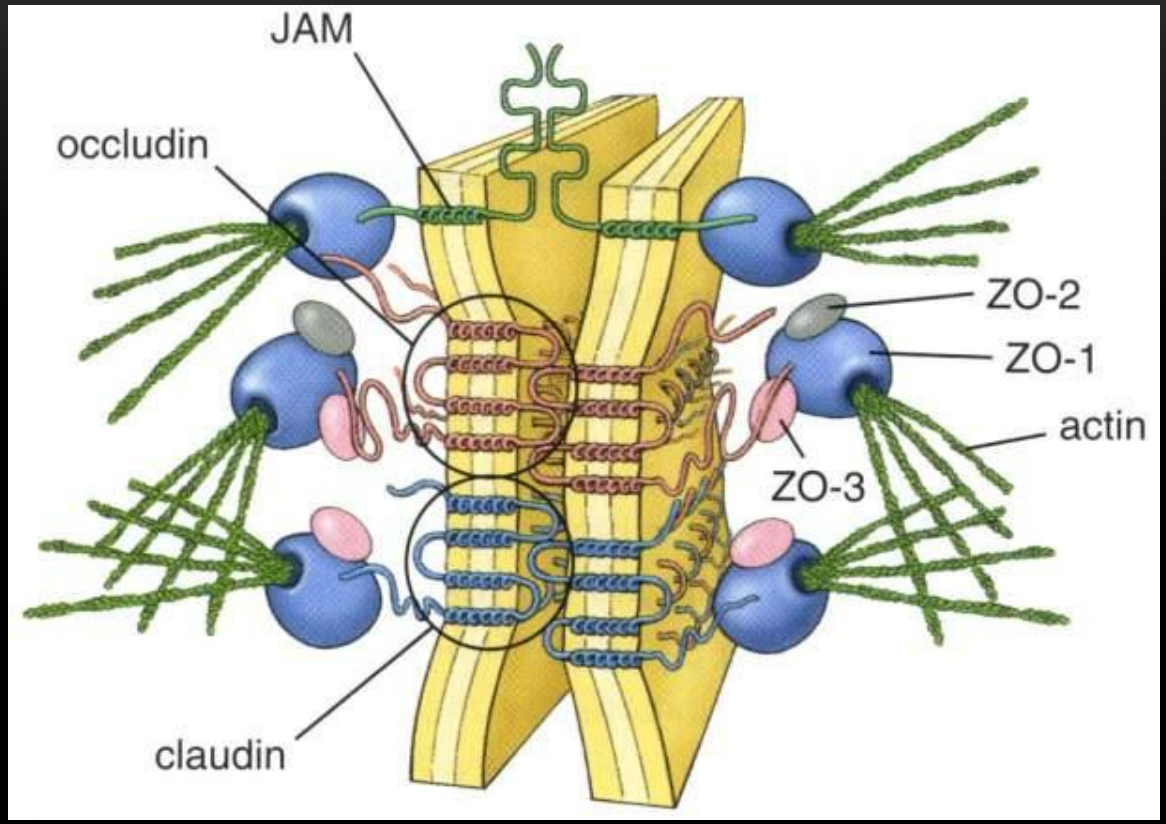
Side view

Top view



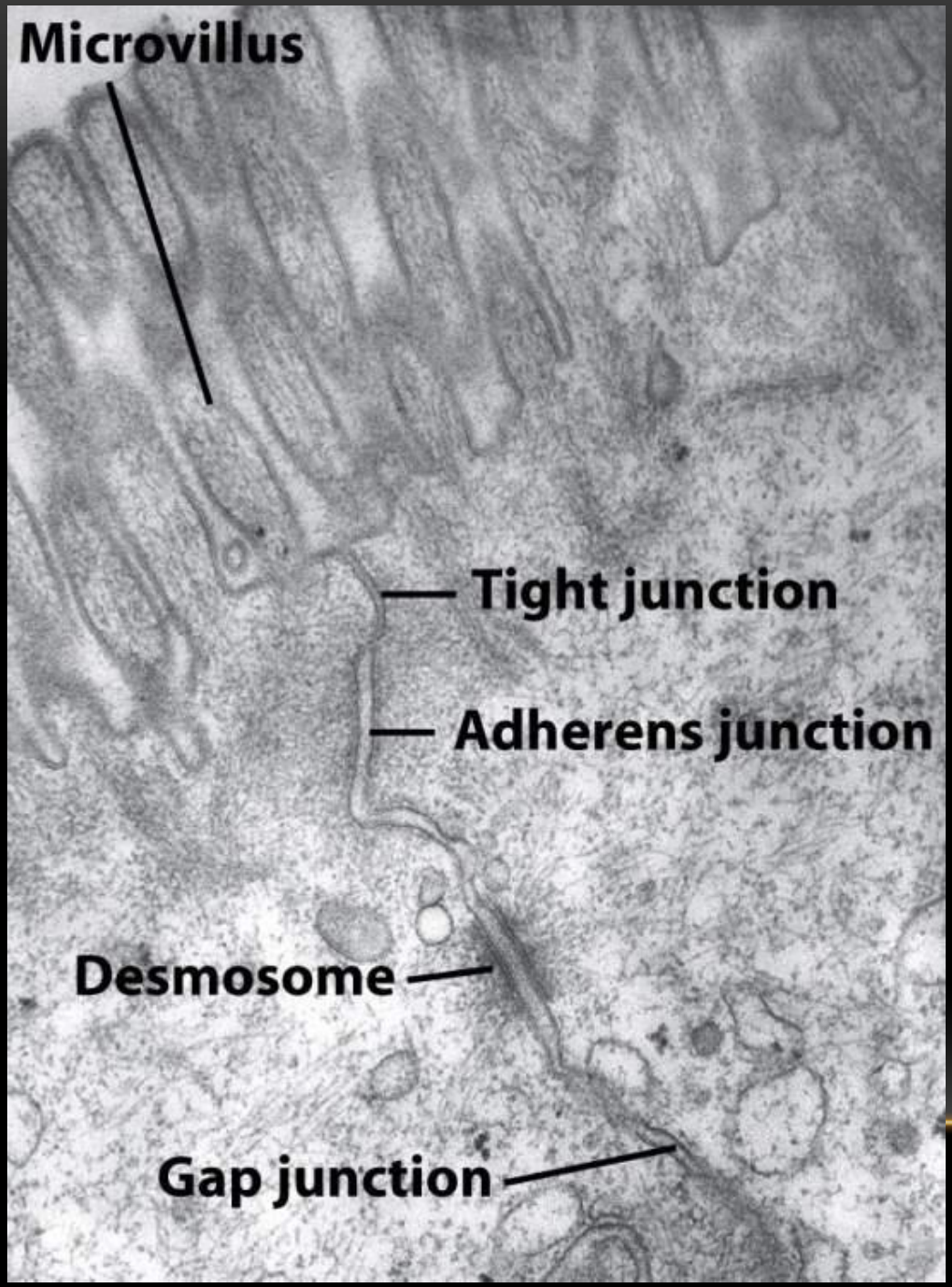
Some claudins and occludins have pores (A, B, and C) that allow selective (paracellular) movement of ions or solutes

Tight Junction Proteins



Occludins and claudins are transmembrane proteins that interact across the intercellular space to form TJs

ZO (zonula occludens) proteins 1-3 link occludin and claudin to each other, to JAMs, and to actin filaments



Zonula Adherens

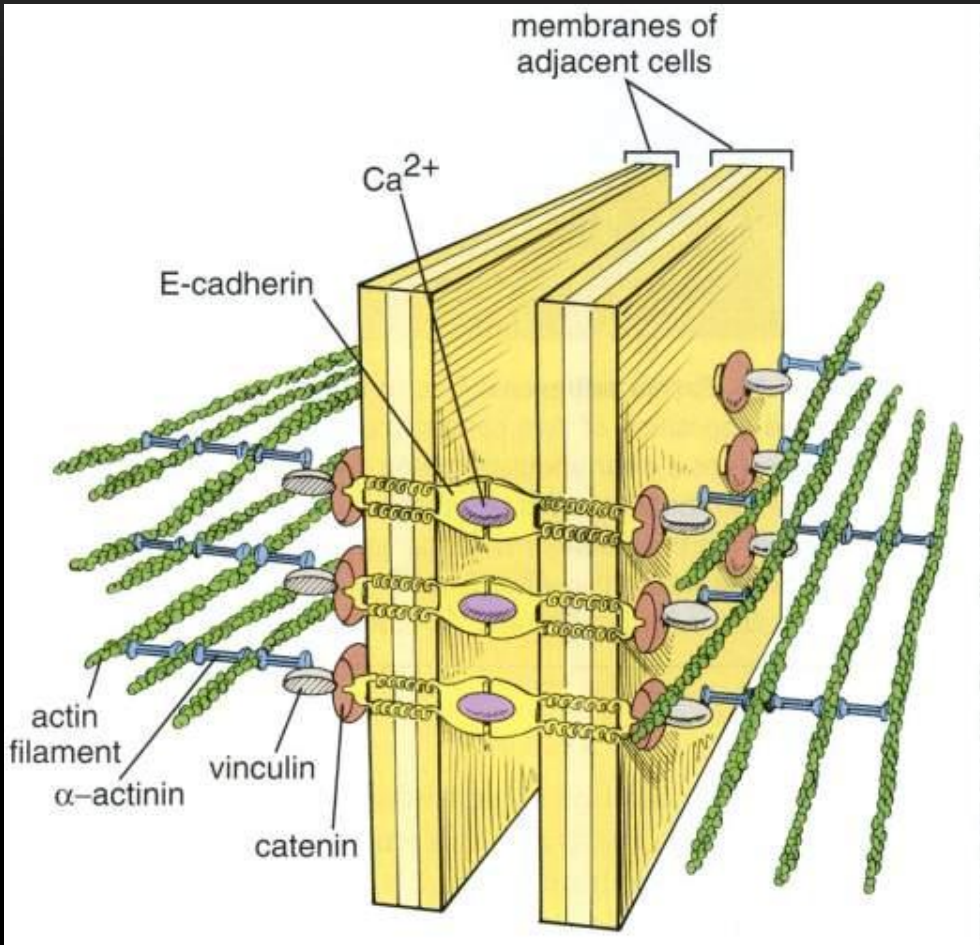
Anchoring junction (encircles the cell)

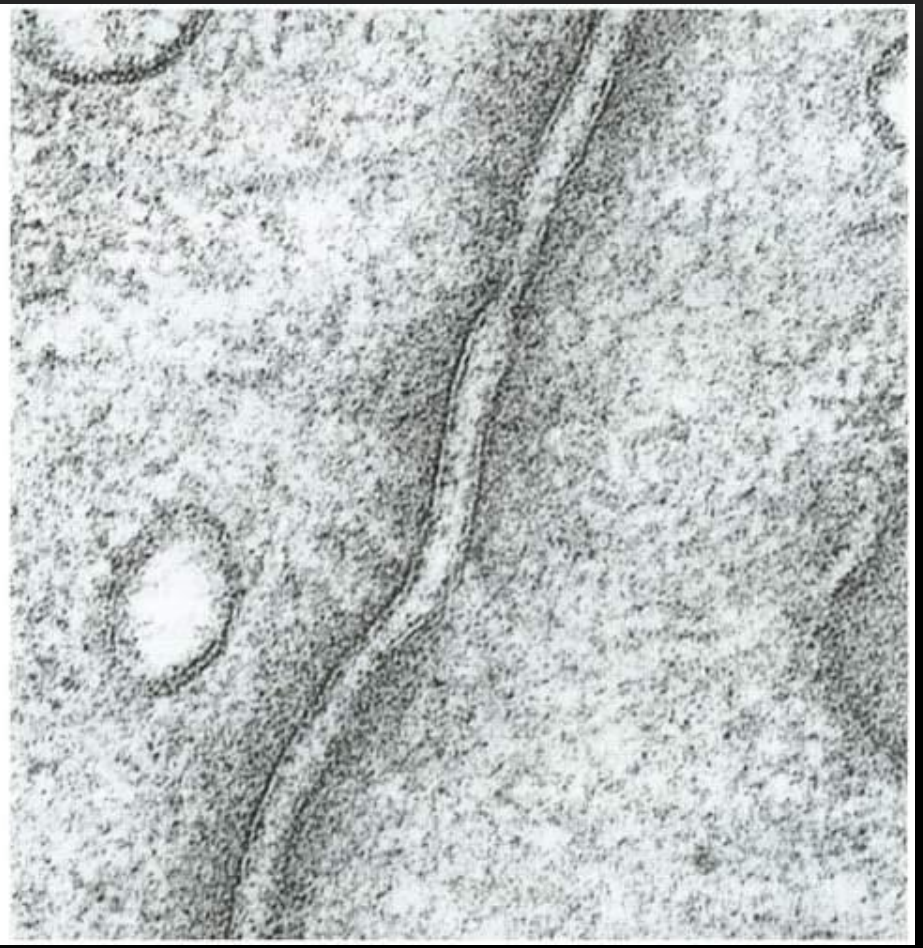
AKA adhesion belt, belt junction, or belt desmosome

Located "under" tight junction in epithelial cells

Connected to actin microfilaments that join terminal web

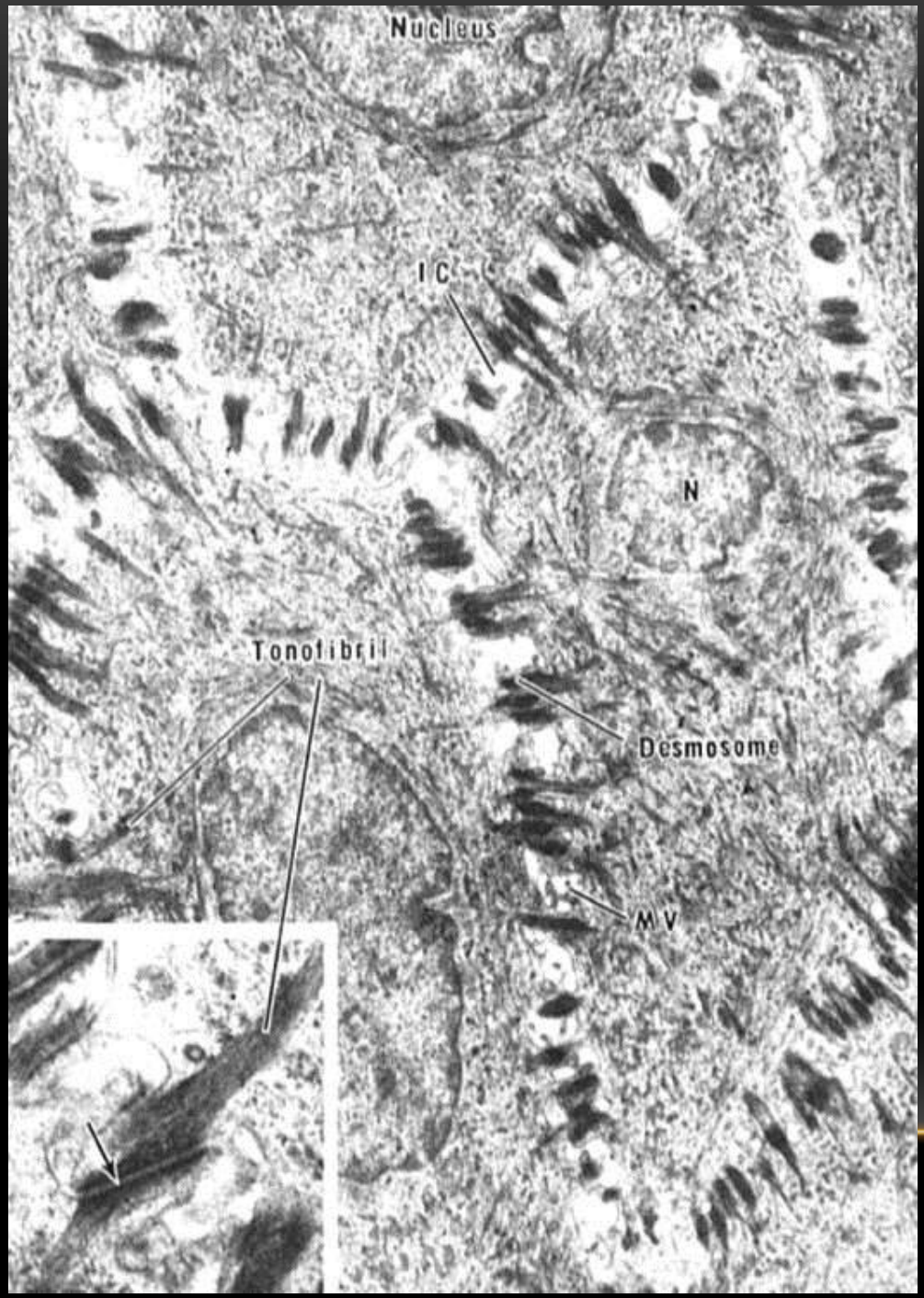
Zonula Adherens





Cadherin proteins attach to crosslinked actin filaments

Mechanical support - ZA and actin filaments transmit and distribute stress throughout cell and to neighboring cells



Desmosomes

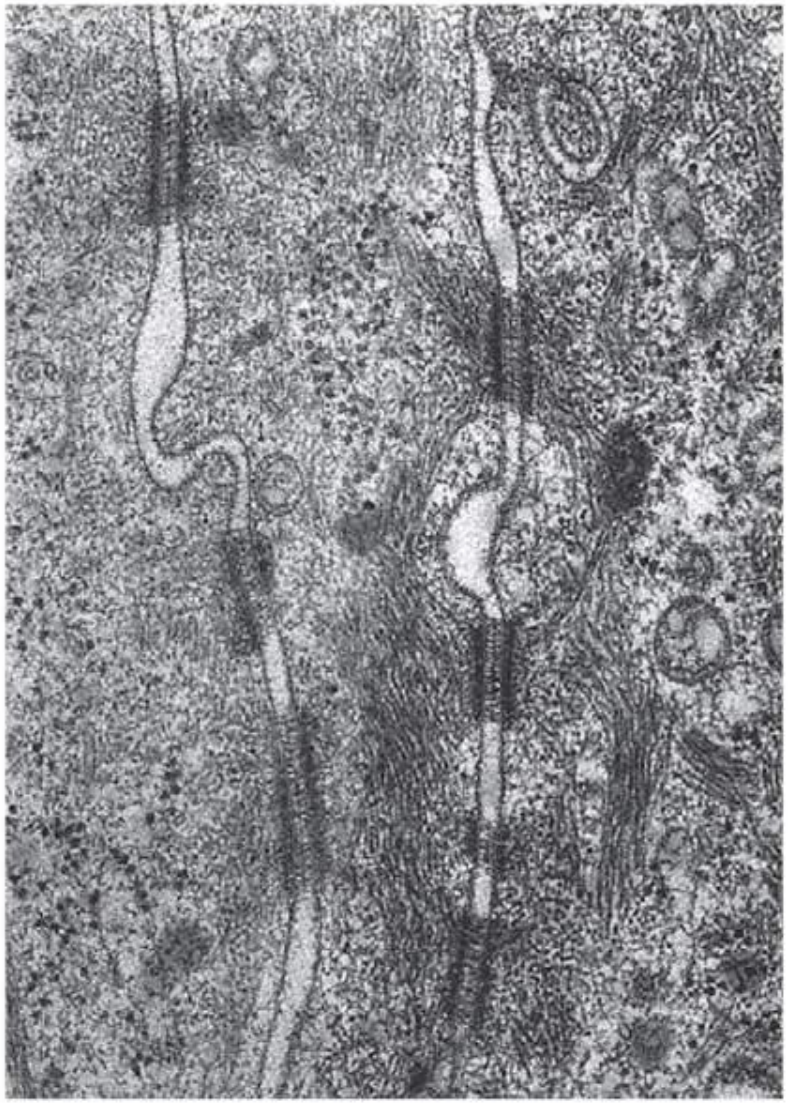
Anchoring junctions

Function as "spot welds" to join cells

Located along lateral plasma membranes of columnar epithelial cells or on processes of squamous cells

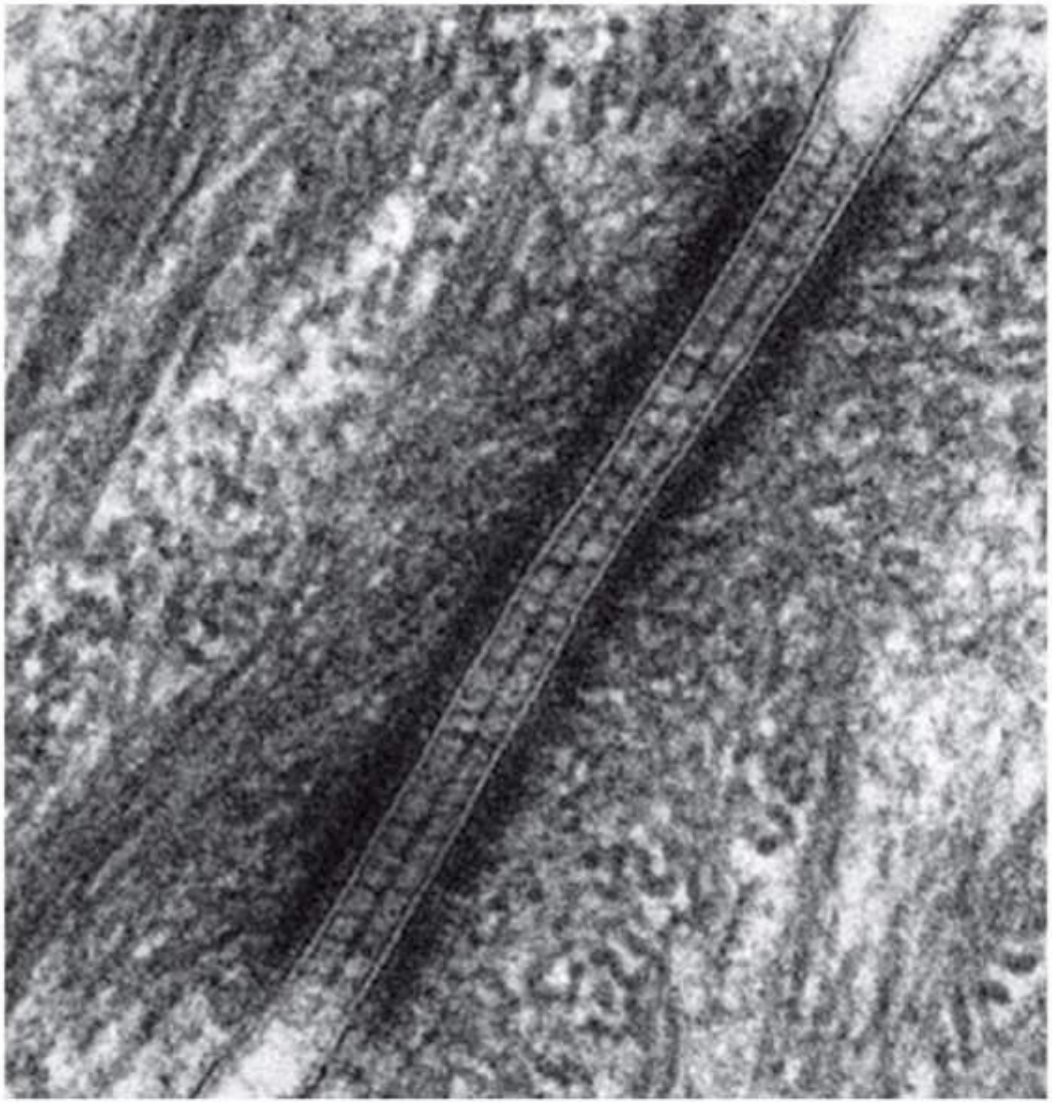
Intermediate filaments associate with plaque proteins in cytoplasm

S



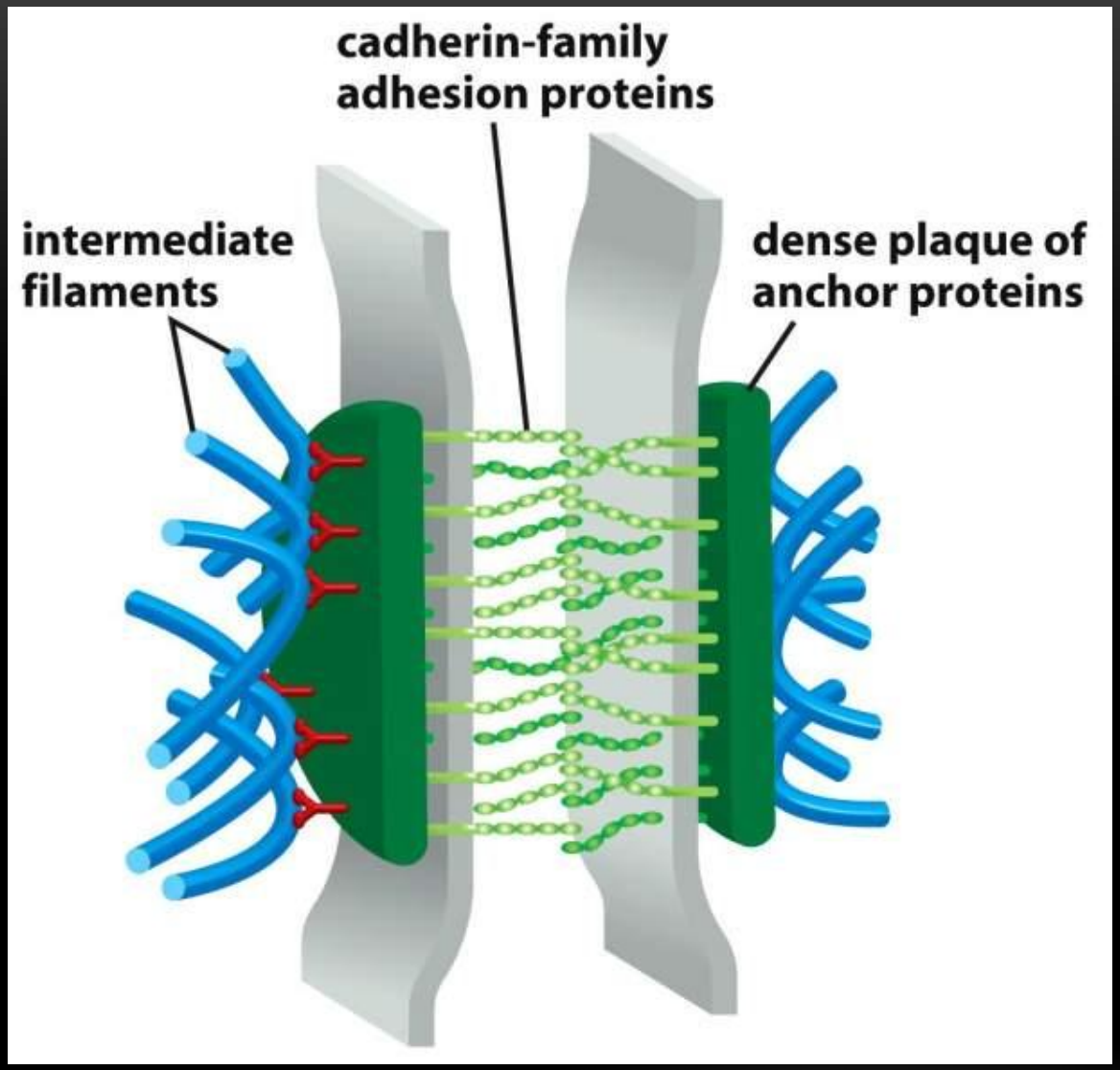
(C)

0.5 μm



(D)

100 nm

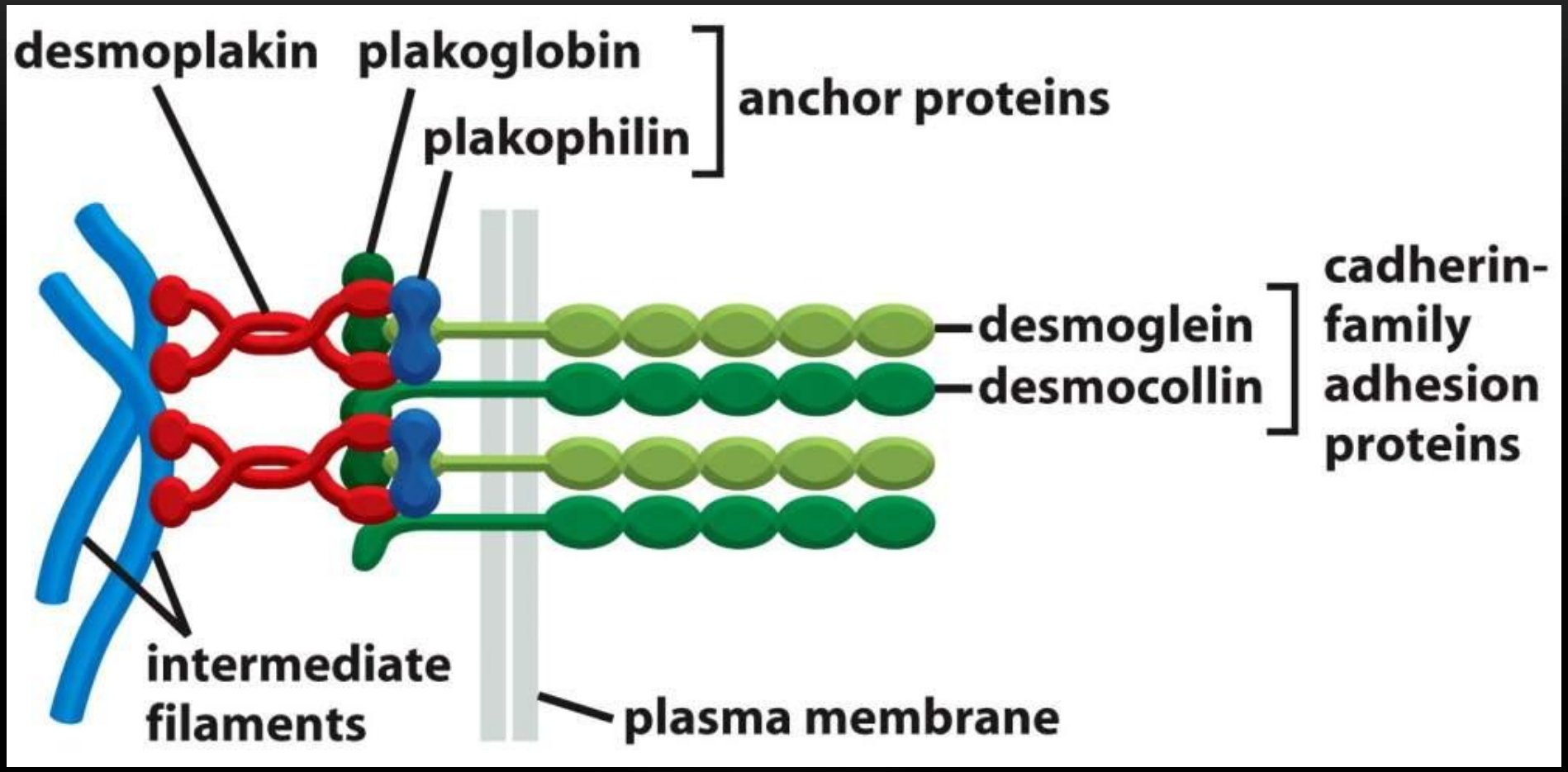


Desmosomes

cadherins interact across intercellular space

Adaptor proteins form a dense plaque that interconnects cadherins and binds them to intermediate filaments

Desmosomes



Desmoglein and desmocollin are non-classical cadherins

Adaptor proteins such as γ-catenin (plakoglobin) and desmoplakin link cadherins to intermediate filaments

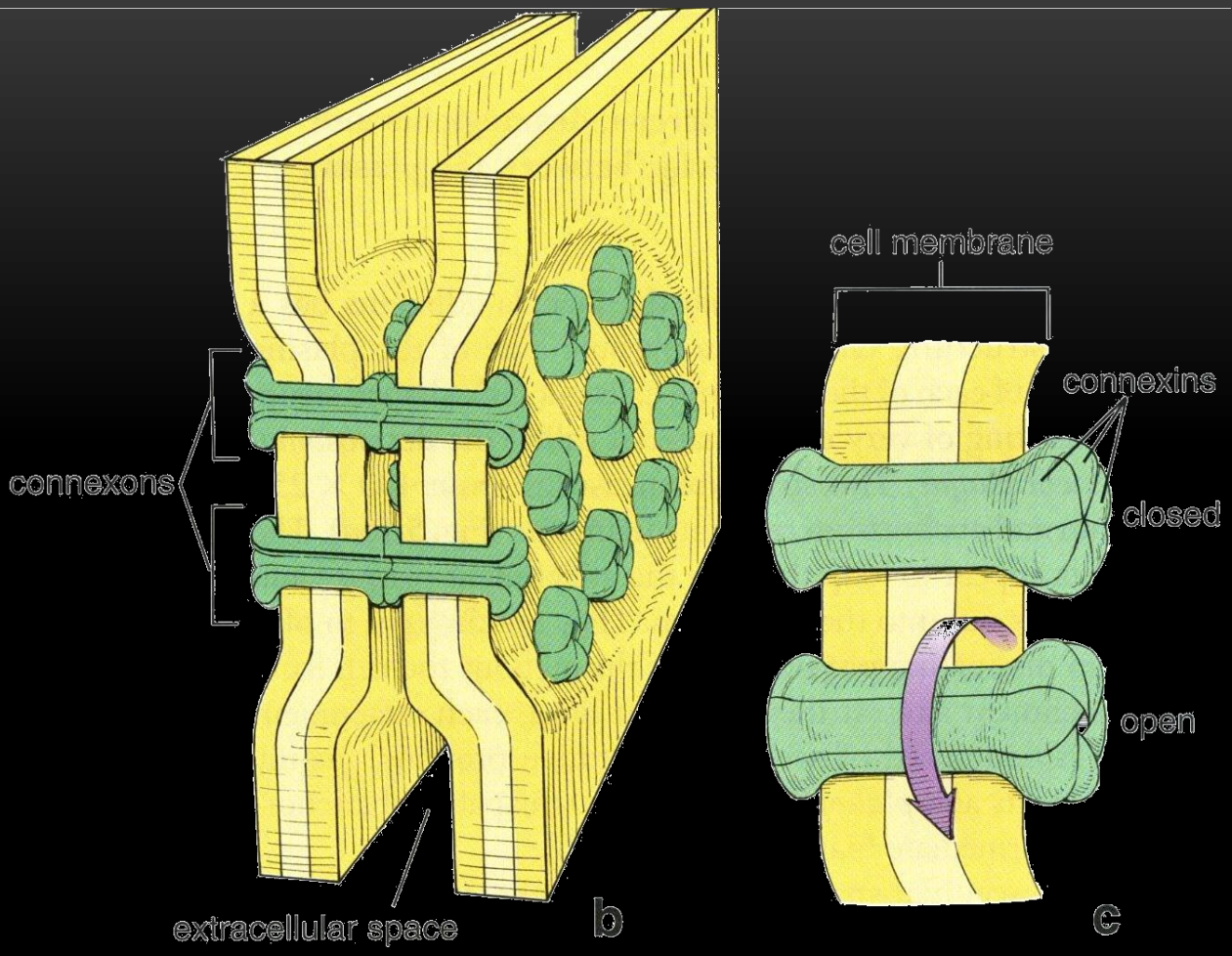
Gap Junction

Channel-forming junction

Named for gap of regular width between cells visualized by TEM

Water-filled junctions transport molecules <1 kDal such as ions, nucleotides (including cAMP), and metabolites

Gap Junction

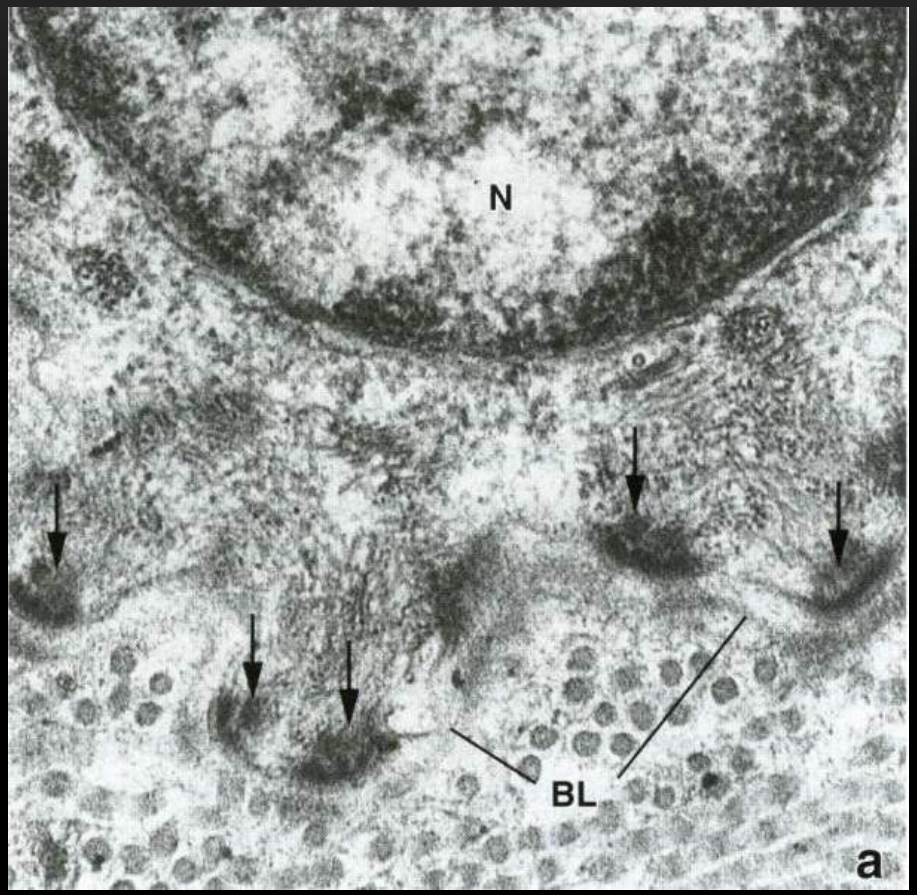


Connexin - protein subunit, six form a hexameric connexon

Connexons - two align to form the gap junction channel

Regulation - elevated calcium concentrations close channel

Hemidesmosomes

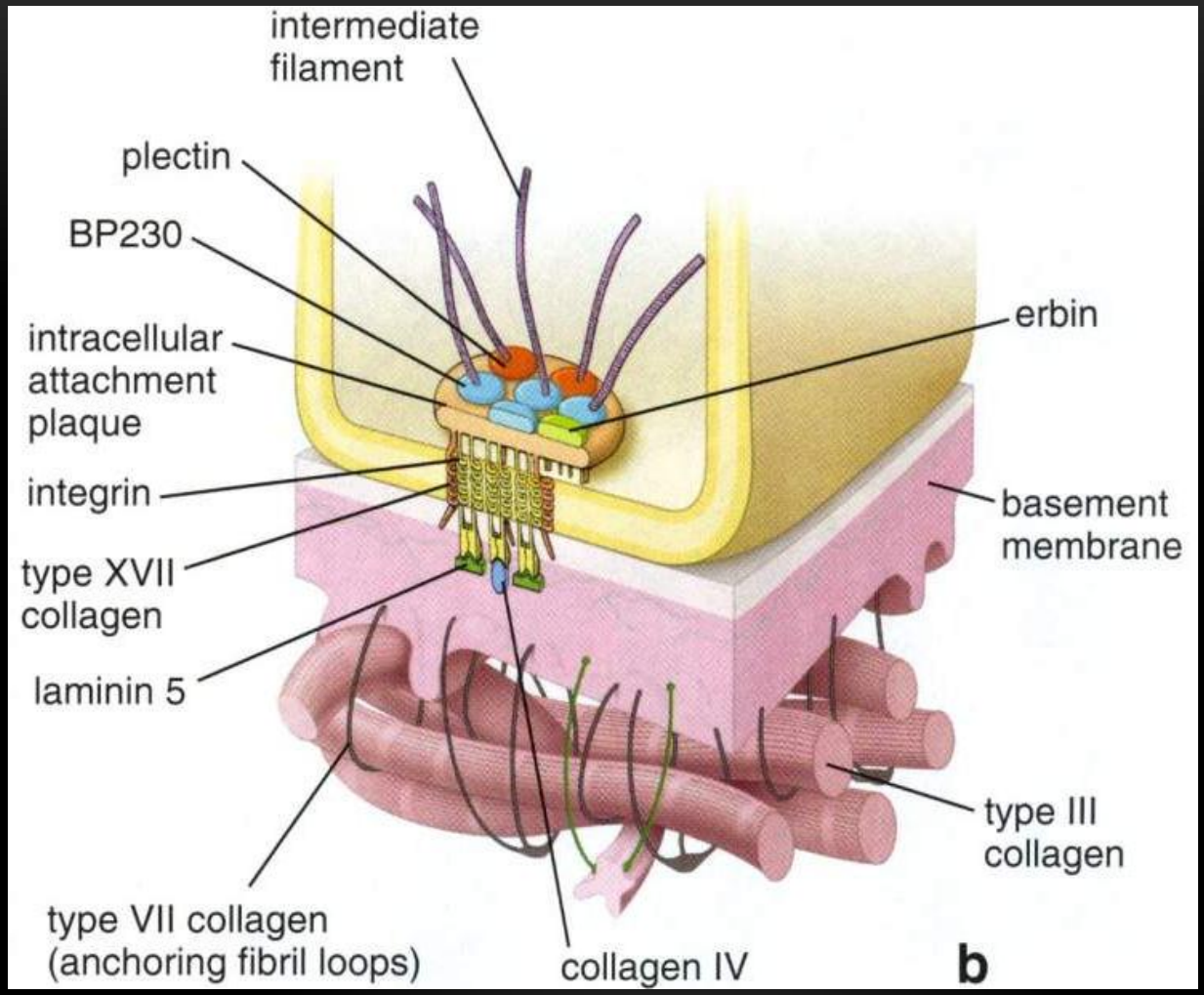


Hemidesmosome - "half-desmosome" in appearance only

Mediates attachment to basal lamina (extracellular matrix)

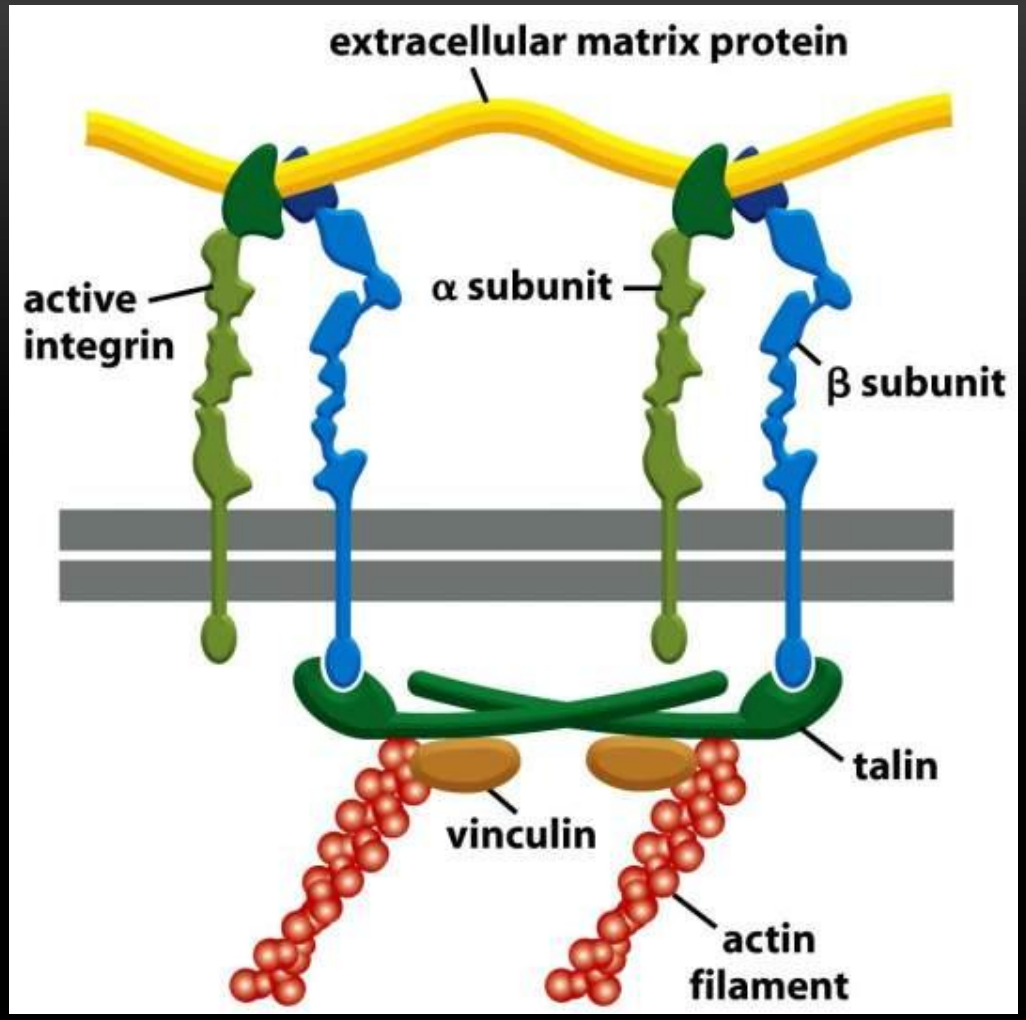
Cytoplasmic plaque is attached to cytoskeletal elements

Hemidesmosomes



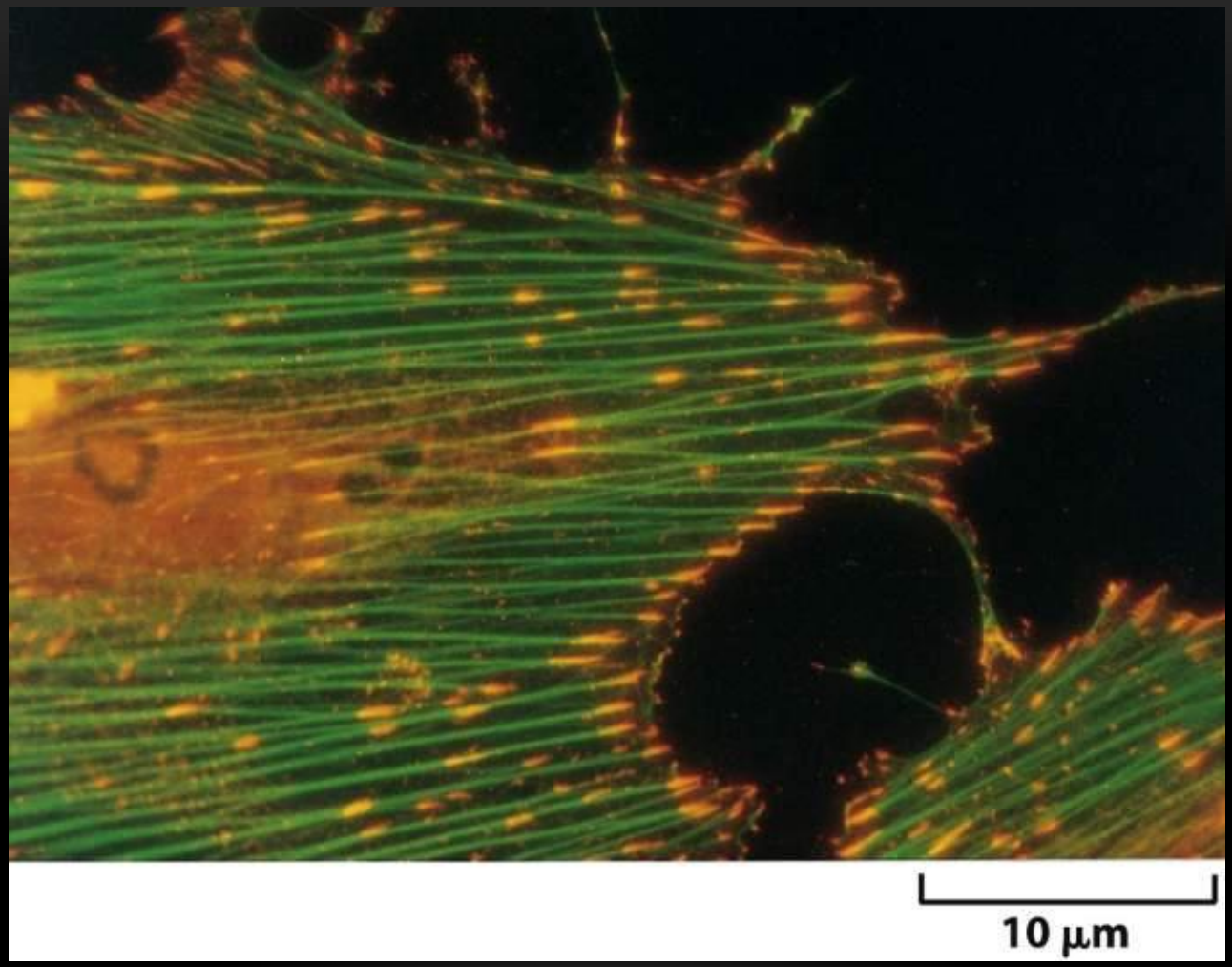
Integrins - membrane protein that "integrates" cell into matrix

Integrins



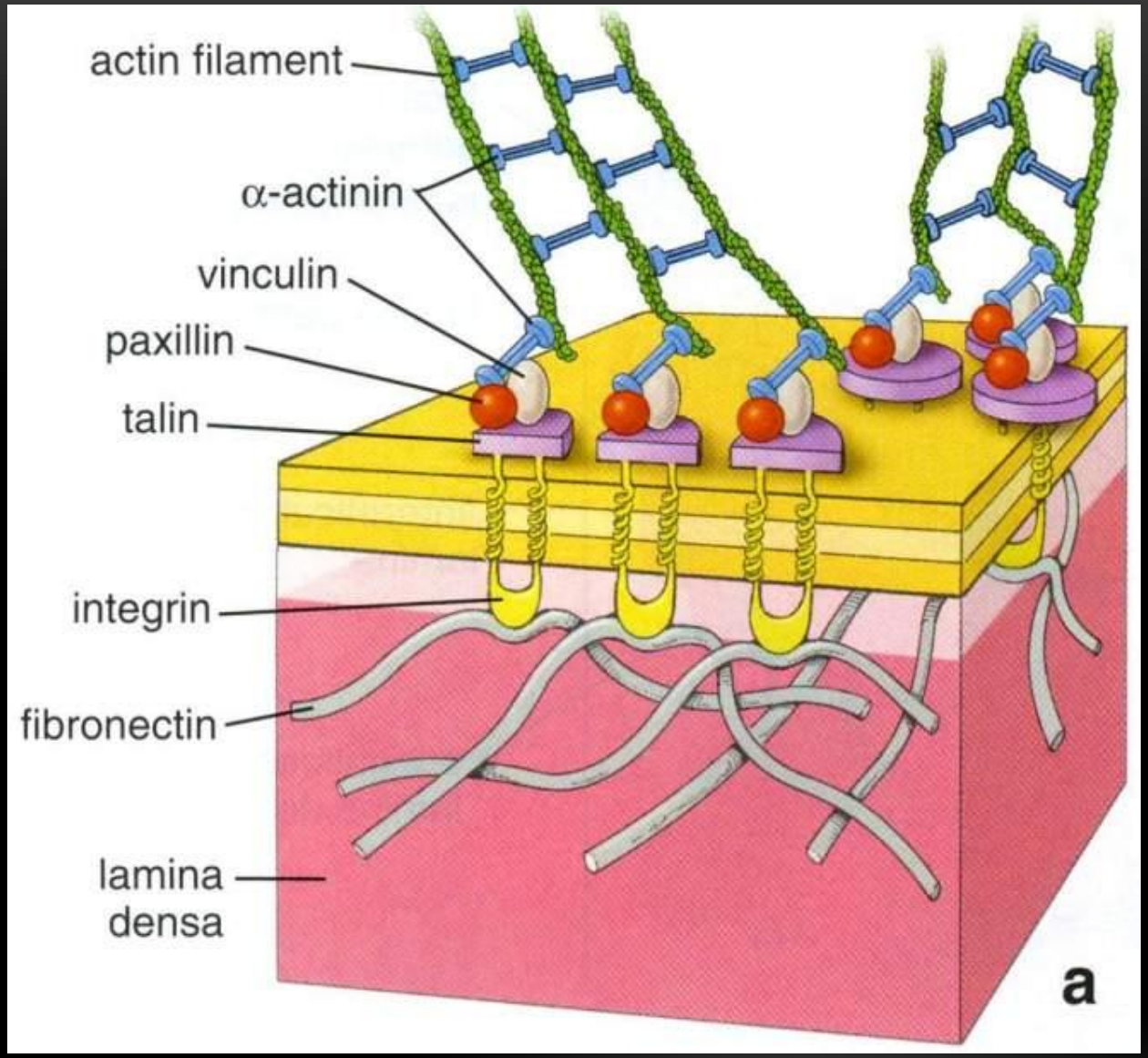
- Mediate calcium-independent cell-matrix adhesion
- Function as dimers of two membrane proteins (α and β)
- Adaptor proteins link integrins to intermediate filaments in hemidesmosomes or actin filaments in focal adhesions
- Integrins bind matrix proteins such as laminin or fibronectin

Focal Adhesions



Anchoring junction (AKA actin-linked cell-matrix adhesion)

Growing fibroblasts form many focal adhesions (orange) that serve as anchoring points for actin filaments (green)



Focal Adhesions

Fibroblasts attach to extracellular matrix via focal adhesions

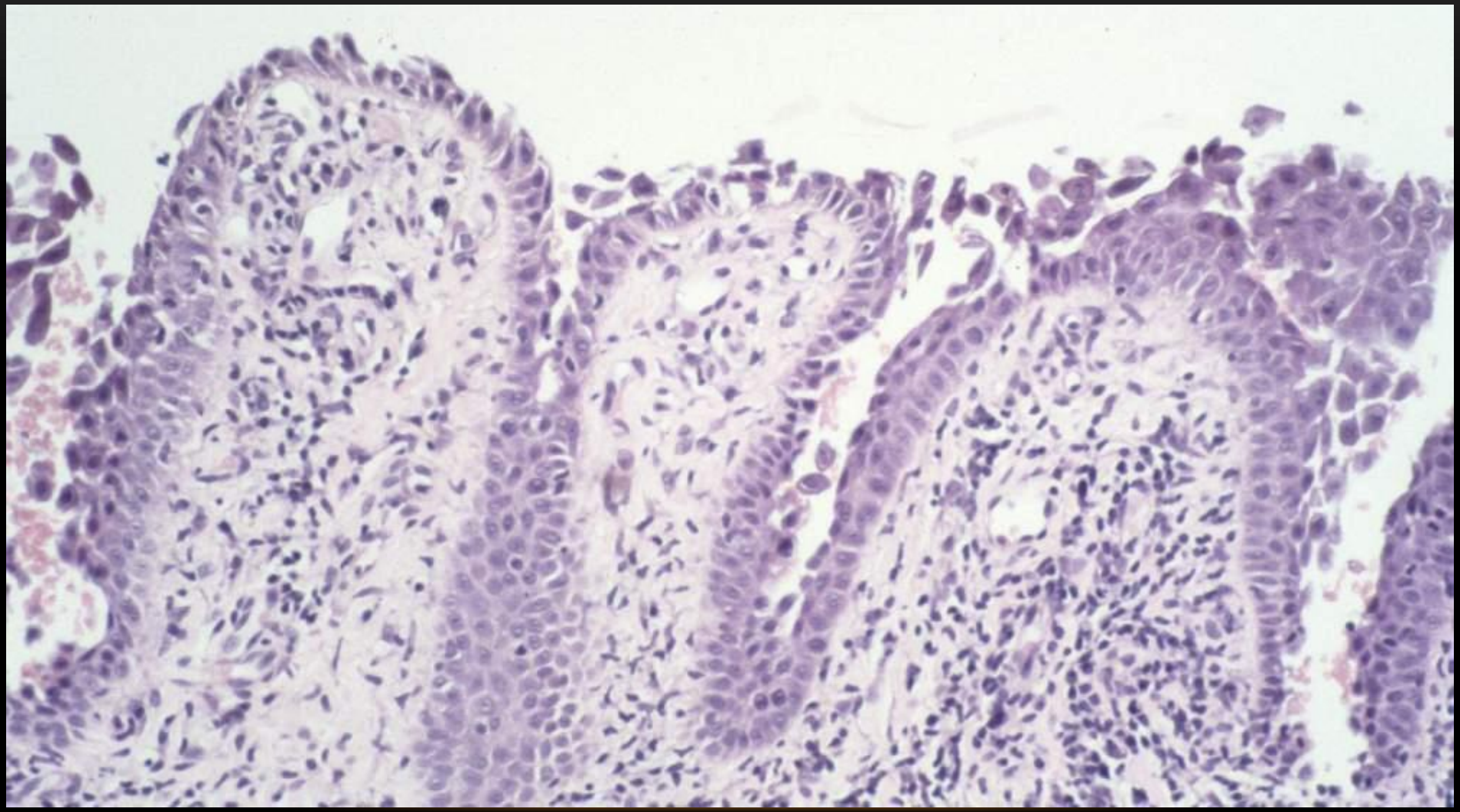
Integrins - membrane proteins link actin filaments and matrix

Blistering Disease

Many mechanisms underlie blistering disorders of the skin

Pemphigus group - autoimmune disease in which autoantibodies target desmogleins present in desmosomes

Pemphigus Histology



Acantholysis - separation of epidermal keratinocytes (H&E)

Glandular Epithelium

Glands are divided into:

Endocrine:

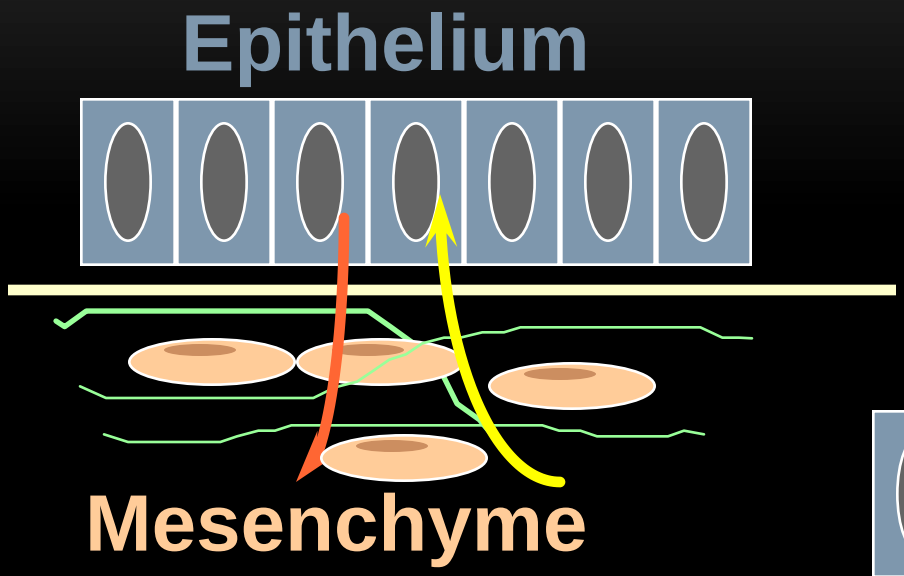
- Unicellular: DNES
- Multicellular: Thyroid, Adrenal

Exocrine:

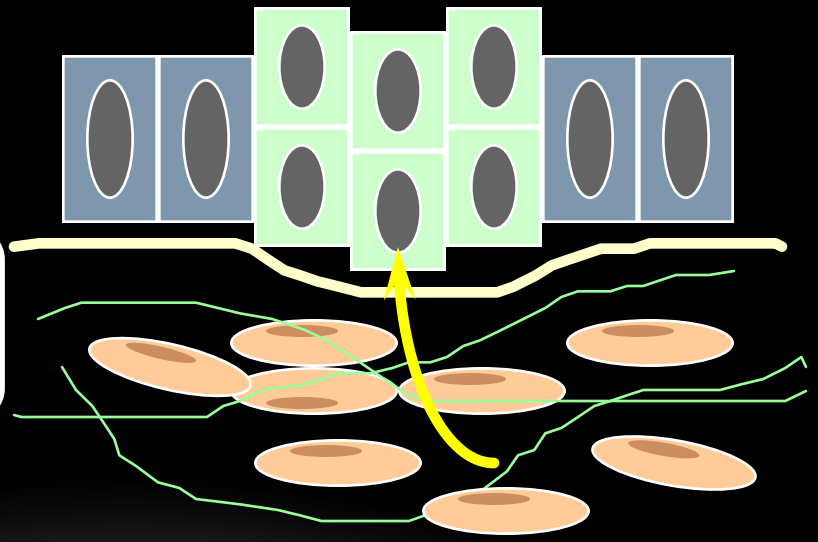
- **Unicellular**: Goblet cell
- **Multicellular**: Parotid, Submandibular, Sublingual

Mixed: Liver, Pancreas, Ovary, Testis.

Gland Development 1



Cell de-differentiation, & proliferation

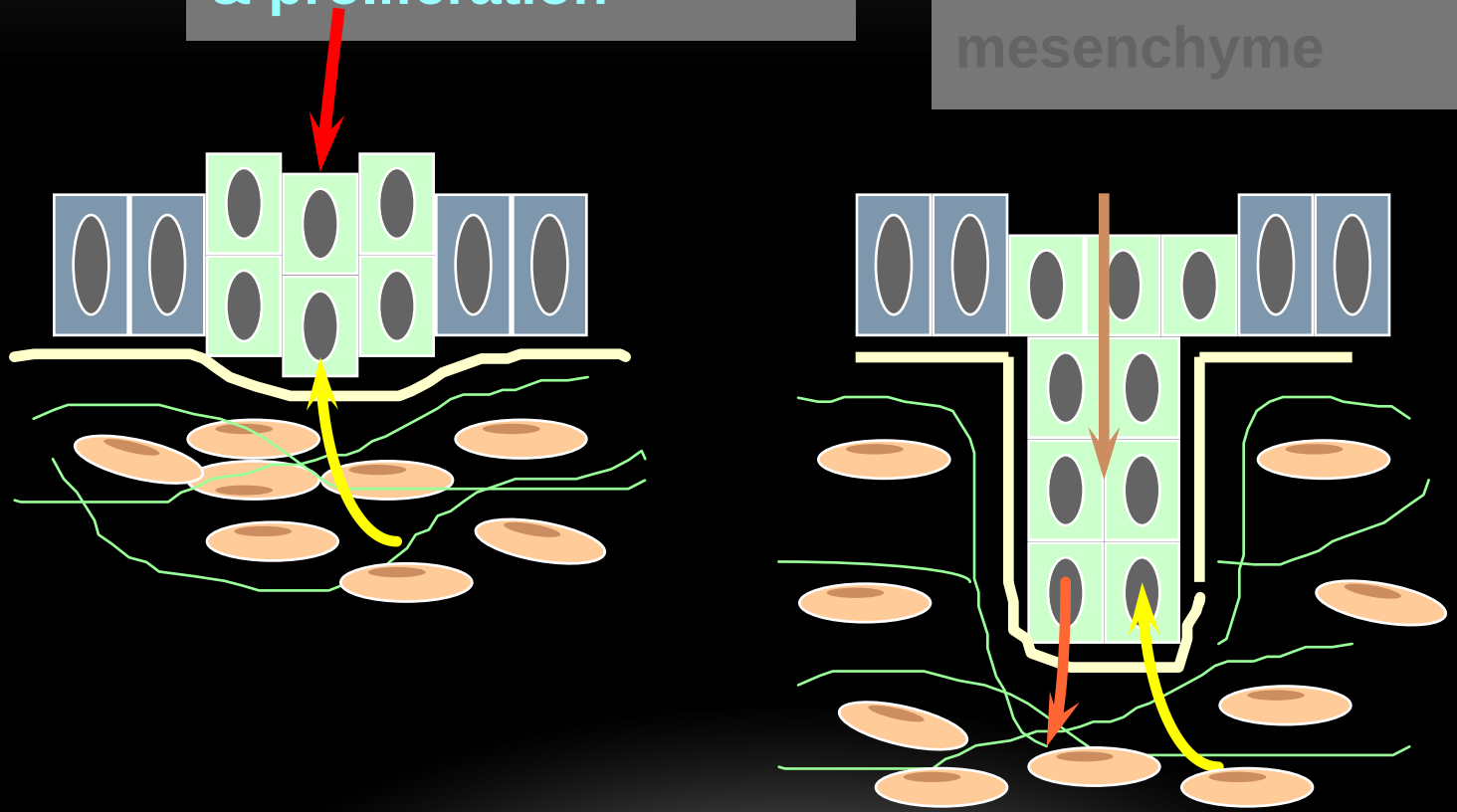


Mesenchymal-epithelial exchange of signals

Gland Development 2

Cell de-differentiation, & proliferation

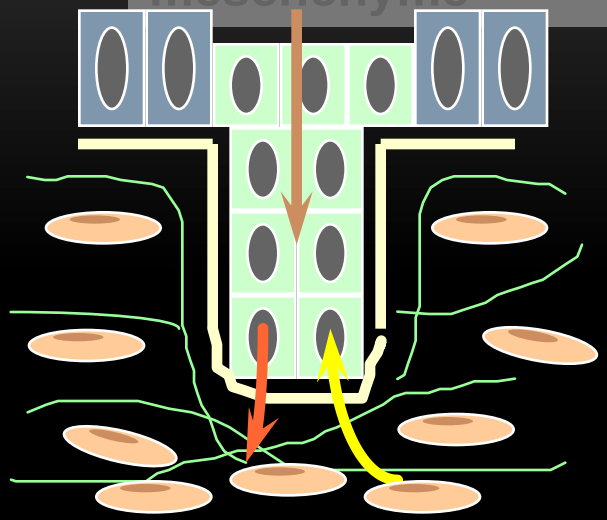
Epithelial downgrowth into modified mesenchyme

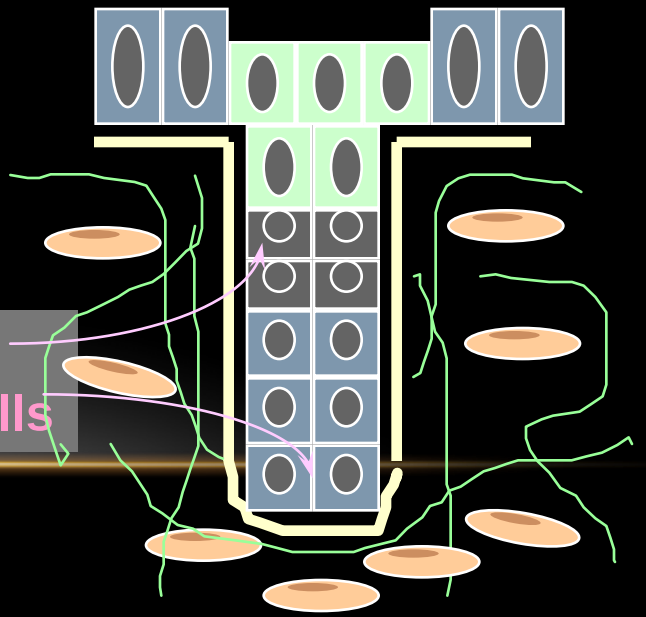


Mesenchymal-epithelial interaction

Gland Development 3

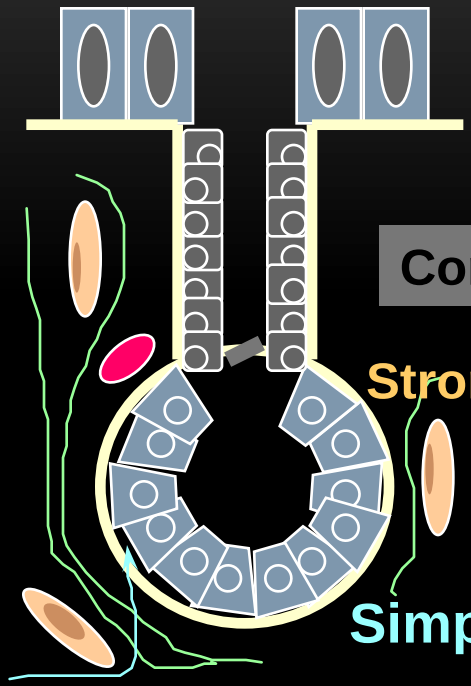
Epithelial downgrowth into modified mesenchyme





Differentiation into duct & secretory cells

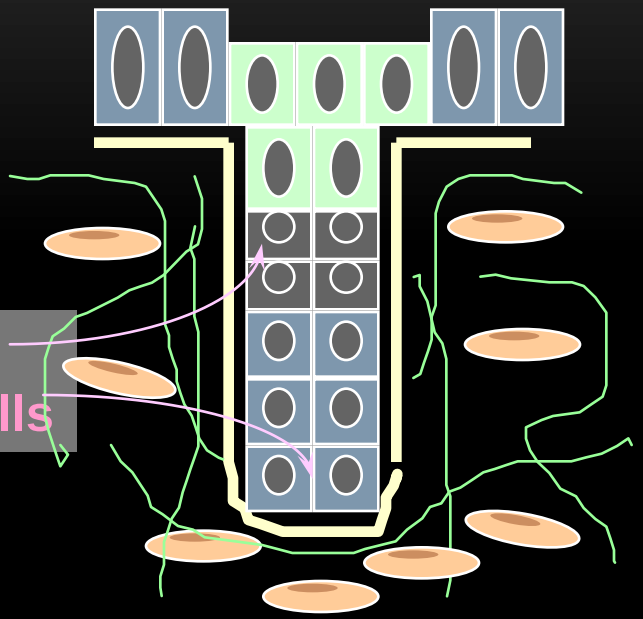
Gland Development 4



Construction of lumens

Stroma

Differentiation into
duct & secretory cells

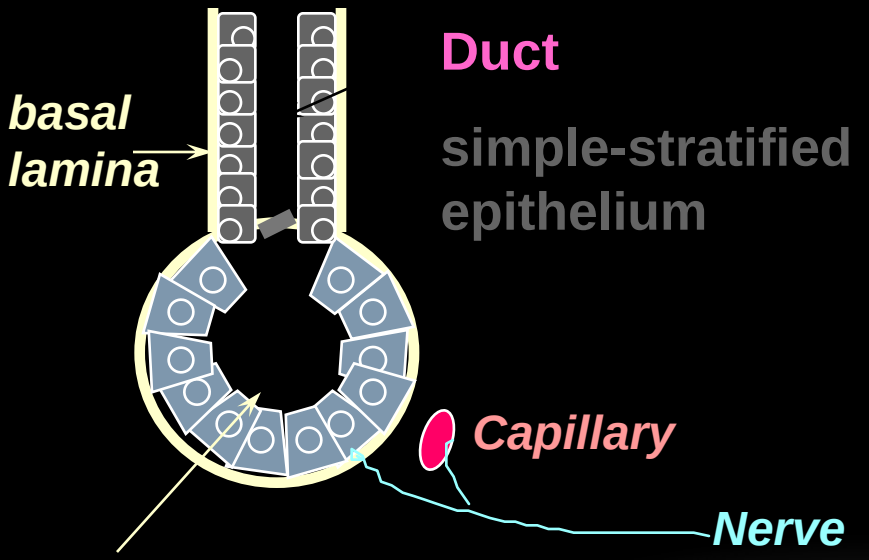


Simple alveolar gland

GLANDULAR EPITHELIA

Although cells i crete, they are limited in number. To get more secreting power, and sometimes to focus it differently, e.g. to interact with blood, rather than dump into a principal tube, epithelial cells can build *glands*

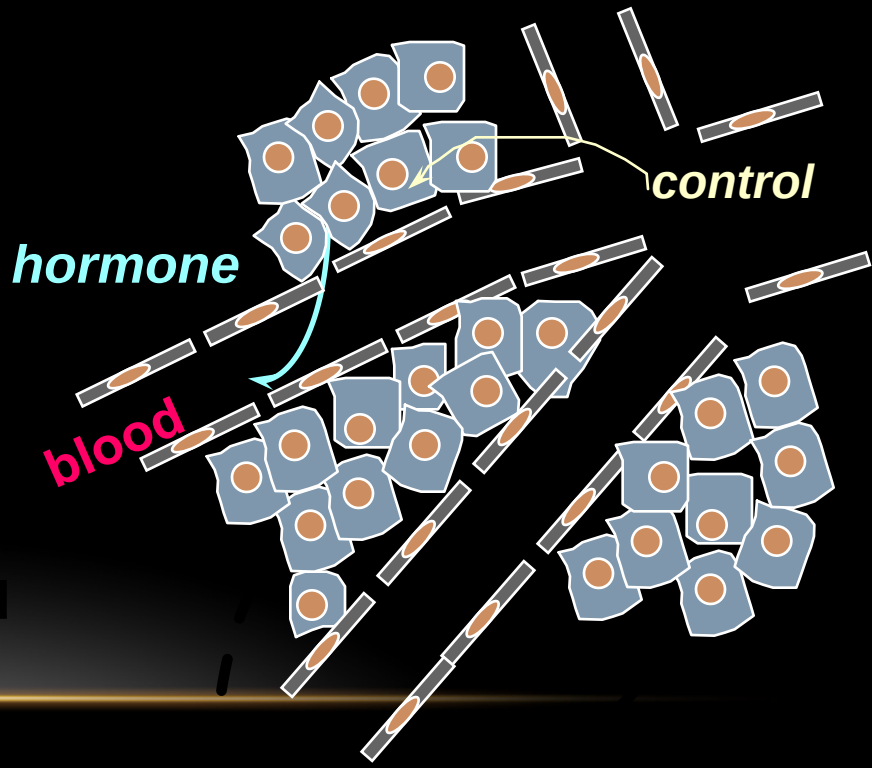
EXOCRINE/DUCTED GLAND



Secretory unit

“cuboidal-pyramidal” cells

ENDOCRINE GLAND



Clumps of endocrine cells

EXOCRINE GLANDS.. 1:

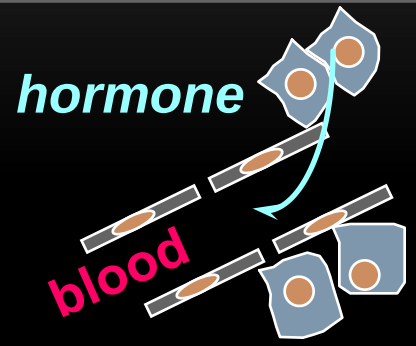
Classified according to the mode of secretion:

- Merocrine (eccrine):
- Apocrine:
- Holocrine:

MODES OF SECRETORY RELEASE

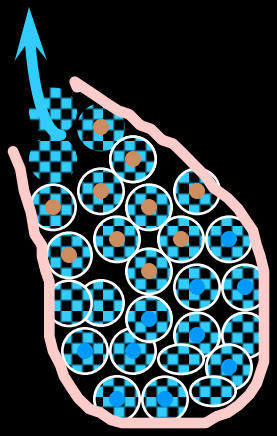
MEROCRINE / ECCRINE

secretion released by exocytosis, with *no loss of cytoplasm*

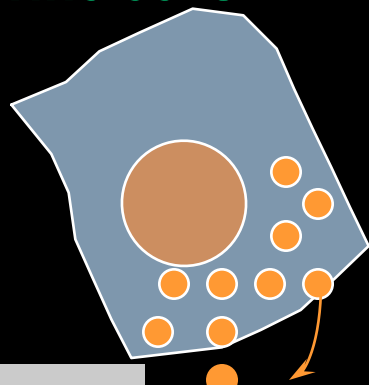


e.g., by endocrine cells

SEBUM



Sebaceous gland



secretion released, filling a *dead* cell

HOLOCRINE

released by exocytosis, with *a little loss of cytoplasm*

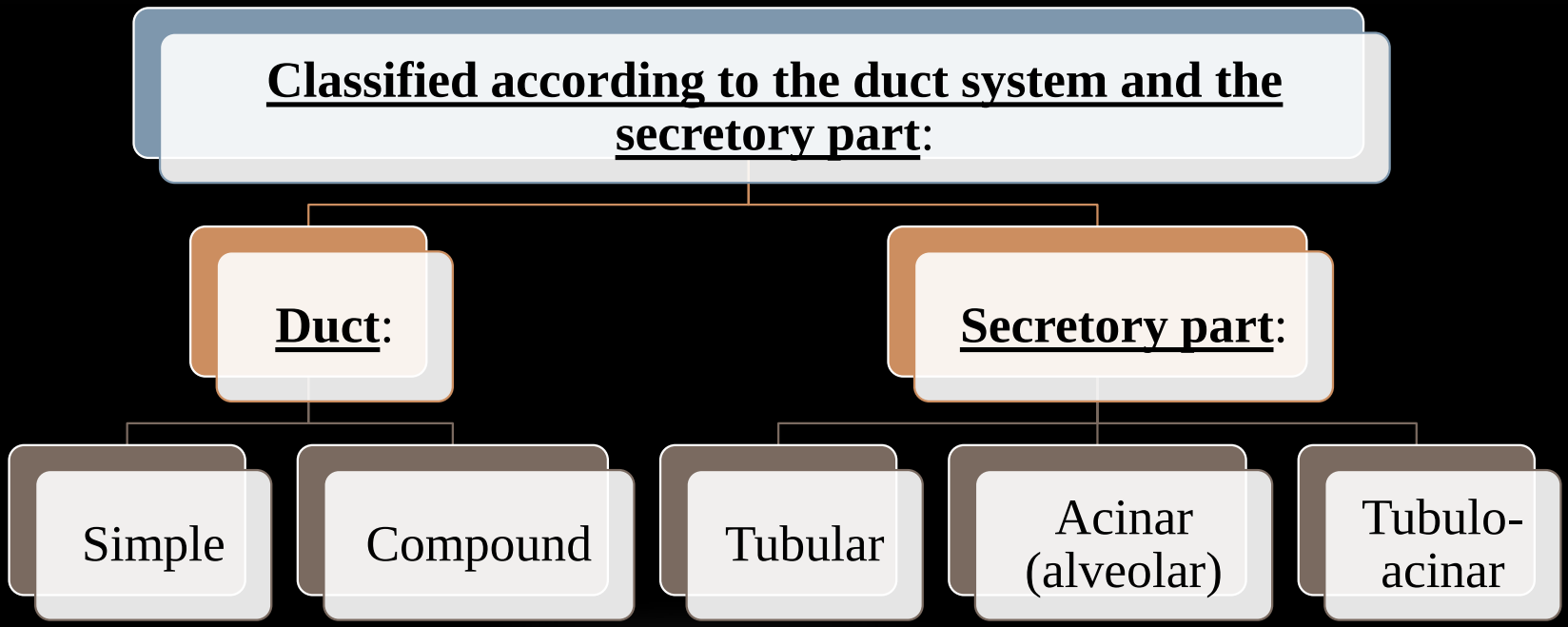
APOCRINE

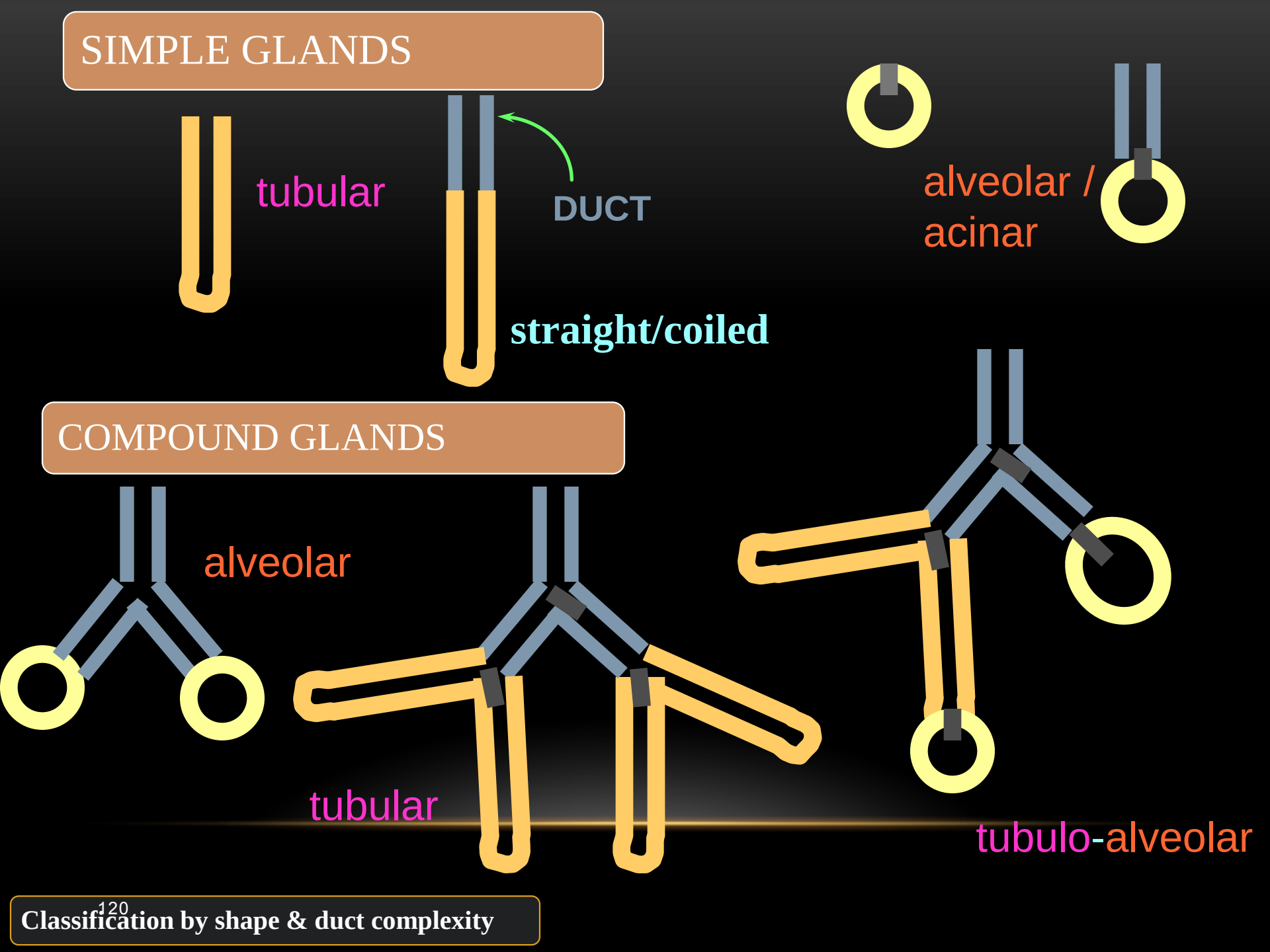
Exocrine Glands.. 2:

Classified according to nature of secretion:

- Serous:
- Mucous:
- Mixed:

Exocrine Glands.. 3:

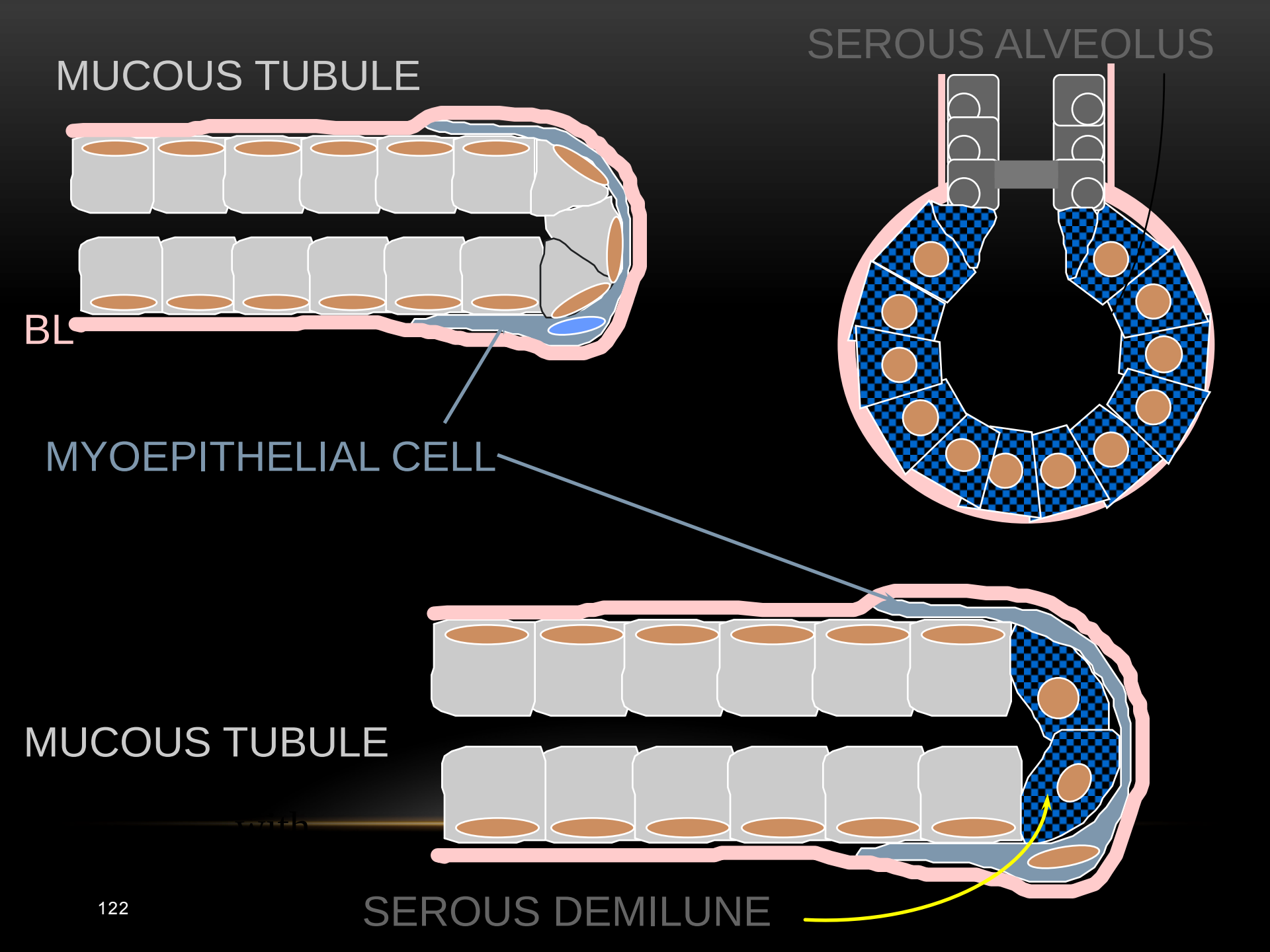




Classification by shape & duct complexity

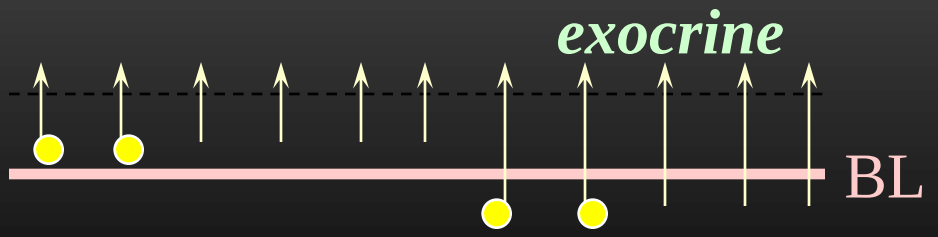
Glandular Epithelia : Products & Roles

Extra mucus	Airway glands, Duodenal & Salivary glands
Extra defense	Airway glands
Digestion	Gastric glands, Pancreas
Blood processing	Liver
Hormones	Endocrine glands
Milk	Mammary glands
Sweat	Sweat glands
Grease	Sebaceous glands
Genital glands	Special genito-urinary functions

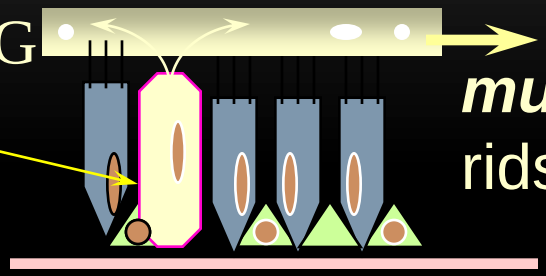

MUCOUS TUBULE
SEROUS ALVEOLUS
BL
MYOEPITHELIAL CELL
MUCOUS TUBULE
SEROUS DEMILUNE

Deliver all along a surface

- **Single cells**

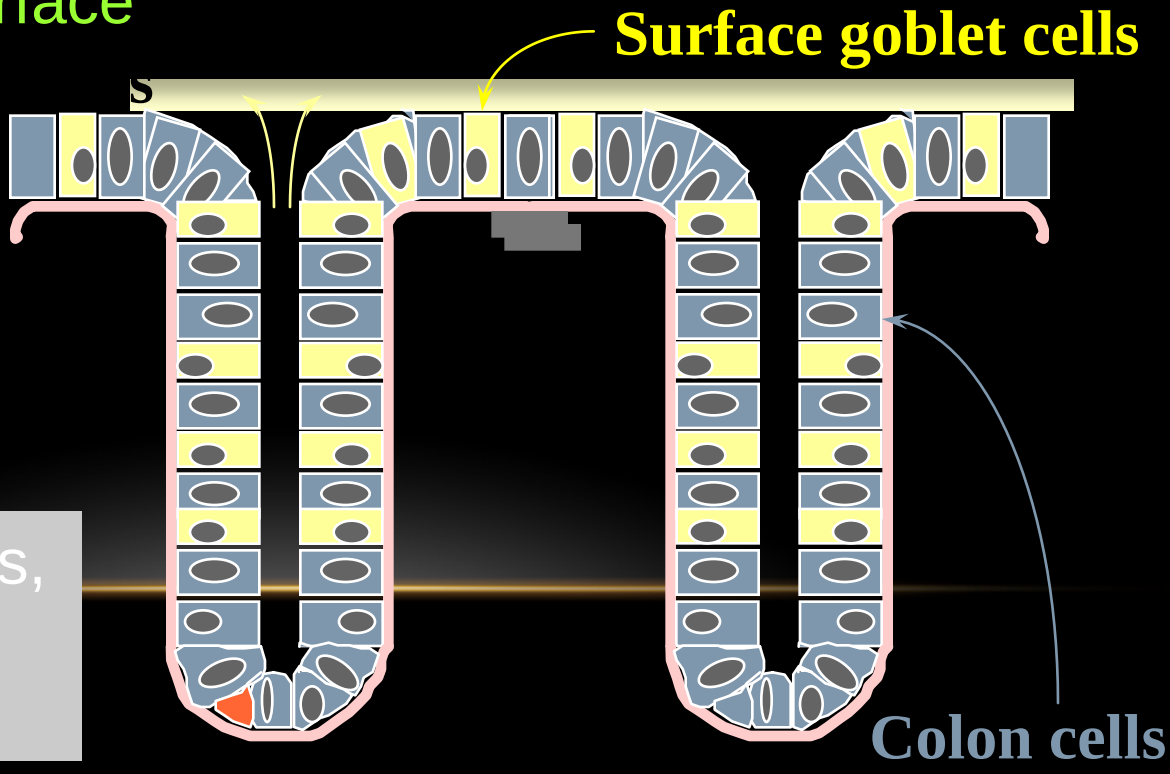


MUCUS-SECRETING GOBLET CELL



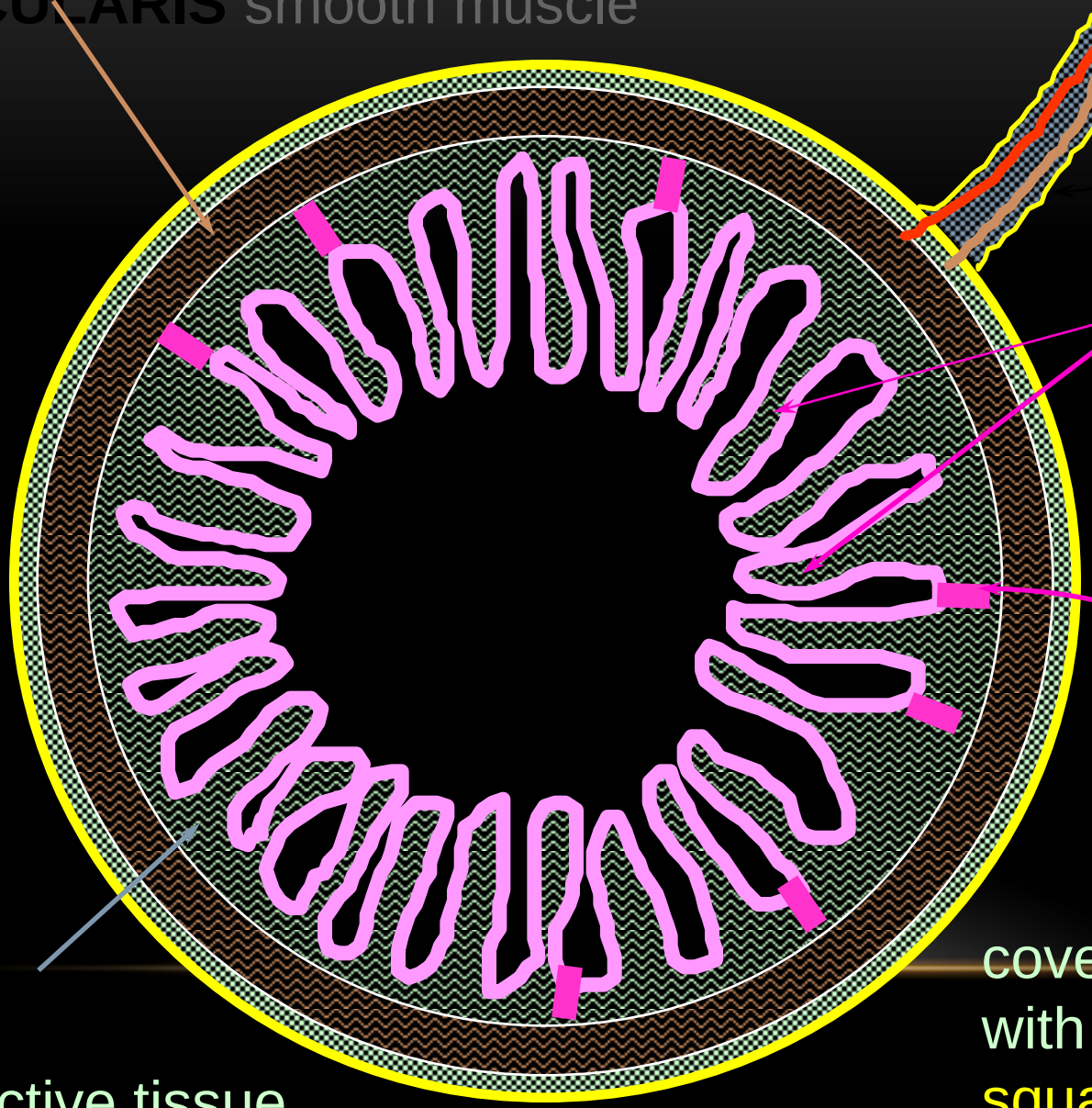
muco-ciliary escalator rids airway of particles

Deliver all along a surface

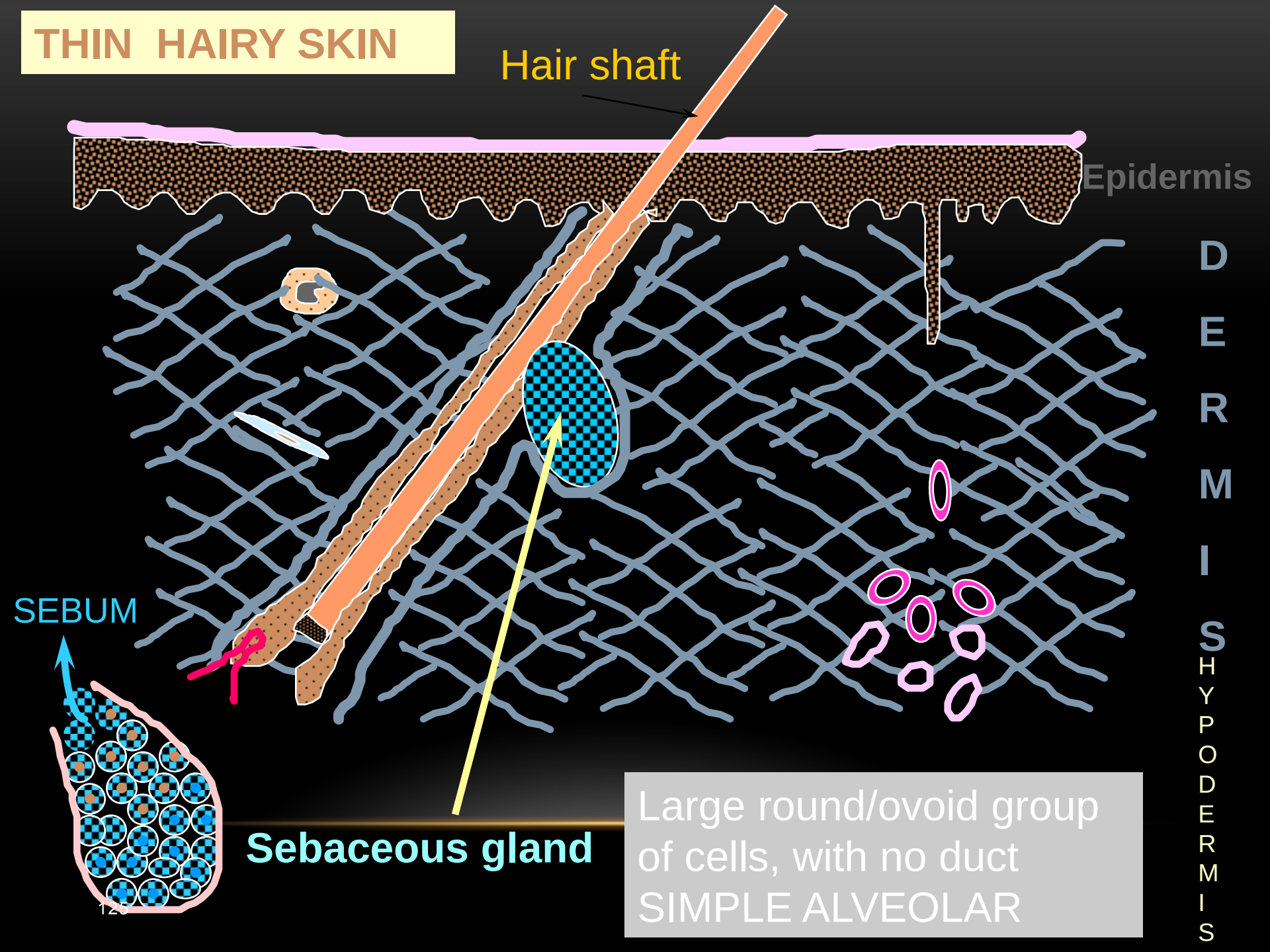


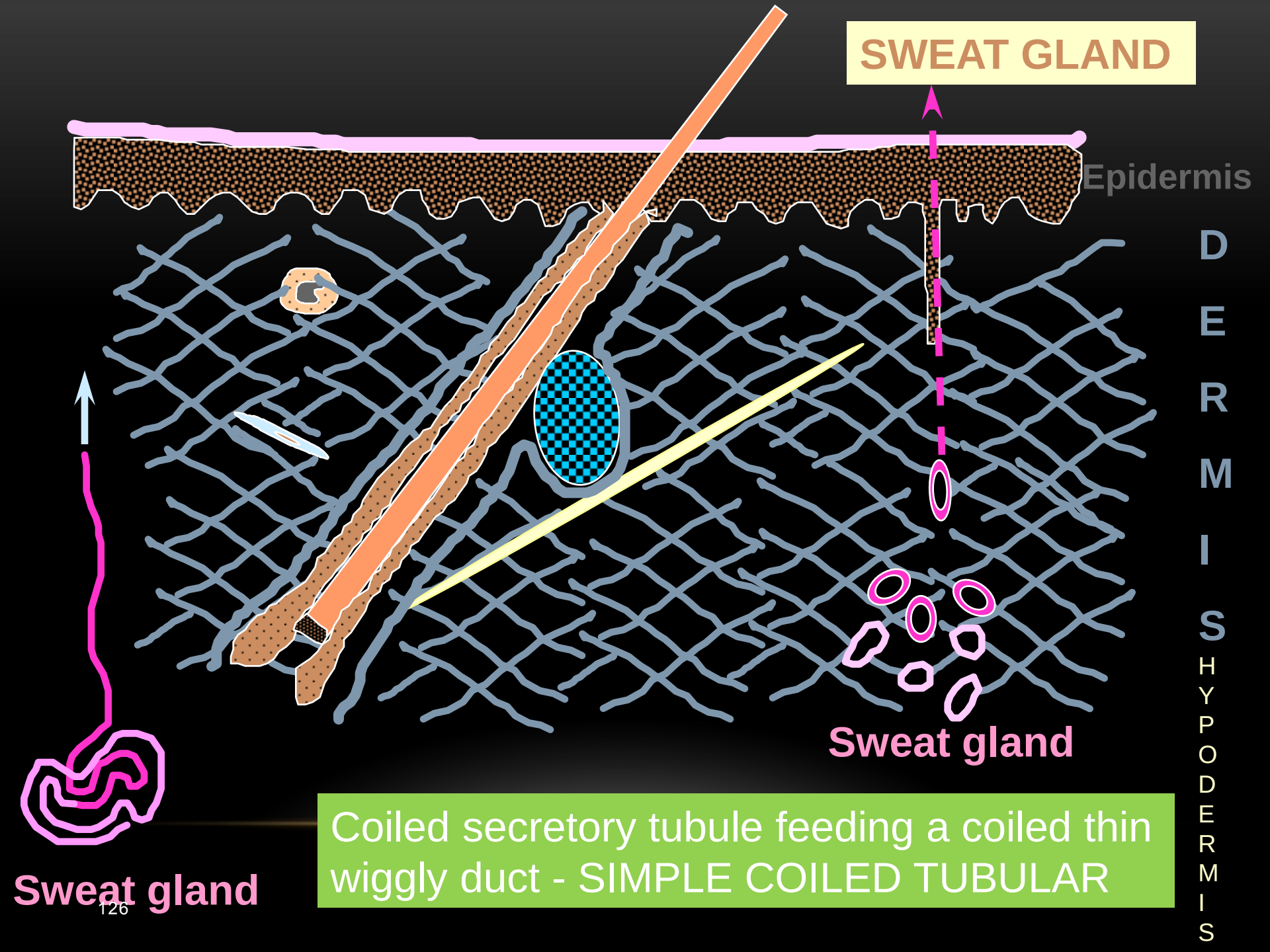
Simple straight tubules, with - SIMPLE TUBULAR

GUT PARTS


suspensory **MESENTERY**
with blood vessels
MUSCULARIS smooth muscle
simple
columnar
epithelium
GLANDS
covering **SEROSA**
with simple
squamous epithelium
connective tissue

THIN HAIRY SKIN

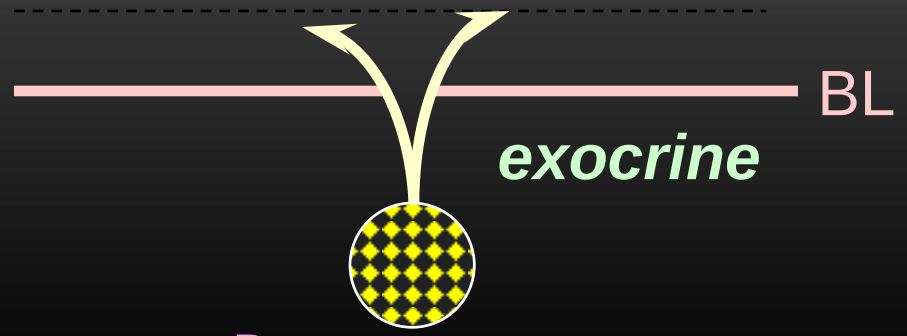


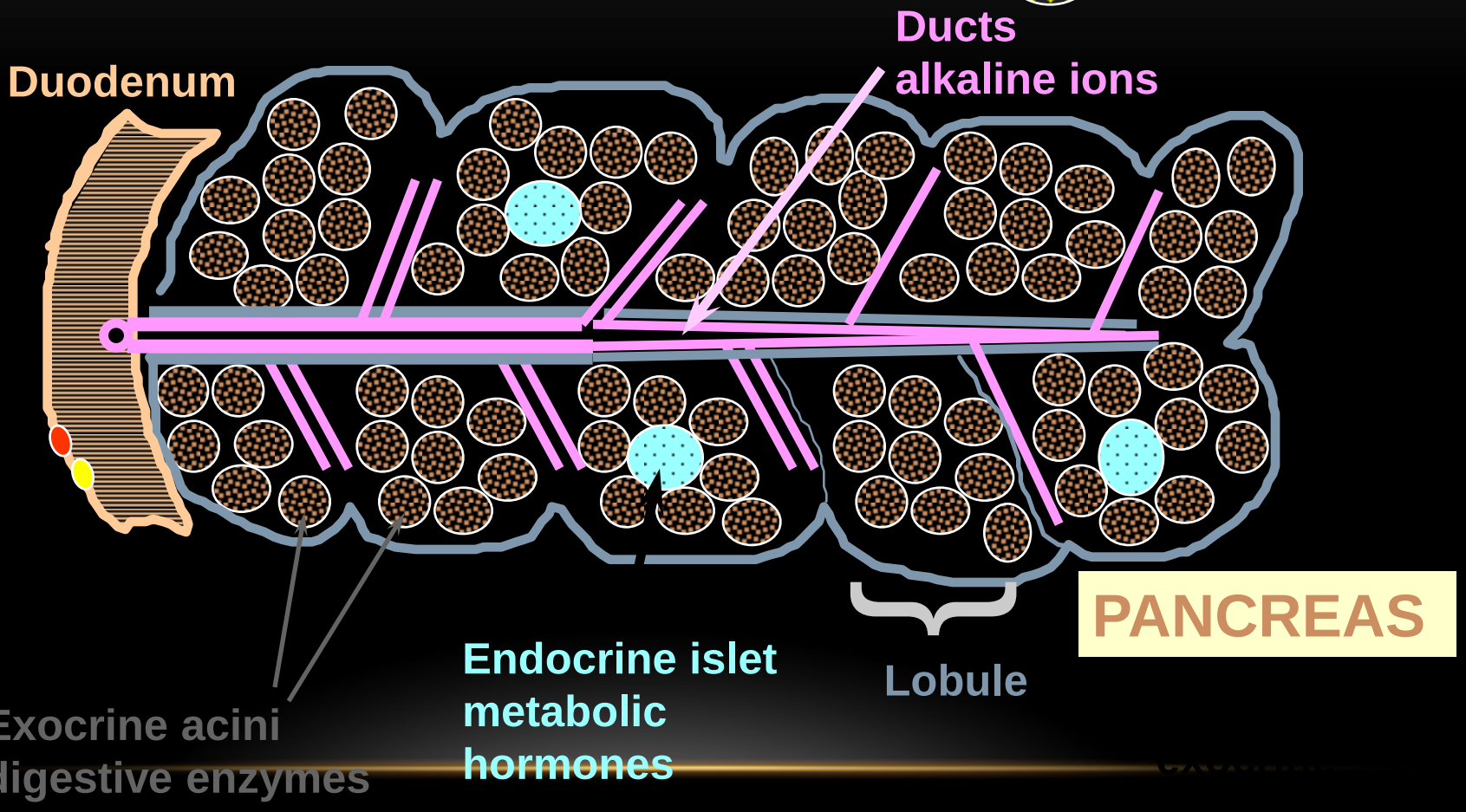


Coiled secretory tubule feeding a coiled thin wiggly duct - SIMPLE COILED TUBULAR

- Deliver at wide intervals along a surface

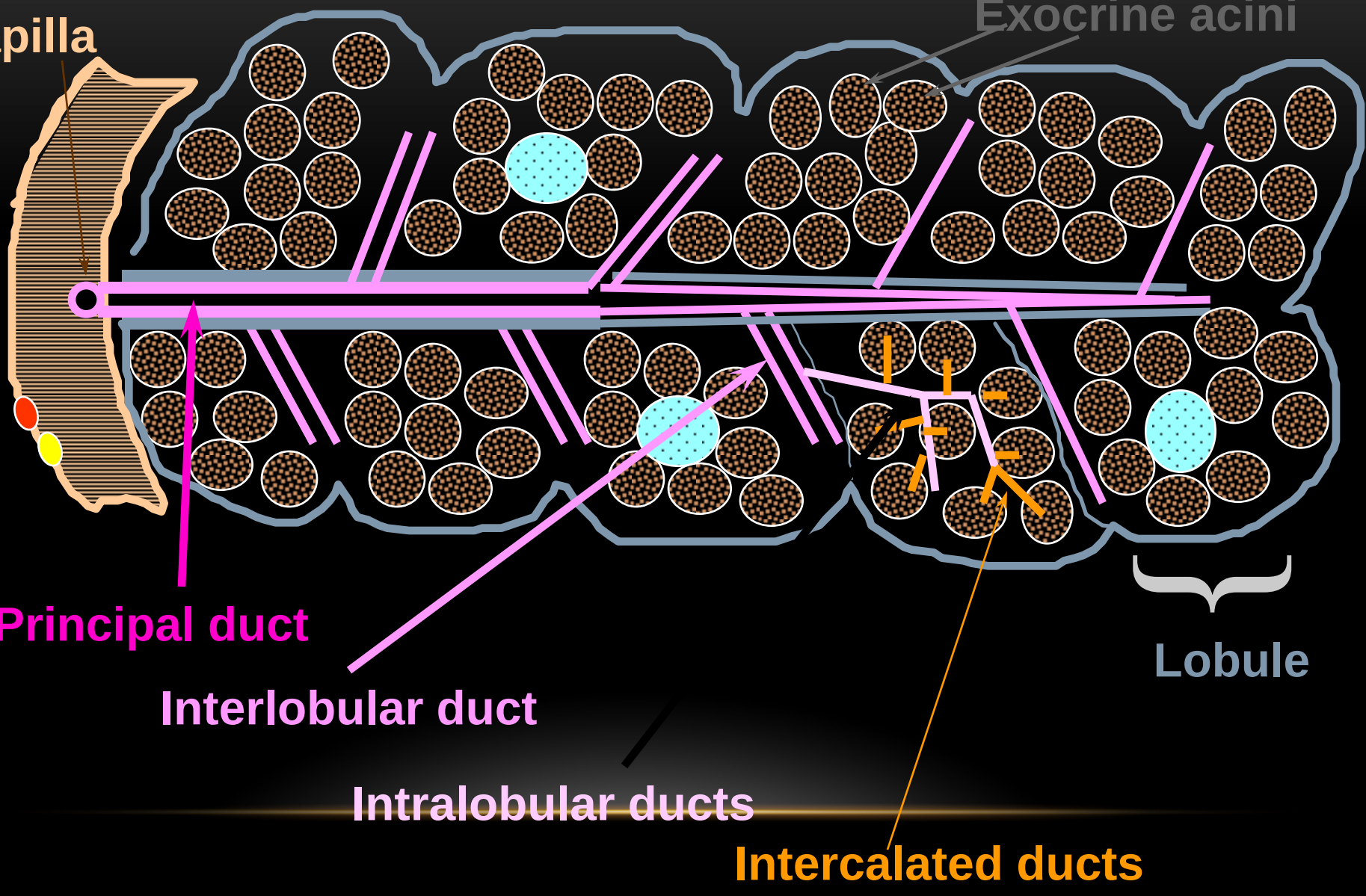
  Large, elaborate, compound glands

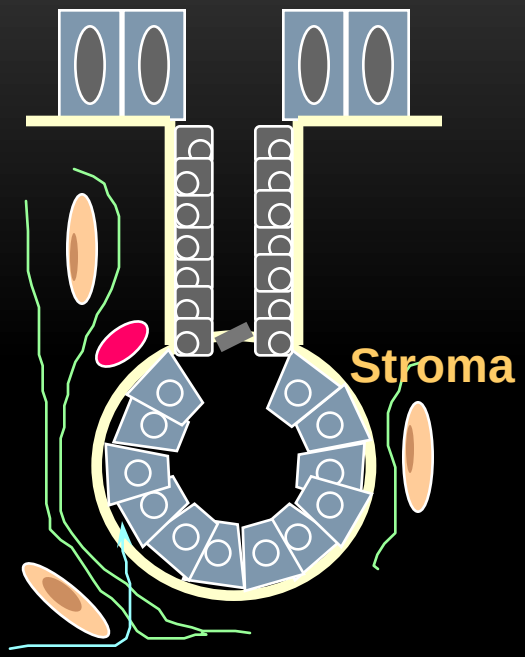




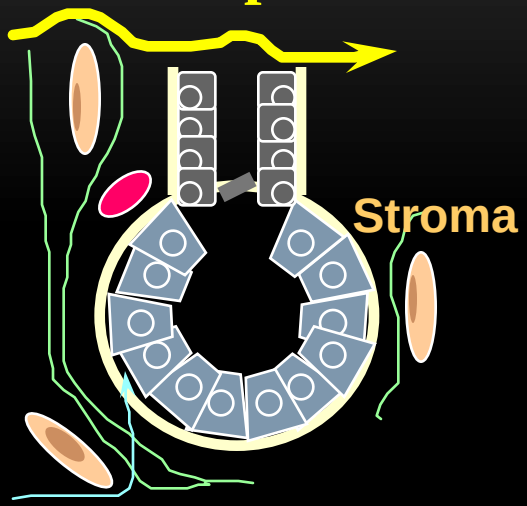
Many secretory acini/alveoli feeding branching duct system - COMPOUND ALVEOLAR

EXOCRINE PANCREAS Ducts 1

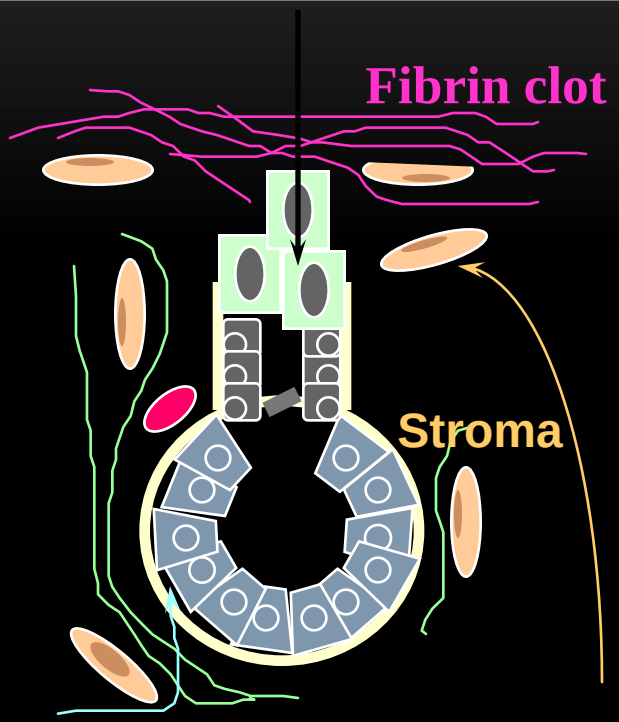




Traumatic loss of surface epithelium

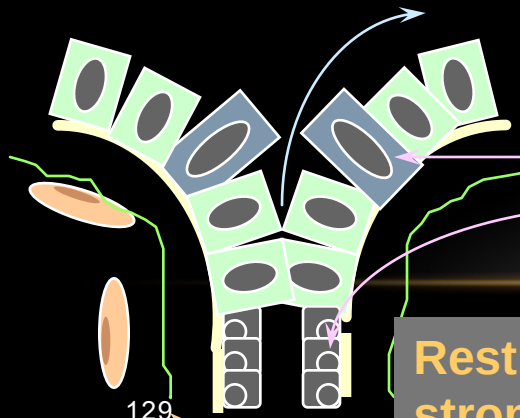


Duct Cell de-differentiation, & proliferation



Epithelial upgrowth and outgrowth over clot

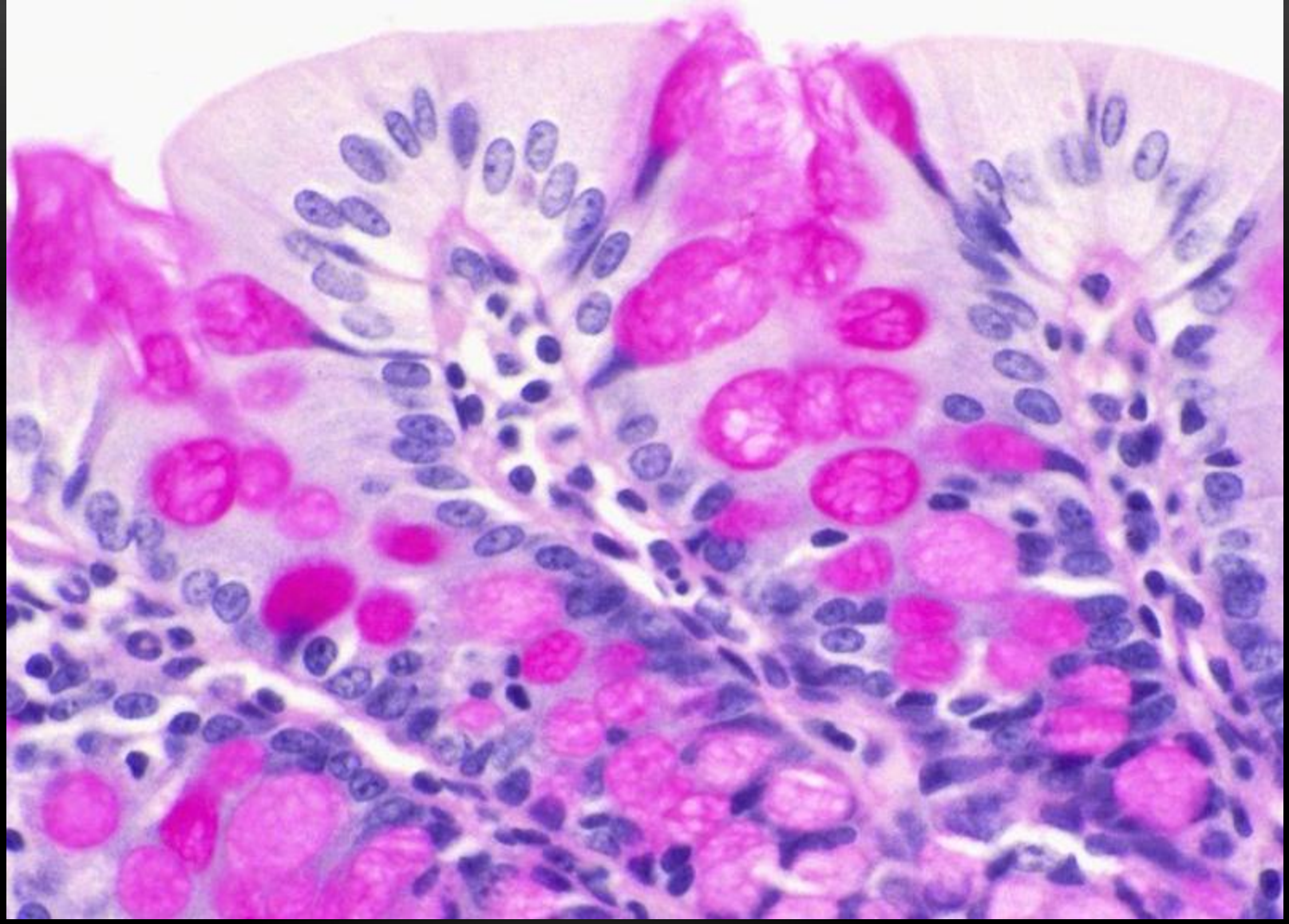
Stromal cell re-activation, & proliferation



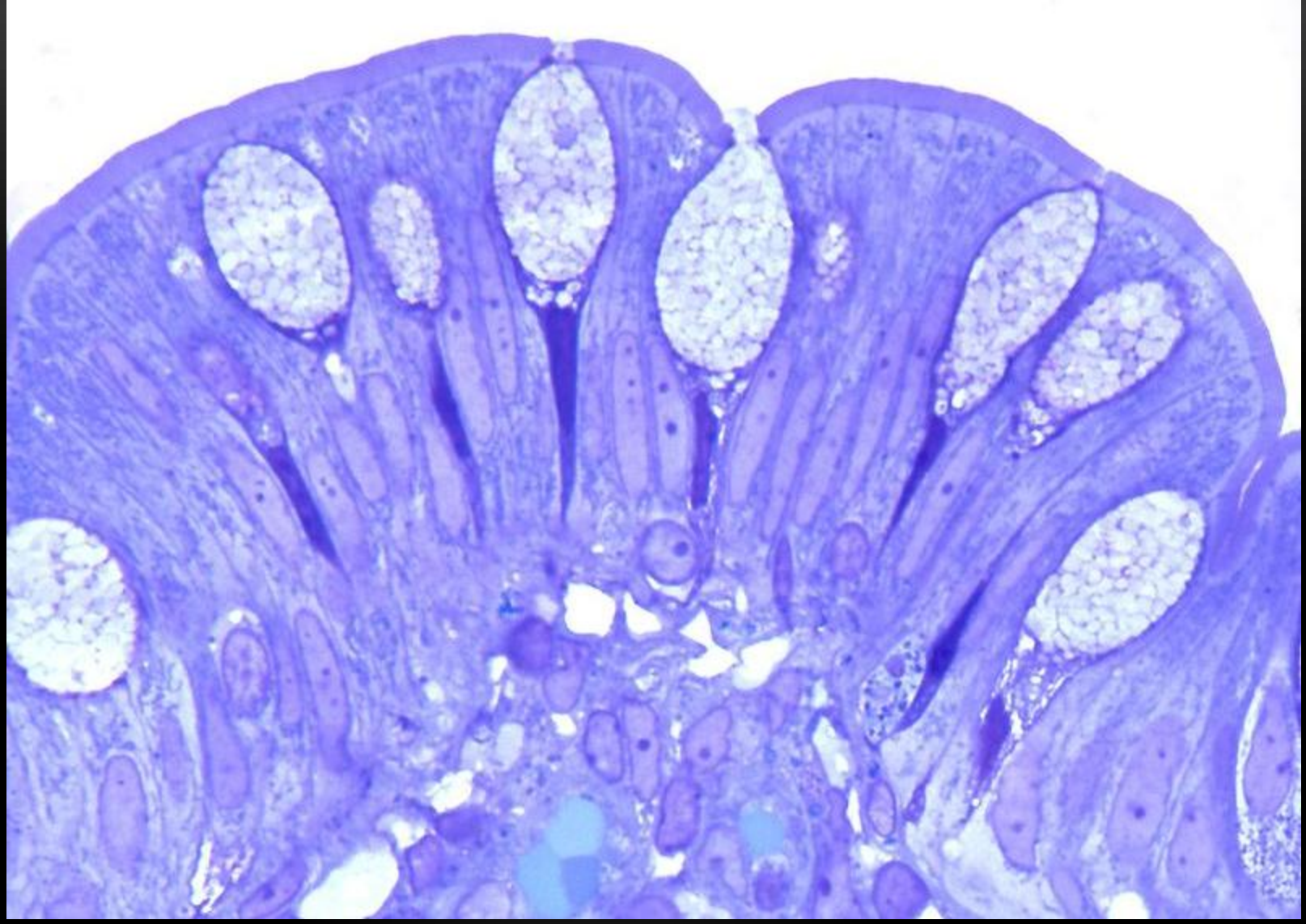
Differentiation into surface & duct cells

Restitution of basal lamina & stroma

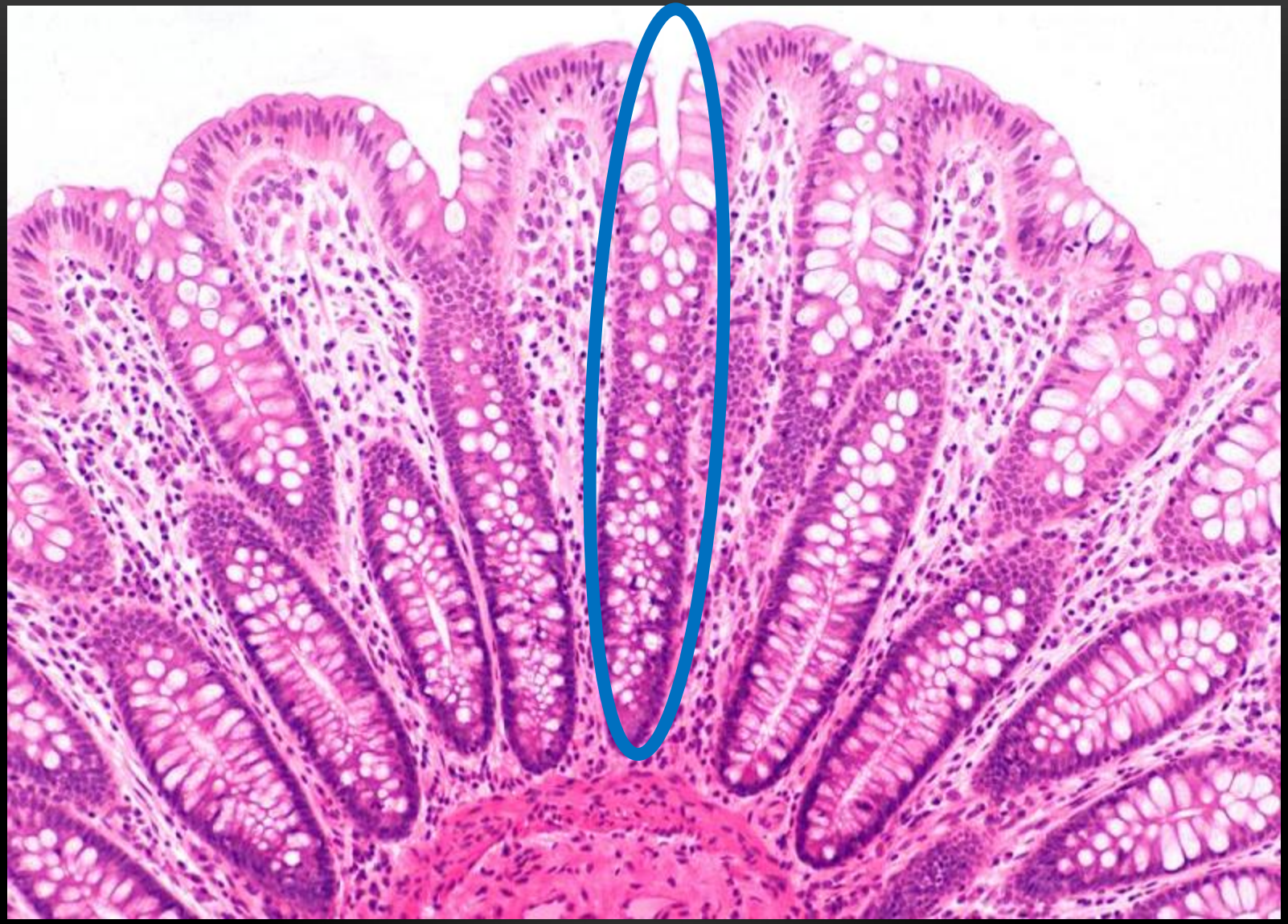
REGENERATION from ducts



Unicellular gland

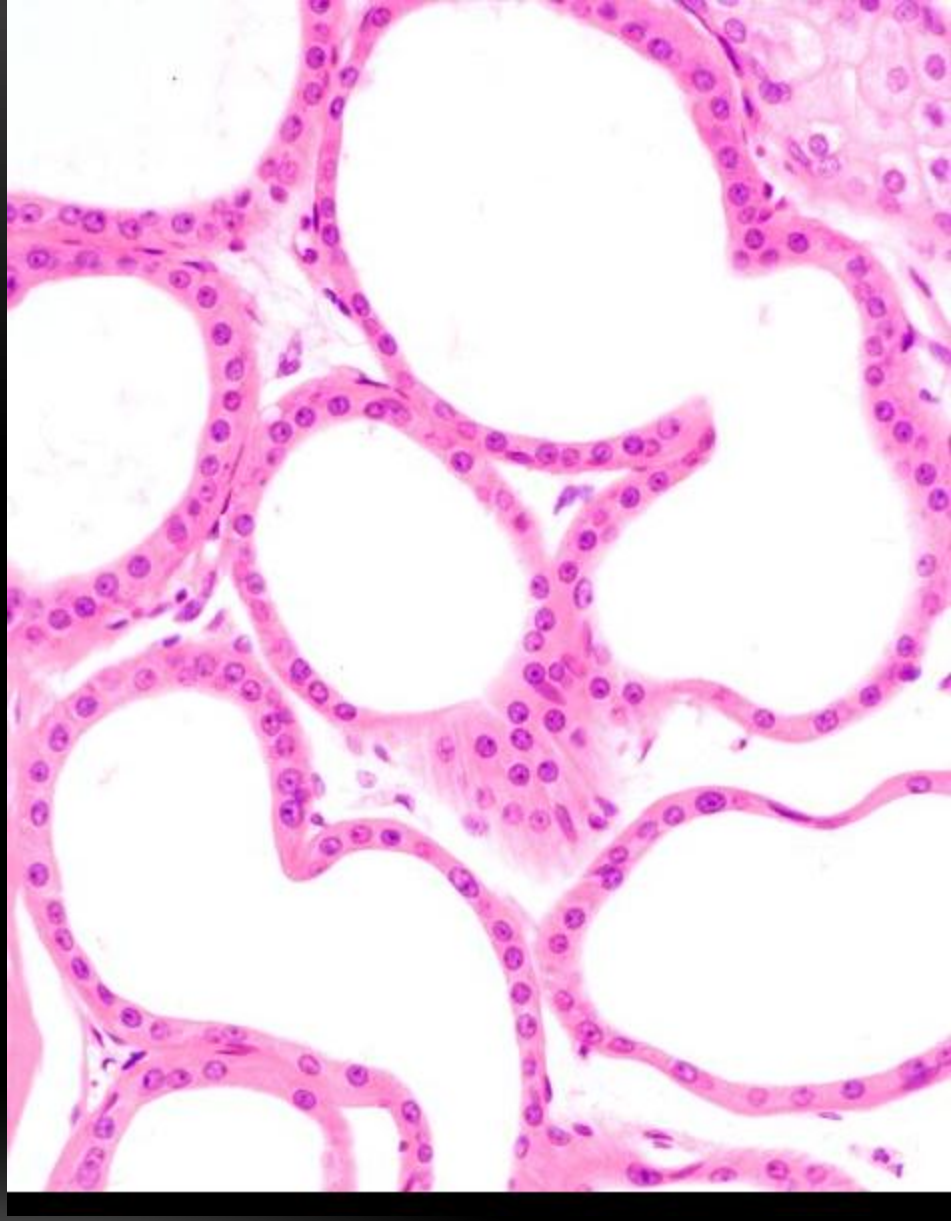


Unicellular gland

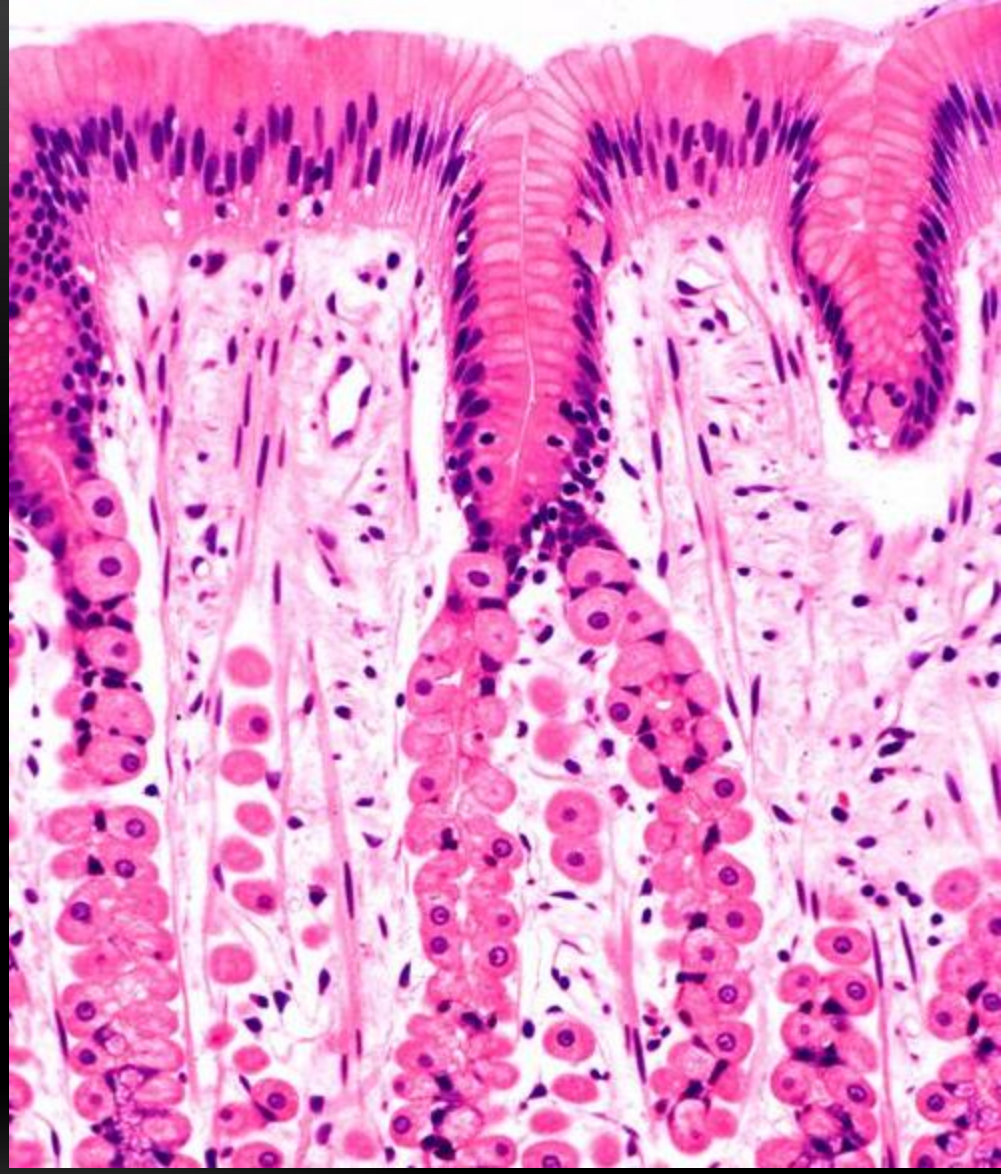


Simple tubular glands

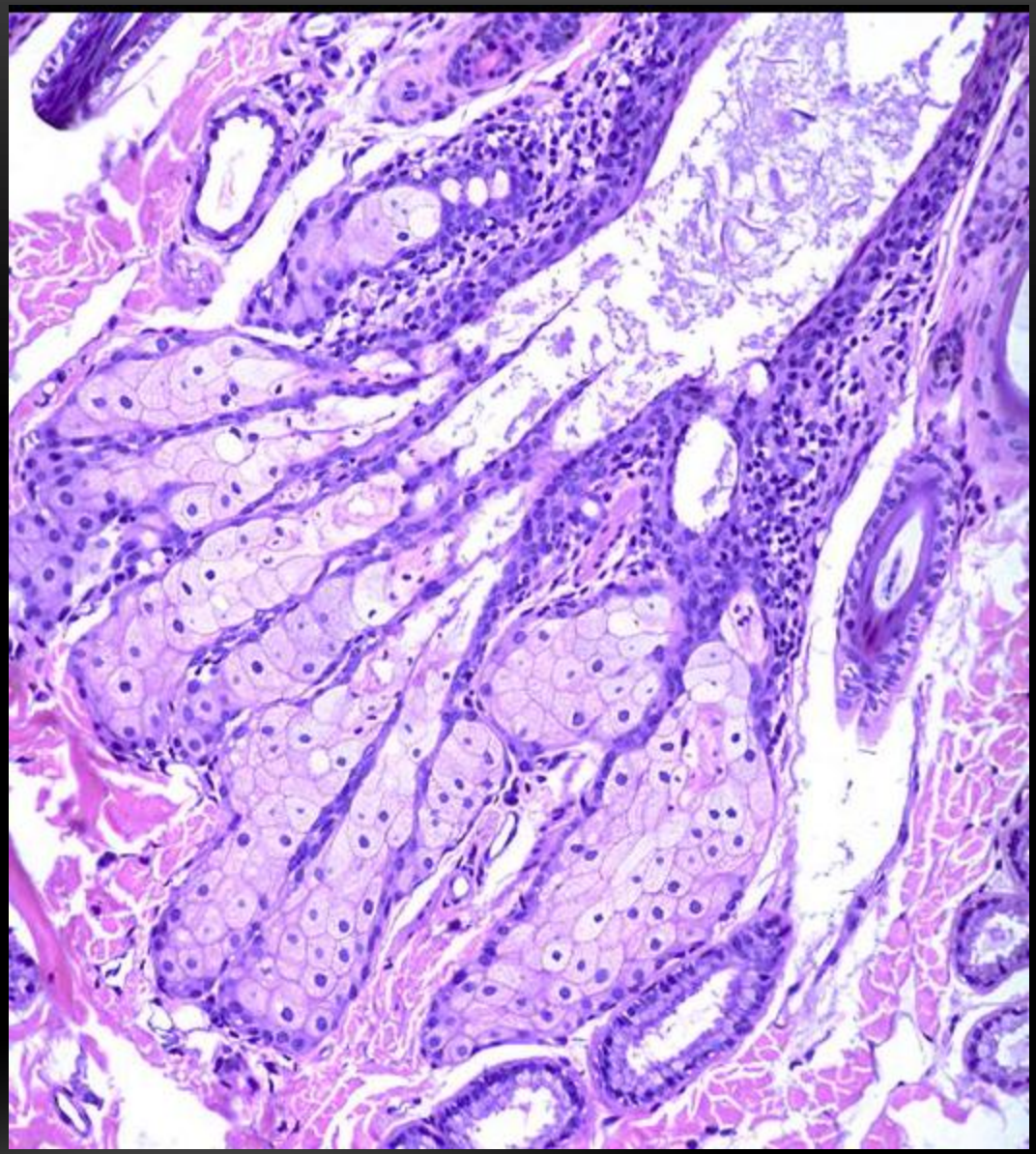
Simple coiled tubular gland



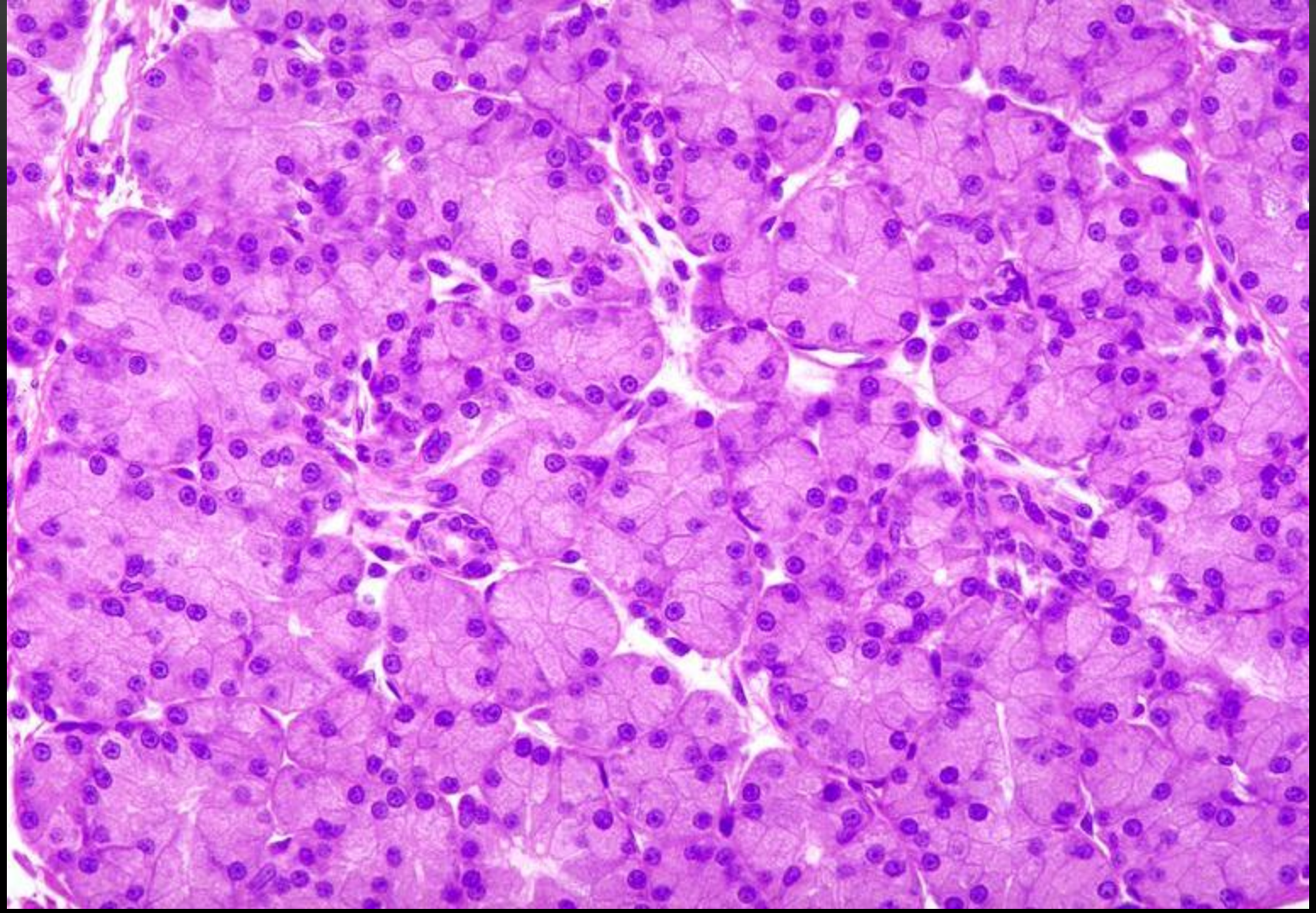
Simple branched tubular



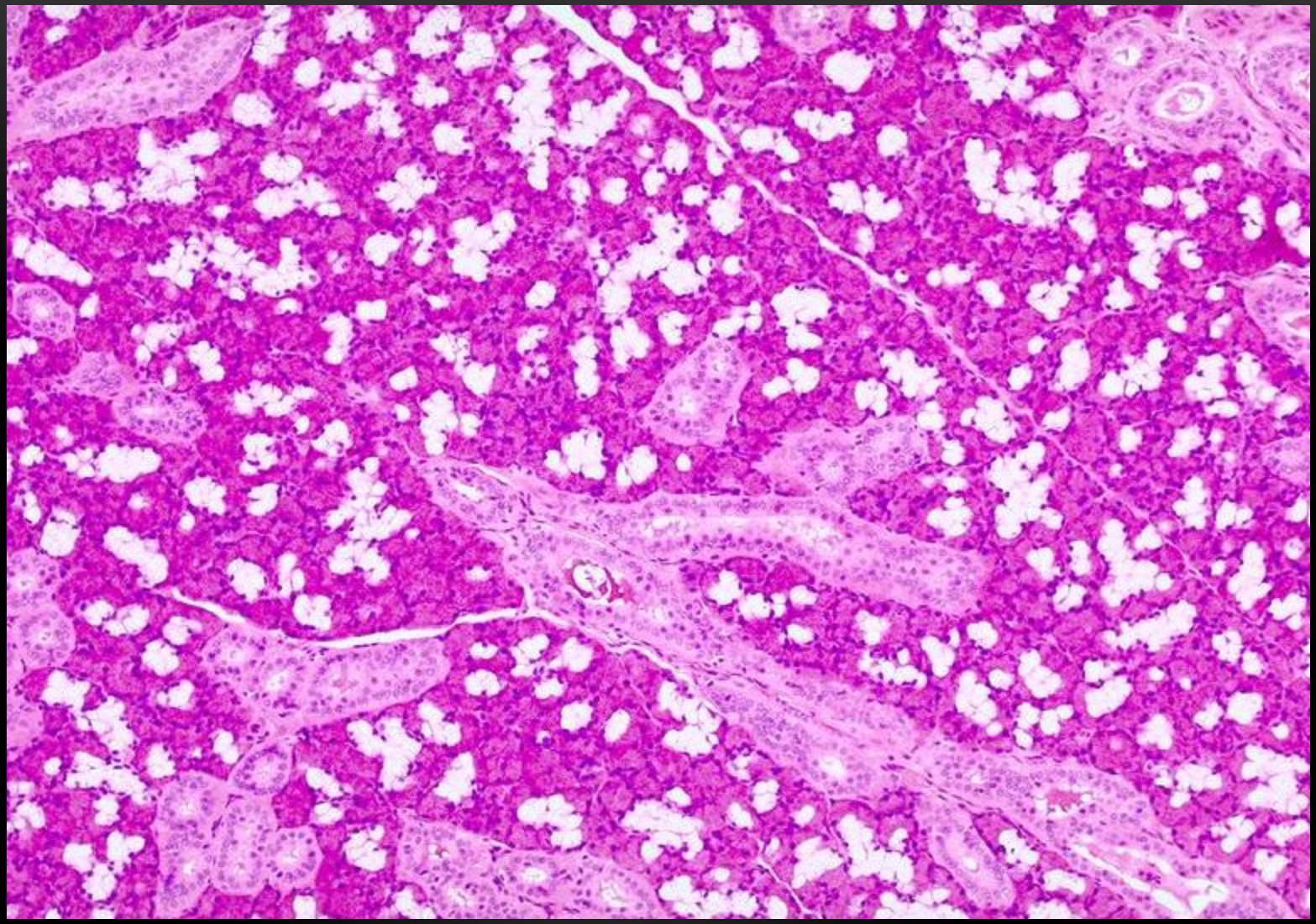
Simple alveolar glands



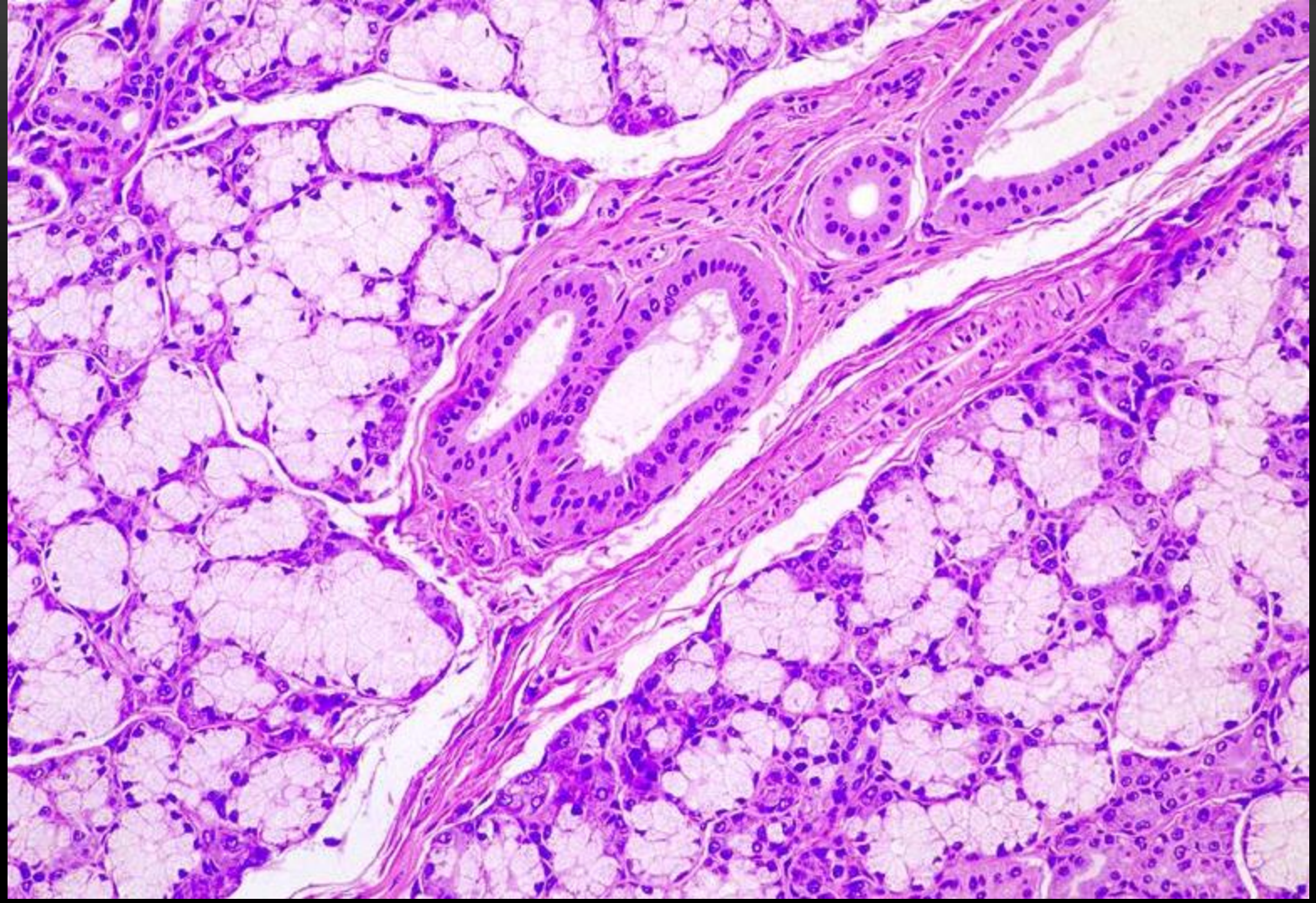
Compound tubular glands



Serous gland- parotid



Seromucous gland



Mucus gland

Apocrine gland