بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

HISTOLOGY

﴿ وَلَقَدْ خَلَقْنَا الْإِنسَانَ وَنَعْلَمُ مَا تُوَسْوِسُ بِهِ نَفْسُهُ ۖ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ ﴾

MID | Lecture 5

Epithelium pt.3

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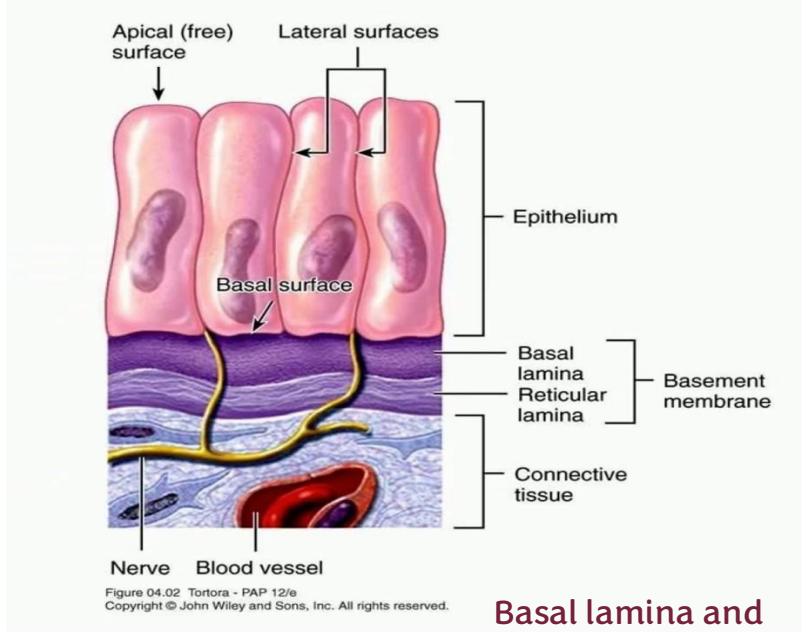
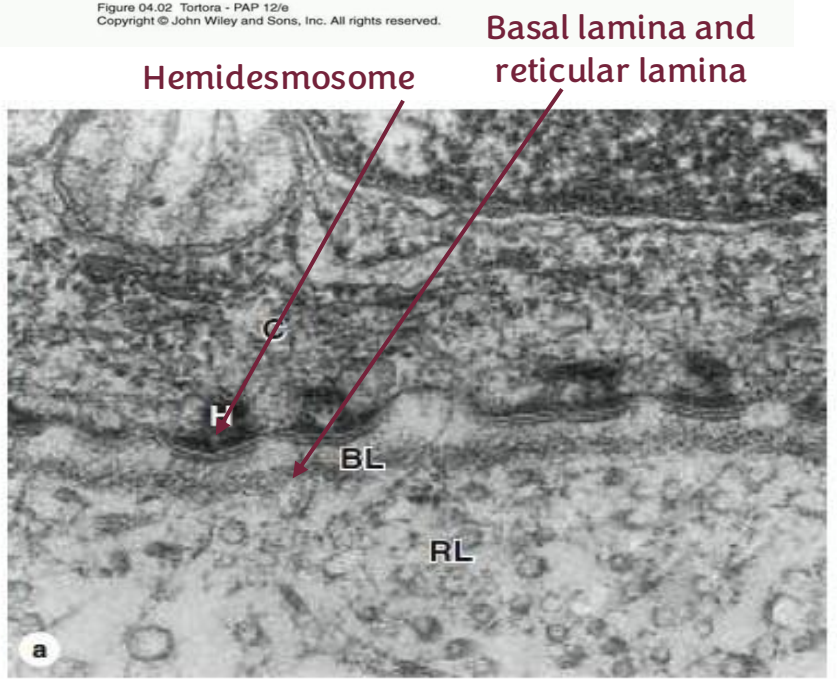
Basement membrane

- The basal surface of all epithelia rests on a thin extracellular sheet of macromolecules beneath epithelial tissue.
- A semipermeable filter for substances reaching epithelial cells from below.
- With the transmission electron microscope: the basal lamina (adjacent to epithelium, and reticular lamina adjacent to connective tissue.



This image is under the transmission electron microscope



**Hemidesmosomes attach to the basal lamina. They look like a hamburger: one dense plate inside the cell and the basal lamina outside, on the other side of the membrane. Each hemidesmosome is located at the basal surface of the cell.

The basement membrane was first observed using the light microscope and was thought to be a single structure. However, with the advancement of electron microscopy, it was discovered that it consists of two layers: the basal lamina, which is adjacent to the epithelium, and the reticular lamina, which is adjacent to the connective tissue.

**In the scanning electron microscope (SEM), the image is three-dimensional and not naturally colored (any color seen is artificially added) photoshopped .

Both TEM and SEM images are not naturally colored; they appear in black, white, and shades of gray. The contrast depends on electron interaction with the specimen. In TEM, areas that are more dense or contain more proteins absorb or scatter more electrons and therefore appear darker. Areas that are less dense allow more electrons to pass through and appear lighter. The greater the density, the darker the image becomes.

Basal Lamina

The basal lamina is formed by several structural proteins, and genetic mutations affecting any of these components may result in severe pathological conditions.

- **Molecules of basal lamina:**

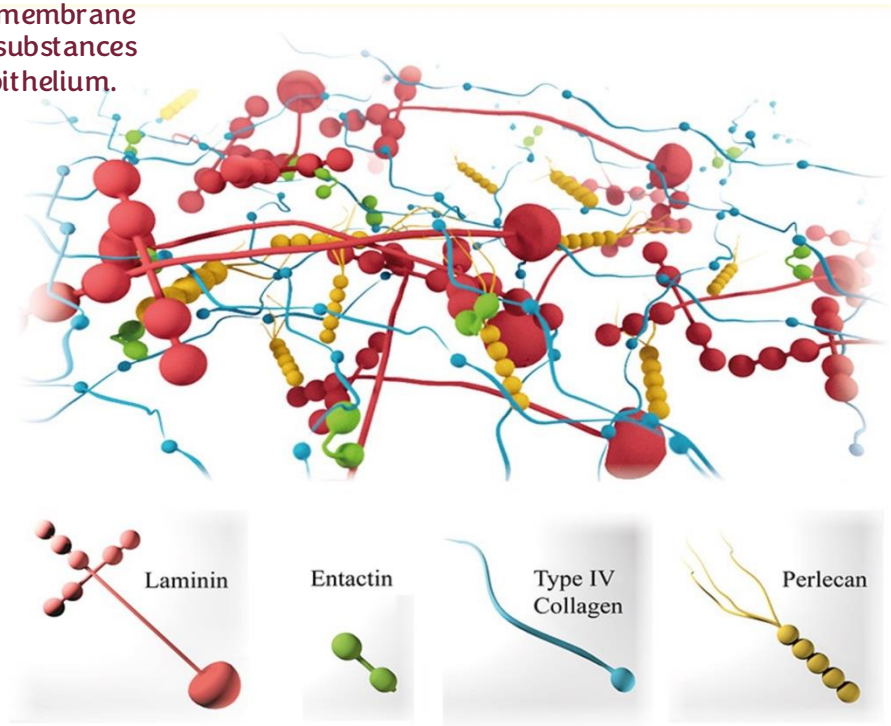
not tightly packed, because the basement membrane is semipermeable. It allows the passage of substances between the connective tissue and the epithelium.

The most abundant

1. **Type IV collagen:** a two-dimensional network of evenly spaced subunits. Collagen is classified into different families based on structure and function. Some collagens are fibril-forming, such as type I, II, and III. Type IV collagen belongs to the network-forming family and forms a three-dimensional (3D) network structure.
2. **Laminin:** large glycoproteins that attach to integrins, and project through the network of collagen IV.

Fewer than the first two

3. **Nidogen (entactin) and perlecan:** protein and a proteoglycan, cross-link laminin to the collagen network and help determine the porosity of the basal lamina and the size of molecules able to filter through it.
4. **Reticular lamina:** contains **collagen type III** which is bound to basal lamina by **collagen type VII.**

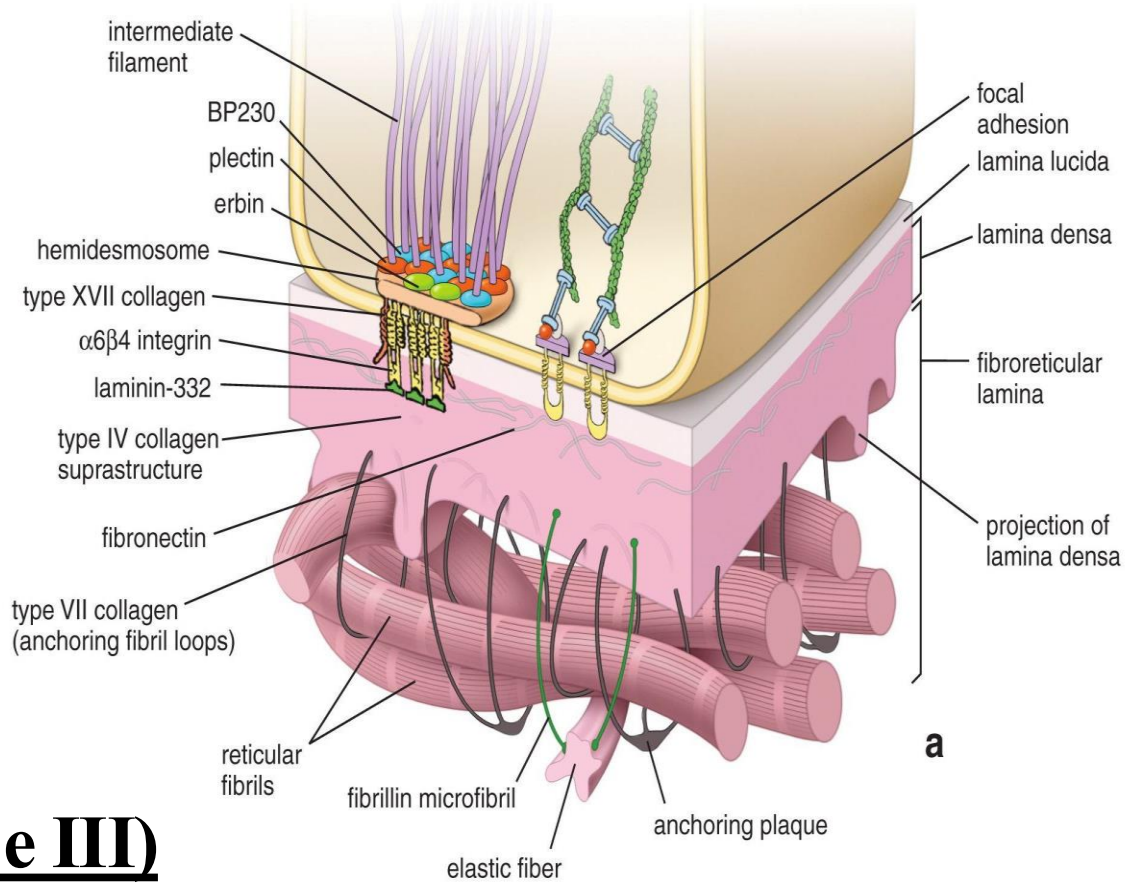


This is the main proteins.
We have small ones , big ones and intermediate.

**Glycoproteins are composed of sugar and protein, with the main core being the protein.

Reticular lamina

The reticular lamina is produced by connective tissue and is relatively diffuse. Under the electron microscope, it appears lighter and contains more spaces, reflecting its less compact structure. In contrast, the basement membrane is denser and more compact.



- **<u>Contain reticular fibers (collagen type III)</u>**

We can see it n the connective tissues as well

- Anchoring fibrils of **type VII collagen <u>link</u>** the basal lamina with the reticular fibers of the reticular lamina.

- **<u>Product of the connective tissue.</u>**

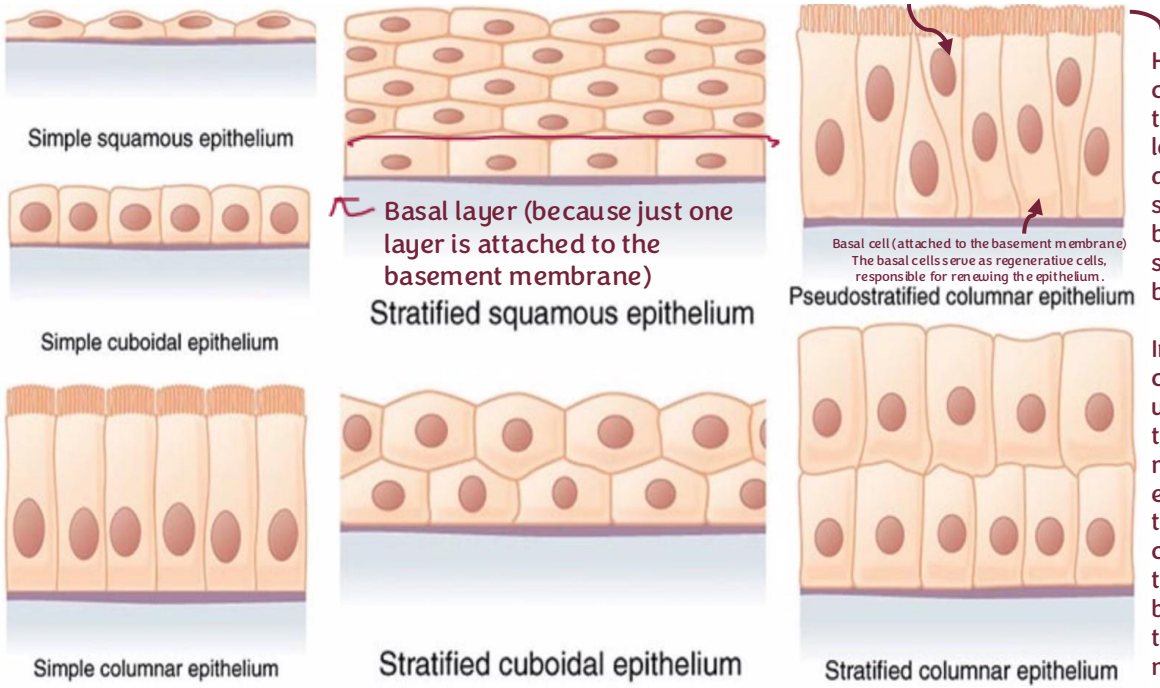
Types of epithelium

- Divide into covering/lining or glandular
- Epithelium.
- Covering/ lining: simple (one cell layer) or
- Stratified (two or more cell layers):

- Simple squamous epithelium
- Simple cuboidal epithelium
- Simple columnar epithelium
- Pseudostratified columnar epithelium
- Stratified squamous epithelium
- Stratified cuboidal epithelium
- Stratified columnar epithelium
- Transitional epithelium

You can see it in two different types

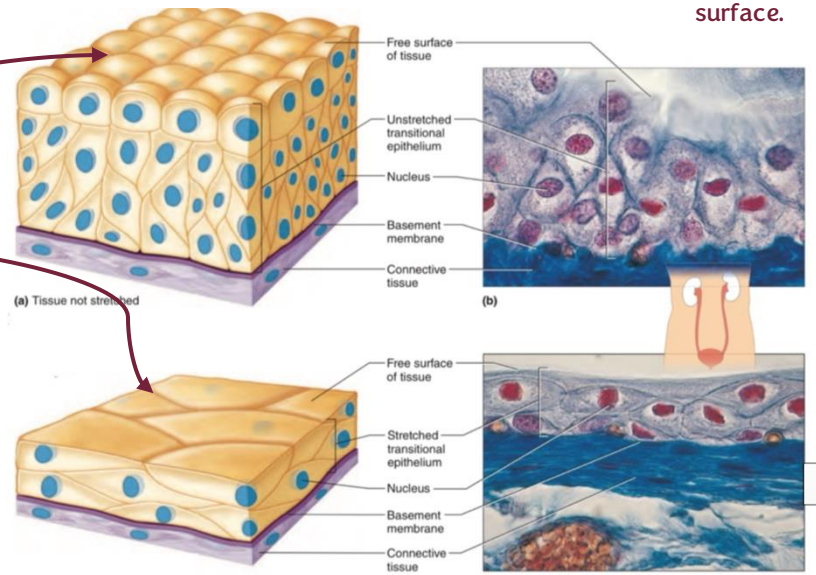
The example is in the next slide



Here, without looking carefully, it may appear that there are multiple levels of nuclei, but this does not make it a true stratified epithelium, because all the cells are still attached to the basement membrane.

In pseudostratified columnar epithelium, we should pay attention that the basal cells have most of their cytoplasm extending apically, while the apical cells have their cytoplasm mainly around the apical surface. The basal cells are attached to the basement membrane, but their apical part is narrow (narrower than the neighboring cells) so they do not reach the free surface.

The superficial cells here are closer in shape to cuboidal cells, and here is closer to squamous cells , so I can see the exact same tissue in two different conditions as this depends on the physiological state (refers to the condition of the tissue when the organ was still alive and functioning)and type of extraction of that tissue



Epithelial cells are classified based on their shape into:
*Squamous: flattened cells.
*Cuboidal: cells with a rounded nucleus, and the cytoplasm is roughly evenly distributed.
*Columnar: cells with elongated nuclei, and the cytoplasm is usually apically located.

It is also classified based on the number of layers:
*One layer: simple epithelium (consists of a single layer of cells, and all the cells are attached to the basal membrane.)
*Two or more layers: stratified epithelium

What distinguishes simple epithelium from stratified epithelium is that in simple epithelium, only one layer of cells is attached to the basement membrane.

When we talk about stratified epithelium (columnar, cuboidal, or squamous), the classification is based on the shape of the most apical (superficial) cells, because the basal layer is almost always cuboidal. Therefore, to determine the type of stratified epithelium, we look at the shape of the cells at the surface.
The gold standard for simple epithelium is that all cells are attached to the basement membrane. The nuclei may appear at different levels, tilted, or to the side — that's not my standard. My standard is to check whether all cells are actually attached or not. In diagrams, it's easy to see, but in real histological sections, it's not always that clear.

Example to explain the transitional epithelium:
suppose I am studying a drug that affects the urinary system in rats. One of the samples that I need to examine is the urinary bladder, because this type of epithelium is normally found in the urinary system. I need to observe the effect of this modification on the bladder.
After finishing the experiment and sacrificing the rats, I start the tissue utilization process. During utilization, the organs usually keep the same shape they had at that moment; they do not undergo additional contraction or stretching.
Some rats had a full urinary bladder at the time of utilization. In this case, the sample represents a distended (stretched) bladder.
Other rats had already urinated before utilization, so their urinary bladder had returned to its normal size and was empty.
Therefore, the rats with an empty urinary bladder show a tissue appearance like the unstretched condition(الصورة اللي فوق)

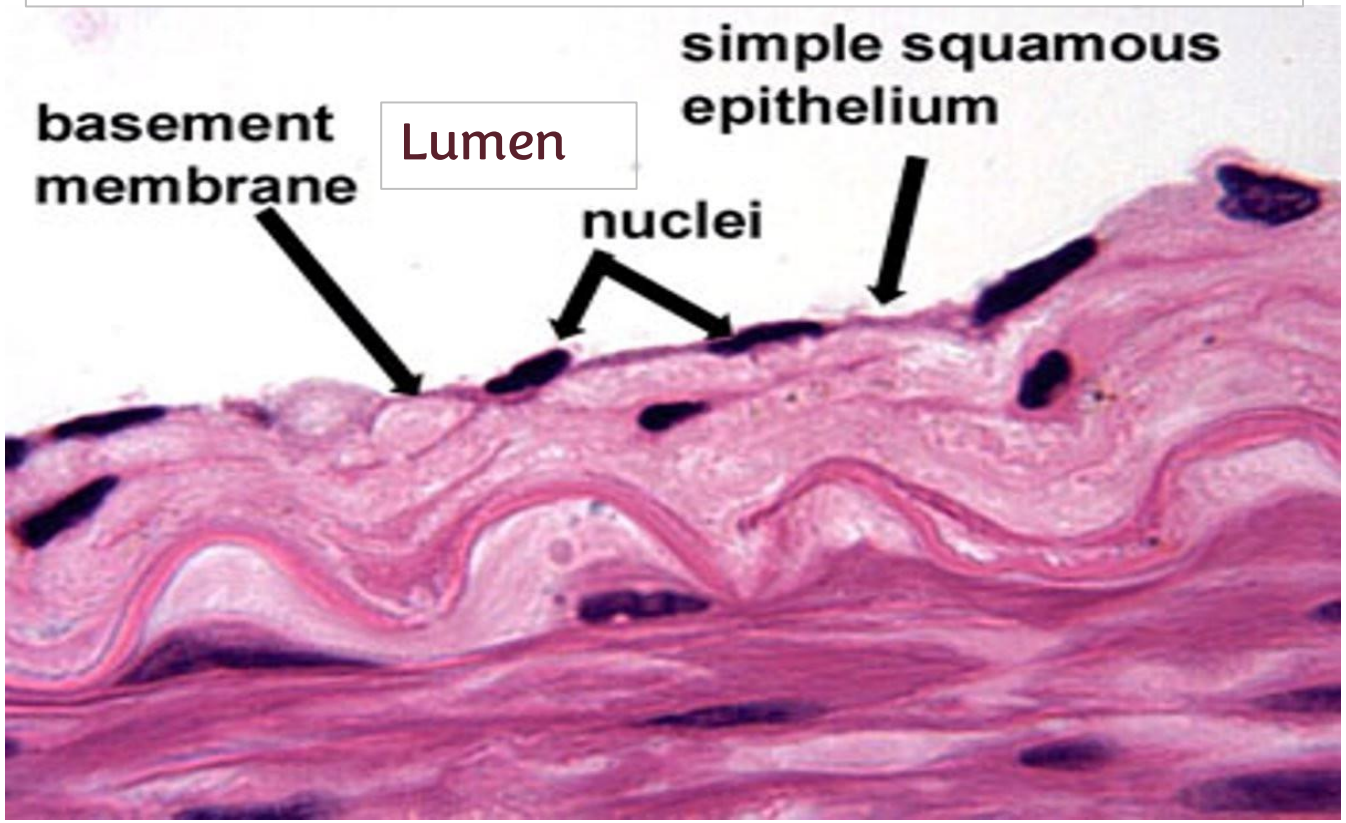
while the full bladder shows the stretched condition(الصورة اللي تحت) .
The urinary bladder is an expanding sac that stretches to store urine. Its capacity can reach about 800 mL of urine. After urination, the bladder gradually fills again and undergoes expansion. This expansion is allowed by involuntary smooth muscles; when these muscles relax, they permit the bladder to stretch as urine accumulates and pushes against the bladder wall.
As a result, the thickness of the epithelium decreases ,so the epithelium that appeared thick at 10× magnification decreases in apparent thickness to 8×, 7×, 6×, or 5× this happens because the cells become compressed and flattened.
This change is possible due to the transitional epithelium, which allows the cells to flatten when the bladder is stretched. Once the urine is emptied, the urinary bladder returns to its unstretched condition.

Simple squamous epithelium:

1. Endothelium

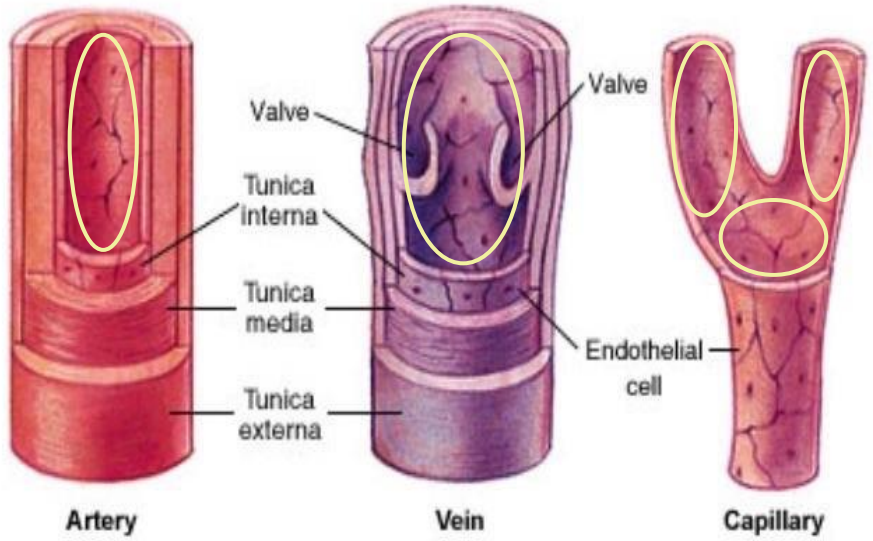
Endothelium is a simple squamous lining epithelium of blood vessels. This means that what is present in arteries, veins, and capillaries is endothelium. It is a type of simple squamous epithelium, but to distinguish it from other locations of simple squamous epithelium, we specifically call it "endothelium." These cells are flattened, and their nuclei follow the same flattened shape.

Remember that we're talking about simple squamous epithelium, so it's one layer-flat tissue



H & E stain

Cavities in yellow are The lumen (where the blood flows)



Blood vessels

- Thin cells
- Nuclei are the thickest structure and most noticeable
- Regulate passages of substances. The blood diffuse

It won't be the exact same image in every endothelium sample, some of them could be rounded a little bit, BUT not as perfectly rounded as the cuboidal epithelium

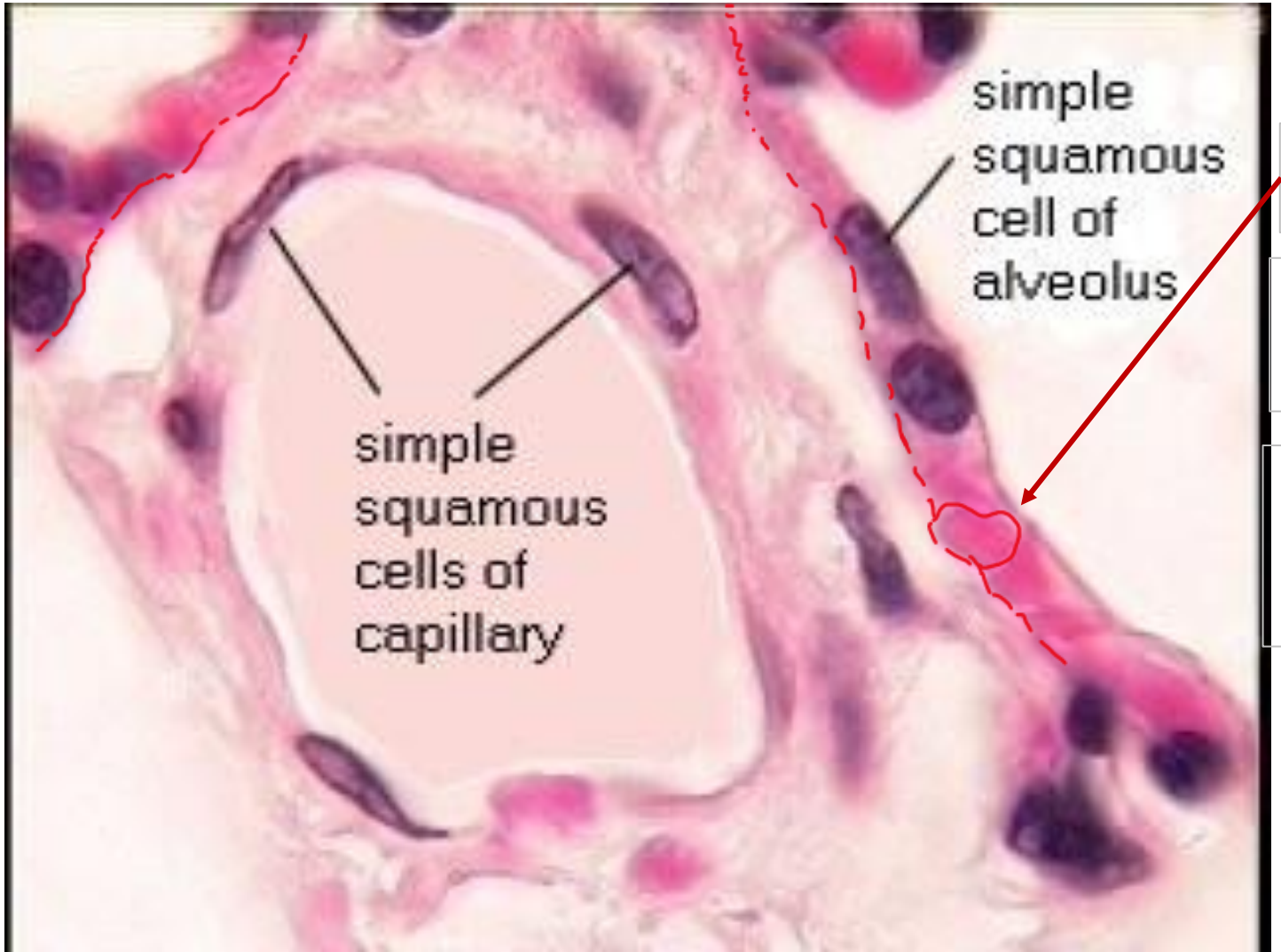
Simple squamous epithelium

2. lung alveoli

The alveoli are located in specific location in the lungs

Question:
Why are nuclei not always visible in squamous epithelial cells in a histological cross-section?

Answer:
Nuclei may not always be visible in squamous epithelial cells because these cells are very thin and flattened. Therefore, the histological section may pass through a part of the cell that does not contain the nucleus. Additionally, in keratinized epithelium, the superficial cells may lose their nuclei during keratinization.



The oxygen will diffuse from the lumen to the capillaries and the carbon dioxide will diffuse to the alveoli, all thanks to the squamous epithelium and their thin layer and permeability

Red blood cells in the capillary

This is not endothelium (only for blood vessels) this is just epithelium

Remember this is a cross section of a specimen, so you might not see all the aligned cells .

The smaller, the cell, the highly likely you see the nuclei of the cell. It is hard to see it here in squamous cells

3. Mesothelium

Mesothelium: is a thin layer of specialized simple squamous epithelial cells derived from the mesoderm. It forms the lining of the body's cavities.

Covering of organs and lining of cavities is called visceral and parietal layers, respectively.

1 Pleura

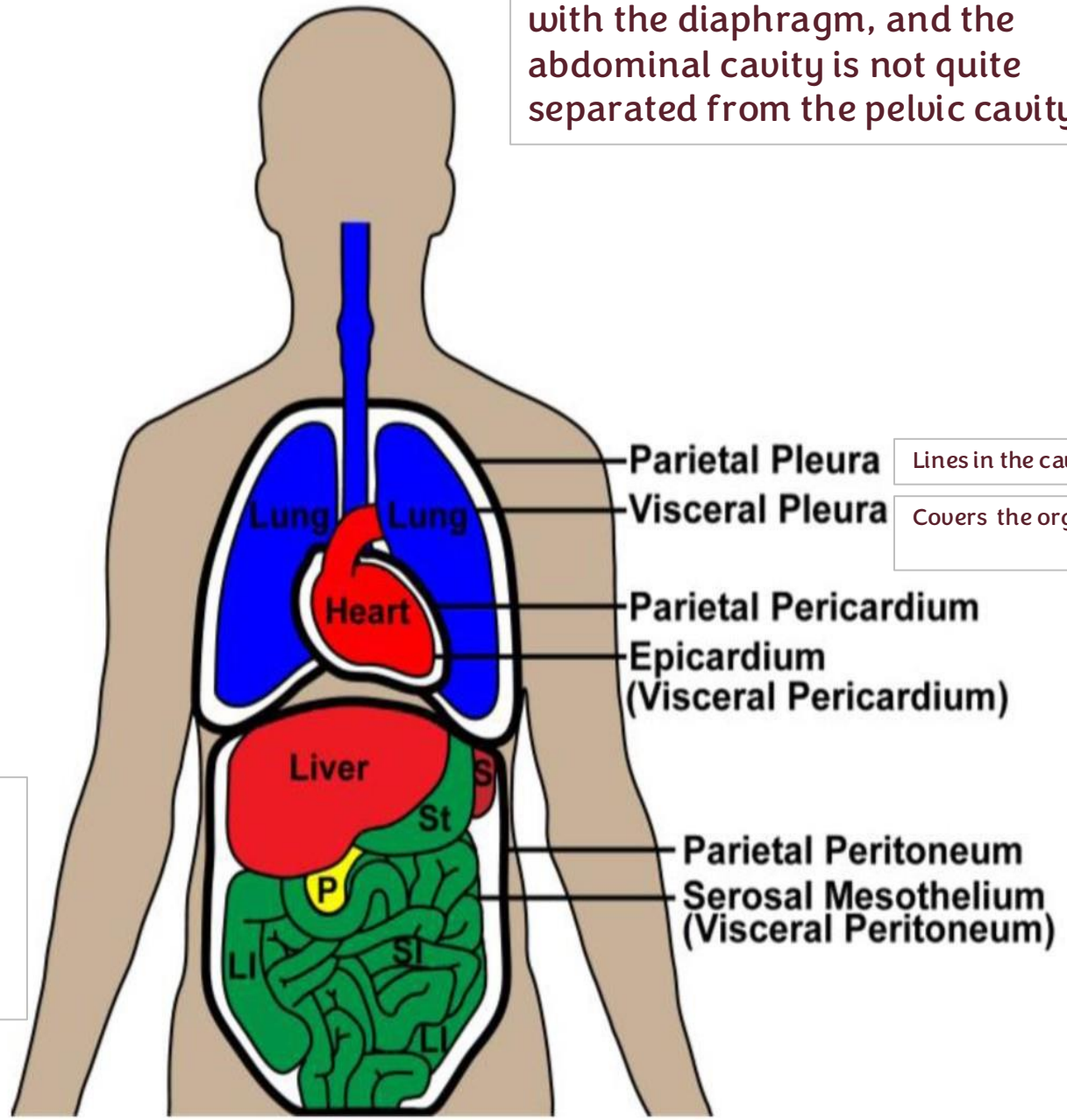
2 Peritoneum

3 Pericardium

4 Mediastinum

There is a space between the two layers that contains small amount of fluids that facilitate the movement of the organs

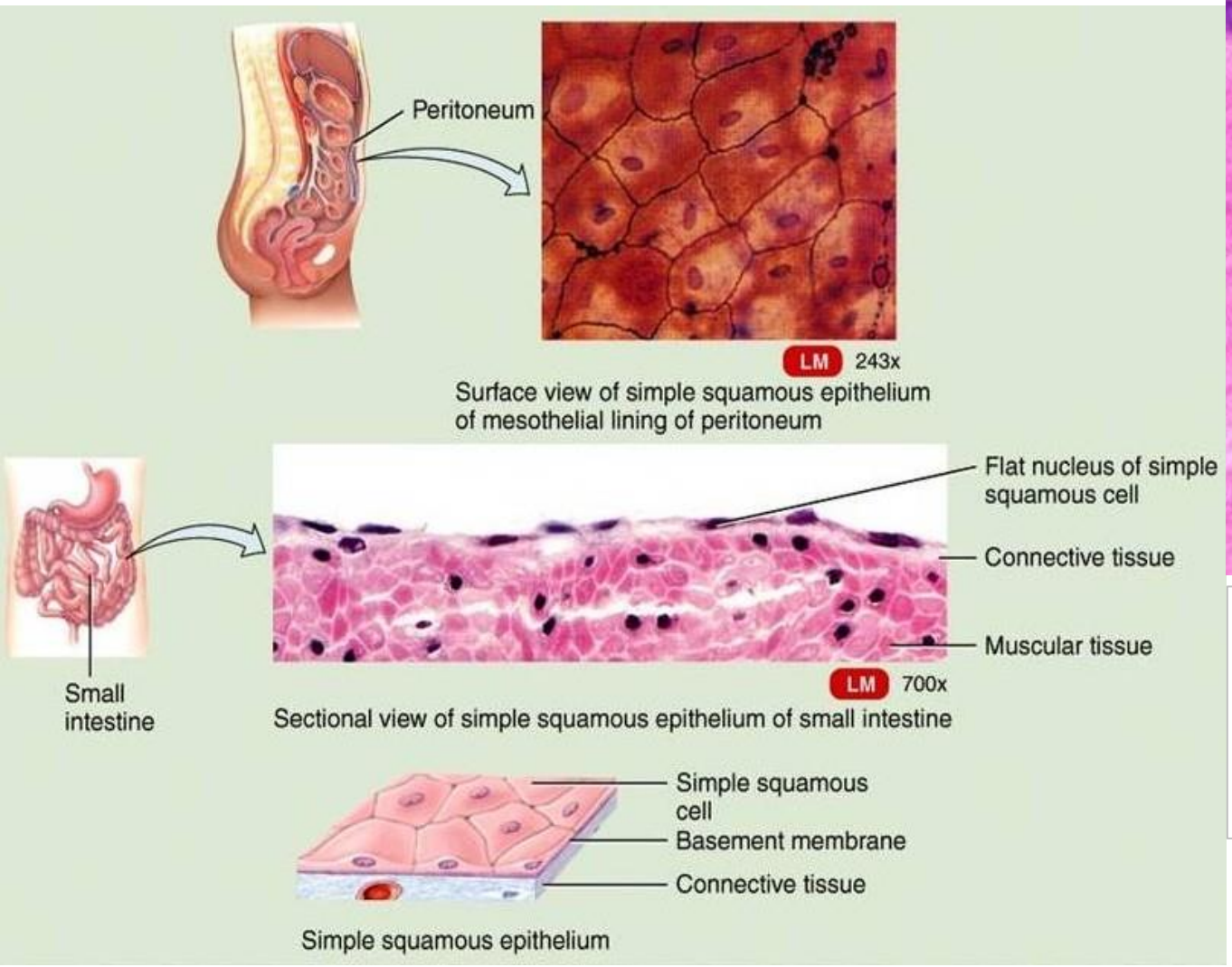
The thoracic cavity is separated from the abdominopelvic cavity with the diaphragm, and the abdominal cavity is not quite separated from the pelvic cavity

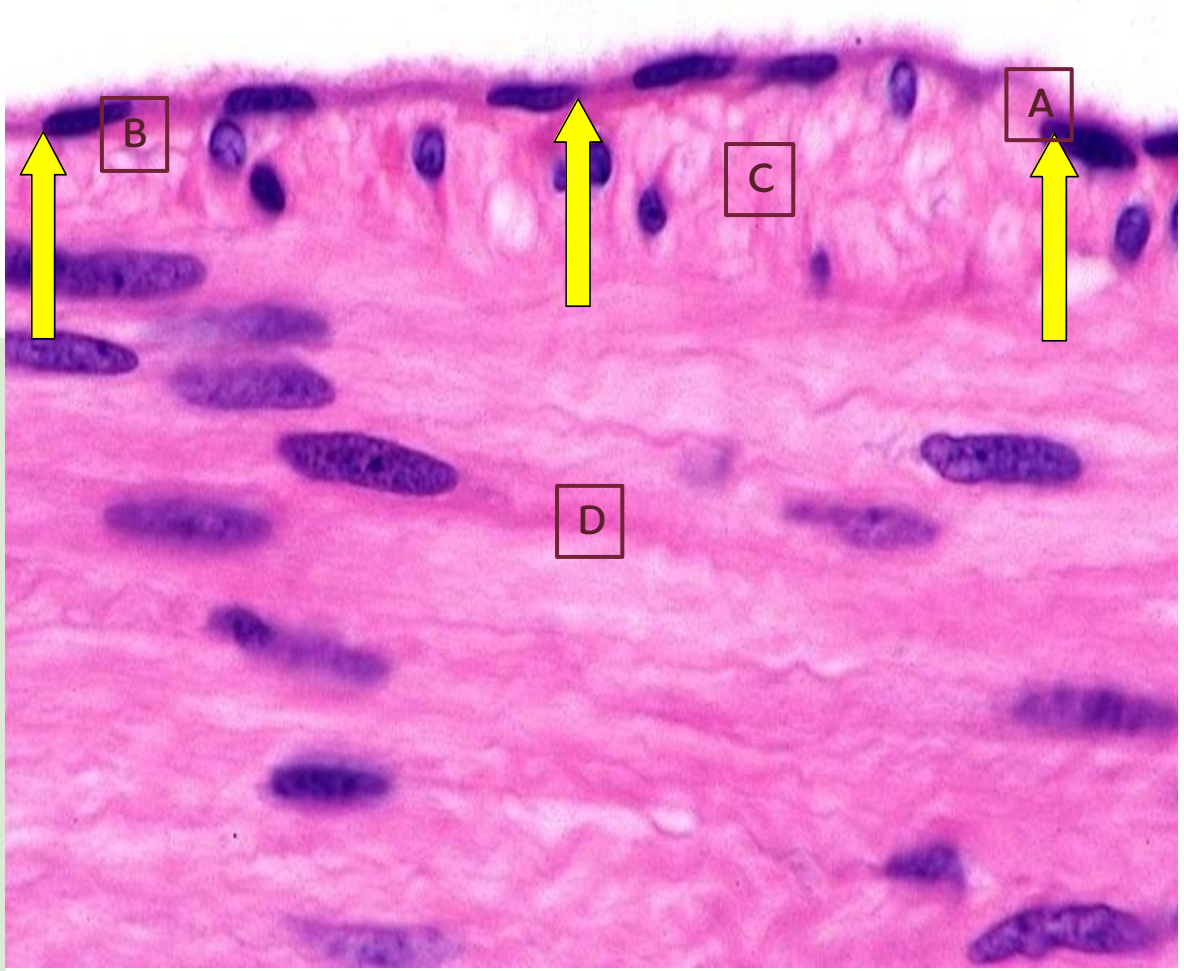


Lines in the cavity

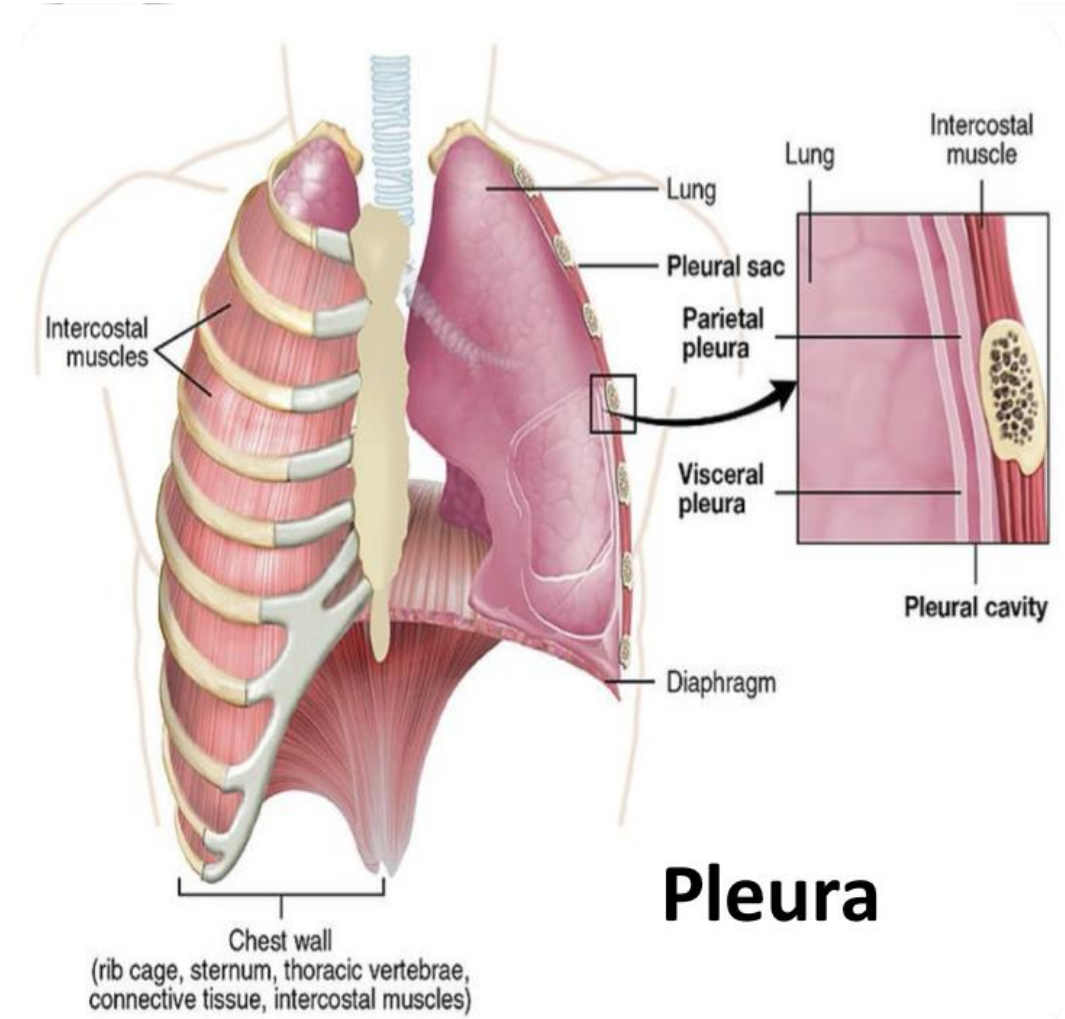
Covers the organ

Mesothelium

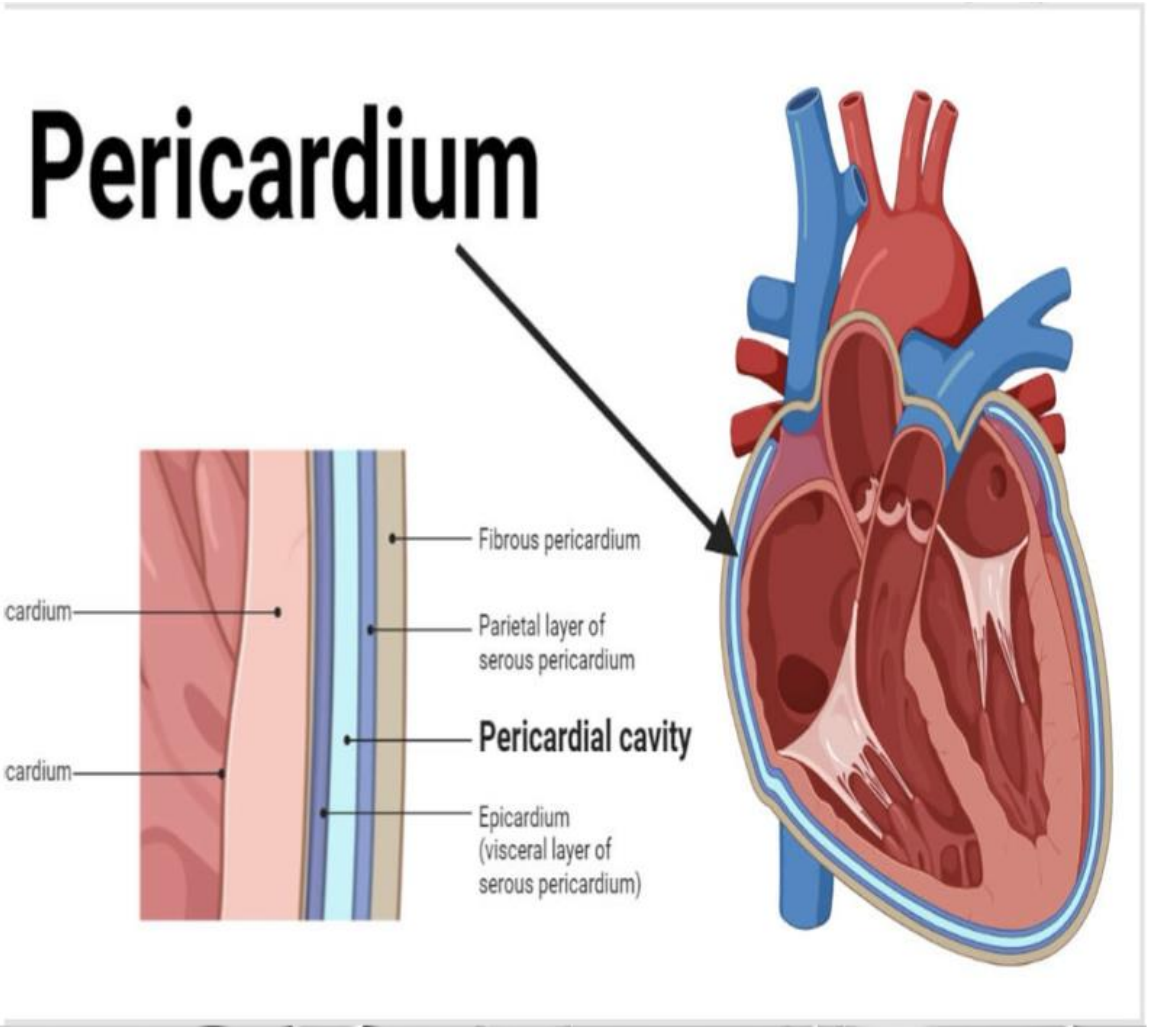




Squamous epithelium cells and their nuclei pointed by the yellow arrows [A],the basement membrane is just under them [B], you might not see it here, but it is there, then there is the supportive connective tissue[C] and whatever tissue under it[D]



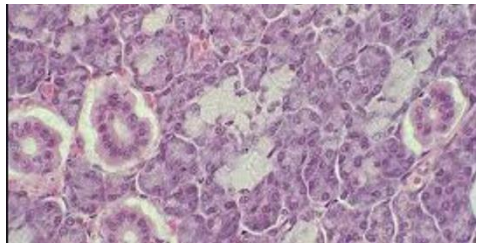
Pleura



There is a space between each two layers (visceral and parietal)that contains small amount of fluids that facilitate the movement of the organs

Simple cuboidal epithelium

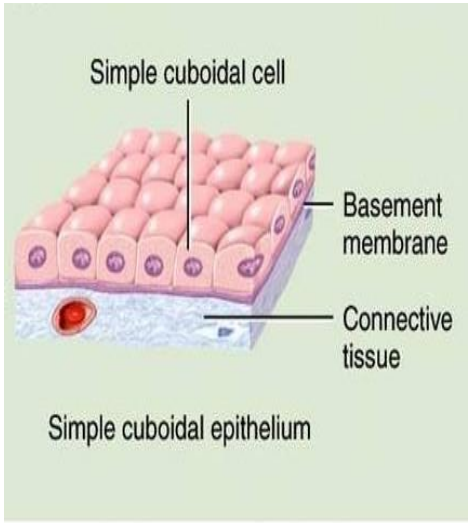
- Width and height are similar.
- Rich with organelles.
- High level of active transport.

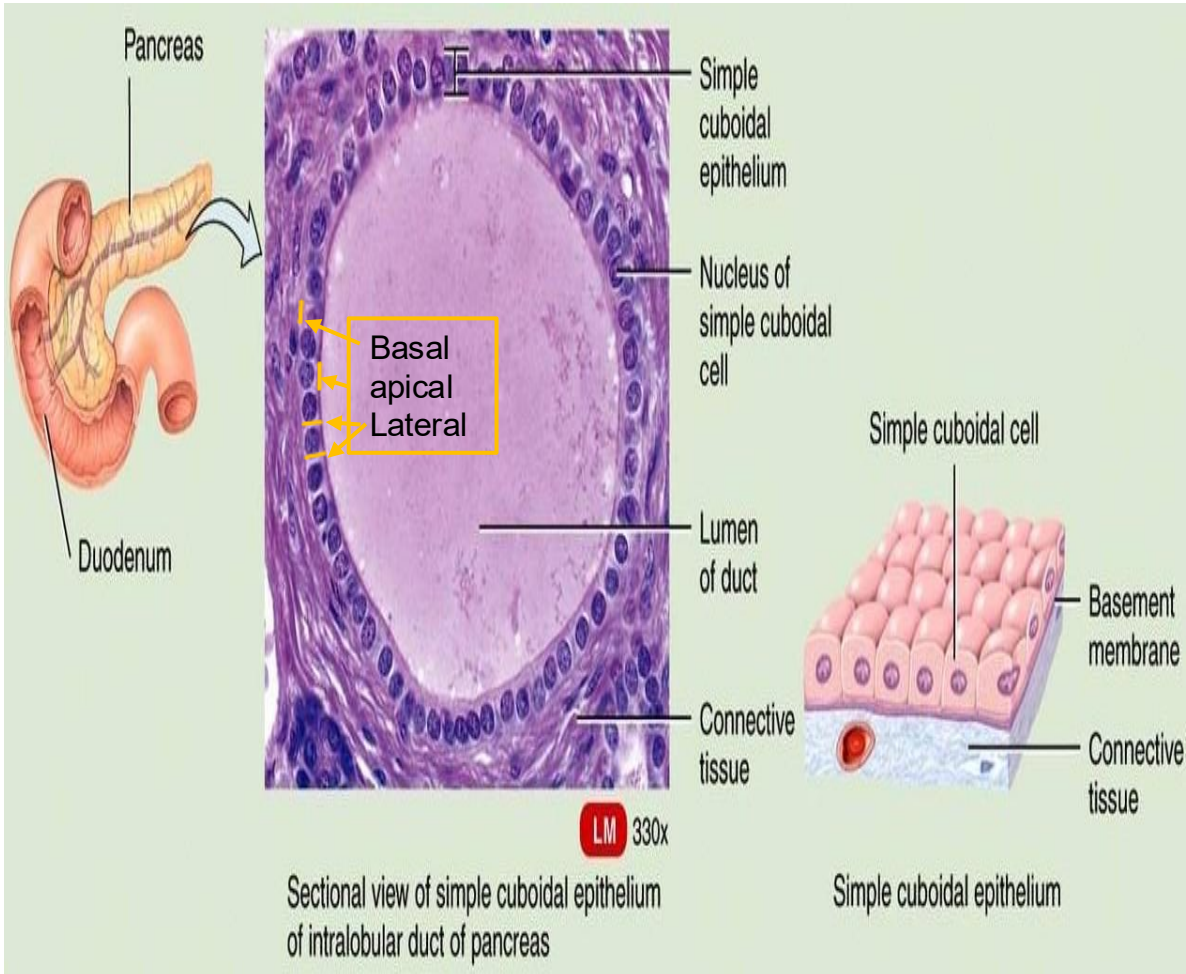


Location

- Small collecting ducts of kidney
- Glands and ducts :
- (pancreas & salivary)
- Kidney tubules
- Covering of ovaries
- Thyroid glands

There is a part that is fibrous too

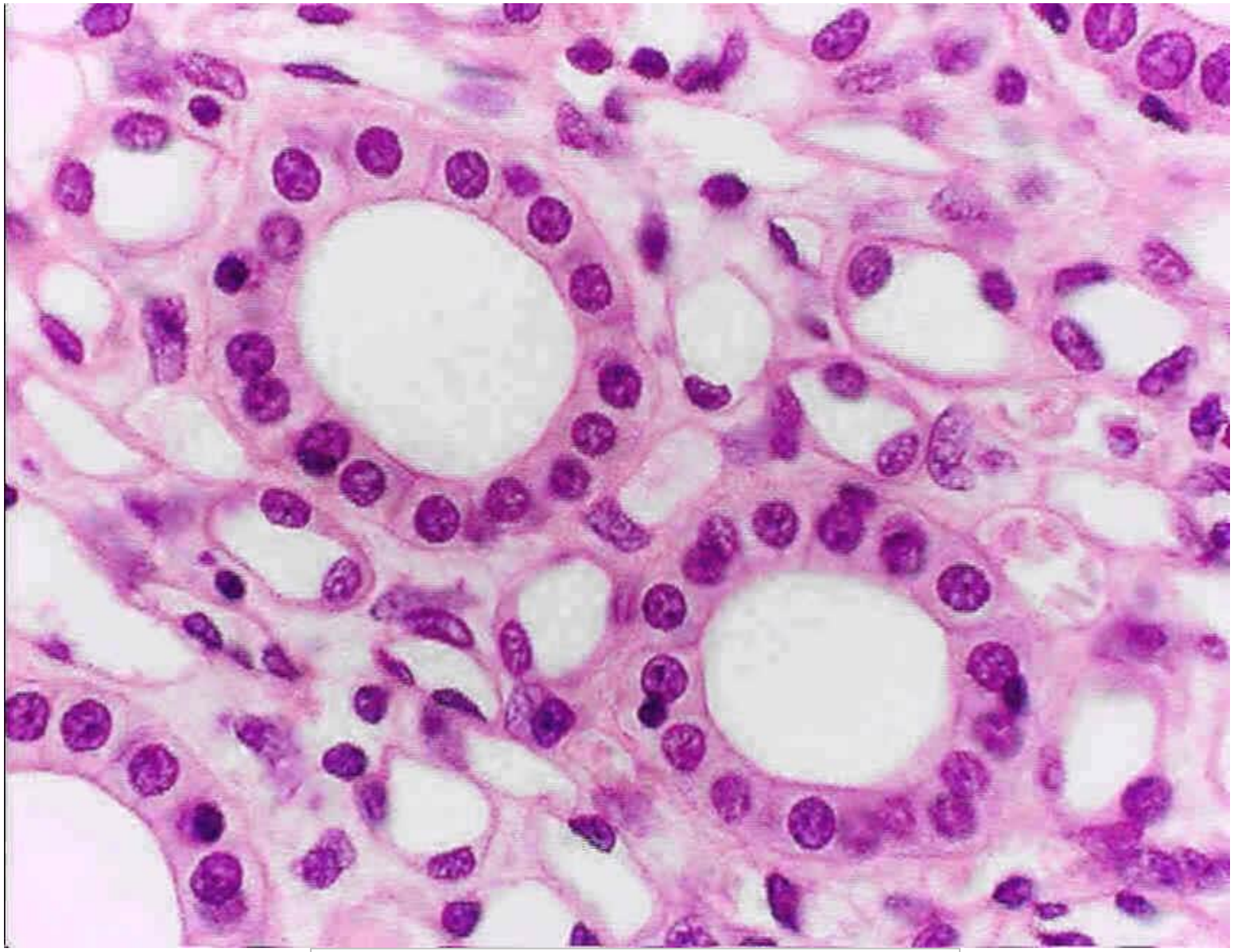




# of layers : 1
Shape : cubic with a roughly rounded nuclei & a cytoplasm that is roughly evenly distributed

Simple cuboidal Epithelium

Simple cuboidal + simple squamous epithelial cells



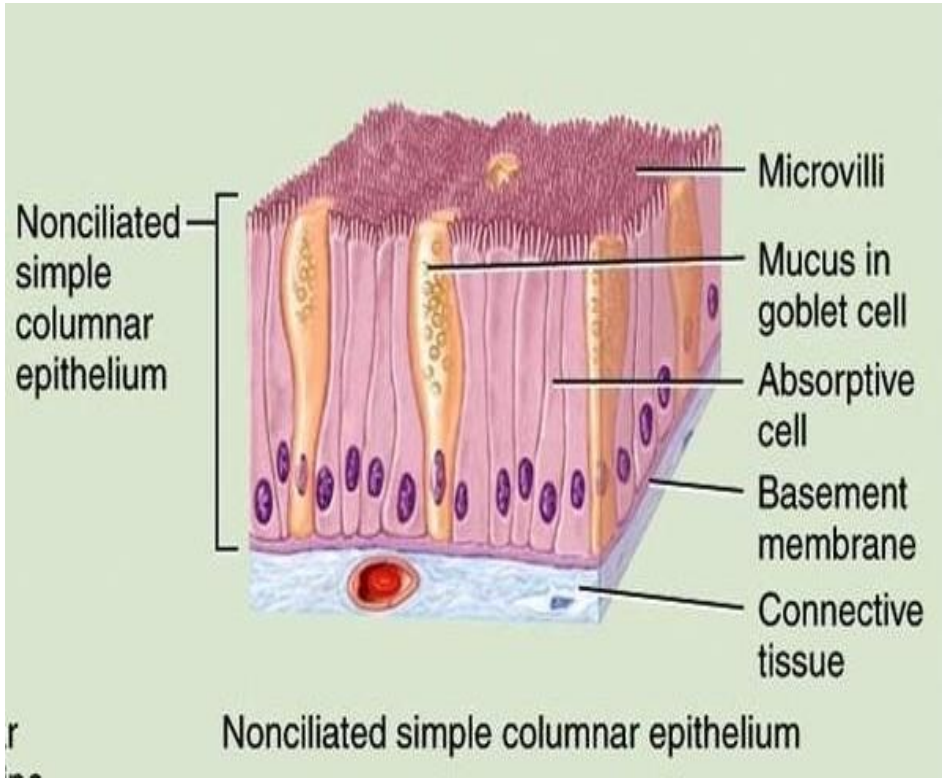
H&E staining
Light microscope (bright field)

Simple columnar epithelium

- Cells are tall.
- Usually with microvilli or cilia.

Cilia move only in one direction for example they move upward in the respiratory track to remove the mucus whereas they move towards the midline in oviduct.

- Engaged in the protection of wet surfaces, absorption (microvilli) and secretion.
- Forms major ducts of exocrine glands.
- When ciliated (**fallopian tube, uterus**), it helps in movement of fluid in the female genital tract.

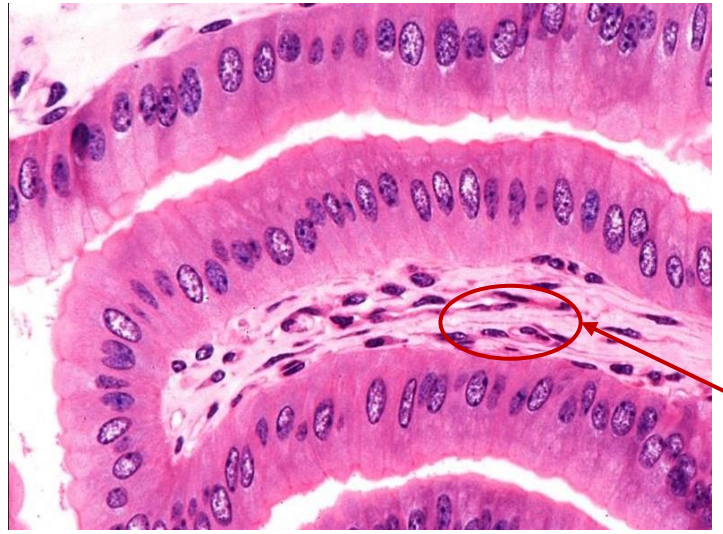


- **Location**

Parts of the GIT

- Small intestine — Microvilli
- Stomach — Microvilli
- Gall bladder — Microvilli
- Oviduct lining — Cilia
- Renal collecting ducts

~ One row for sure
~We could have a little variation in the position of the nuclei of each cell (some nuclei is slightly higher & some is slightly lower)
~ attach to the basement membrane
~ could have goblet calls between them, these cells are responsible for producing mucus (we'll see it in the small intestine and their respiratory track)

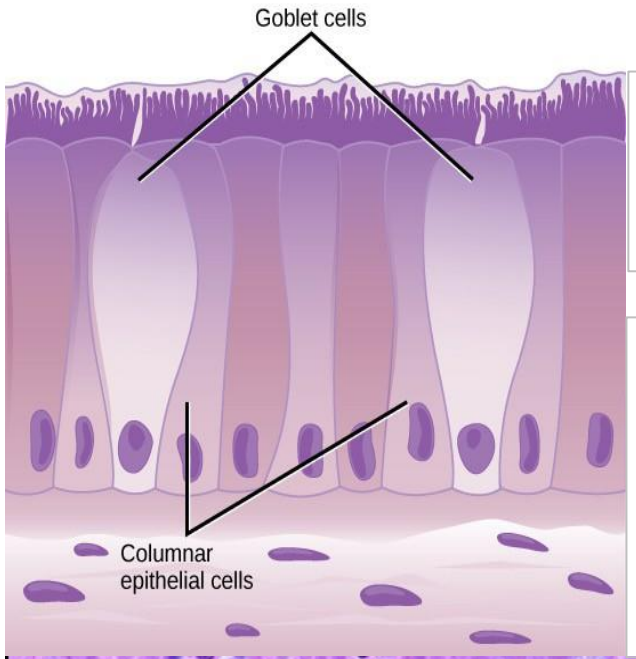


Goblet Cells

Don't have specialized apical structures

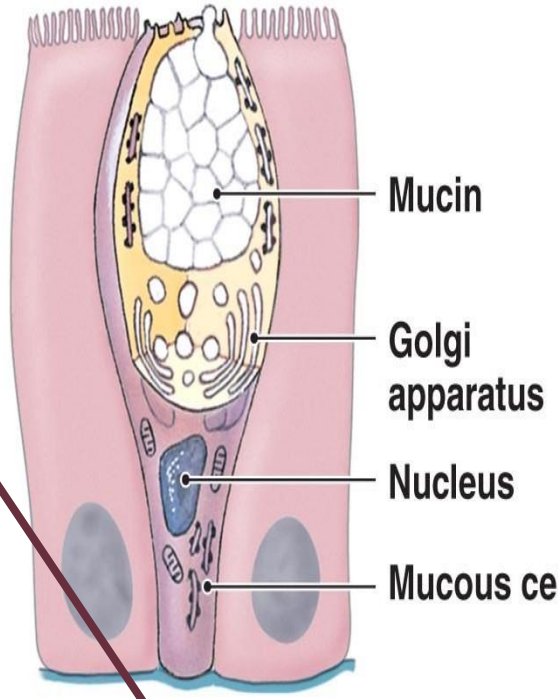
- **Goblet cells:** produce mucus.
- **Cilia** (larger than microvilli): sweep mucus.
- Associated mainly with columnar, pseudostratified, and stratified columnar (conjunctiva) epithelia

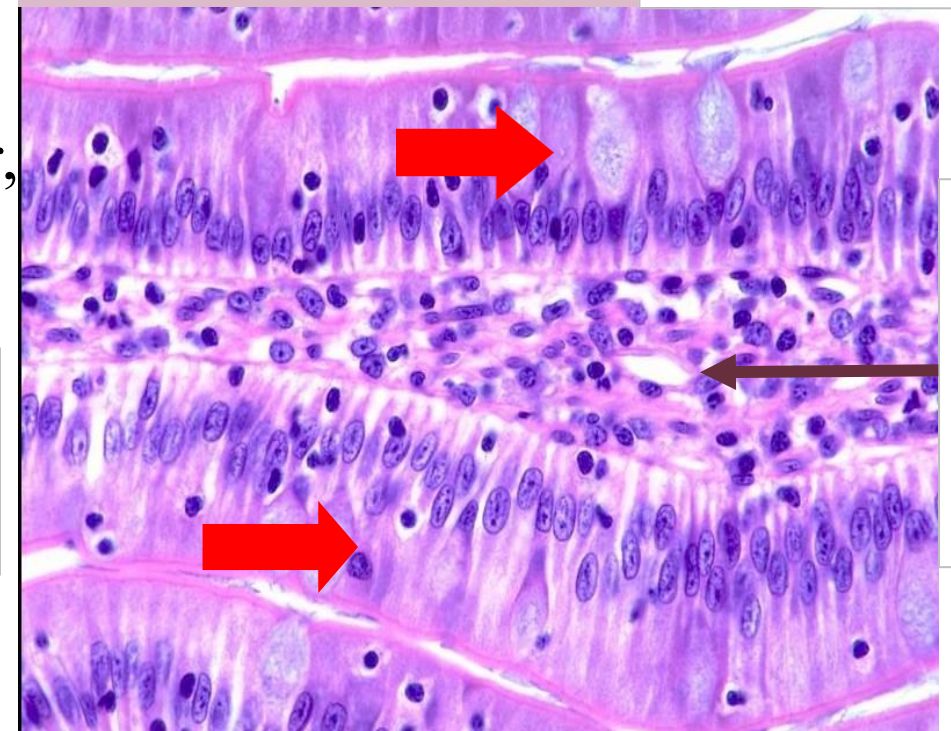
If we have goblet cells in the respiratory tract, we should find Cilia to swipe up the mucus that the goblet cells secret, BUT there is no cilia at the GIT of course



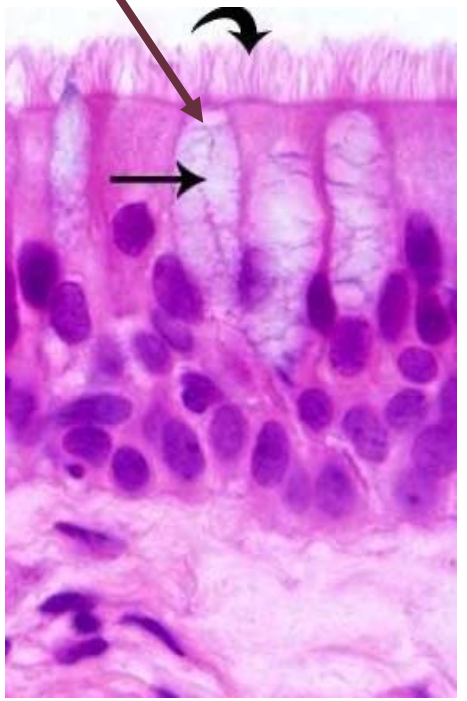
Mucin is a highly hydrated protein collects a huge amount of water

This is the proteinous backbone of the mucin and it surrounded by water molecules that it collects, and when the goblet cells secretes its components, it appears for me and Ghosty on the microscope





Connective tissue



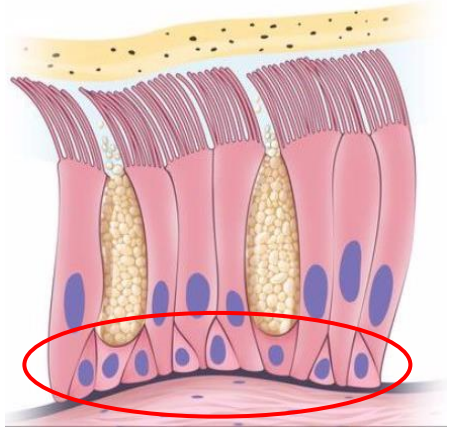
Pseudostratified columnar epithelium

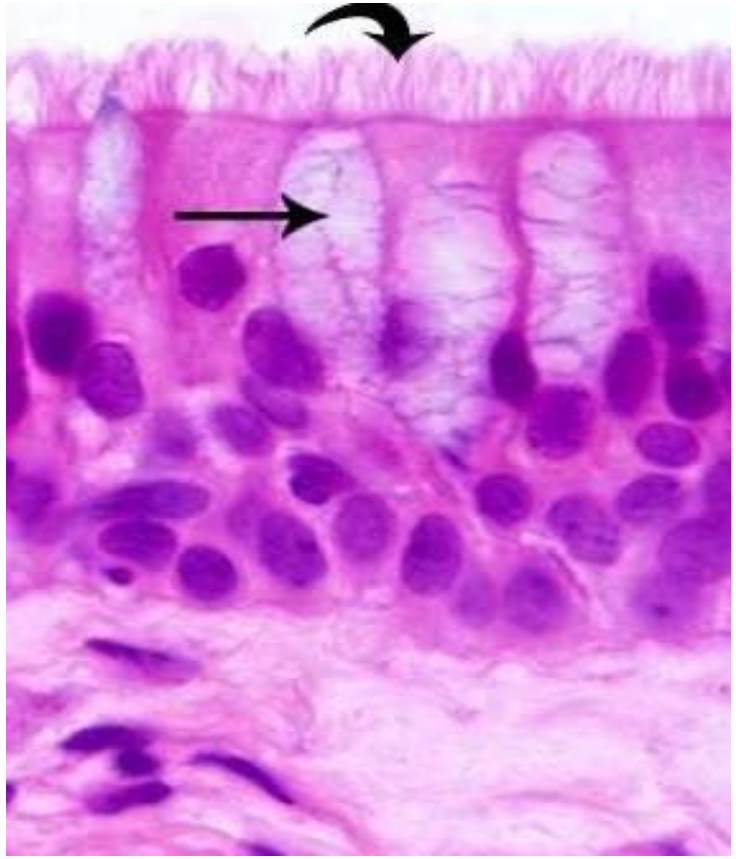
- Small basal cells and taller apical ones; nuclei
- At different levels----false stratifications.
- All cells are attached to the basement membrane.
- **Locations**:

1. Respiratory tract (trachea and bronchi; Ciliated with goblet cells)
2. Male genital tract.

- Goblet cells: are usually seen in respiratory tract to produce mucus mucous: it entraps foreign particles in the respiratory tract

In the Stratified columnar
Only the basal layer touches
the basement membrane
unlike here





Do all cells touch the basement membrane?
Yes
Are there real stacked layers?
No

For any feedback, scan the code or click on it

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي: