REMEMBER:

1- When trying to find an epithelium, search for a space. Because epithelial cells either cover a surface or line a cavity/ a lumen.

2- To allow the material to be transported through the epithelial layer, the epithelium will be simple squamous epithelium which has the least amount of cytoplasm, just like the lining of the blood vessels.

3- If you are looking at a tissue under LM (light microscope) and you want to determine the type of its cells, look at the shape of the nuclei. Because the cell membrane cannot be seen under LM.

- Squamous: flat cells and nuclei.
- Cuboidal: square membrane, rounded nuclei.
- Columnar: tall and basal nuclei.
For example:

- If your microscope showed you a single layer of flat nuclei, your sample would be a simple squamous epithelium.
- If your microscope showed you more than one layer of round nuclei, your sample would be stratified cuboidal cells.
- Elongated nuclei are an indicator for columnar cells.

1) Simple Epithelium

A- Simple Squamous Epithelium

In order to permit bidirectional movement of gases, fluids and nutrients, we need a thin, single layer of cells with a minimal amount of cytoplasm, these properties are found in simple squamous (flat) epithelium. This is why one of the most important functions of simple squamous epithelium is that it allows the bidirectional movement of different substances.

Take for instance,

1- the endothelium which lines blood vessels (endothelium is a special type of simple squamous epithelium)
2- The mesothelium which covers the outer layer of visceral organs such as the heart and lungs.
3- The lining of lung alveoli (singular is alveolus and it is the site of gas exchange (O2 and CO2)).
The capillaries that surround the lung alveoli are lined by endothelium

- To differentiate between mesothelium and endothelium:
  - The endothelium surrounds blood vessels so it will be a rounded membrane of endothelium.
  - The mesothelium surrounds or lines the outer layer of organs.
- The alveolus is surrounded by blood vessels/capillaries (which are lined by endothelium), and they are surrounded by simple squamous epithelium, too.
- The skin is covered by stratified squamous epithelium

**A membrane, histologically, is an epithelium underlined by connective tissue.**

In our body, we have 3 types of membranes:

1- **Cutaneous membrane**
   Cutaneous: related to skin
   Your skin -which covers the outer surface of your body- is a cutaneous membrane, which means that it is composed of epithelial layer and an underlining connective tissue.

2- **Mucous membrane**
   Epithelial tissue with the underlining connective tissue which line cavities that have a connection or an opening to the outer environment, such as the lining of the oral cavity, esophagus, stomach, trachea, urinary bladder.

3- **Serous membrane**
   It lines cavities that have no connection to outside. In other words, it covers visceral organs such as the heart and lungs.
Go to slide 9 in lab slides number 3 to see the colors that will be mentioned in the following paragraph.

As a fetus, you used to have a serous cavity, during embryonic development, the organ which is shown in red—for example, a lung—invaginates this cavity. During its invagination, it would be surrounded by a serous membrane too—which is in blue-. Eventually, the lung would be surrounded by two membranes. The one which is in direct contact with the lung is the inner membrane, and the one is the outer membrane (serous membrane). Between these two membranes, you can find a thin layer of fluid which leads to smooth, frictionless movement and protects the nearby structures from the organ’s movement and vice versa.

Another example is the heart.

Histologically, if you want to study the heart, you should know that it would be surrounded by the inner membrane, so when studying the outermost layer of it, you expect this layer to be a mesothelium (a simple squamous epithelium)

We call the inner membrane which surrounds the organ (visceral serous membrane) and we call the outer membrane (parietal serous membrane)-Not included in the exam-

B- Simple Cuboidal Epithelium:

- **Location**: small ducts of certain glands, pancreas, salivary glands and kidney tubules.

- As the duct gets larger in size, its lining will be turned from simple cuboidal cells into simple columnar epithelium, then into stratified cuboidal epithelium, and finally to stratified columnar epithelium.
C- Simple columnar epithelium:
- The cell is polarized, it has apical and basolateral surfaces.
- The apical surface is different from the basolateral surface.
- The apical surface has modifications: Cilia, microvilli.

Simple columnar with microvilli:
- Location: intestines, stomach and gall bladder to increase absorption.
- Microvilli are cytoplasmic extensions that are shorter, thinner, and higher in density per cell than cilia.
- The cell will have brush apical border (striated) under LM.

Ciliated simple columnar:
- Location: fallopian tubes, to convey the 2nry oocyte.
- Cilia are taller and more widely separated than microvilli.
- They appear as hairlike structures under LM.

- In simple columnar epithelium, we might see under the LM, cells that look like the cells of connective tissue between the epithelial cells, these cells are defensive cells to attack foreign bodies in the lumen that the epithelium is lining.
- The goblet cells protects the intestines from the acidic secretion of the stomach.
- Pseudostratified columnar epithelium with goblet cells is only found in respiratory tract, hence it’s also called respiratory epithelium.
- The goblet cells will not appear under LM with H&E stain, PAS stain must be used.
• If you have one cell at least attached to the basement membrane, and reaches the surface, then this tissue is 100% not stratified epithelium.
• Stratified ciliated epithelium is very rare.

2) Stratified Epithelium

A- **Stratified squamous non-keratinized epithelium:**

- **Location:** some parts of the oral cavity, esophagus, anal canal, vagina. (wet)

- If the apical cells have nuclei, they are not keratinized.

- If there are no nuclei on the apical cells, they are keratinized.

- The basement membrane is made of collagen fibers and ECM (extracellular matrix) with glycoproteins and proteoglycans.

- When the basement membrane is straight, it can be easily separated. However, it is not always straight, this not perfectly straight appearance increases the surface of the epithelial layer which is important to facilitate the epithelial tissue functions whether in nourishment by diffusion or protection from mechanical force.

B- **Stratified squamous epithelium (keratinized)**

- **Location:** skin, some of the oral cavity.

- When you scratch your skin, you scratch dead cells, filled with keratin (keratin bags).
-The amount (height) of keratin on the skin differs, depending on the site.

-When the apical cells are injured, the basal cells go under mitosis to replace the injured layer.

C- **Stratified cuboidal:**

-Usually 2 to 3 layers.

-**Location:** the large gonads ducts of exocrine glands such as the branched duct.

-Sometimes we can’t see the nucleus in the cell, because of the section plane.

D- **Stratified columnar epithelium:**

**Location:**

- Conjunctiva, the lining of the upper&lower eyelids and the white portion of the eye ball.

- the largest ducts

E- **transitional epithelium:**

-The lining of the upper urethra is **transitional epithelium** and the lower part which is exposed to the outside is **simple squamous non-keratinized** epithelium.

-As the urinary bladder gets filled (stretched), its cells turn from dome- shaped cells to squamous cells.

-Desmosomes will keep the epithelial cells in the bladder strongly attached to each other and will not be separated.
It’s called stretchy epithelium. (the skin cells is connected to each other by desmosomes, too.)

Modifications of apical surface of columnar cells:

- Microvilli: under TEM appears as finger like cytoplasmic projections.
- Cilia: under TEM is widely separated and taller than microvilli.
- Cross section in cilia: 9+2 the arrangement of microtubules. (axoneme appearance).
- The basal body of the cilia has 9+0 appearance and this part gives the a& B subunits of tubulin.

Clinical case:

Usually (45 year-olds and above), when they are diagnosed with cancer, their epithelial tissue has gone under abnormal mitosis which caused the tumor (malignant or benign).

“A year from now, you may wish you had started today.”