Lectures of Histology

(1st Stage)
First Semester 2024-2025

Anatomy and Histology Department

By

Prof. Dr. Khulood Naji Rasheed

The Tissue

Introduction

Tissues are composed of cells somewhat similar in structure and specialized to perform a specific function for the body. The human body is made of four general types of tissues (Fig.1a, b):

1. **Epithelial tissue:** for lining body cavities, covering internal organs and large surfaces. Major component of glands.
2. **Connective tissue:** for supporting and linking tissues or organs together, some are specialized to provide protection, to store fat, and even to provide circulatory function in the cardiovascular system.
3. **Muscle tissue:** for providing contraction and relaxation in the body surfaces, in the heart chambers, and in hollow organs such as blood vessels and the digestive tract.
4. **Nerve tissue:** for generating and transmitting electrical signals (nerve impulses) in the brain, spinal cord, and nerves, to control the activities of the body.

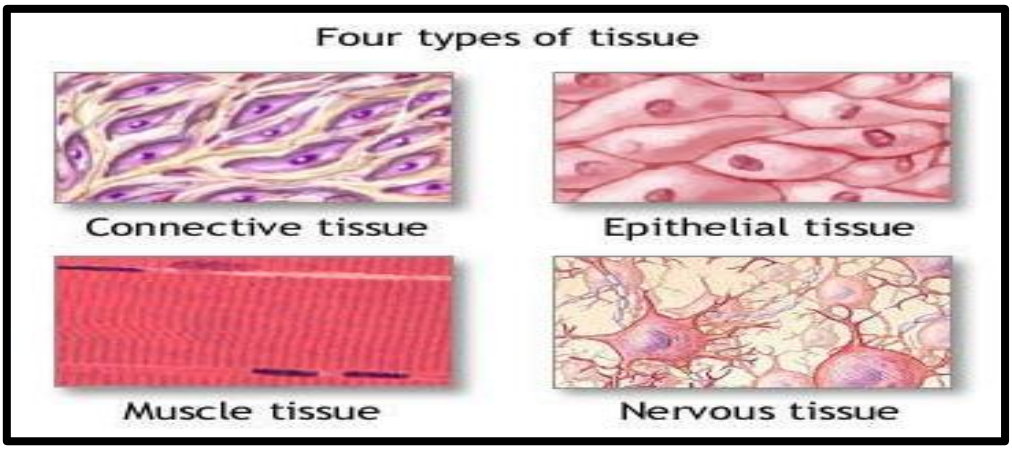


Fig. 1a: The Four Primary Tissue Types.

Tissue	Cells	Extracellular Matrix	Main Functions
Epithelial	Aggregated polyhedral cells	Small amount	Lining of surface or body cavities; glandular secretion
Connective	Several types of fixed and wandering cells	Abundant amount	Support and protection of tissues/organs
Muscle	Elongated contractile cells	Moderate amount	Strong contraction; body movements
Nervous	Elongated cells with extremely fine processes	Very small amount	Transmission of nerve impulses

Fig. 1b: Main characteristics of the four basic types of tissues.

Epithelial Tissue (Epithelium)

Is an aggregation of cells separated by very little extracellular substance. These cells are closely adjacent due to intercellular junctions, a characteristic that allows these cells to form sheets that cover body surfaces (such as the epidermis of skin) and line the cavities of internal organs that open to outside the body as well as the body cavities (such as peritoneum) and they line blood and lymphatic vessels, as well as they are organized and arranged as secretory units (glands).

* General Features of Epithelium

1. Can be derived from all three germinal layers.
2. Contain a little extracellular substance.
3. Rests on a basement membrane.
4. Lack vessels (avascular).
5. Mitotically active.
6. Diverse in thickness from one layer of cells to several layers.

* Derivation

It arises from the three germinal (or embryonic) layers:
- ectoderm.
- endoderm.
- mesoderm.

Membranous lining the body cavities is known as **mesothelium**, while the lining of heart, lymphatic and blood vessels is called **endothelium**.

* Polarity

Epithelial cells exhibit distinct polarity (Fig.2):

- Apical domain: that looks towards the lumen or the surface, can has cilia, microvilli, stereocilia.

- Lateral domain: bind cells together and provide cellular connections.

- Basal domain: faced towards the basement membrane (thin, extracellular matrix that separates the epithelial cells from underlying connective tissue, allow nutrients and waste to diffuse, Fig.3).

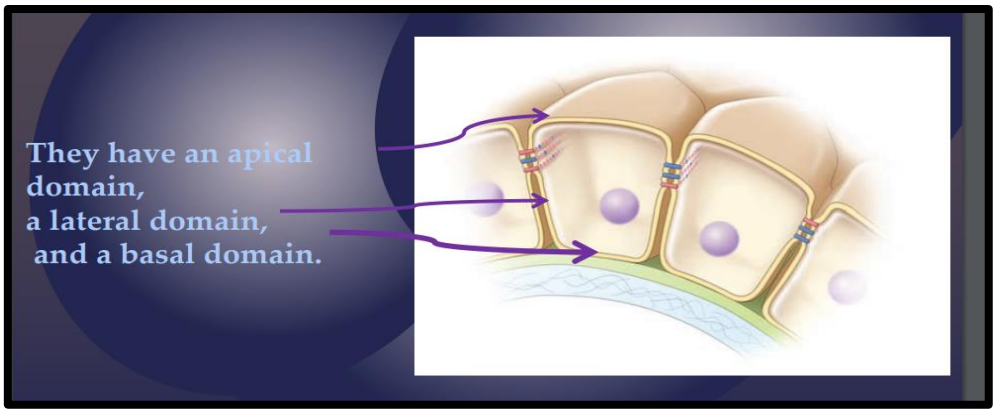


Fig. 2: Polarity of Epithelial Cells.

Fig. 3: Basement Membrane.

* Classification of Epithelium

Epithelial tissue can be classified according to two basic principles (Fig.4,5):

1. Number of cells layers:

- **Simple epithelium:** single layer of cells.
- **Stratified epithelium:** several layers of cells.
- **Pseudostratified epithelium:** single layer of cells of variable size and shape, with nuclei at a different level.

2. Shape of superficial layer cells:

- **Squamous:** the width of the cell is greater than its height.
- **Cuboidal:** the width, depth, and height are approximately the same.
- **Columnar:** the height of the cell exceeds the width.

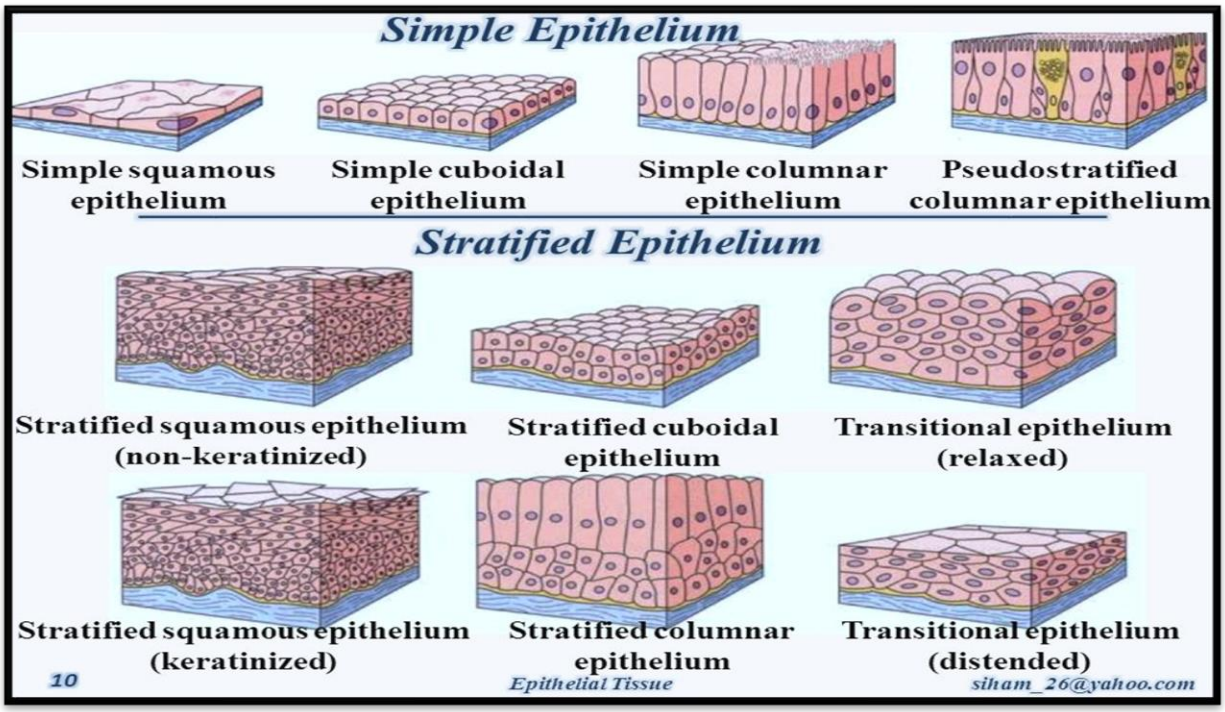


Fig. 4: Classification of Epithelium.

Major Feature	Cell Form	Examples of Distribution	Main Function
Simple (one layer of cells)	Squamous	Lining of vessels (endothelium); Serous lining of cavities: pericardium, pleura, peritoneum (mesothelium)	Facilitates the movement of the viscera (mesothelium), active transport by pinocytosis (mesothelium and endothelium), secretion of biologically active molecules (mesothelium)
	Cuboidal	Covering the ovary, thyroid	Covering, secretion
	Columnar	Lining of intestine, gallbladder	Protection, lubrication, absorption, secretion
Stratified (two or more layers of cells)	Squamous keratinized (dry)	Epidermis	Protection; prevents water loss
	Squamous nonkeratinized (moist)	Mouth, esophagus, larynx, vagina, anal canal	Protection, secretion; prevents water loss
	Cuboidal	Sweat glands, developing ovarian follicles	Protection, secretion
	Transitional	Bladder, ureters, renal calyces	Protection, distensibility
	Columnar	Conjunctiva	Protection
Pseudostratified (layer of cells with nuclei at different levels; not all cells reach surface, but all adhereto basal lamina)		Lining of trachea, bronchi, nasal cavity	Protection, secretion; cilia-mediated transport of particles trapped in mucus out of the air passages

Fig. 5: Common Types of Covering and Lining Epithelium.

* Simple Squamous Epithelium

Its cells are flat and squamous with sinuous edges overlapping with each other, and the width of cell is greater than its length, its nuclei are central and flat. The cells of this tissue appear spindle-shaped in the lateral or vertical section (Fig.6).

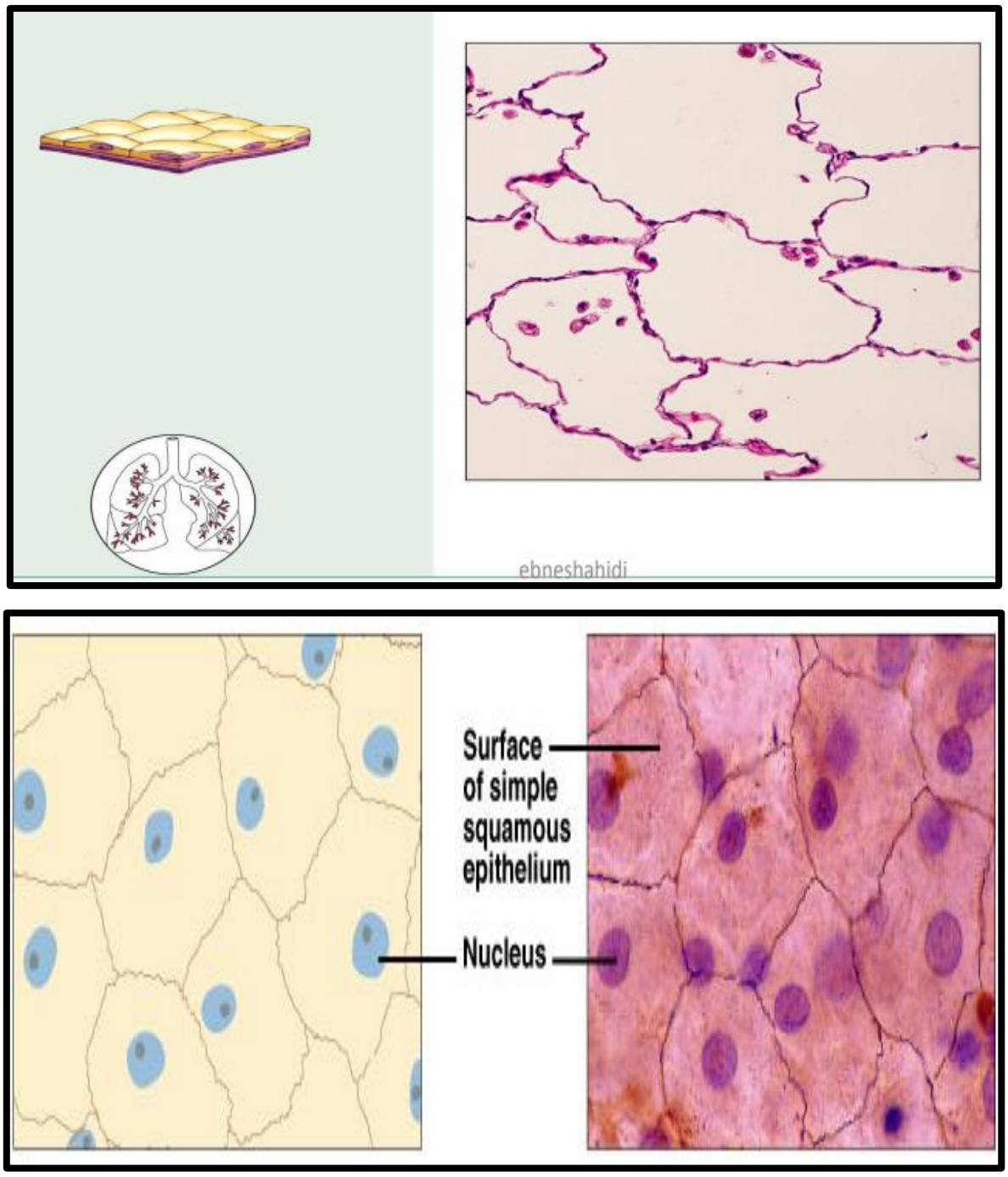


Fig. 6: Simple Squamous Epithelium.

* Simple Cuboidal Epithelium

Its cells resemble cube and appear in vertical section in a form of approximately square, while in superficial and transverse sections the cells appear approximately hexagonal in shape, their length is generally equal to width, and its nuclei appear spherical with a central location (Fig.7).

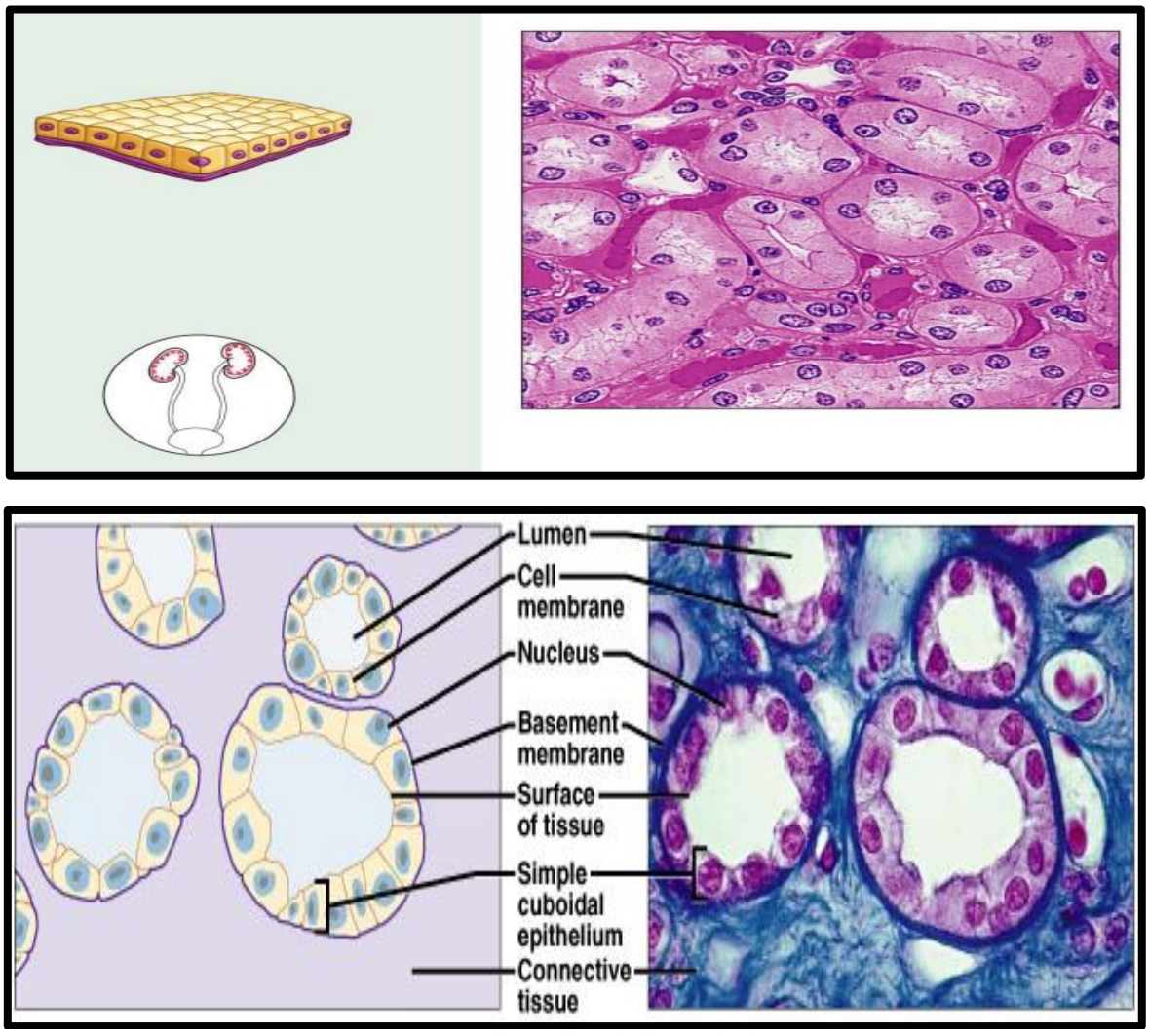
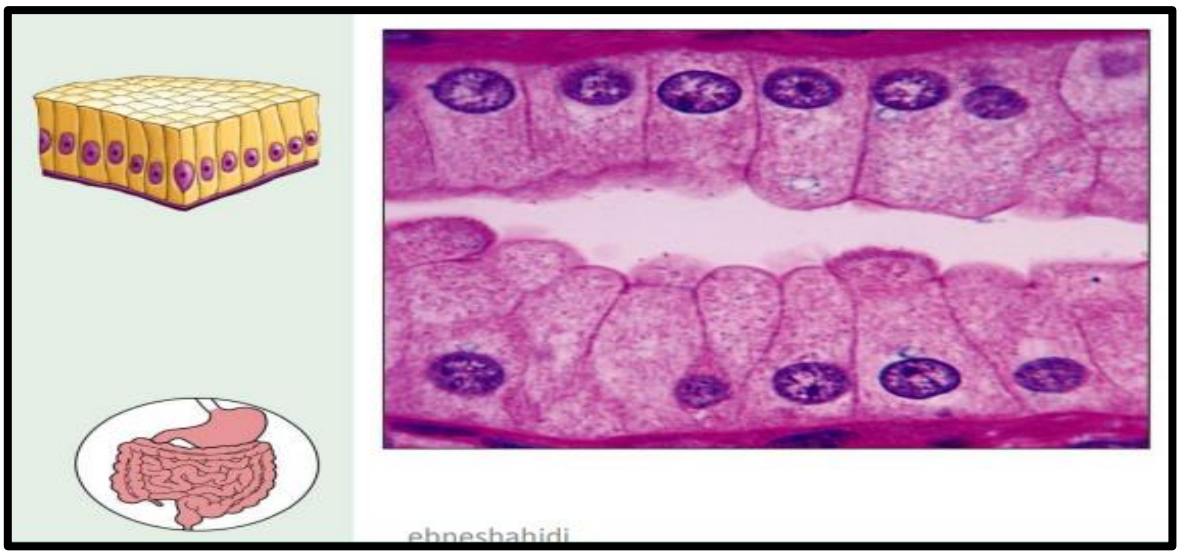


Fig. 7: Simple Cuboidal Epithelium.

* Simple Columnar Epithelium

Its cells appear in the vertical section in a form of rectangles, and in general their length is greater than width. Their nuclei are oval, with longitudinal axis parallel to the axis of cell, located near the base of cell (at the same level for all cells). Cells of this tissue may be accompanied by another type of cell that secretes mucus substances called goblet cells (Fig.8).



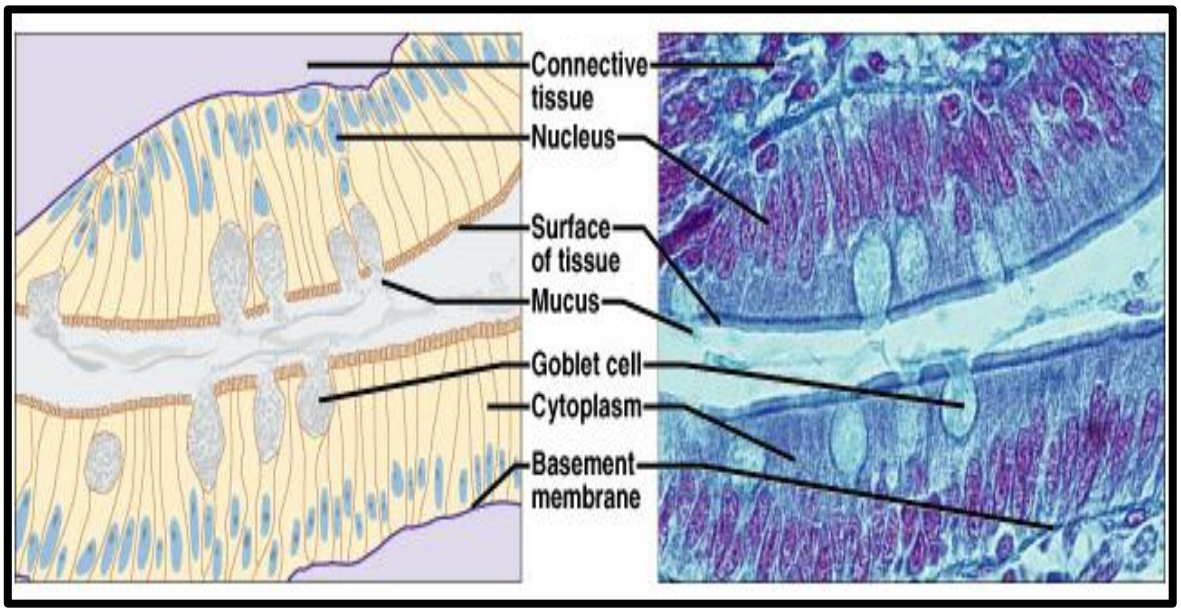


Fig. 8: Simple Columnar Epithelium.

* Pseudostratified Columnar Epithelium

It consists of more than one type of cells which nuclei are located at different levels as shown in the vertical section, so this suggests that tissue is composed of more than one layer of cells (but it not true), because all cells are attached with the basement membrane, but some do not reach to the surface (Fig.9). Much abundant two types of cells can be distinguished of this tissue are columnar and basal and may be sometimes interspersed with goblet cells.

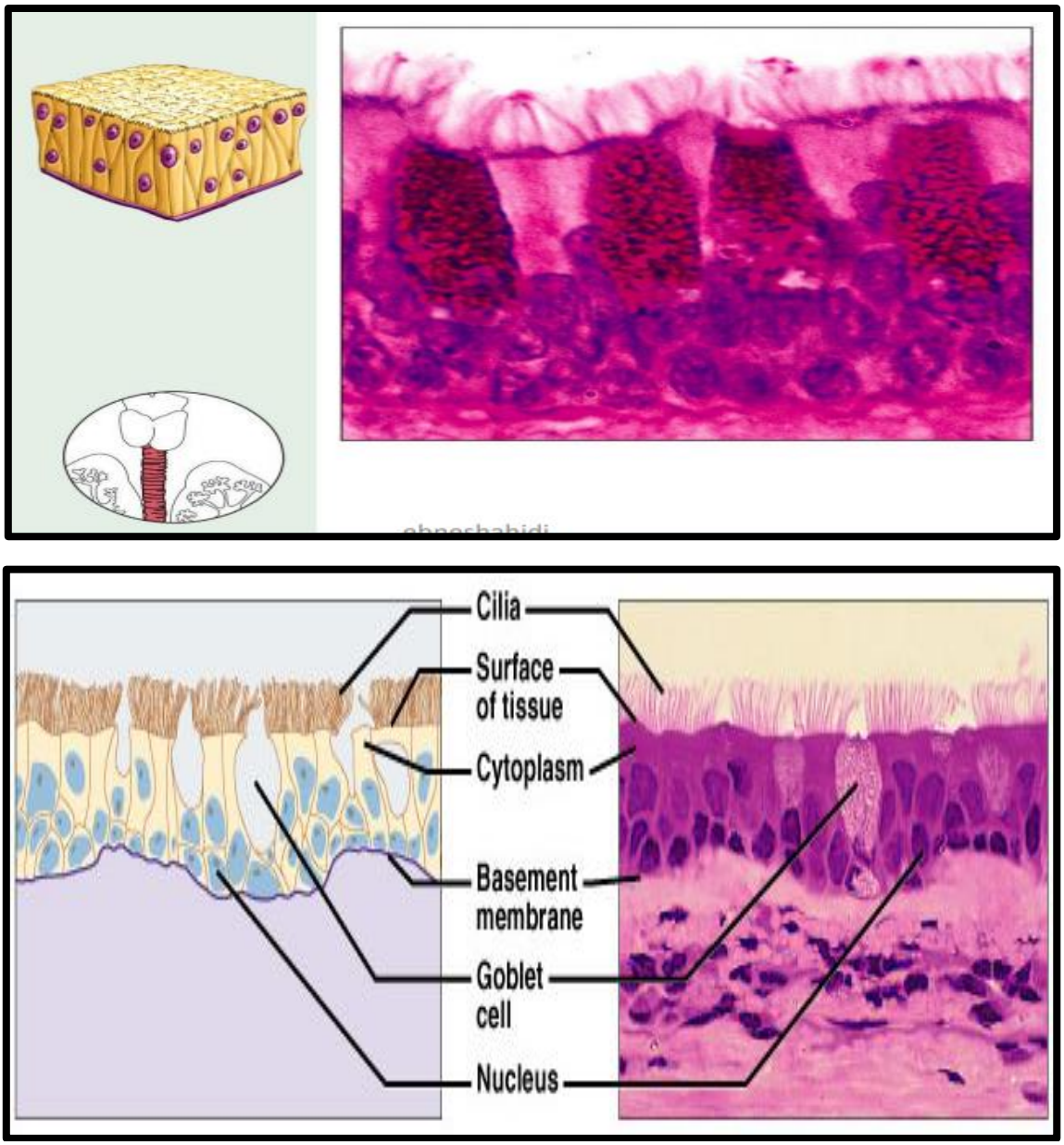


Fig. 9: Pseudostratified Columnar Epithelium.

As for the **stratified** or **compound epithelial tissue**, it consists of more than one layer of cells that differ in shape and level from one layer to another. Therefore, only the cells that make up the surface layer are used to classify the shape of this tissue. Stratified or compound epithelial tissue is found in the areas subject to injury and friction, thus preserving these parts of the body organs that it covers or lines. It is classified according to the shape of its surface cells into:

* Stratified Squamous Epithelium

Represent the main protective type to the body, consists of several layers of cells, the number of which varies according to their location. Cells attached to the basement membrane are cuboidal or columnar, while the cells of middle layer are polygonal and larger than them. Then the cells begin to flatten as they approach to the surface of outer tissue, where they become thin squamous and may become keratinized, so they lose their nuclei and die and become in form of scales (tissue then is called keratinized squamous stratified) as a result of deposition keratin in the cells of surface layers, this material is a strong, non-living fibrous protein that is resistant to chemical changes, friction and is relatively resistant to the entry of bacteria and water, an example of this tissue is the epidermis of skin. While the tissue lining oral cavity, esophagus, anal canal, and vagina are wet, so the cells of surface layers of it are not keratinized (so it is called a non-keratinized squamous stratified). It replaces the surface cells that shed in both types with new ones that are originally composed of cells of the basal layer (Fig.10).

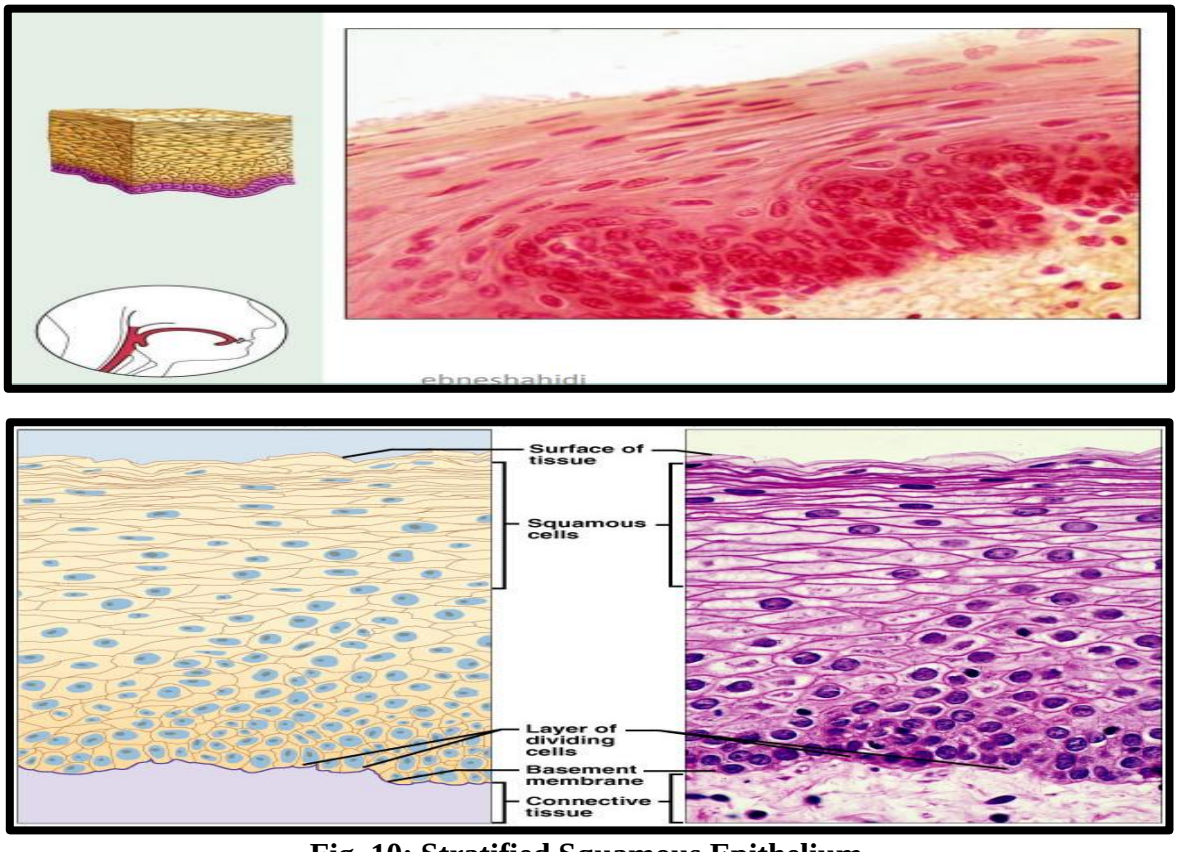


Fig. 10: Stratified Squamous Epithelium.

* Stratified Cuboidal Epithelium

Surface cells are cuboid in shape, which consists of two or three layers of cells (Fig.11).

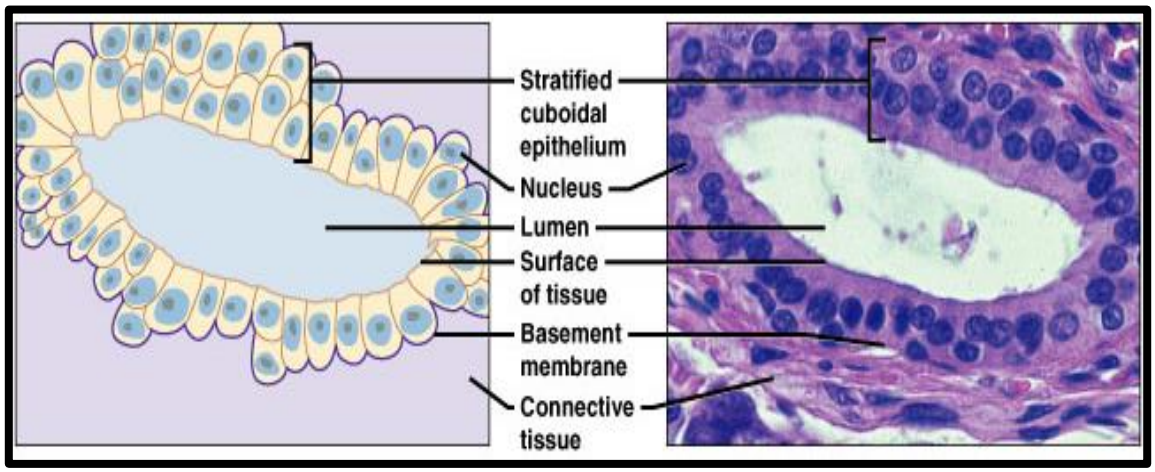


Fig. 11: Stratified Cuboidal Epithelium.

* Stratified Columnar Epithelium

Surface cells are columnar, while those of layers below are polygonal and smaller in size. This type of tissue is rare and covers small areas of some organs (Fig.12).

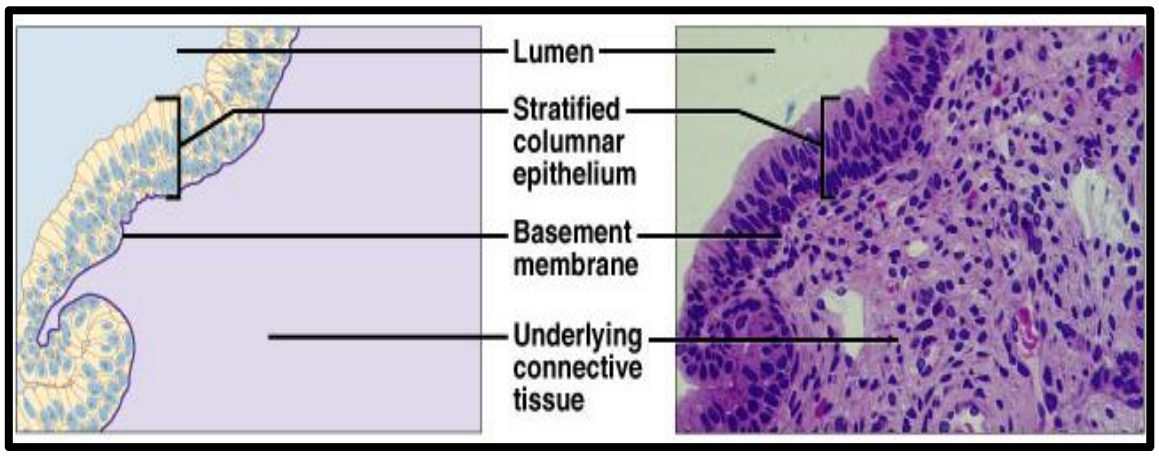


Fig. 12: Stratified Columnar Epithelium.

* Transitional Epithelium

It like non-keratinized stratified squamous epithelial tissue when it is stretched, while when it is relaxed the cells of superficial layer are umbrella-shaped instead of squamous, and the number of cellular layers is "appeared" more than in the case of stretching. Thus, this type of tissue is very suitable for lining the exposed hollow organs for such an expansion (Fig.13).

Cells of the basal layer are small, polygonal, irregular, and attached to the basement membrane, while in the superficial layers are large, convex, and may contain more than one nucleus. A little number of desmosomes, with many overlapping folds present in plasma membranes of the cells located under the surface layer help process of expansion/distended and relaxed (unique morphological features of the cells allow **distension** of transitional epithelium as the urinary bladder **fills**, and **relaxation** as the urinary bladder **empty**).

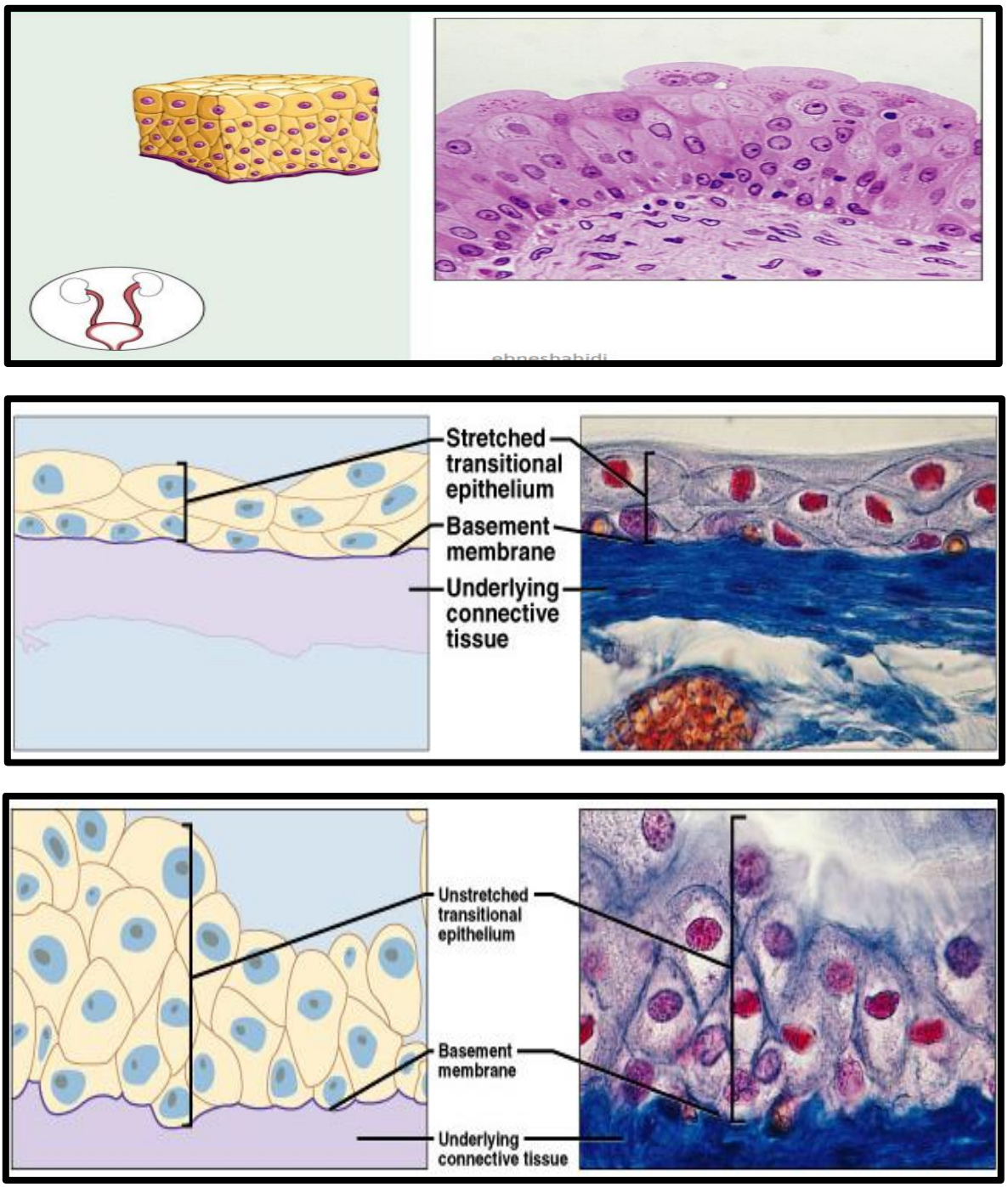
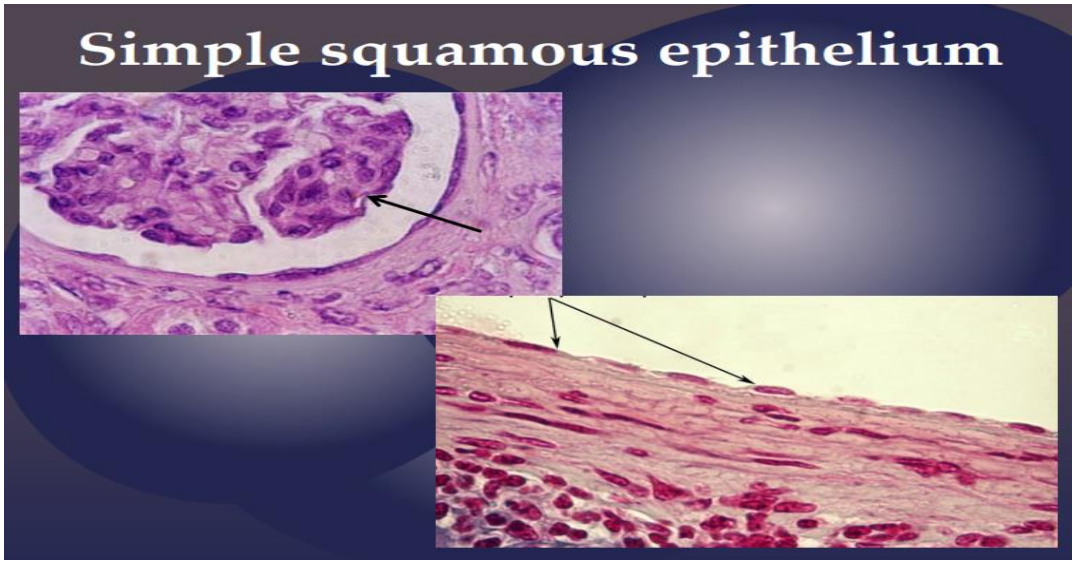
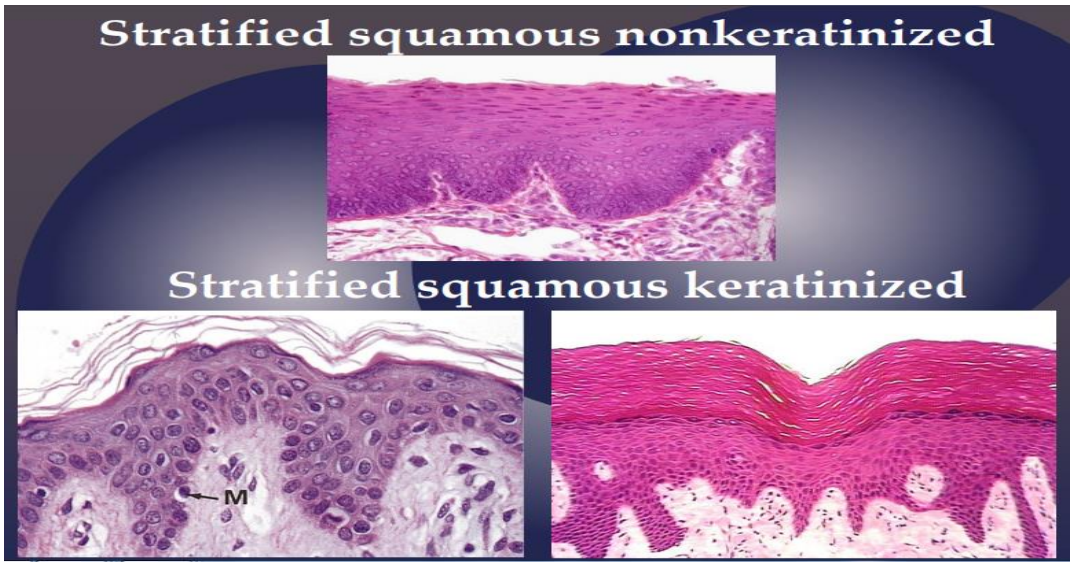
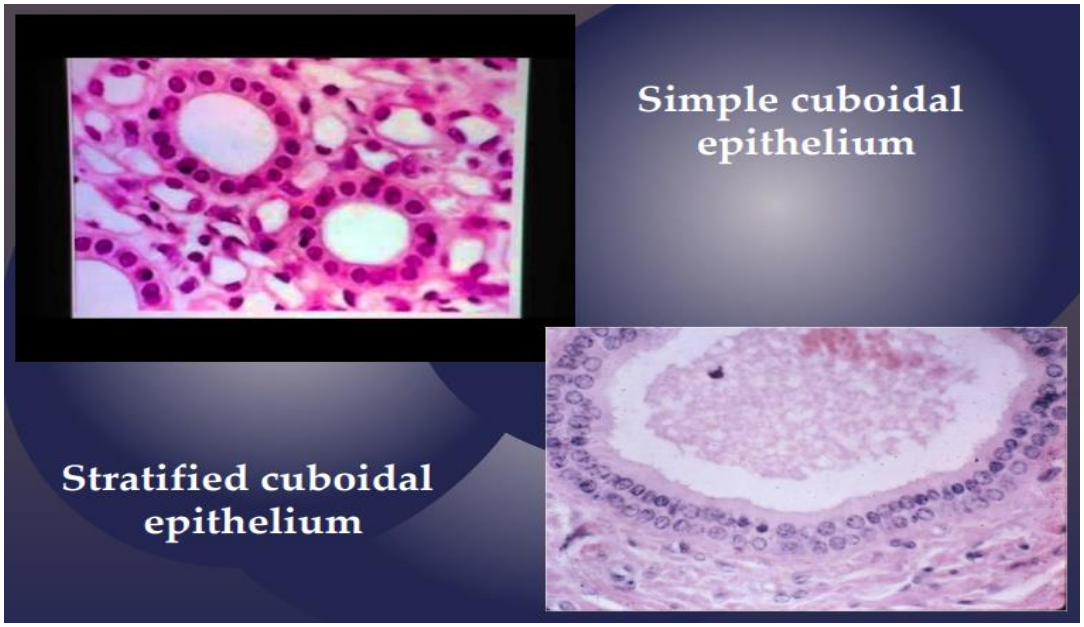


Fig. 13: Transitional Epithelium.

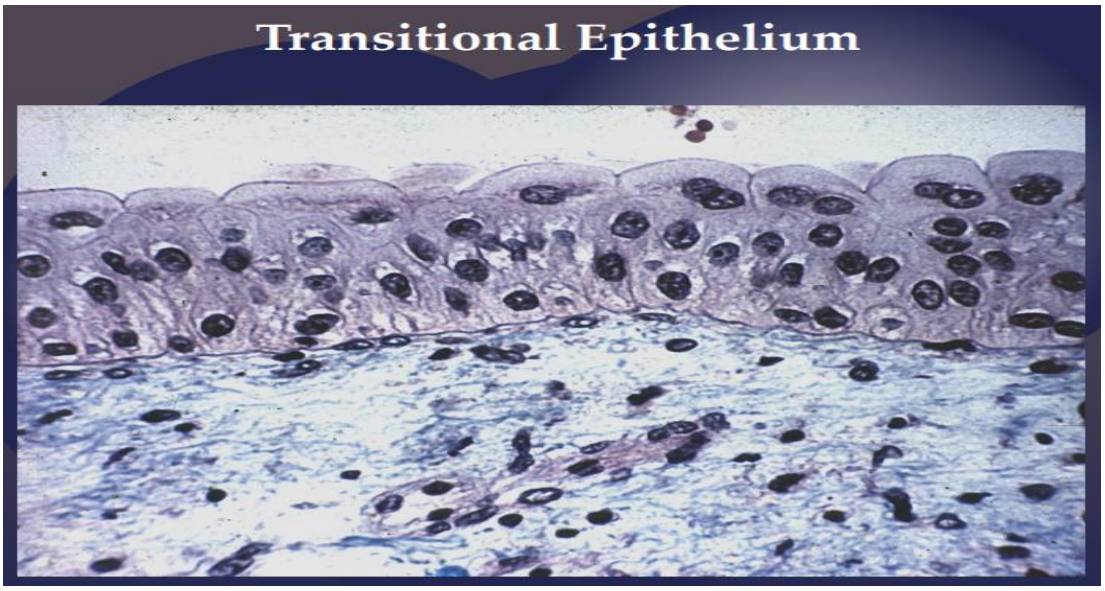

Simple squamous epithelium

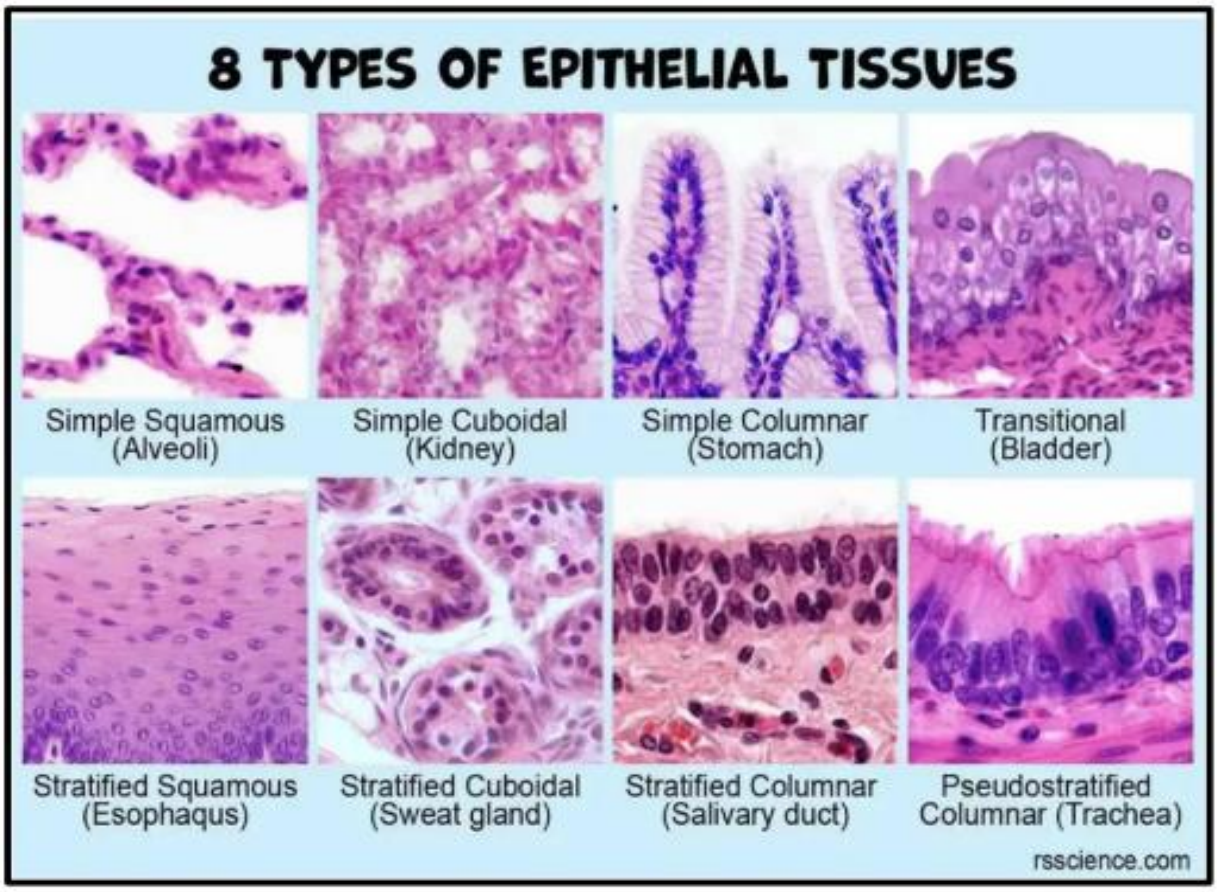

Stratified squamous nonkeratinized
Stratified squamous keratinized
M


Simple cuboidal epithelium
Stratified cuboidal epithelium


Simple columnar epithelium
KU MEDICAL CENTER


Pseudostratified columnar epithelium


Transitional Epithelium



* Functions of Epithelial Tissue

1. Protection, as in the stratified squamous epithelium of the skin (epidermis) and the transitional epithelium of the urinary bladder.

2. Secretion and absorption, as in the columnar epithelium.

3. Transportation, as in the transport of materials or cells along the surface of an epithelium by motile cilia.

4. Receptor function to receive external stimuli, as in the taste buds of the tongue, olfactory epithelium of the nasal mucosa, and the retina of the eye, this type of tissue is called **neuroepithelium**.

5. Contraction, as in some epithelial tissue cells which have ability to contract, so they are called **myoepithelium**, their cytoplasm contains an abundance of actin and myosin filaments, many of these cells surround the excretory duct and by contracting it helps to release secretions (e.g., salivary glands, mammary glands and sweat glands).