

TISSUE LEVELS OF ORGANIZATION

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TISSUES

- A **tissue** is a group of cells that usually have a common origin in an embryo and function together to carry out specialized activities.
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- The structure and properties of a specific tissue are influenced by factors such as the nature of the extracellular material that surrounds the tissue cells and the connections between the cells that compose the tissue.
- Tissues may be hard, semisolid, or even liquid in their consistency, a range exemplified by bone, fat, and blood.
- Tissues vary tremendously with respect to the kinds of cells present, how the cells are arranged, and the types of fibers present, if any.

TYPES OF TISSUES

Body tissues can be classified into four basic types according to their structure and function:

- Epithelial Tissue
- Connective Tissue
- Muscle Tissue
- Nervous Tissue

CELL JUNCTIONS

Cell junctions are **contact points** between the plasma membranes of tissue cells.

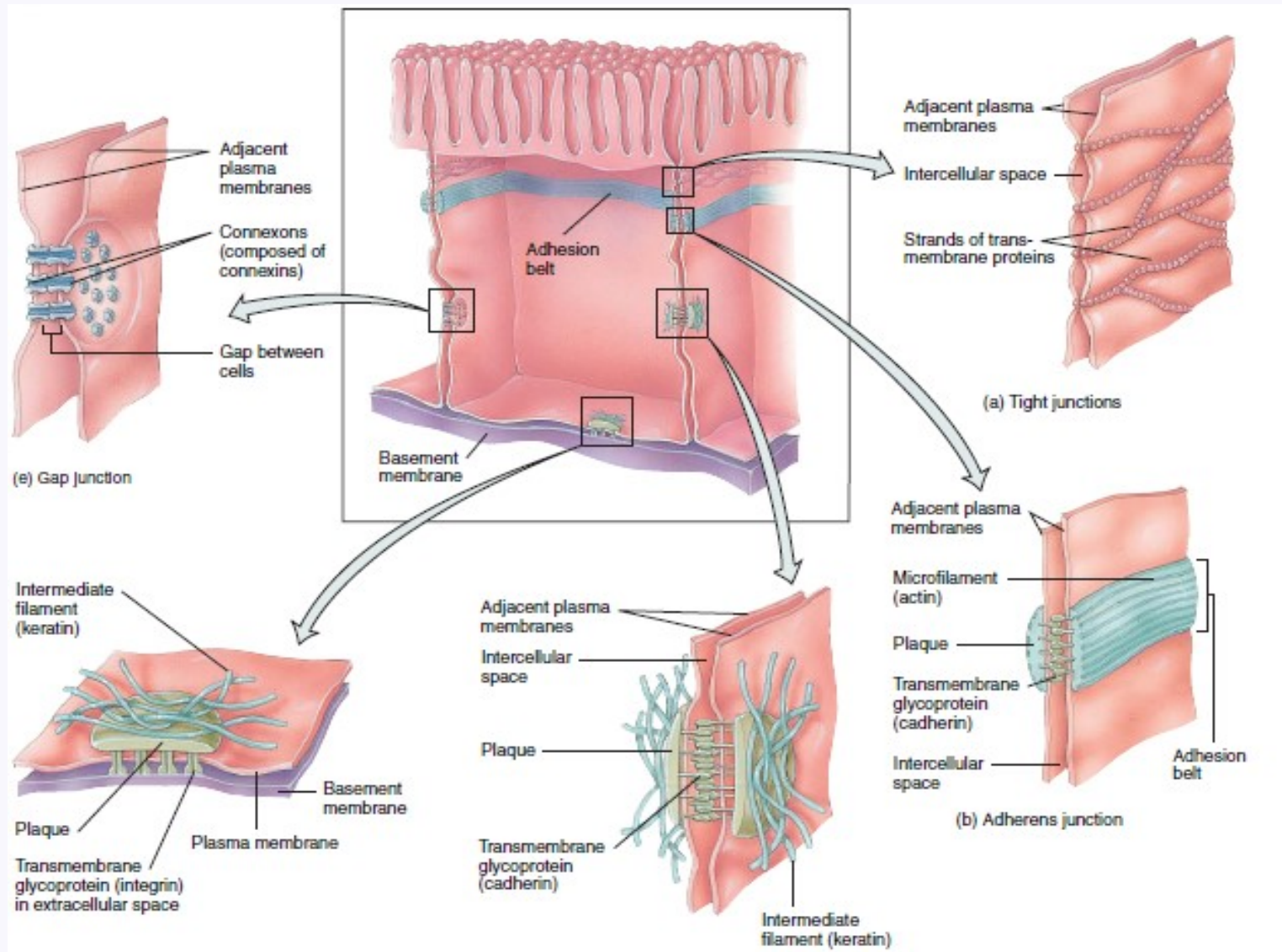
Here we consider the five most important types of cell junctions:

- 1- **Tight junctions**: weblike strands of transmembrane proteins that **fuse** together the outer surfaces of adjacent plasma membranes to **seal off** passageways between adjacent cells.
- 2- **Adherens junctions**: This type of junction help epithelial surfaces **resist separation** during various contractile activities, as when food moves through the intestines

CELL JUNCTIONS (continued)

- 3- **Desmosomes**: This structural arrangement contributes to the **stability** of the cells and tissue. These spot weld–like junctions are common among the cells that make up the epidermis (the outermost layer of the skin) and among cardiac muscle cells in the heart.
- 4- **Hemidesmosomes**: **anchor cells** not to each other but to the **basement** membrane.
- 5- **Gap junctions**: membrane proteins called **connexins** form tiny fluid-filled **tunnels** called *connexons* that connect neighboring cells. The allow the cells in a tissue to **communicate** with one another, and enable nerve or muscle impulses to spread rapidly among cells

Cell Junctions



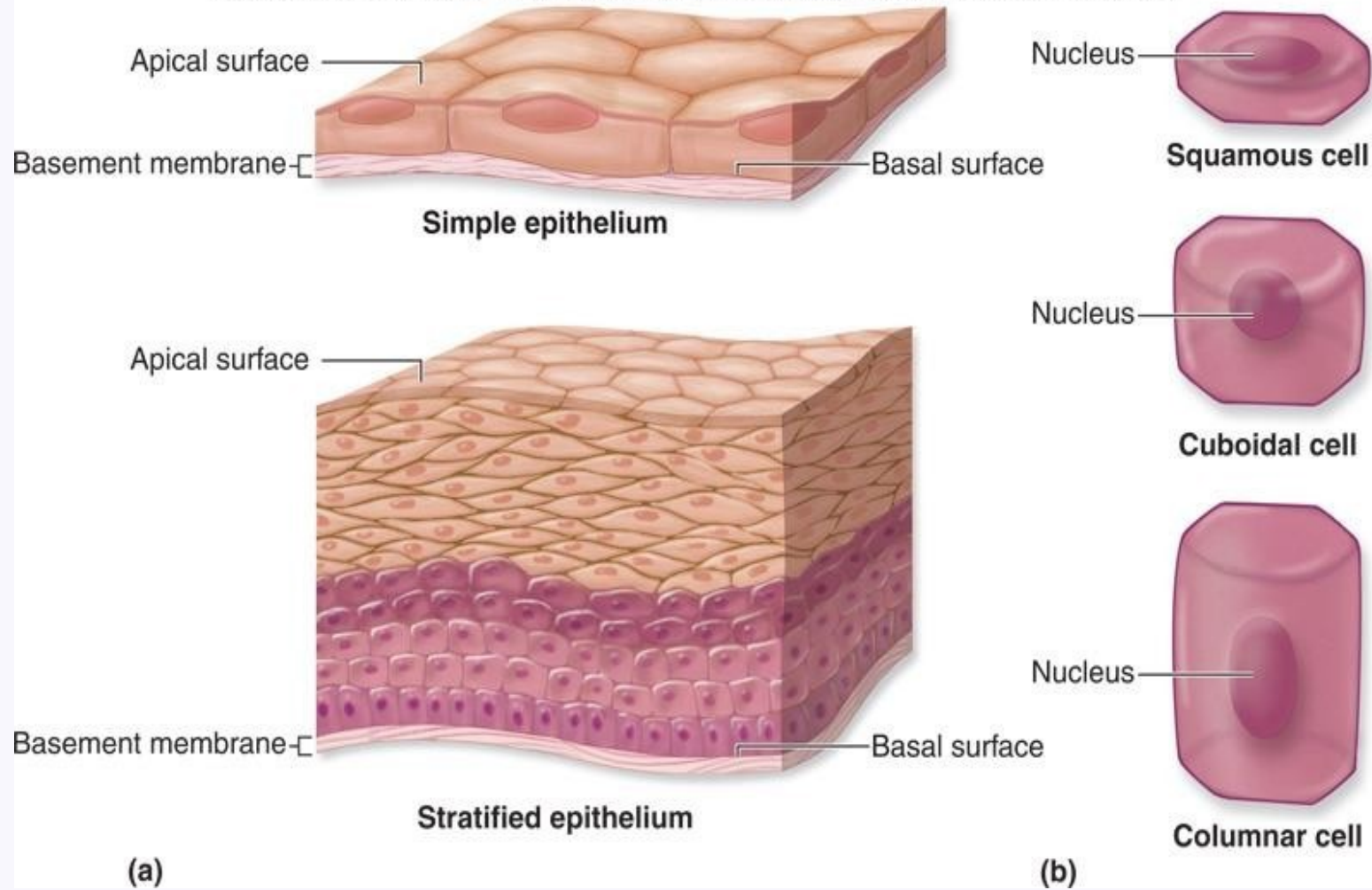
EPITHELIAL TISSUE

An epithelial tissue (ep-i-THE⁻-le⁻-al) or epithelium (plural is epithelia) consists of cells arranged in continuous sheets, in either single or multiple layers.

Characteristics:

- ✓ The cells are closely packed and are held tightly together by many cell junctions. Composed of one or more layers of closely packed cells that form a *barrier* between two compartments having different components.
- ✓ There is little or no intercellular space between adjacent plasma membranes.
- ✓ Epithelial tissue forms coverings and linings throughout the body. It is not covered by another tissue, so it always has a free surface. → both the external and internal lining of many organs.
- ✓ Constitutes the majority of glands.
- ✓ No blood vessels penetrate an epithelium.
- ✓ It is repeatedly subjected to physical stress and injury. A high rate of cell division allows epithelial tissue to constantly renew and repair itself.

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Characteristics of Epithelial Tissue:

1- Cellularity

- Composed almost entirely of cells bound closely together by different types of cell junctions.

Characteristics of Epithelial Tissue:

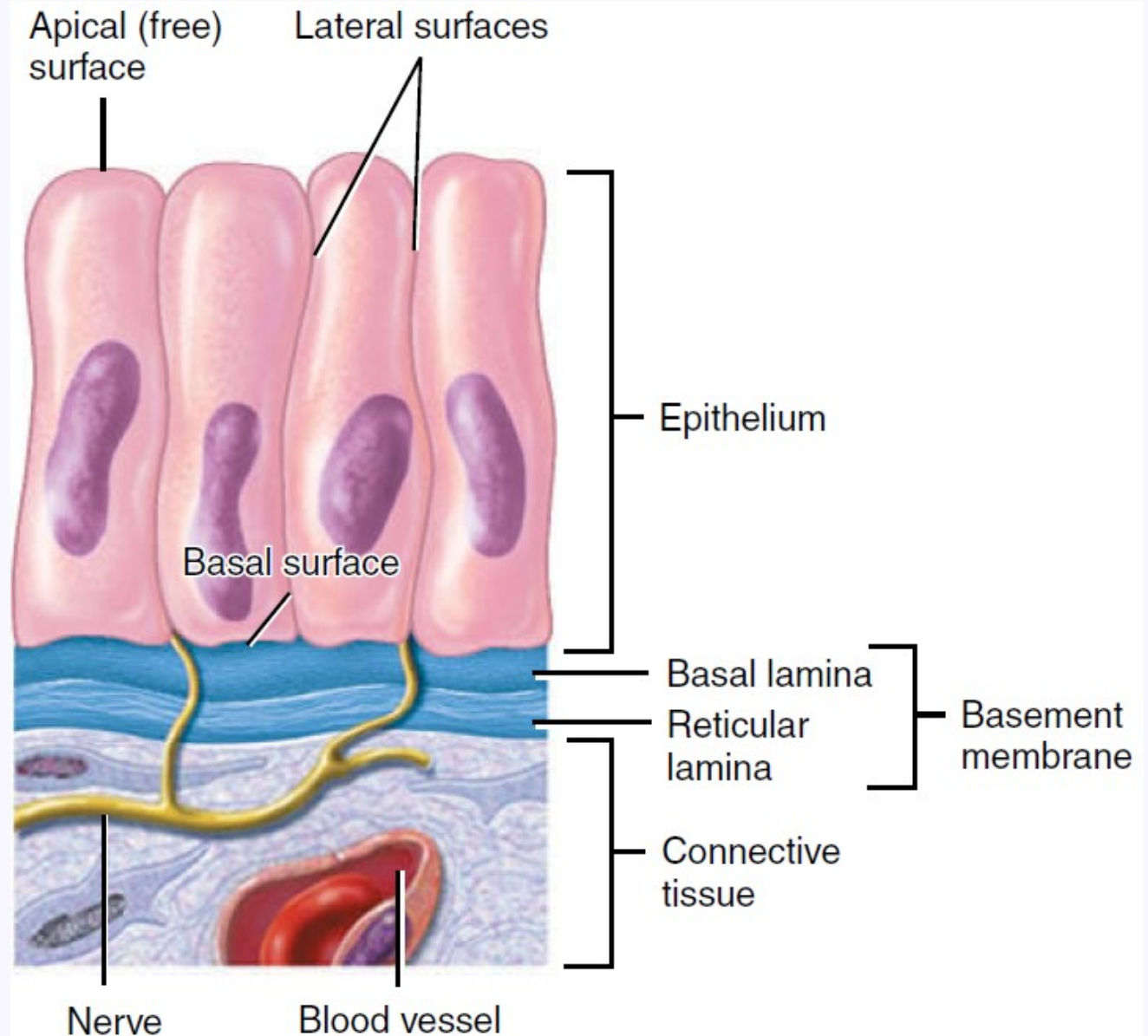
2- Polarity:

- The **apical** (*free*) **surface** of an epithelial cell faces the body surface,
- The **lateral surfaces** of an epithelial cell, which face the adjacent cells on either side, may contain tight junctions, adherens junctions, desmosomes, and/or gap junctions.
- The **basal surface** of an epithelial cell is opposite the apical surface. The basal surfaces of the deepest layer of epithelial cells adhere to extracellular materials such as the basement membrane → fixed, or bottom surface

NOTE: Epithelia with multiple layers, the term *apical layer* refers to the most superficial layer of cells, and the *basal layer* is the deepest layer of cells

→ Surfaces of epithelial cells and the structure and location of the basement membrane.

→ The basement membrane is found between an epithelial tissue and a connective tissue.



Characteristics of Epithelial Tissue:

3- Attachment

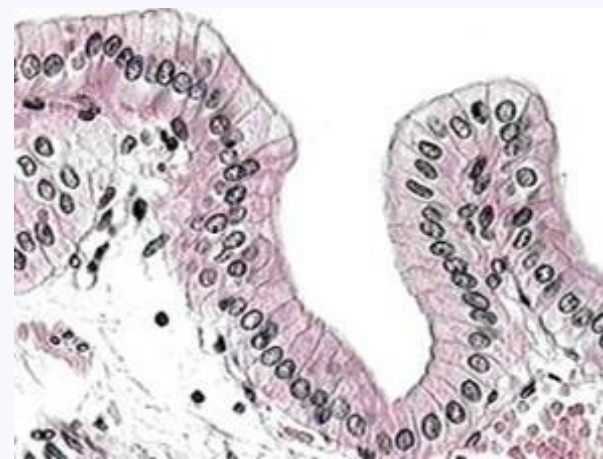
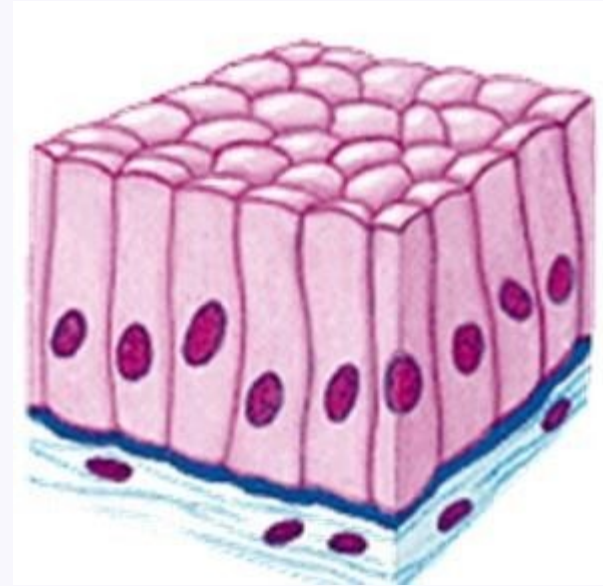
- The basal surface of an epithelium is bound to a thin basement membrane.



Characteristics of Epithelial Tissue:

4- Avascularity

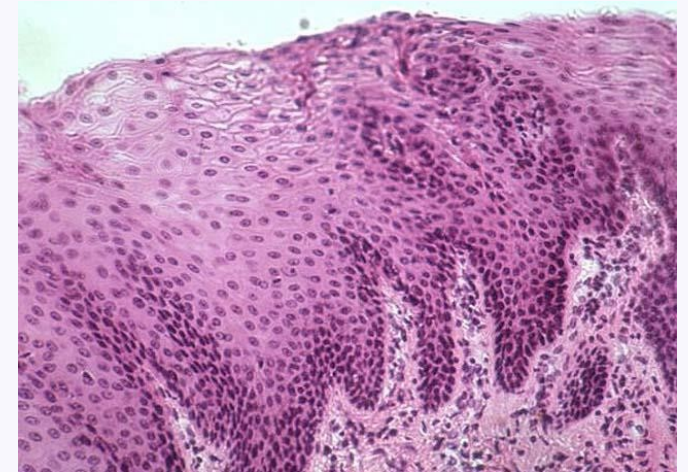
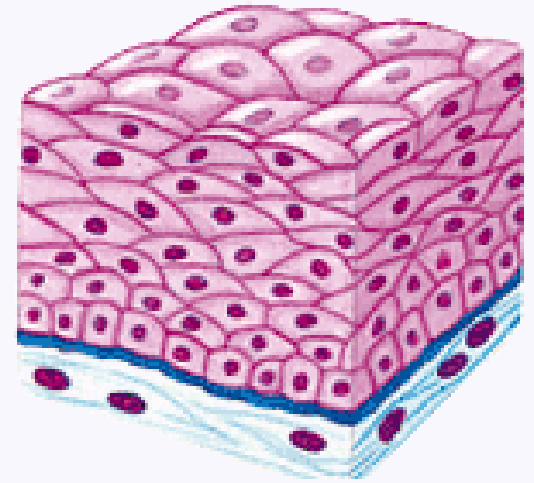
- Lack blood vessels.
- Nutrients obtained either directly across the apical surface or by diffusion across the basal surface.



Characteristics of Epithelial Tissue:

5- Innervation

- Some epithelia are richly innervated to detect changes in the environment at that body or organ surface.
- Most nervous tissue is in the underlying connective tissue.



Characteristics of Epithelial Tissue:

6- Regeneration Capacity

- Frequently damaged or lost by abrasion and is replaced via **high regeneration capacity**.
- Continual replacement occurs through the divisions of the deepest epithelial cells (called stem cells) near its base.

Functions of Epithelial Tissue

Epithelial tissue has major functions:

- (1) a selective **barrier** that limits or aids the transfer of substances into and out of the body → regulation.
- (2) a **secretory surface** that releases products produced by the cells onto its free surfaces.
- (3) a **protective surface** that resists the abrasive influences of the environment.
- (4) Nerve endings **detect changes** in the external environment at their surface. Continuously supply information to the nervous system concerning touch, pressure, temperature, and pain.

Epithelial tissues are classified according to:

1- Number of cell layers:

- Simple (monolayer of cells) epithelia
- Stratified (at least 2 cell layers) epithelia
- Pseudostratified epithelia: *cell nuclei lie at different levels and not all cells reach the apical surface; it is actually a simple epithelium because all its cells rest on the basement membrane.*

Epithelial tissues are classified according to:

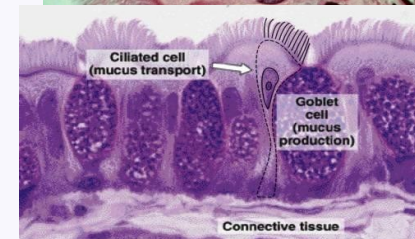
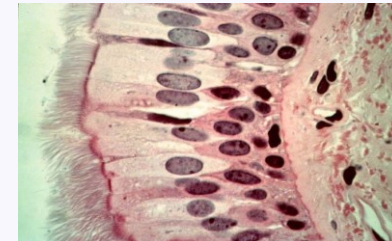
2- Shape of cells:

- a. *Squamous* cells (SKWA⁻-mus flat) are thin, which allows for the rapid passage of substances through them.
- b. *Cuboidal* cells are as tall as they are wide and are shaped like cubes or hexagons. They may have **microvilli** at their apical surface and function in either secretion or absorption.
- c. *Columnar* cells are much taller than they are wide, like columns, and protect underlying tissues. Their apical surfaces may have **cilia** or **microvilli**, and they often are specialized for secretion and absorption.
- d. *Transitional* cells change shape, from squamous to cuboidal and back, as organs such as the urinary bladder stretch (distend) to a larger size and then collapse to a smaller size.

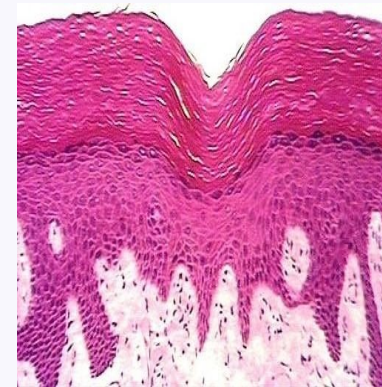
Epithelial tissues are classified according to:

3- Modifications at their free surface:

A- Cilia → **Pseudostratified ciliated columnar epithelium** Appears to be layered but it is not. Eg: Lines the bronchi, trachea



B- Keratinized



Arrangements Of Epithelial Tissues:

When we combine the two characteristics (arrangements of layers and cell shapes), we come up with the following types of epithelial tissues:

I. Simple epithelium

- A. Simple squamous epithelium
- B. Simple cuboidal epithelium
- C. Simple columnar epithelium (nonciliated and ciliated)
- D. Pseudostratified columnar epithelium (nonciliated and ciliated)

II. Stratified epithelium

- A. Stratified squamous epithelium (keratinized, when surface cells are dead and become hardened, and nonkeratinized, when surface cells remain alive)*
- B. Stratified cuboidal epithelium*
- C. Stratified columnar epithelium*
- D. Transitional epithelium

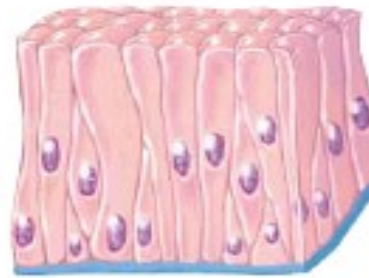
**This classification is based on the shape of the cells in the apical layer.*

Cell shapes and arrangement of layers for covering and lining epithelium

Arrangement
of layers



Simple



Pseudostratified



Stratified

Basement
membrane

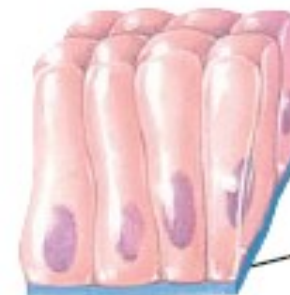
Cell shape



Squamous



Cuboidal



Columnar

Basement
membrane