

Epithelial Tissue:

The human body is composed of only **four basic types of tissue**: epithelial, connective, muscular, and nervous. These tissues, which are formed by cells and molecules of the **extracellular matrix**.

CHARACTERISTIC FEATURES OF EPITHELIAL CELLS:

- 1-The forms of epithelial cells range from high **columnar** to **cuboidal** to low **squamous** cells, their common polyhedral form .
- 2-Epithelial cell nuclei have a distinctive shape, varying from spherical to elongated or elliptic. cuboidal cells have spherical nuclei, and squamous cells have flattened nuclei.
- 3- The lipid-rich membranes between cells are frequently indistinguishable with the light microscope.
- 4-Most epithelia rest on connective tissue. In the case of epithelia lining the cavity of internal organs (especially in the digestive, respiratory, and urinary systems) this layer of connective tissue is often called the **lamina propria**. The lamina propria not only serves to support the epithelium but also provides nutrition and binds it to underlying structures.
- 5-The membranes on the lateral surfaces of adjoining cells often have numerous in foldings to increase the area of that surface, increasing its functional capacity. The different regions of polarized cells may have different functions.

Basal Laminae :

- 1-All epithelial cells in contact with subjacent connective tissue have at their basal surfaces a felt-like sheet of extracellular material called the **basal lamina** .
- 2-The macromolecular components of basal laminae form three-dimensional arrays and the best known of these include:
 - i- **Laminin**: These are large glycoprotein molecules .
 - ii- **Type IV collagen**: contain three polypeptide chains .
 - iii- **Entactin (nidogen)**, a glycoprotein, a proteoglycan with heparan sulfate side chains: these glycosylated proteins and others serve to link together the laminin and type IV collagen sheets.

Basal laminae functions.

- 1-Filtering functions.
- 2- Able to influence cell polarity.
- 3- Regulate cell proliferation and differentiation by binding and concentrating growth factors.
- 4-Influence cell metabolism and survival.
- 5- Organize the proteins in the adjacent plasma membrane .
- 6- Serve as pathways for cell migration.

Basement membrane:

The basement membrane is formed by the combination of a basal lamina and a reticular lamina and is therefore thicker.

Intercellular Adhesion & Other Junctions:

Several membrane-associated structures contribute to adhesion and communication between cells.

Function of junction:

The lateral membranes of epithelial cells exhibit several specialized **intercellular junctions**. Various junctions serve to function as:

- i- Seals to prevent the flow of materials between the cells (**occluding junctions**)
- ii- Sites of adhesion (**adhesive or anchoring junctions**)
- iii- Channels for communication between adjacent cells (**gap junctions**).

Type of junctions:

1-Tight junctions: are the most apical of the junctions and that the junctions form bands completely encircling each cell, and the membrane fusions that close off the space between the cells.

Function of the tight junction :

- A-** Form a seal that prevents the flow of materials between epithelial cells .
- B-** Help form in an apical compartment that is composed of an organ cavity .

C- Prevent the integral membrane proteins of the apical surface from transferred to the basolateral surface and vice versa.

2- The adherent junction :

This junction also encircles the cell, usually immediately below the Tight junctions, and provides for the firm adhesion of one cell to its neighbors. Adhesion is mediated by transmembrane glycoproteins of each cell.

3-Desmosome :

The desmosome is a disk-shaped structure at the surface of one cell that is matched with an identical structure at the surface of an adjacent cell . Desmosomes provide firm adhesion among the cells. In non epithelial cells, the intermediate filaments attached to desmosomes are composed of other proteins, such as desmin .

4-Gap or communicating junctions.

Occur almost anywhere along the lateral membranes of epithelial cells, but are also found between cells in nearly all mammalian tissues. gap junctions appear as regions where adjacent cell membranes are closely apposed . these junctions are seen as aggregated transmembrane protein complexes that form circular patches in the plasma membrane .

Specializations of the Apical cell Surface:

The free or apical surface of many types of epithelial cells has specialized structures to increase the cell surface area or to move substances or particles bound to the epithelium.

I- Microvilli.

1-Many cells are seen to have cytoplasmic projections. These projections may be short or long finger like extensions or folds that pursue a sinuous course, and they range in number from a few to many. Most are temporary, reflecting cytoplasmic movements and the activity of actin filaments.

2-In absorptive cells, such as the lining epithelium of the small intestine, the apical surface presents orderly arrays of many hundreds of more permanent **microvilli** .

II-Stereocilia.

1-Stereocilia are long apical processes of cells in other absorptive epithelia

such as that lining the epididymis and ductus deferens.

2-These structures are much longer and less motile than microvilli, are branched, and should not be confused with true cilia.

3-Like microvilli, stereocilia also increase the cells' surface area, facilitating the movement of molecules into and out of the cell.

III-Cilia.

1-Cilia are elongated, highly motile structures on the surface of some epithelial cells, which is much longer and two times wider than a typical microvillus. Each cilium is bounded by the cell membrane .

2-A ciliated cell of the trachea lining is estimated to have about 250 cilia. Flagella, present in the human body only in spermatozoa , are similar in structure to cilia but are much longer and are normally limited to one flagellum per cell.

Types of Epithelia:

Epithelia can be divided into two main groups according to their structure and function: **covering (or lining) epithelia** and **glandular epithelia**.

I-Covering or Lining Epithelia.

Covering epithelia are tissues in which the cells are organized in layers that cover the external surface or line the cavities of the body.

Classification of Lining Epithelia:

They are classified according to the number of cell layers and the morphologic features of the cells in the surface layer .

1-Simple epithelia contain only one layer of cells and classified as **squamous** (thin cells), **cuboidal** (cells roughly as thick as they are wide) or **columnar** (cells taller than they are wide) .

Common types of covering epithelia in the human body.

| Common types of covering epithelia in the human body. | | | |
|---|------------|----------------------------------|---------------------------------|
| Number of Cell Layers | Cell Form | Examples of Distribution | Main Function |
| I-Simple (one layer) | a-Squamous | Lining of vessels (endothelium). | Facilitates the movement of the |

| | | | |
|---|-----------------------------------|---|---|
| | | Serous lining of cavities; pericardium, pleura, peritoneum (mesothelium). | viscera (mesothelium), active transport by pinocytosis (mesothelium and endothelium), secretion of biologically active molecules (mesothelium). |
| | b-Cuboidal. | Covering the ovary, thyroid. | Covering, secretion. |
| | c-Columnar. | Lining of intestine, gallbladder. | Protection, lubrication, absorption, secretion. |
| II-Pseudostratified (layers of cells with nuclei at different levels; not all cells reach surface but all adhere to basal lamina) | | Lining of trachea, bronchi, nasal cavity. | Protection, secretion; cilia-mediated transport of particles trapped in mucus out of the air passages. |
| III-Stratified (two or more layers) | a-Squamous keratinized (dry) | Epidermis. | Protection; prevents water loss. |
| | b-Squamous nonkeratinized (moist) | Mouth, esophagus, larynx, vagina, anal canal. | Protection, secretion; prevents water loss. |
| | c-Cuboidal | Sweat glands, developing ovarian follicles. | Protection, secretion. |

| | | | |
|--|----------------|----------------------------------|-----------------------------|
| | d-Transitional | Bladder, ureters, renal calyces. | Protection, distensibility. |
| | e-Columnar | Conjunctiva. | Protection. |

2- **Stratified epithelia** contain more than one layer. Based on cell shape.

and classified according to the cell shape of the superficial layer:
squamous, cuboidal, columnar, and transitional.

i-Stratified squamous keratinized epithelium:

It is found mainly in the epidermis of skin. Its cells form many layers, and the cells closer to the underlying connective tissue are usually cuboidal or low columnar. The cells become irregular in shape and flatten as they accumulate keratin in the process of **keratinization** and are moved progressively closer to the surface, where they become thin.

ii- Stratified squamous nonkeratinized epithelium:

lines wet cavities (eg, mouth, esophagus, and vagina). the flattened cells of the epithelial surface layer are living cells containing much less keratin and retaining their nuclei.

iii-Stratified cuboidal epithelium:

Stratified cuboidal epithelium is restricted to large excretory ducts of sweat and salivary glands, where it apparently provides a lining more active than that of a simple epithelium.

iv-Stratified columnar epithelium:

Stratified columnar epithelium can be found in the conjunctiva lining the eyelids, where it is both protective and mucus secreting. Stratified cuboidal epithelium is restricted to large excretory ducts of sweat and salivary glands, where it apparently provides a lining more active than that of a simple epithelium.

v-Transitional epithelium or urothelium:

which lines only the urinary bladder, the ureter, and the upper part of the urethra, is characterized by a superficial layer of domelike cells that are neither squamous nor columnar. These cells, sometimes called umbrella cells, are essentially protective against the hypertonic and potentially

cytotoxic effects of urine.

vi- Pseudostratified columnar epithelium:

These cells are attached to the basal lamina even though their nuclei lie at different levels in the epithelium and the height of some cells does not extend to the surface. The best-known example of pseudostratified columnar epithelium is that lining the passages of the upper respiratory tract . The columnar cells of this epithelium are also heavily ciliated.

II-Glandular Epithelia.

Characteristic features of Glandular Epithelia:

1-Glandular epithelia are formed by cells specialized to secrete. The molecules to be secreted are generally stored in the cells in small membrane-bound vesicles called **secretory granules**.

2-Glandular epithelial cells may synthesize, store, and secrete proteins (eg, in the pancreas), lipids (eg, adrenal, sebaceous glands), or complexes of carbohydrates and proteins (eg, salivary glands). Mammary glands secrete all three substances.

3- The cells of some glands have low synthetic activity (eg, sweat glands) and secrete mostly water and electrolytes transferred into the gland from the blood.

Classification of glandular epithelium:

The epithelia that form glands can be classified according to various criteria.

1-Unicellular glands consist of large isolated secretory cells. The classic unicellular gland is the **goblet cell** in the lining of the small intestine or respiratory tract.

2- Multicellular glands have clusters of cells.

Type of glands:

I- Exocrine glands:

Characteristic features of Exocrine glands:

1-It is connection with the surface epithelium, the connection taking the form of tubular ducts lined with epithelial cells through which the secretions pass to the surface.

2- Multicellular glands, whether exocrine or endocrine, also have

connective tissue in a surrounding capsule and in septa that divide the gland into lobules. These lobules then subdivide, and in this way the connective tissue separates and binds the glandular components together.

3-Exocrine glands have a **secretory portion**, which contains the cells specialized for secretion, and **ducts**, which transport the secretion out of the gland.

Classification of Exocrine glands :

A- Exocrine glands are also classified morphology according to ,

- 1- Ducts can be **simple** (unbranched) or **compound** (with two or more branches).
- 2- Secretory portions can be **tubular** (either short or long and **coiled**) or **acinar** (round or globular).
- 3- Either type of secretory portion may be **branched**.
- 4- Compound glands can have tubular, acinar, or tubuloacinar secretory portions.

B- Exocrine glands are also classified functionally according to the way the secretory products leave the cell ,

- 1- **Merocrine secretion** (sometimes called eccrine) involves typical exocytosis of proteins or glycoproteins. This is the most common mode of secretion.
- 2- **Holocrine secretion** involves the cell filling with secretory product and then the whole cell being disrupted and shed. This is best seen in the sebaceous glands of skin .
- 3- **Apocrine secretion**, the secretory product is typically a large lipid droplet and is discharged together with some of the apical cytoplasm and plasmalemma .

C-Exocrine glands with merocrine secretion can be further categorized as either **serous** or **mucous** according to the nature of the proteins or glycoproteins secreted and the resulting staining properties of the secretory cells.

(**i**)-The acinar cells of the pancreas and parotid salivary glands are examples of the **serous** type which secrete **digestive enzymes**.

(ii)- Mucous cells, such as goblet cells are filled apically with secretory granules containing strongly hydrophilic glycoproteins called **mucins**. When mucins are released from the cell, they become hydrated and form **mucus**, a viscous, elastic, protective lubricant material.

II-Endocrine glands:

Endocrine glands have lost connection to the surface .These glands are ductless and their secretions are picked up and transported to their sites of action by the blood stream rather than by a duct system and the producers of **hormones**.

Hormones:

which are generally polypeptide or lipid-derived factors that are released into the interstitial fluid.Hormones diffuse into the blood for circulation and bind specific receptors on target cells elsewhere in the body, often within other endocrine glands.

Paracrine secretion:

The receptors may also be on cells very close to the hormone-secreting cells.

Autocrine secretion:

The receptors may also on the secreting cell itself.