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EPITHELIAL TISSUE

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EPITHELIAL TISSUE

Despite its complexity, the human body is composed of only four basic types of tissue**:**

1- Epithelial tissue
2- Connective tissue
3- Muscular tissue
4- Nervous tissue

These tissues, which are formed by cells and molecules of the extracellular matrix . The main characteristics of these basic types of tissue are shown in Table 2–1. Also of great functional importance are the free cells found in body fluids such as blood and lymph.

Table 2–1. Main characteristics of the four basic types of tissues.

Tissue	Cells	Extracellular Matrix	Main Functions
Nervous	Intertwining elongated processes	None	Transmission of nervous impulses
Epithelial	Aggregated polyhedral cells	Small amount	- glandular secretion - Lining of surface or body cavities
Muscle	Elongated contractile cells	Moderate amount	Movement
Connective	Several types of fixed and wandering cells	Abundant amount	Support and protection

Epithelial tissues

The principal functions of epithelial tissues are:

1- Covering, lining, and protecting surfaces (eg, skin)
2- Absorption (eg, the intestines)
3- Secretion (eg, the epithelial cells of glands)
4- Contractility (eg, myoepithelial cells).

Specific cells of certain epithelia are also highly specialized sensory cells, such as those of taste buds or the olfactory epithelium.
Because epithelial cells line all external and internal surfaces of the body, everything that enters or leaves the body must cross an epithelial sheet.

CHARACTERISTIC FEATURES OF EPITHELIAL CELLS

1- The forms and dimensions of epithelial cells range from high columnar to cuboidal to low squamous cells.
2- Their common polyhedral form results from their close juxtaposition in cellular layers or masses and is similar to what would be observed if a large number of inflated balloons were compressed into a limited space.
3- Epithelial cell nuclei have a distinctive shape, varying from spherical to elongated or elliptic.
4- The nuclear form often corresponds roughly to the cell shape; thus, cuboidal cells have spherical nuclei, and squamous cells have flattened nuclei.
5- 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. The area of contact between epithelium and lamina propria is increased by irregularities in the connective tissue surface in the form of small evaginations called papillae . Papillae occur most frequently in epithelial tissues subject to friction, such as the covering of the skin or tongue.

6- Epithelial cells generally show polarity, with organelles and membrane proteins distributed unevenly in different parts of the cell. The region of the cell that faces the connective tissue is called the basal pole, whereas the opposite pole, usually facing a space, is the apical pole and the intervening sides apposed in neighboring cells are the lateral surfaces. The membranes on the lateral surfaces of adjoining cells often have numerous infoldings to increase the area of that surface, increasing its functional capacity. The different regions of polarized cells may have different functions.

Basal Laminae & Basement Membranes

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 . This structure is visible only with the electron microscope, where it appears as an electron-dense layer, 20–100 nm thick, consisting of a network of fine fibrils, the dense layer or lamina dense. In addition, basal lamina may have electron-lucent layers on one or both sides of the dense layer, called clear layers or lamina Lucida . Between epithelia with no intervening connective tissue, such as in lung alveoli and renal glomeruli, the basal lamina is often thicker due to the fusion of the basal lamina from each epithelial layer.

Basal lamina

An extracellular basal lamina always lies at the interface of epithelial cells and connective tissue. The basal lamina to two neighboring epithelia can fuse or appear to fuse in places where there is no intervening connective tissue. Nutrients for epithelial cells must diffuse across the basal lamina. Nerve fibers normally penetrate this structure, but small blood capillaries (being epithelial themselves) never enter an epithelium across a basal lamina. When components of a basal lamina are resolved with the light microscope, the structure is often called a basement membrane. The macromolecular components of basal laminae form precise three-dimensional arrays and are described individually in the next chapter. The best known of these include:

- **Laminin**: These are large glycoprotein molecules that self-assemble to form a lace-like sheet immediately below the cells' basal poles where they are held in place by the transmembrane integrins.
- **Type IV collagen**: Monomers of type IV collagen contain three polypeptide chains and self-assemble further to form a felt-like sheet associated with the laminin layer.
- **Entactin (nidogen)** : a glycoprotein, and perlecan, a proteoglycan with heparan sulfate
- **side chains:** these glycosylated proteins and others serve to link together the laminin and type IV collagen sheets.

All these components are secreted at the basal poles of the epithelial cells. Their precise proportions in basal laminae vary between and within tissues. Basal laminae are attached to reticular fibers made of type III collagen in the underlying connective tissues by anchoring fibrils of type VII collagen. These proteins are produced by cells of the connective tissue and form a layer below the basal lamina called the reticular lamina that is also visible by TEM .

Basement membranes :

This section of kidney shows the typical basement membranes (arrows) of several tubules and of structures within the single glomerulus included here. In renal glomeruli the basement membrane, besides having a supporting function, has an important role as a filter. X100. Picrosirius-hematoxylin (PSH).

Types of Epithelial

Epithelia can be divided into two main groups according to their structure and function

a- **Covering (or lining) epithelia**
b- **Glandular epithelia.**

This is an arbitrary division, for there are lining epithelia in which all the cells secrete (eg, the lining of the stomach) or in which glandular cells are distributed among the lining cells (eg, mucous cells in the small intestine or trachea).

a- Covering or Lining Epithelia

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Covering epithelia are tissues in which the cells are organized in layers that cover the external surface or line the cavities of the body. They are classified according to the number of cell layers and the morphologic features of the cells in the surface layer (Table 2–2). Simple epithelia contain only one layer of cells and stratified epithelia contain more than one layer.

Table 2–2. Common types of covering epithelia in the human body.

Number of Cell Layers	Cell Form	Examples of Distribution	Main Function
Simple (one layer)	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
Pseudostratified		Lining of trachea, bronchi, nasal cavity.	Protection, secretion; cilia-mediated transport of particles trapped in mucus out of the air passages.
Stratified (two or more layers)	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

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1- Simple squamous epithelia.

In simple squamous epithelium, cells of the single layer are flat and usually very thin, with only the thicker cell nucleus appearing as a bulge to denote the cell. Simple epithelia are typically specialized as lining of vessels and cavities and regulate substances which can enter underlying tissue from the vessel or cavity. The thin cells often exhibit transcytosis.

2- Simple cuboidal epithelium.

Cells of simple cuboidal epithelia vary in their height but are roughly as tall as they are wide. Their greater thickness often includes cytoplasm rich in mitochondria providing energy for a high level of active transport of substances across the epithelium.

3- Simple columnar epithelium.

Cells of simple columnar epithelia are taller than they are wide. Such cells are usually highly specialized for absorption, with microvilli, and often have interspersed secretory cells or ciliated cells. Such epithelial cells always have tight and adherent junctional complexes at their apical ends, but are often loosely associated in more basolateral areas. This allows for rapid transfer of absorbed material to the space between the cells rather than transport the full length of the cells. The additional cytoplasm in columnar cells allows additional mitochondria and other organelles needed for absorption and processing.

4- **Stratified squamous keratinized epithelium** 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, metabolically inactive packets (squames) of keratin lacking nuclei. This surface layer of cells helps protect against water loss across this epithelium.

5- **Stratified squamous nonkeratinized epithelium** lines wet cavities (eg, mouth, esophagus, and vagina). In such areas where water loss is not a problem, the flattened cells of the epithelial surface layer are living cells containing much less keratin and retaining their nuclei.

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

7- **Stratified columnar epithelia** can be found in the conjunctiva lining the eyelids, where it is protective and mucus secreting.

8- **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. Importantly, the form of the surface cells changes according to the degree of distention of the bladder wall.

9- **Pseudostratified columnar epithelium** Cells of pseudo-stratified epithelia appear to be in layers, but the basal ends of the cells are all in contact with the basement membrane, which is often very thick in these epithelia. 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.

Glandular Epithelia

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. 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. 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. The epithelia that form glands can be classified according to various criteria. Unicellular glands consist of large isolated secretory cells and multicellular glands have clusters of cells. The classic unicellular gland is the goblet cell in the lining of the small intestine or respiratory tract. The term "gland," however, is usually used to designate large aggregates of secretory epithelial cells, such as in the salivary glands and the pancreas.