Medical Biology

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Histology:

Histology: is the study of the tissues of the body.

Tissue: group of similar cells combined to perform a common function.

The human body is composed of only 4 basic types of tissue:

1. epithelial tissues.
2. connective tissues.
3. muscular tissues.
4. nervous tissues.

Epithelial Tissues:

Features of epithelium:

❋ Epithelium lines the surfaces of the body and is mainly located on the borders between the external and internal environments. Epithelium also lines all the internal body spaces that have a connection with the external environment at some stage.

❋ Epithelium plays an important role in homeostasis of the body and in maintaining the physiological parameters of the internal environment different from those outside the body.

❋ Epithelium is a tissue composed of cells, tightly bound to each other, with no intercellular connective tissue. There are specializations of the cell membranes that play roles in maintaining the integrity of the tissue.

❋ Epithelium is an avascular tissue and has no integral blood supply.

❋ Epithelium develops in the embryo from all the three germ layers (Ectoderm, Mesoderm, Endoderm). For example, the epidermis of the skin is ectodermal in origin, the epithelium lining the serous cavities (peritoneum, pleura, pericardium) is derived from mesoderm (and is often referred to as mesothelium), whereas the epithelium lining most of the intestinal tract is endodermal.

Functions of epithelium:

1. Protection: Epithelial cells from the skin protect underlying tissue from mechanical injury, harmful chemicals, invading bacteria and from excessive loss of water.
2. Sensation: Specialized epithelial tissue containing sensory nerve endings is found in the skin, eyes, ears, nose and on the tongue.
3. Secretion: In glands, epithelial tissue is specialized to secrete specific chemical substances such as enzymes, hormones, and lubricating fluids.
4. Absorption: Certain epithelial cells lining the small intestine absorb nutrients from the digestion of food.
5. Cellular transport: Transport of molecules across epithelial layers.

Polarity:

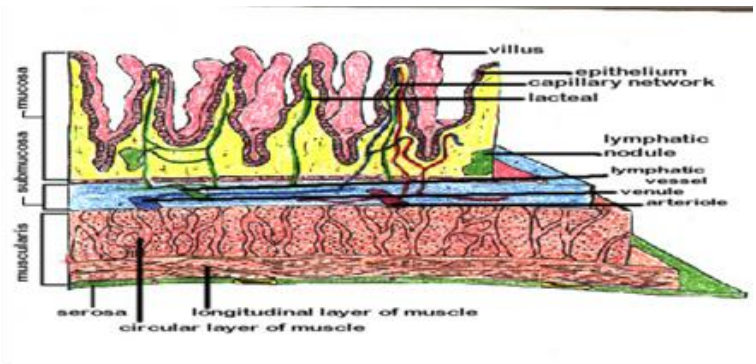
Epithelial cells are polarized cells, and we can distinguish different areas of the cells (apical, basal, lateral) with specific structural modifications (unlike other tissues, where structural polarity is not found).

Apical modification of plasma membrane

Specific structures found on the apical surface (the free surface facing the lumen or external environment) include microvilli, stereocilia, cilia or flagella.

microvilli:

Finger like extensions of plasma membrane that are particularly abundant on the surface of the cells, involved in the absorption, such as the epithelial cells lining the intestine.



Medical notes:

Celiac disease (gluten-sensitive entropathy) is a disorder of the small intestine in which one of the first pathologic changes is loss of the microvilli brush border of

the absorptive cells. This is caused by an immune reaction against the wheat protein gluten during its digestion which produce diffuse enteritis (intestinal inflammation). The changes are reversable when gluten is removed from the diet.

Stereocilia:

Specialized forms of microvilli. e.g. the stereocilia of auditory hair cells, are responsible for hearing by detecting sound vibration.

Lateral modification of plasma membrane

Several membrane-associated structures provide adhesion and communication between cells. Some are present in other tissues, but all are particularly numerous and prominent in epithelia. Epithelial cells adhere strongly to neighbouring cells and basal laminae, particularly in epithelia subject to friction or other mechanical forces. Lateral surfaces of epithelial cells have complexes of several specialized intercellular junctions with different functions:

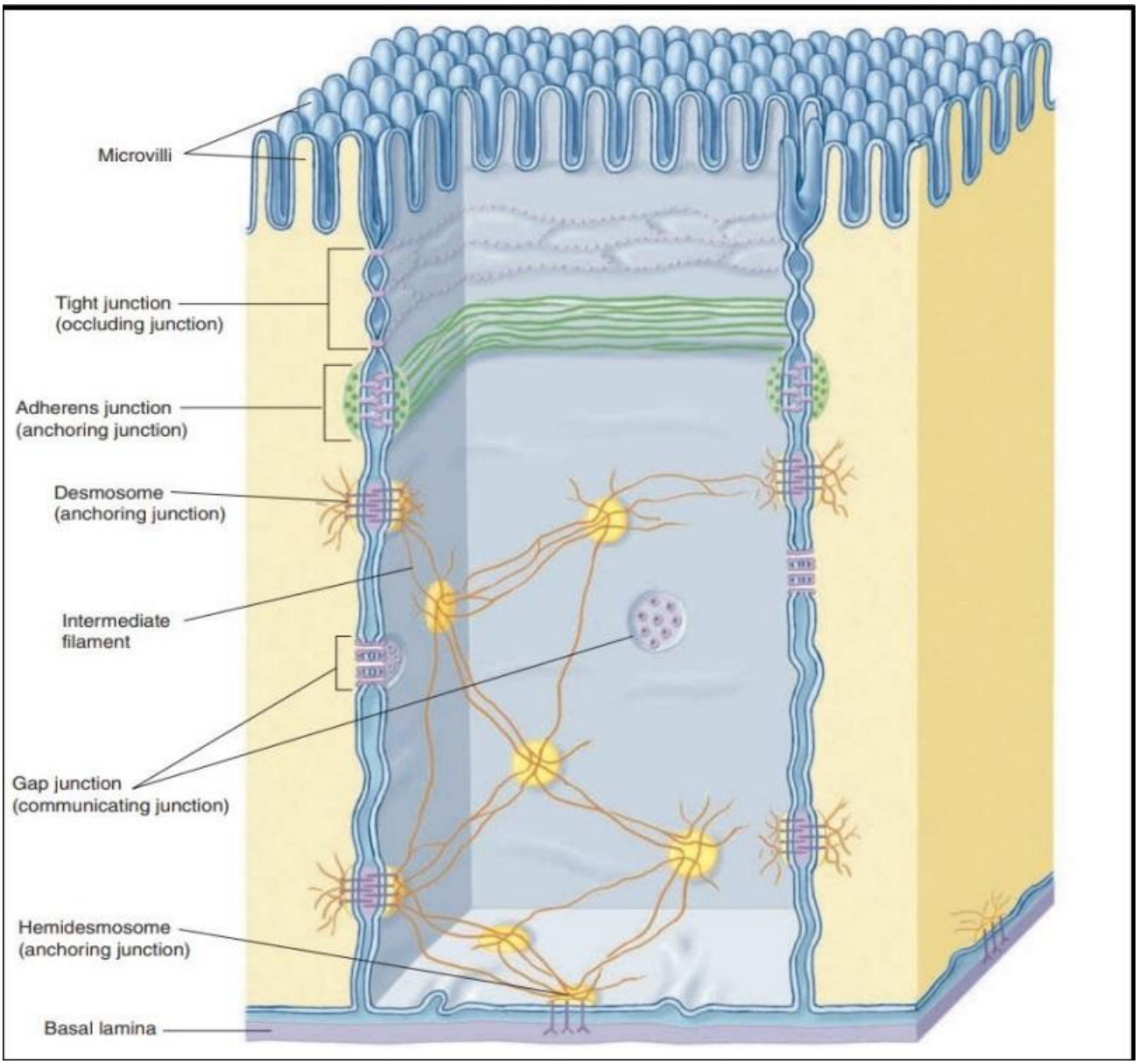
- **Tight or occluding junctions** are formed by interacting transmembrane proteins such as **claudin** and **occludin**; linear arrangements of these linked proteins surround the apical ends of the cells and prevent paracellular passage of substances (between the cells).
- **Adherent or anchoring junctions**, formed by interacting proteins of the **cadherin** family (E-cadherin), are points of strong attachment holding together cells of the epithelium immediately below tight junction.
- **Desmosome** spot-like attachment sites called maculae adherens, are composed of **cadherin** family proteins, they are attached to cytoplasmic keratins and considered stronger than adherent junctions.
- **Gap or communicating junctions** are points of cell contact where both plasma membranes have numerous hexameric complexes of transmembrane **connexons** (6 connexins in each), each forming a channel allowing passage of small molecules from one cell to the other.

■ **Hemidesmosomes** composed of transmembrane **integrins** attach cells to proteins of the basal lamina.

Medical notes:

1. Defect in occludins of tight junction may compromise the fetal blood-brain barrier leading to severe neurologic disorders.

2. Loss of E-cadherin in adhesion junction in epithelial cell tumours promotes tumour invasion.

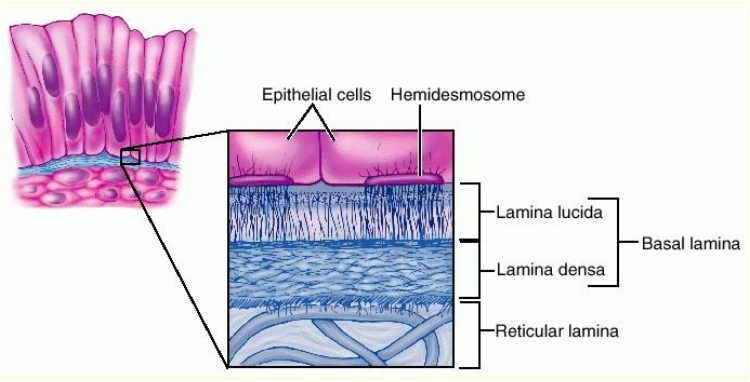


Basal modification of plasma membrane

Epithelial cells are separated from the underlying connective tissue by a basal lamina. The plasmalemma at the base of epithelial cells, especially those with metabolic function (ion-transporting epithelia) may be modified by having marked invaginations to increase the surface area.

Basal lamina:

All epithelial cells have at their basal surface a sheet like extracellular structure called the basal lamina, separating them from the underlying connective tissue (*lamina propria*). The basal laminae, are visible only by transmission electron microscopy, where are formed from an electron-dense layer (20-100 nm thick) composed of:

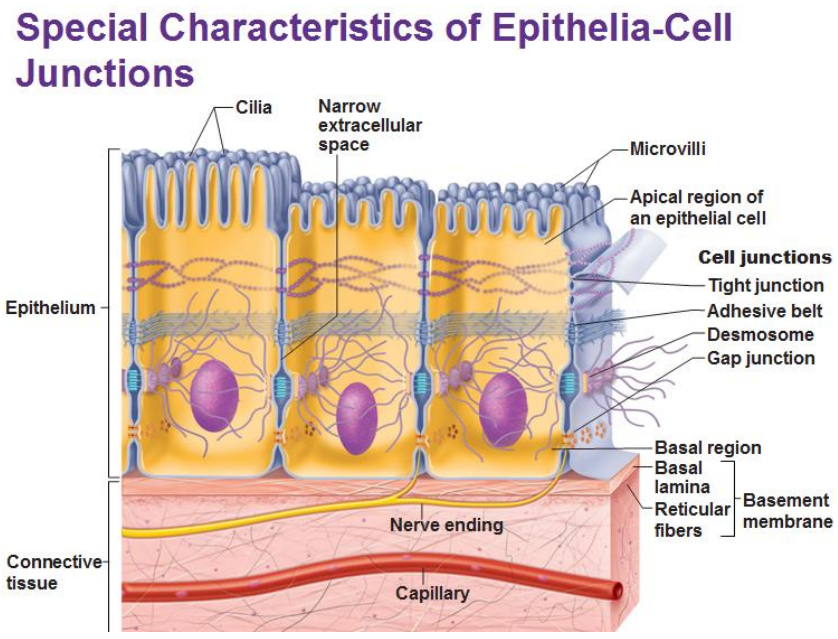


1. **lamina lucidae:** which appear to be transparent.
2. **lamina densa:** a delicate network of fine fibrils.

Basal laminae are composed mainly of type IV collagen and a glycoprotein, called laminin.

Basal laminae are not exclusive features of epithelia but are also found associated with some other cell types.

Basal lamina is sometimes attached to the underlying connective tissue by anchoring fibrils of unknown composition.



In some instance, reticular fibers are closely associated with the basal lamina forming a layer termed the reticular lamina, the reticular fibers are produced by connective tissue cells, and it is responsible for affixing the lamina densa to the underlying connective tissue thus the epithelial sheath is bound to the underlying connective tissue.

Basement membrane:

Is formed by the combination of a basal lamina and a reticular lamina and therefore, it is thicker. It is stained well by special histochemical stains and so it is seen by the light microscope.

Functions of basal lamina:

1. it is considered as a molecular filter and as a flexible, firm support for the overlying epithelium.
2. provide a selective barrier between connective tissue and other cells.
3. the presence of the basal lamina around a muscle cell is necessary for the establishment of new neuromuscular junctions.
4. the ability to influence cell polarity.
5. regulate cell proliferation and differentiation by binding with growth factors.
6. influence cell metabolism.

Epithelia are avascular. Blood vessels of the underlying connective tissue (*lamina propria*) supply the necessary nutrients and metabolites, which are transported to and from the epithelial cells by diffusion.

In the contact area between epithelial cells and the basal lamina, there is hemidesmosomes, these structures resemble a half desmosome and bind the cell to the basal lamina.

Classification of epithelia:

Epithelia are divided into main groups according to their structure and function:

- ❖ covering epithelium.
- ❖ glandular epithelium.

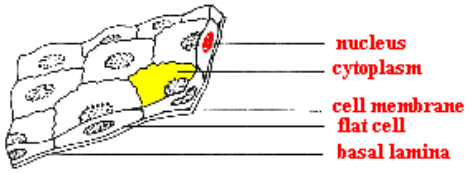
Covering epithelium:

Covering epithelia are tissues in which the cells are organized in layer that cover the external surface or line the cavities of the body. They can be divided into two groups depending on the number of layers of which it is composes. Epithelial tissue which is only one cell thick is known as **simple epithelium**. If it is two or more cells thick, it is known as **stratified epithelium**.

Simple epithelia:

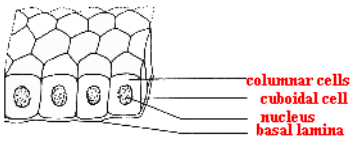
Simple epithelium can be subdivided according to the shape and function of its cells:

- **Simple squamous epithelium:**



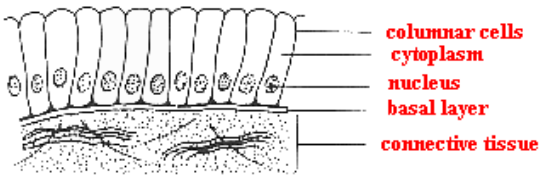
Squamous cells have the appearance of thin, flat plates. Squamous cells tend to have horizontal flattened nuclei because of the thin flattened form of the cell. They form the lining of cavities such as blood vessels (endothelium), also line the serous cavities of the body (peritoneum, pleura, pericardium) which known as Mesothelia.

- **Simple Cuboidal Epithelium:**



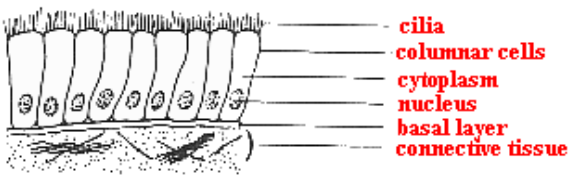
Cuboidal cells are roughly square or cuboidal in shape. Each cell has a spherical nucleus in the centre. Cuboidal epitheliums line many small ducts in the body. Examples include ovary, and cells lining thyroid follicles.

- **Simple Columnar Epithelium:**



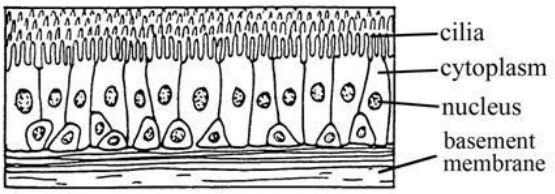
Columnar epithelial cells are elongated and rectangular-shaped. The nuclei are elongated and are usually located near the base of the cells. It either striated or non striated. *Non striated columnar epithelium* forms the lining of the stomach and gall bladder.

Striated epithelium (or called simple columner with striated border or with brush border) is usually found in the small intestine, there are goblet cells between the columnar cells and the microvilli is called brush border.



- **Pseudo stratified epithelium:**

Consists of a single layer of cells in which all cells attach to the basement membrane, but not all cells reach the surface. It consists of different cell shapes (fusiform, columnar, and basal cells), the nuclei of these cells located at different levels so giving the tissue this pseudo stratified pattern.



It either *ciliated* or *non-ciliated*. It is lining the passage of the respiratory system (e.g. trachea) which is the ciliated form. The non ciliated form present in ducts of parotid glands, lining of vas deferens of male reproductive system.