GENERAL HISTOLOGY

Lec 2

Dr. Alya'a K. AL-Ghurabi

PhD. Oral Pathology

Basic Tissue

Epithelium Properties

Epithelium (plural, epithelia) is the tissue that covers and lines both the external and internal body surfaces, including vessels and small cavities. Epithelium not only serves as a protective covering or lining but is also involved in tissue absorption, secretion, sensory, and other specialized functions. It serves to protect the more complex inner structures from physical, chemical, and pathogenic attack, as well as dehydration and heat loss by its formation as an epithelial barrier.

Depending on individual classification, epithelial tissue can be derived from any of the three embryonic cell layers based on the location when developing. Importantly, for dental professionals, both the epithelium of the skin and oral mucosa is of similar ectodermal origin. In comparison, those lining the respiratory and digestive tract are of endodermal origin, and those lining the urinary tract are derived from mesoderm.

Epithelium Histology

Epithelium generally consists of closely grouped polyhedral cells surrounded by very little or no intercellular substance or tissue fluid (Figure 1).

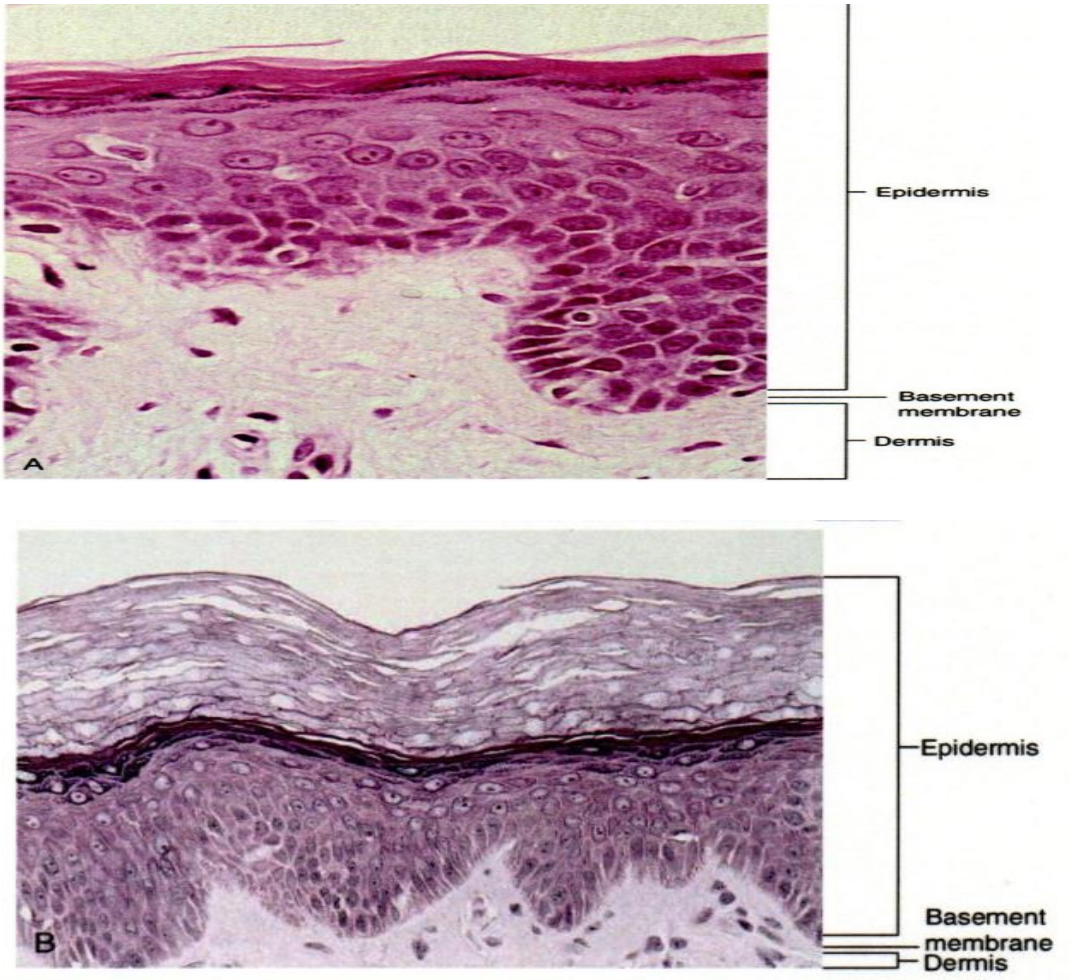


Figure 1. Microscopic sections of the skin (A and B), which demonstrates the epidermis and dermis or epithelium and connective tissue, respectively. A basement membrane is located between these
two tissue types.

Epithelium is avascular, having no blood supply of its own. Cellular nutrition consisting of oxygen and metabolites is obtained by diffusion from the adjoining connective tissue, which is usually highly vascularized, sharing its source of nutrition. This tissue is capable of rapid cellular turnover. In fact, epithelium is highly regenerative because its deeper germinal cells are capable of reproduction by mitosis. Epithelial cells usually undergo cellular differentiation as they move from the deeper germinal layers to the surface of the tissue to be shed or lost. An exception to the process of cellular maturation is the junctional epithelium of the

gingival sulcular region that is attached to the tooth surface. Epithelial cells are usually tightly joined to each another by intercellular junctions provided for by the desmosomes except in the more superficial layers (see Figure 3 in Lecture 1).

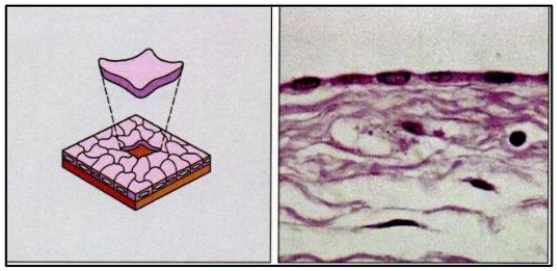
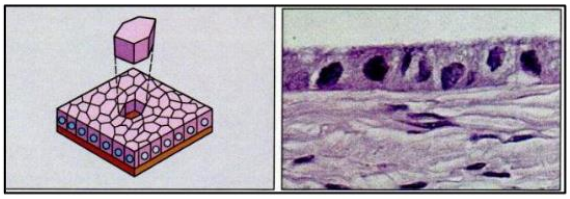
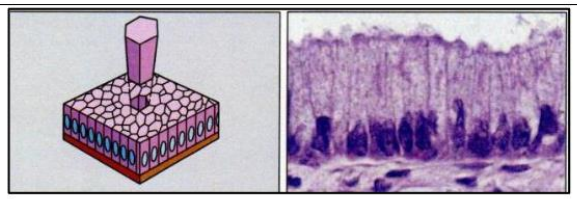
The epithelial cells are also tightly joined in some cases to adjacent noncellular surfaces by hemidesmosomes, as is the case with its relationship to the basement membrane (see Figure 4 in Lecture 1) as well as the junctional epithelium of the gingival sulcular region that is attached to the tooth surface.

A basement membrane is located between most epithelium and deeper connective tissue, such as with both the skin and oral mucosa. Components of basement membrane are produced by both the overlying epithelium as well as the adjoining connective tissue.

Epithelium Classification

Epithelium can be classified into two main categories based on the arrangement into layers of cells: Simple epithelium consists of a single layer of epithelial cells. The further classification of the tissue involves different types of epithelial cells according to cellular structure; they can be classified as either simple squamous, simple cuboidal, or simple columnar (Table 2).

Table 2. Epithelial Cell Types

Cell Types and Features	Microscopic Structure*
Squamous cells Flattened cells with cell height much less than cell width (i.e., endothelium)	
Cuboidal cells Cube-shaped cells with approximately equal cell height and cell width (i.e., salivary gland duct lining)	
Columnar cells Rectangular cells in which cell height exceeds cell width (i.e., salivary gland duct	

*Note that these epithelial cells are shown only within simple epithelium

Simple squamous epithelium consists of flattened platelike epithelial cells, or squames, lining blood and lymphatic vessels, heart, and serous cavities, as well as interfaces in the lungs and kidneys. The term endothelium is used to refer to the simple squamous epithelium lining of these vessels and serous cavities.

Simple cuboidal epithelium consists of cube-shaped cells that line the ducts of various glands, such as certain ducts of the salivary glands. Simple columnar epithelium consists of rectangular cells, such as in the lining of other salivary gland ducts, as well as the inner enamel epithelium of a maturing tooth germ, whose cells become enamel-forming ameloblasts.

Epithelium can also be considered pseudostratified columnar epithelium, which is named as such since it falsely appears as multiple

cell layers when viewed with lower power magnification due to the cells' nuclei appearing at different levels (Figure 2)

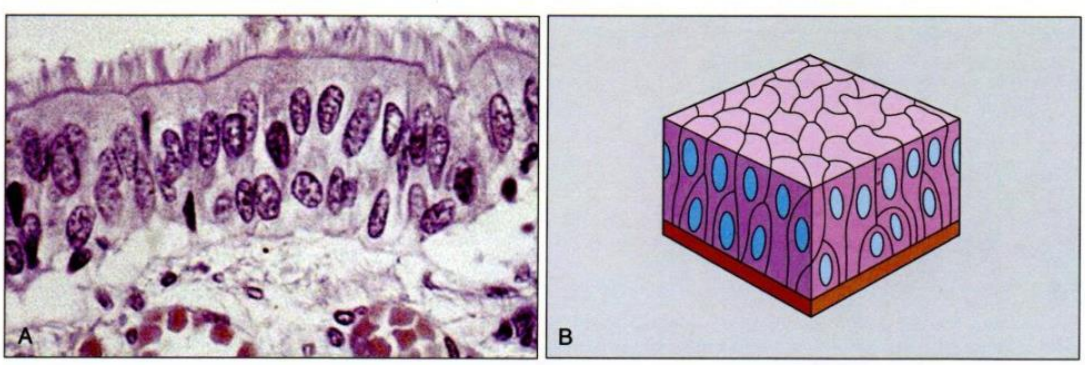


Figure 2. Pseudostratified columnar epithelium. A, Photomicrograph. B, Diagram. This type of epithelium can line the respiratory system.

However, in reality, as viewed with higher power magnification, only cells of different heights are seen. Thus, this is a type of simple epithelium because all the cells line up to contact the inner surface of the basement membrane even if not all the cells reach the outer surface of the tissue.

Pseudostratified columnar epithelium lines the upper respiratory tract, including the nasal cavity and paranasal sinuses. This type of epithelium may have cilia or be non-ciliated at the tissue surface. In contrast to simple epithelium, stratified epithelium consists of two or more layers of cells, with only the deepest layer lining up to contact the basement membrane.

It is important to note that only the cellular shape of the surface layer is used to determine the classification of stratified epithelium. Thus, stratified epithelium can consist of cuboidal, columnar, or squamous epithelial cells, or a combination of cell types, as seen in a transitional epithelium. Most epithelium in the body consists of stratified squamous

epithelium, which includes the superficial layer of both the skin and oral mucosa. Only the most superficial layers of this tissue are flat cells, or squames; the deeper cells vary from the deeper cuboidal to the more superficial polyhedral. Interdigitation of the outer epithelium with the deeper connective tissue occurs with the epithelial tissue forming rete ridges (or rete pegs) (see Figure 8 in Lecture 4); however, there is always a basement membrane located between these two tissue types.

Stratified squamous epithelium can be nonkeratinized or keratinized. Nonkeratinized tissue can be found in certain regions of the oral mucosa as well as keratinized tissue.

The keratin found within the keratinized tissue is a tough, fibrous, opaque, waterproof protein that is impervious to pathogenic invasion and resistant to friction. Keratin is produced during the maturation of the keratinocyte epithelial cells as they migrate from near the basement membrane to the surface of the keratinized tissue. Another example of keratinized stratified squamous epithelium is epidermis, which is the superficial layer of the skin (see Figure 1).

The epidermis overlies a basement membrane and the adjoining deeper layers of connective tissue (dermis and hypodermis, respectively). The skin has varying degrees of keratinization depending on the region of the body. Areas such as the palms of the hands and bottom of the feet have thicker layers of keratin, which form calluses. However, the keratin is less densely packed in both the skin and oral cavity, as compared with the densely packed hard keratin of the nails and hair.

Basement Membrane Properties

The basement membrane is a thin, acellular structure always located between any form of epithelium and the underlying connective tissue, as noted in both the skin and oral mucosa (Figure 4). This type of structure is even present between the components of the tooth germ during tooth development.

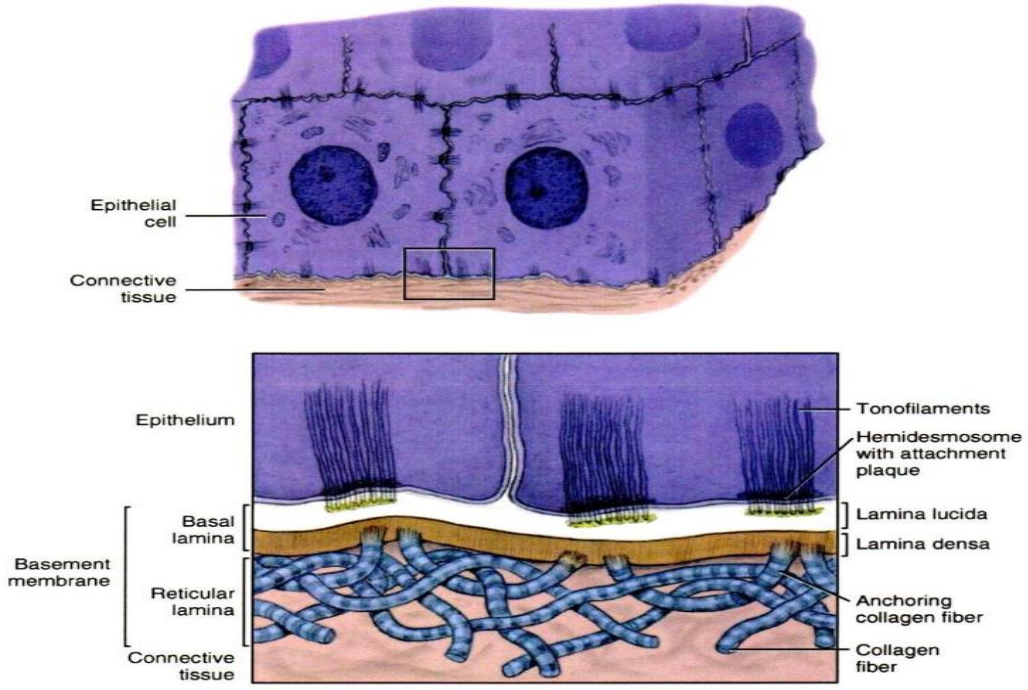


Figure 4. Basement membrane with its basal lamina and reticular lamina. Close-up view shows the attachment devices from an epithelial cell by way of hemidesmosomes and tonofilaments with attachment plaques connecting to the connective tissue by way of anchoring collagen fibers.

Basement Membrane Histology

The details of the basement membrane are not seen when it is viewed by scanning or lower-power magnification; only its location can be indicated. A higher-power magnification, such as that afforded by an electron microscope, is needed to see the intricacies of the basement membrane.

The basement membrane consists of two layers: **basal lamina and reticular lamina**. The terms basement membrane and basal lamina are sometimes used interchangeably, but the basal lamina is, in fact, only a part of the basement membrane. The term "basal lamina" is usually used with electron microscopy, whereas the term "basement membrane" is usually used with lower-power light microscopy.

The superficial layer of the basement membrane is the basal lamina, which is produced by the epithelium, and it is about 40 to 50 nm thick. Microscopically, the basal lamina consists of two sublayers: The lamina lucida is a clear layer that is closer to the epithelium, and the lamina densa is a dense layer that is closer to the connective tissue.

The deeper layer of the basement membrane is usually the reticular lamina (the exception is lung alveoli and kidney, with fusion of basal laminae).

The reticular lamina consists of collagen fibers and reticular fibers produced and secreted by the underlying connective tissue. Attachment mechanisms are also part of the basement membrane. These involve hemidesmosomes with the attachment plaque as well as tonofilaments from the epithelium and the anchoring collagen fibers from the connective tissue. The tonofilaments from the epithelium loop through the attachment plaque, whereas the

collagen fibers of the reticular lamina loop into the lamina densa of the basal lamina, forming a flexible attachment between the two tissue types.

It is important to note that the interface between the epithelium and connective tissue of both the skin and oral mucosa where the basement membrane is located is not two-dimensional, as seen in microscopic cross sections of the tissue with its epithelial rete ridges and connective tissue papillae. Instead, in reality, the interface consists of three-dimensional interdigitation of the two tissue types.

This complex arrangement increases the amount of surface area for the interface, thus increasing the mechanical strength of the interface, as well as the nutrition potential for the avascular epithelium from the vascularized connective tissue.