CELLS TO SYSTEMS – EPITHELIAL TISSUES

Classification of epithelia

Epithelium (singular), epithelia (plural) present in two major forms:

- **Surface epithelium** – sheets of cells that cover external surfaces and line internal surfaces of the body
- **Glandular epithelium** – secretory cells of glands

Classification of epithelia based on the number of cell layers

1. **Simple epithelia** – a single cell layer thick
2. **Stratified epithelia** – two or more layers of cells
3. **Pseudostratified epithelia** – appear to be stratified, because the cells vary in height and the nuclei lie at different levels

Classification of epithelia based on the shape of cells

1. **Squamous cells** – flat cells
2. **Cuboidal cells** – Height and width of the cells are the same
3. **Columnar cells** – cells are taller than they are wide

Simple squamous epithelium

- This type is composed of a single layer of flattened, scale- or plate-like cells.
- Occurs in many organs.
- The large body cavities and heart, blood vessels and lymph vessels are typically lined by a simple squamous epithelium.
- The nuclei of the epithelial cells are often flattened or ovoid, i.e. egg-shaped, and they are located close to the centre of the cells.

Simple cuboidal epithelium

- Cells appear cuboidal in sections perpendicular to the surface of the epithelium. Viewed from the surface of the epithelium they look rather like small polygons.
- Simple cuboidal epithelium occurs in small excretory ducts of many glands, the follicles of the thyroid gland, the tubules of the kidney and on the surface of the ovaries.

Simple columnar epithelium

- The cells forming a simple columnar epithelium are taller than they are wide.

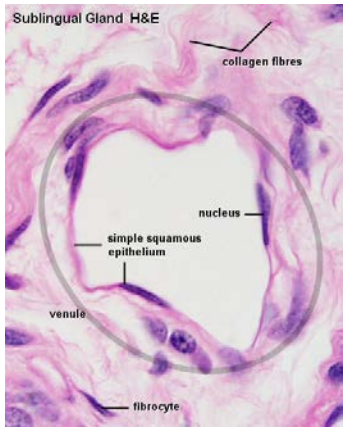
- The nuclei of cells within the epithelium are usually located at the same height within the cells - often close to the base of the cells.
- An example is the simple columnar epithelium which lines the internal surface of the small and large intestines.

Tips for Identifying epithelium in histology sections

- The outlines of individual epithelial cells are not always visible, and it may be difficult to identify the shape of the cells.
- It is often helpful to look at the shape, location and spacing of the nuclei in the epithelium.
- How many cell layers seem to be visible in a section depends very much on the angle between the plane of the section and the plane of the surface of the epithelium.
- Oblique sections of epithelium will be visible in almost all slides of organs in which epithelium lines a surface with a very irregular profile. A single surface is usually not lined by several types of epithelia.
- The number of epithelial cell layers will usually be the smallest number of layers visible anywhere along the surface lined by the epithelium.

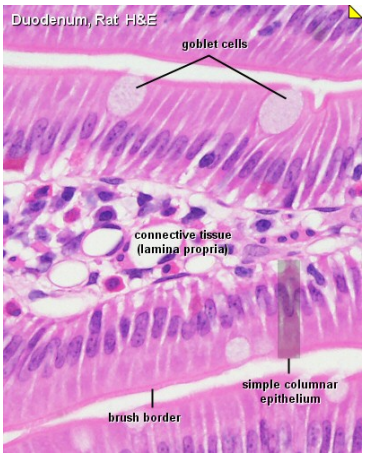
Sublingual Gland, H&E

Blood vessels are probably present in all sections you will ever see. With very few exceptions, they are lined by a **simple squamous epithelium**. The individual epithelial cells are extremely flattened and form a much larger part of the surface than individual cells in cuboidal or columnar epithelia. The nuclei of the squamous epithelial cells are also flattened and often stain darkly. **Not every epithelial cell nucleus will be included in the plane of the section**, and if the vessel is very small (e.g. a capillary), there may not be any visible nuclei in the epithelial lining.



Capillaries and other small vessels are **easily deformed during tissue processing**, and the epithelium of larger vessels may be damaged or look corrugated. It may therefore take a little more patience than you expect to find a "good" simple squamous epithelium.

Duodenum, H&E



The small intestines are lined by a **simple columnar epithelium**. Most of the epithelial cells (enterocytes) are involved in the absorption of components of the digested food in the lumen of the intestines. Complex folds of the intestinal lining increase the surface area available for absorption. The plane of the section will therefore often pass at an oblique angle through the epithelium. The epithelium may look stratified where this happens.

Mucus producing **goblet cells** are a second cell type of this epithelium. Mucus stains

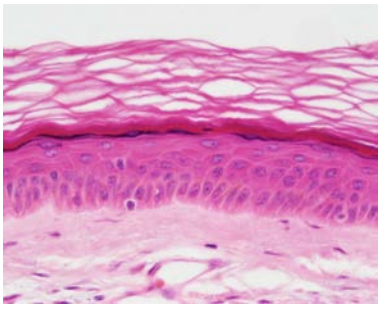
only weakly or not at all in H&E stained sections. Round, light "hollows" in the epithelium represent the apical cytoplasm of the goblet cells, which is filled with mucin-containing secretory vesicles.

Oesophagus H&E

Stratified squamous epithelium

- The deepest cells, which are in contact with the basement membrane, are cuboidal or columnar in shape (basal layer).
- At the surface of the epithelium, cells appear like flat scales - similar to the epithelial cells of simple squamous epithelia.
- The shape of the cells that form the surface of the epithelium gives the name to the epithelium.

Keratinised epithelium



- Most apical layers (exterior) of cells are dead and lose their nucleus and cytoplasm, instead contain a tough, resistant protein called keratin.
- This specialization makes the epithelium waterproof, so is found in the mammalian skin

Pseudostratified and transitional epithelia

- These two types of epithelia are difficult to classify using the shape of the cells in the surface layer and the number of the cell layers as criteria.
- Transitional epithelium is found exclusively in the excretory urinary passages (including the ureter and the urinary bladder).

Transitional epithelium

- The shape of the cells in the surface layer of a transitional epithelium varies with the **degree of distension** of the organ with a lumen lined by this type of epithelium. In the '**relaxed**' state of the epithelium, it seems to be formed by many cell layers. The most basal cells have a **cuboidal or columnar shape**. There are several layers of polyhedral cells, and, finally, a layer of superficial cells, which have a convex, dome-shaped luminal surface. In the **distended state** of the epithelium, only one or two layers of cuboidal cells are covered by a superficial layer of large, low cuboidal or squamous cells; the epithelium will resemble a **stratified squamous** epithelium.

Pseudostratified columnar epithelium

All cells of this type of epithelium are in contact with the basement membrane, but not all of them reach the surface of the epithelium. Nuclei of the epithelial cells are typically located in the widest part of the cell. Consequently, the nuclei of cells which do or do not reach the surface of the epithelium are often located at different heights within the epithelium and give the epithelium a stratified appearance. The epithelium will look stratified but it is not - hence its name "pseudostratified". Pseudostratified columnar epithelia are found in the excretory ducts of ***many glands.***

Surface characteristics

Epithelial cells have three distinct surfaces

1. Basal surface – rests on the basement membrane
2. Lateral (or contact) surface – in contact with neighbouring epithelial cells
3. Apical (or free) surface

Basement membrane

- Epithelia are separated from the underlying connective tissue by an extracellular supporting layer called the basement membrane.
- Membrane proteins of the epithelial cells are anchored in the basement membrane, which is produced by the epithelial cells.
- In addition to its function as support of the epithelium, the basement membrane acts as a selectively permeable filter between epithelium and connective tissue.

Apical surface modifications

Microvilli and stereocilia:

- Non-motile finger- or thread-shaped extensions of epithelial cells.
- Their main function is to increase the surface area of cells active in absorption.
- Microvilli are much shorter than stereocilia.

Cilia:

- Motile structures that beat in a synchronous manner to move material across epithelial surfaces.

Lateral surface modifications

Junctional complexes

- *Occluding type*
    - Tight junctions (= *zonulae occludens*), connects adjacent cells; close to the apical surface
- *Adhering type*
    - Desmosomes (*maculae adherens*) and *zonulae adherens* anchor cells to each other; connected to the cytoskeleton
    - Hemidesmosomes connect cells to the basement membrane
- *Communicating type*
    - Gap junction (nexus), allows movement of small molecules from one cell to an adjacent cell

Glandular epithelia

Glands

- Cells or aggregations of cells that function to secrete.

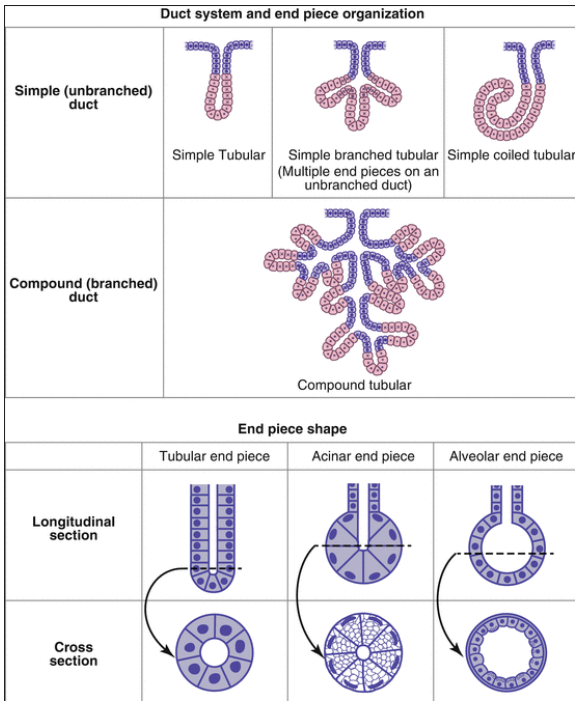
Exocrine glands release the secretory product (e.g. milk, mucus, sweat) via a system of ducts that open onto of the surfaces of the body which are in contact with the external world (skin, respiratory tract, etc).

Endocrine glands release their secretory product (typically hormones) into the spaces between the secretory cells (extracellular space) from which it enters the bloodstream**.**

Both endocrine and exocrine glands are developmentally derived from epithelia that grow into the underlying connective tissue, then develop the special characteristics of the mature gland. Exocrine glands maintain the connection with the surface epithelium, whereas the connection is lost by endocrine glands.

Classification of glands

Glands are classified anatomically based on the **shape of their secretory units** and the **complexity of their duct system**



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Type of secretion

- Mucous product: viscous secretion, made from mucin and H_2O
- Serous product: thin, aqueous secretion, containing various enzymes
- Mixed product: mixed mucous/serous secretion

Method of secretion

- Merocrine secretion corresponds to the process of exocytosis. Vesicles open onto the surface of the cell, and the secretory product is discharged from the cell without any further loss of cell substance.
- Apocrine secretion is a mechanism in which part of the apical cytoplasm of the cells is lost together with the secretory product. The continuity of the plasma membrane is restored by the fusion of the broken edges of the membrane, and the cell is able to accumulate the secretory product anew. This mechanism is used by apocrine sweat glands, the mammary glands and the prostate.
- Holocrine secretion designates the breakdown and discharge of the entire secretory cell. It is only seen in the sebaceous glands of the skin.