

Epithelial Tissues

General Considerations

➤ Classification of epithelial tissues

❖ *Lining and covering epithelia*

- Form the boundary between external environment and body tissues
- Cover body surfaces (e.g., the epidermis of the skin) and lines the lumens of internal organs that open to the exterior of the Body.
- Line body cavities (e.g., peritoneal cavity) and covers the exterior of organs that project into these cavities.
- Line blood and lymph vessels
- Cell shape and number of layers correlate with the function of the epithelium.

❖ *Glandular (secretory) epithelia*

- Develop from a lining or covering epithelium by invagination into the underlying connective tissue.
- Form exocrine and endocrine glands.

General features of all epithelial tissues

- Highly cellular (sparse intercellular space)
- Numerous intercellular junctions for attachment and anchorage.
- Avascular.
- High regenerative capacity, especially in epithelial membranes, to replace continual sloughing of cells from free surface.
- Most rest on a basement membrane.
 - The basement membrane is composed of a basal lamina and a reticular lamina.
- The basal lamina is secreted by the epithelial cells and consists of the lamina lucida and the lamina densa. A similar structure is also present in muscle and nervous tissue, where it is referred to as an external lamina.
- The reticular lamina is secreted by fibroblasts located in the underlying connective tissue.
- Functions of the basement membrane
 - Provides support and attachment for the epithelial cells
 - Selective diffusion barrier
- Free and basal surfaces
 - Basal surface contacts the basal lamina of the basement membrane.
 - Free surface interfaces with the external environment or spaces within the body.
 - Polarity. A polarized cell is one that exhibits contrasting properties or structures on opposite sides of the cell. Because epithelial tissues face a free surface, the function of the apical surface is often very different from that at the base of the cell. This diversification is reflected by the nonhomogeneous distribution of organelles.

Lining and Covering Epithelial Tissues

Method of Classification

➤ Classification by number of layers

- *Simple epithelium*

1. One cell layer thick
2. All cells rest on the basement membrane (basal surface) and all cells face the free surface.

- *Stratified epithelium*

1. More than one cell layer thick.
2. Only the deepest layer of cells contact the basement membrane and only the superficial-most cells have a free surface.
3. Named according to the shape of the cells at the free surface omit.

➤ Classification by shape of surface cells

- *Squamous*

1. Cells are much wider than tall, resembling a “fried egg.”
2. Nucleus is highly flattened.

- *Cuboidal*

1. Cells are of equal height and width.
2. Nucleus is spherical.

- *Columnar*

1. Cells are much taller than they are wide.
2. Nucleus is oval shaped, generally located toward the base of the cell.

Types of Lining and Covering Epithelium

➤ Simple epithelial tissues

- *Simple squamous*

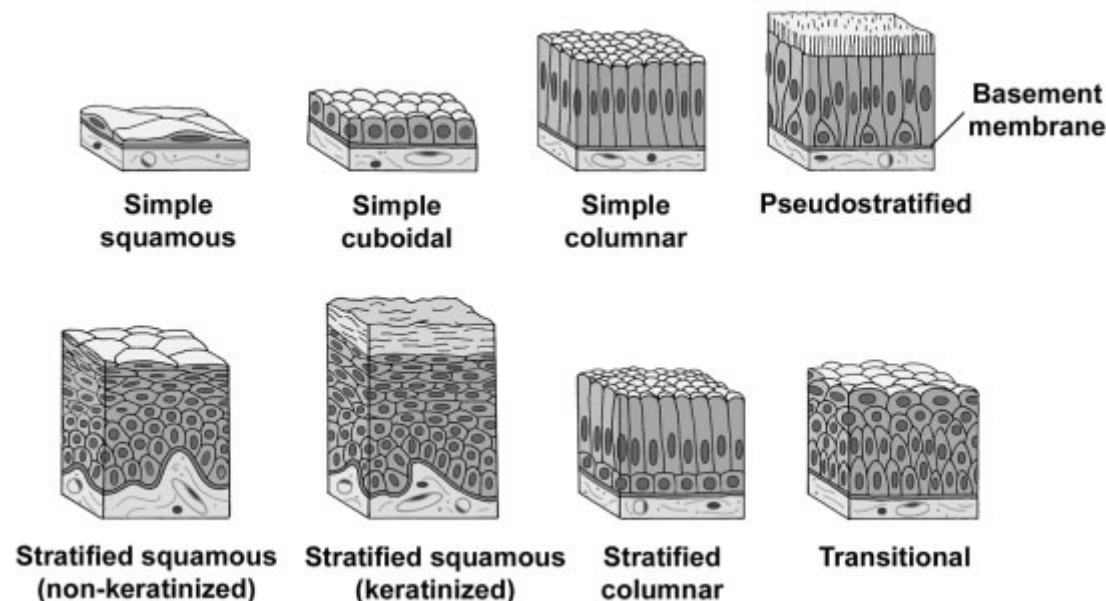
1. Allows for rapid diffusion across the epithelium.
2. Forms the lining of blood vessels, alveoli of the lungs, and internal body cavities

- *Simple columnar*

1. Lines and absorbs
2. Forms the lining of the intestines and gall bladder

- *Pseudostratified*

1. Cells are of various heights. All cells rest on the basement membrane, but only the tallest cells reach the free surface. Variation in height of the cells and the location of nuclei give the appearance of a stratified epithelium. Frequently ciliated.
2. Provides protection
3. Forms the lining of much of the respiratory tract and much of the male reproductive system



➤ Stratified epithelial tissues

- *Stratified squamous*

- Protects from physical abrasion and prevents desiccation

- Types

1. *Nonkeratinized (moist). Lining of wet cavities, including the mouth, esophagus, rectum, and anal canal; surface cells are nucleated and living.*

2. *Keratinized (dry). Epidermis of the skin; surface cells are nonliving.*

- *Stratified cuboidal/columnar. Lines the larger ducts of exocrine glands.*

- *Transitional*

1. Protective function; constructed to expand with distension of the hollow organs it lines

2. Unique to the urinary system; lines the urinary bladder and ureter

Surface Specializations

➤ *Microvilli*

1. Finger-like extensions from the free surface of the cell, about 1 micron in height
2. Are present in large numbers on each cell and, collectively, are called a *brush or striated border*
3. Contain a core of actin microfilaments
4. Are relatively nonmotile
5. Increase surface area for absorption
6. Prominent on cells lining the digestive tract and proximal tubules in the kidney

➤ *Stereocilia*

1. Large, nonmotile microvilli; not cilia
2. Contain a core of actin microfilaments
3. Increase surface area
4. Present on cells lining the epididymis and ductus deferens in the male reproductive tract

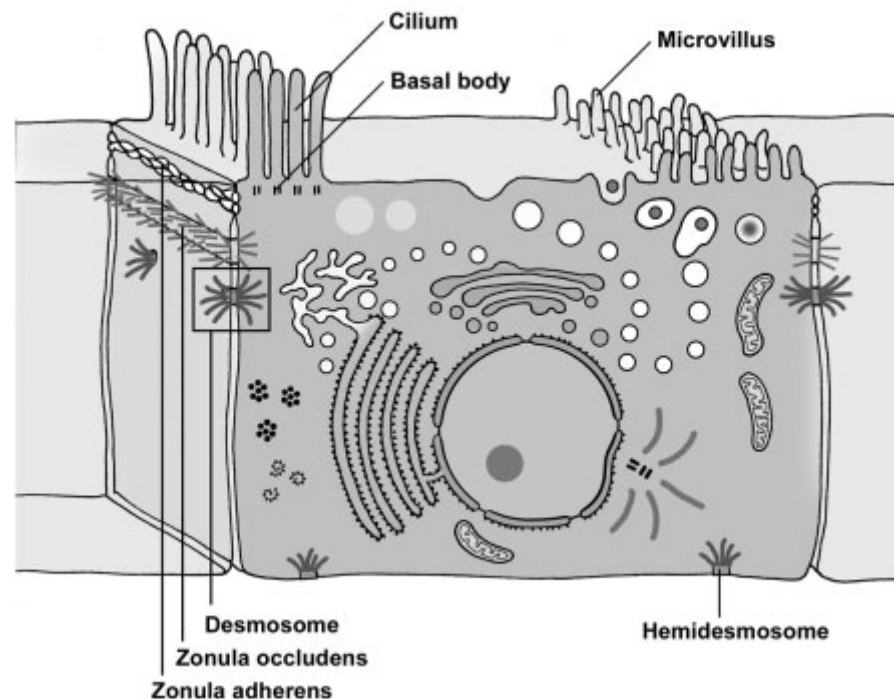
➤ *Cilia*

1. Multiple hair-like extensions from free surface of the cell; 7–10 microns in height
2. Highly motile; beat in a wave-like motion
3. Function to propel material along the surface of the epithelium (e.g., in the respiratory system and the oviduct of the female reproductive system)
4. Core of a cilium is called the *axoneme*, in which *nine pairs of* microtubules surround a central pair of microtubules (9 + 2 arrangement).
5. The axoneme of each cilium originates from a *basal body that is* located at the apex of the cell and is composed of nine triplets of microtubules

Cell Junctions

- Specialized structures of the plasma membrane that:
 - Attach and anchor cells
 - Establish apical and basolateral membrane domains by sealing adjacent plasma membranes
 - Provide channels for ionic and metabolic coupling
- Not restricted to epithelial cells; cell junctions occur, however, in large number in epithelial tissues to resist the physical forces acting on the cells.
- Types
 - *Tight junction (zonula occludens)*
 - Belt-like, barrier junction around apex of the cell
 - Provides close apposition of adjacent plasma membranes and occludes the intercellular space
 - Functions
 1. Prevents diffusion of material between the intercellular space and the lumen of the organ
 2. Establishes apical and basolateral membrane domains in the cell by preventing the lateral migration of proteins in plasma membrane
 - *Adherent junctions*
 - Attach cells to each other and anchor them to the basal lamina; no fusion of the plasma membrane

- Types of adherent junctions
 1. *Belt desmosome (zonula adherens)*. Belt-like junction that encircles the apex of the cell like a barrel strap and is located immediately beneath the zonula occludens; serves to attach adjacent cells together; associated with actin filaments.
 2. *Spot desmosome (macula adherens)*. Disk-like junctions scattered over the surface of the cell, which are paired with similar structures in adjacent cells; associated with intermediate filaments (e.g., keratin filaments in epithelial cells).
 3. *Hemidesmosome*. Represent a “half desmosome”; these junctions anchor the basal surface of the cell to basal lamina
- *Junctional complex*. Consists of the zonula occludens, zonula adherens, and desmosomes; because these structures cannot be resolved as separate structures at the light microscopic level, they appear as a single, bar-shaped, dark region at the apical corners of adjacent cells. The term *terminal bar* was used by early microscopists to define the zonula occludens and zonula adherens at the light microscopic level.
- *Gap junction*. Gap junctions consist of *connexons*, six transmembrane proteins clustered in a rosette that defines a central pore. Connexons from adjacent cells abut one another, forming a continuity between cells. Provides metabolic and electrical continuity (coupling) via the pores between cells



Glandular Epithelial Tissues

- General Considerations
 - Develop from or within a lining or covering epithelium
 - Secretory cells may
 - Differentiate but remain in the lining epithelium
 - Invaginate into the underlying connective tissue and remain attached to the lining epithelium
 - Invaginate into the underlying connective tissue but lose their connection to the epithelium

Exocrine vs. Endocrine Glands

- Major classification of glands, which is based on the method by which their secretory product is distributed
- *Exocrine glands*
 - Secretory products are released onto an external or internal epithelial surface, either directly or via a duct or duct system.
 - Secretory cells display polarized distribution of organelles.
- *Endocrine glands*
 - No ducts; secretory products are released directly into the extracellular fluid where they can affect adjacent cells (paracrine secretion) or enter the bloodstream to influence cells throughout the body (endocrine secretion).
 - No polarization of organelles, except the thyroid gland and enteroendocrine cells of the digestive tract
 - Secretory products are called hormones.

Methods of Product Release from Glandular Cells

- *Merocrine. Secretory product is released by exocytosis of contents contained within membrane-bound vesicles. This method of release is used by both exocrine and endocrine glands. Examples are digestive enzymes from pancreatic acinar cells and insulin from pancreatic islet cells.*
- *Apocrine. Secretory material is released in an intact vesicle along with some cytoplasm from the apical region of the cell. This method of release is used by exocrine glands only. An example is the lipid component of the secretory product of the mammary gland.*
- *Holocrine. Entire cell is released during the secretory process. Cells that are released may be viable (oocyte or sperm) or dead (sebaceous glands). This method of release is used by exocrine glands only.*
- *Diffusion. Secretory product passes through the cell membrane without the formation of secretory granules. Examples are steroid hormones. This method of release is used by endocrine glands only.*

Types of Secretory Products

➤ Exocrine glands

- *Mucus. Thick, viscous, glycoprotein secretion*

1. Secretory cells are usually organized into tubules with wide lumens.
2. Cytoplasm appears vacuolated, containing mucigen that, upon release, becomes hydrated to form mucus.
3. Nucleus is flattened and located in the base of the cell.

- *Serous. Thin, watery, protein secretion*

1. Secretory cells are usually organized into a flask-shaped structure with a narrow lumen, called an acinus.
2. Cytoplasm contains secretory granules.
3. Nucleus is round and centrally located in the cell.

- *Special*

1. *Lipid. Oily secretion (sebum) from sebaceous glands and lipid portion of milk from the mammary gland.*
2. *Sweat. Hypotonic, serous secretion that is low in protein content.*
3. *Cerumen. A waxy material formed by the combination of the secretory products of sebaceous and ceruminous glands with desquamated epidermal cells in the auditory canal*

➤ Endocrine glands

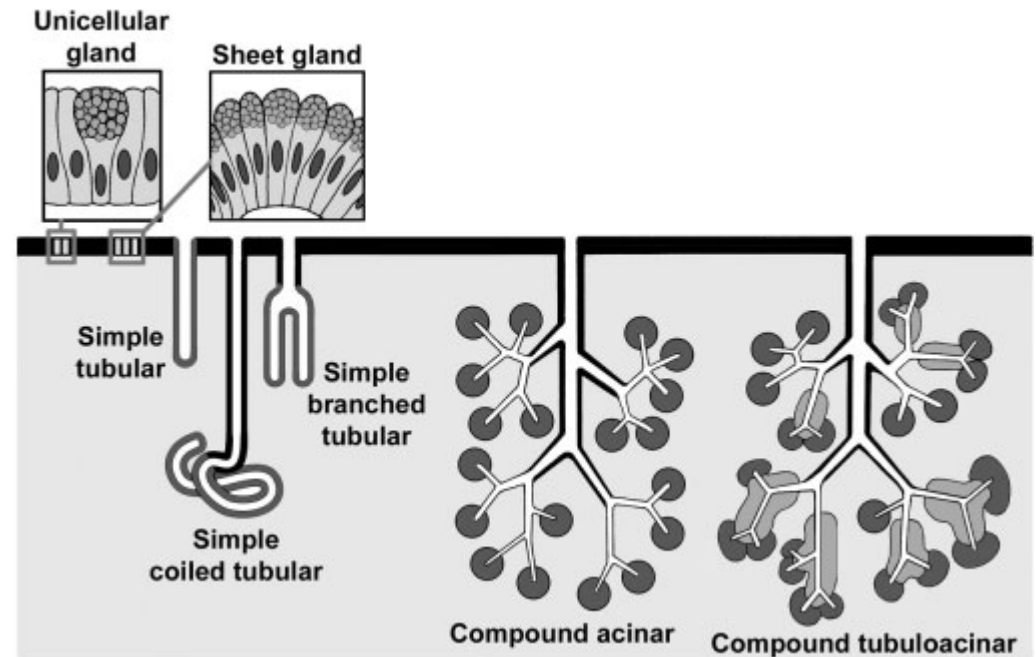
1. *Protein (e.g., insulin) or amino acid derivatives (e.g., thyroxine)*
2. *Steroid (e.g., estrogen and testosterone)*

Classification of Exocrine Glands

- *Unicellular glands. Individual cells located within an epithelium, such as goblet cells that secrete mucus*
- Multicellular glands
 - *Sheet gland. Composed of a surface epithelium in which every cell is a mucus-secreting cell. A sheet gland is unique to the lining of the stomach.*
 - The remaining multicellular glands are classified according to:
 - ❑ The shape(s) of the secretory units
 1. Presence of *tubules only*
 2. Presence of *acini (singular, acinus) or alveoli (singular, alveolus)* (these two terms are synonymous), which are flask-shaped structures
 3. Presence of both tubules and acini
 - ❑ The presence and configuration of the duct
 1. *Simple. No duct or a single, unbranched duct is present.*
 2. *Compound. Branching duct system*

❑ Classification and types of multicellular glands

1. *Simple tubular. No duct; secretory cells are arranged like a test tube that connects directly to the surface epithelium (e.g., intestinal glands).*
2. *Simple, branched tubular. No duct; tubular glands whose secretory units branch (e.g., fundic glands of stomach)*
3. *Simple, coiled tubular. Long unbranched duct; the secretory unit is a long coiled tube (e.g., sweat glands).*
4. *Simple, branched acinar (alveolar). Secretory units are branched and open into a single duct (e.g., sebaceous glands).*
5. *Compound tubular. Branching ducts with tubular secretory units (e.g., Brunner's gland of the duodenum)*
6. *Compound acinar (alveolar). Branching ducts with acinar secretory units (e.g., parotid salivary gland)*
7. *Compound tubuloacinar (alveolar). Branching ducts with both tubular and acinar secretory units (e.g., submaxillary salivary gland)*

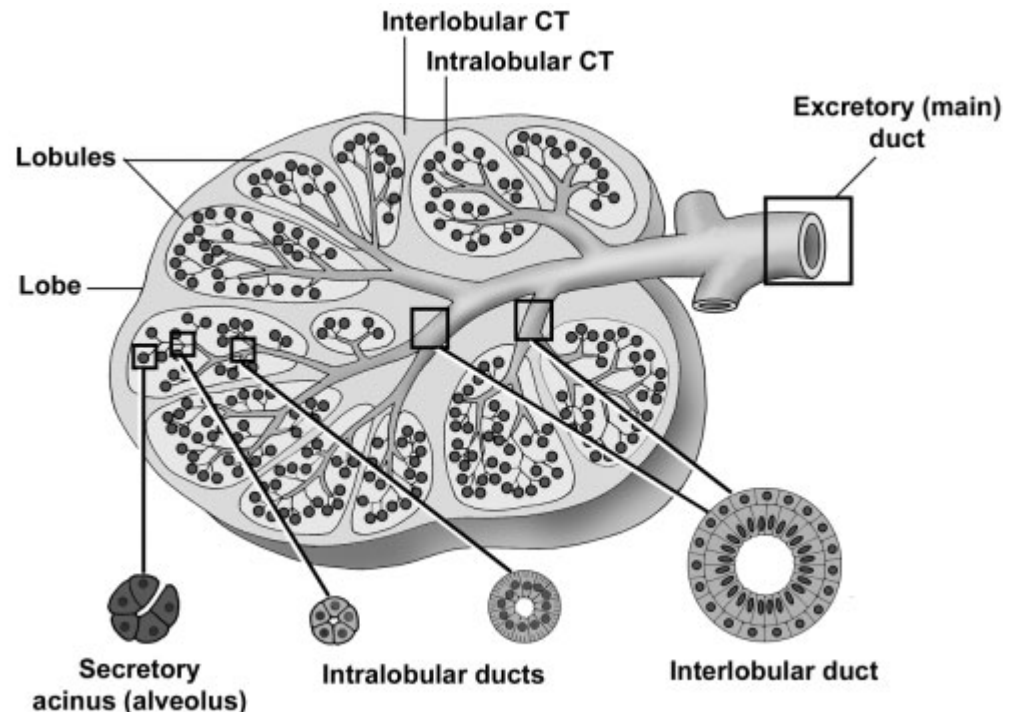


Special Features of Some Exocrine Glands

- *Serous demilunes.* Consist of a “cap” of serous cells around the end of a mucous tubule; appear half-moon shaped in section
- *Myoepithelial cells.* Resemble smooth muscle cells in their fine structure but are of epithelial origin; prominent in sweat and mammary glands, they surround secretory units, lying inside the basement membrane, and aid in the expulsion of secretory products from the gland.

Duct System of Compound, Exocrine Gland:

- *Intralobular ducts.* Contained within a lobule; simple cuboidal to columnar epithelium
- *Interlobular ducts.* Receive numerous intralobular ducts; located in the connective tissue between lobules; stratified columnar epithelium
- *Excretory (main) duct.* Macroscopic duct draining the entire gland



Endocrine Glands

- No ducts; generally cells are not polarized
- Occurrence
 1. Unicellular (e.g., enteroendocrine cells of the digestive tract); these cells do show polarity because they are located within an epithelium and secrete away from the free surface of the epithelium.
 2. Small clusters of cells (e.g., islet of Langerhans in pancreas)
 3. Organs (e.g., thyroid gland, adrenal gland)
- Secretory cells of multicellular glands are usually arranged as plates or cords. The thyroid gland, where the cells form fluid-filled spheres, is an exception to this pattern.
- Highly vascular with fenestrated capillaries
- Secretory products are called hormones. Hormones can be:
 1. Derived from amino acids (e.g., thyroxine and epinephrine)
 2. Peptides and proteins (e.g., insulin and oxytocin)
 3. Steroids (e.g., testosterone and cortisol); steroid-secreting cells display mitochondria with tubular cristae and contain large amounts of lipid droplets and smooth endoplasmic reticulum.
- Secrete by the merocrine or diffusion methods only