Epithelial Tissue

Dr. Emad I Shaqoura
M.D, M.Sc. Anatomy
Faculty of Medicine, Islamic University-Gaza
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Outlines

Basic tissue types

Epithelial tissue

Characteristic features of epithelial cells

Types of epithelia

Transport across epithelia

Renewal of epithelial cells
Levels of Structural Organization

1. Chemical Level
   - Atoms (C, H, O, N, P)
   - Molecule (DNA)

2. Cellular Level
   - Smooth muscle cell
   - Smooth muscle tissue

3. Tissue Level
   - Serous membrane
   - Smooth muscle tissue layers

4. Organ Level
   - Stomach
   - Epithelial tissue

5. System Level
   - Esophagus
   - Liver
   - Stomach
   - Pancreas
   - Gallbladder
   - Small intestine
   - Large intestine

6. Organismic Level
   - Digestive system
Basic Tissue Types

A tissue is composed of:

1. Cells.
2. Extracellular matrix components; fibers and ground substance.

These tissue constituents are present in variable proportions resulting in four different tissue types.
Basic Tissue Types (cont’d)

- Epithelial Tissue
- Connective Tissue
- Muscular Tissue
- Nervous Tissue
### Basic Tissue Types (cont’d)

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Cells</th>
<th>Extracellular Matrix</th>
<th>Main Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous</td>
<td>Elongated cells with extremely fine processes</td>
<td>Very small amount</td>
<td>Transmission of nerve impulses</td>
</tr>
<tr>
<td>Epithelial</td>
<td>Aggregated polyhedral cells</td>
<td>Small amount</td>
<td>Lining of surface or body cavities; glandular secretion</td>
</tr>
<tr>
<td>Muscle</td>
<td>Elongated contractile cells</td>
<td>Moderate amount</td>
<td>Strong contraction; body movements</td>
</tr>
<tr>
<td>Connective</td>
<td>Several types of fixed and wandering cells</td>
<td>Abundant amount</td>
<td>Support and protection of tissues/organs</td>
</tr>
</tbody>
</table>
Most organs of the body can be divided into two components:

1. **Parenchyma**: which is composed of the cells that perform the main functions of the organ.
2. **Stroma**: which is composed of supporting tissue.

N.B. The stroma is always C.T except in the brain & spinal cord.
Epithelial Tissue
Functions of Epithelium

- Covering, lining and protecting surfaces (e.g., epidermis)
- Absorption (e.g., the intestinal lining)
- Secretion (e.g., parynychmal cells of glands)
- Sensory function (e.g., taste buds and olfactory epithelium)
- Contractile function (e.g., myoepithelial cells)
Characteristic Features of Epithelial Cells

- Epithelial cell nuclei vary in shape and may be elliptic (oval), spherical, or flattened.

- Nuclear shape corresponds roughly to cell shape; tall cells have elongated nuclei, squamous cells have flattened nuclei and cuboidal or pyramidal cells usually have more spherical nuclei.

- The number and shape of stained nuclei can indicate cell density, shape and also allow one to determine the number of cell layers in an epithelium.
Characteristic Features of Epithelial Cells (cont’d)

- Most epithelia rest on connective tissue that contains the blood vessels that bring nutrients and O2 to both tissues.
- The connective tissue that underlies the epithelia lining the digestive, respiratory, and urinary tracts is called the lamina propria.
- The area of contact between the epithelium and connective tissue may be increased by irregularities in the form of small evaginations called papillae which occur most frequently in epithelial tissues subject to friction, such as the covering of the skin or tongue.
Epithelial cells generally show polarity. The region of the cell in contact with the connective tissue is called the basal pole and the opposite end, usually facing a space, is the apical pole.

Regions of cuboidal or columnar cells that adjoin the neighboring cells are the lateral surfaces; cell membranes here often have numerous infoldings to increase the area of that surface, increasing its functional capacity.
Basement Membranes

- All epithelial cells in contact with subjacent connective tissue rest on a felt-like sheet of extracellular material referred to as the basement membrane.

- The basement membrane can be stained and hence can be viewed with the light microscope.
Figure 4-2
Basement Membranes (cont’d)

With TEM

- Basal lamina
- Reticular lamina
Basal Lamina

- It is present near the basal poles of epithelial cells.
- It is an electron-dense layer (lamina densa), 20-100 nm thick, consisting of a network of fine fibrils surrounded by thin clear zones on each side called lamina rara or lamina lucida.
Basal Lamina (cont’d)

- It is composed of ECM components:
  1. **Laminin**: large glycoproteins that form a network immediately below the cells’ basal poles where they are held in place by the transmembrane integrins.
  2. **Type IV collagen**: form a felt-like layer.
  3. **Entactin/nidogen** glycoproteins and **perlecan** proteoglycan: They hold laminin and collagen type IV together.
The components of the basal lamina are secreted by the epithelial cells. They are also formed by muscle cells, adipocytes and Schwann cells, where they form an external lamina surrounding these cells.
Reticular Lamina

- It is a more diffuse meshwork of reticular fibers containing type III collagen.
- It is bound to the basal laminae by anchoring fibrils of type VII collagen.
- These components of the basement membrane are produced by cells of the connective tissue.
Basal Lamina & Reticular Lamina

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Figure 4-14 Basal lamina and lamina reticularis. (Adapted from Fawcett DW: Bloom and Fawcett's A Textbook of Histology, 12th ed. New York, Chapman and Hall, 1994.)
Functions of the Basement Membranes

- They provide **structural support to epithelial cells** and attach epithelia to underlying connective tissue.

- Proteins of the BM help **filter substances entering the epithelium from below**, **concentrate growth factors**, and **form a scaffold for epithelial repair and regeneration**.
Functions of the Basement Membranes (cont’d)

- Basal lamina components help organize proteins in the plasma membrane of epithelial cells, affecting endocytosis, signal transduction, and other activities.

- Basement membrane proteins also mediate many cell-to-cell interactions involving epithelia and mark routes for certain cell migrations along epithelia.
Intercellular Adhesion & Other Junctions

- Epithelial cells adhere strongly to neighboring cells and basal laminae, particularly in epithelia subject to friction.
- *Lateral surfaces* of epithelial cells exhibit several specialized intercellular junctions, which serve different functions:

1. **Tight or occluding junctions**: form a seal between adjacent cells.
2. **Adherent or anchoring junctions**: are sites of string cell adhesion.
3. **Gap junctions**: are channels for communication between adjacent cells.
1. Tight Junctions

- Also called **zonulae occludens**.
- The **most apical** of the junctions.
- The term “zonula” indicates that the junction forms a band completely encircling each cell.
- They cause seal between the membranes due to interactions between the transmembrane proteins **claudin** and **occludin** of each cell.
1. Tight Junctions (cont’d)

- They ensure that molecules cross an epithelium through the cells (transcellular path) rather than between them (paracellular pathway).

- So, epithelia with very few tight junctions (e.g., proximal renal tubule) are more permeable to water and solutes than are epithelia with numerous tight junctions (e.g., the lining of the urinary bladder).

- They prevent membrane proteins at the apical cell surface from moving to the basal and lateral surfaces, and vice versa. This produces two membrane domains (apical and basolateral) with different protein populations, different receptors and different function.
2. Zonula Adherens

- It also encircles the epithelial cell, usually immediately below the zonula occludens.

- Cell adhesion here is mediated by cadherins, transmembrane glycoproteins of each cell that interact in the presence of Ca²⁺.

- Cadherins bind catenin in the cell cytoplasm, that is in turn linked via actin-binding proteins to actin filaments.

- Adherent junctions hold adjacent epithelial cells together.
3. Desmosomes (Macula Adherens)

- The latter name implies, this junction resembles a single “spot-weld” and does not form a belt around the cell.
- Desmosomes are disc shaped structures at the surface of one cell that are matched with identical structures at an adjacent cell surface.
- Desmosomes contain larger members of the cadherin family called desmoglein and desmocollin.
- On the cytoplasmic side of each cell membrane, these proteins insert into a dense attachment plaque that bind intermediate filaments rather than actin filaments.
3. Desmosomes (Macula Adherens) (cont’d)

- **Cytokeratin** are most common intermediate filaments in desmosomes of epithelia.
- In **non epithelial cells**, the intermediate filaments attached to desmosomes are composed of **other proteins**.
- Desmosomes provide firm adhesion among the cells.
Tight junction (occluding junction)

Adherens junction (anchoring junction)

Desmosome (anchoring junction)

Intermediate filament

Gap junction (communicating junction)
Blistering (bullous) Diseases

e.g., Pemphigus Vulgaris

- They involve the epidermis or epithelium of the oral mucosa.

- They result from autoimmune reaction against desmogleins of desmosomes resulting in reduced cell-to-cell adhesion.
4. Gap Junctions

- They mediate communication rather than adhesion between cells.
- The gap junction proteins, called connexins, form hexameric complexes called connexons, each of which has a central hydrophilic pore about 1.5 nm in diameter.
- When two cells attach, connexins in the adjacent cell membranes move laterally and align to form connexons between the two cells.
4. Gap Junctions (cont’d)

- Gap junctions permit intercellular exchange of molecules with small (<1.5 nm) diameters.
- In heart and visceral muscles gap junctions help produce rhythmic contractions.
Intercellular Adhesion & Other Junctions (cont’d)

- The basal domain of an epithelial cell attaches to the subjacent basal lamina by junctions called hemi-desmosomes (Gr. hemi, half + desmos + soma).

Hemi-desmosomes

- They are adhesive structures that resemble a half-desmosome ultrastructurally, but, unlike desmosomes, they contain abundant integrins rather than cadherins.
- The transmembrane integrin proteins bind the extracellular macromolecules laminin and collagen type IV.
Specializations of the Apical Cell Surface

- The apical ends of many tall or cuboidal epithelial cells face an organ’s lumen and often have specialized projecting structures.
- These function either to increase the apical surface area for absorption or to move substances along the epithelial surface.
Specializations of the Apical Cell Surface (cont’d)

- Microvilli
- Stereocilia
- Cilia & Flagella
Microvilli

- Finger-like projections arising from the apical cell surface.
- Each microvillus measures about 1 µm high and 0.1 µm wide.
- Microvilli found in absorptive cells, such as the lining epithelium of the small intestine and the cells of the proximal renal tubule are dense and uniform, forming a brush or striated border.
Figure 4-8
Microvilli (cont’d)

- **Glycocalyx** covering intestinal microvilli is thick and includes enzymes for digestion of certain macromolecules.

- Each microvillus contains many bundles of actin filaments capped and cross-linked to each other and to the surrounding plasma membrane by many different actin-binding proteins.

- Although microvilli are often relatively stable, the microfilament arrays are dynamic and undergo various myosin-based movements, which help maintain optimal conditions for absorption.

- The actin filaments insert into the terminal web of similar filaments at the base of the microvilli.
Celiac disease

- Also called gluten-sensitive enteropathy or sprue.
- 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 produces diffuse enteritis (intestinal inflammation), changes to the epithelial cells leading to malabsorption, and eventually to pathologic changes in the intestinal wall.
- The malabsorption problems and structural changes are reversible when gluten is removed from the diet.
Stereocilia

They are a much less common type of apical process, restricted to:

1. absorptive epithelial cells lining the epididymis.
2. the proximal part of ductus deferens.
3. More specialized stereocilia with a motion-detecting function are present in the inner ear sensory cells.

Like microvilli, stereocilia increase the cells’ surface area, facilitating absorption.

Stereocilia resemble microvilli in containing arrays of actin filaments and various actin-binding proteins, with similar diameters, and with similar connections to the cell’s terminal web. However, stereocilia are typically much longer and much less motile than microvilli, and may show distal branching along their length.
Cilia

- Cilia are **long projecting structures**, larger than microvilli, which contain internal arrays of microtubules.

- **Most cell types have at least one cilium** of variable length, usually called a **primary cilium**, which is **not motile** but is **enriched with receptors** and signal transduction complexes for detection of light, odors, motion, and flow of liquid past the cells.

- Primary cilia are also important in the early embryo.

- **Motile cilia are found only in epithelia**, where they are abundant on the apical domains of many **cuboidal or columnar** cells.

- Typical cilia are 5-10 μm long and 0.2 μm in diameter.
Cilia (cont’d)

- Each cilium has **nine peripheral microtubular doublets** surrounding **two central microtubules**; the **9 + 2** assembly of microtubules is called an **axoneme** (Gr. axon, axis + nema, thread).

- **Kinesin** and **cytoplasmic dynein motors** move along the peripheral microtubules for the transport of molecular components into and out of these structures.

- Axonemes are continuous with **basal bodies**, located just below the apical cell membrane.

- Basal bodies are **similar in structure to centrioles**, with **triplets of microtubules** and dynamic tubulin protofilaments forming rootlets anchoring the entire structure to the cytoskeleton.
Figure 4-11

Transport of proteins upward through cilia involves kinesin II motors moving along microtubules of peripheral doublets.

Distal tips of cilia contain dynamic pools of tubulin, other ciliary precursor proteins, and motor proteins.

Pair of dynein arms

Nexin cross-links between doublets

Transport of proteins back to base of cilia involves cytoplasmic dynein motors moving along microtubules of peripheral doublets.

Basal body

Rootlet
Immotile Cilia Syndrome

- Several mutations have been described in the proteins of the cilia and flagella.
- They are responsible for the immotile cilia syndrome (Kartagener syndrome).
- Symptoms are chronic respiratory infections caused by the lack of the cleansing action of cilia in the respiratory tract and immotile spermatozoa, causing male infertility.
Types of Epithelia

Covering (or Lining)
- Simple Epithelia
- Stratified Epithelia

Secretory (or Glandular)
- Exocrine Glands
- Endocrine Glands
Simple Epithelia

- Contain one cell layer.
- Can be classified according to cell shape into:
  1. Simple squamous epithelium.
  2. Simple cuboidal epithelium.
  4. Pseudostratified epithelium.
Simple Squamous Epithelium

- Epithelium
- Basement membrane
- Lamina propria
- Capillaries

Figure 4-12
Simple Cuboidal Epithelium
Simple Columnar Epithelium

- Cilia
- Terminal bars
- Epithelium
- Basement membrane
- Lamina propria
- Capillary

Figure 4-14
Pseudostratified Epithelium

Figure 4-17
In chronic bronchitis, common among habitual smokers, the number of goblet cells in the lining of airways in the lungs often increases greatly.

This leads to excessive mucus production in areas where there are too few ciliated cells for its rapid removal and contributes to obstruction of the airways.

The ciliated pseudostratified epithelium lining the bronchi of smokers can also be transformed into stratified squamous epithelium by metaplasia.
Stratified Epithelia

- Contain two or more cell layers.
- Can be classified according to the shape of superficial cells into:
  1. Stratified squamous epithelium.
     A. Keratinized.
     B. Non-keratinized.
  2. Stratified cuboidal epithelium.
  3. Stratified columnar epithelium.
  4. Transitional epithelium.
Stratified Epithelia

Figure 4-15
Transitional Epithelium

Figure 4-16
<table>
<thead>
<tr>
<th>Major Feature</th>
<th>Cell Form</th>
<th>Examples of Distribution</th>
<th>Main Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple (one layer of cells)</td>
<td>Squamous</td>
<td>Lining of vessels (endothelium); Serous lining of cavities: pericardium, pleura, peritoneum (mesothelium)</td>
<td>Facilitates the movement of the visera (mesothelium), active transport by pinocytosis (mesothelium and endothelium), secretion of biologically active molecules (mesothelium)</td>
</tr>
<tr>
<td></td>
<td>Cuboidal</td>
<td>Covering the ovary, thyroid</td>
<td>Covering, secretion</td>
</tr>
<tr>
<td></td>
<td>Columnar</td>
<td>Lining of intestine, gallbladder</td>
<td>Protection, lubrication, absorption, secretion</td>
</tr>
<tr>
<td>Pseudostratified (layers of cells with nuclei at different levels; not all cells reach surface but all adhere to basal lamina)</td>
<td></td>
<td>Lining of trachea, bronchi, nasal cavity</td>
<td>Protection, secretion; cilia-mediated transport of particles trapped in mucus out of the air passages</td>
</tr>
<tr>
<td>Stratified (two or more layers of cells)</td>
<td>Squamous keratinized (dry)</td>
<td>Epidermis</td>
<td>Protection; prevents water loss</td>
</tr>
<tr>
<td></td>
<td>Squamous nonkeratinized (moist)</td>
<td>Mouth, esophagus, larynx, vagina, anal canal</td>
<td>Protection, secretion; prevents water loss</td>
</tr>
<tr>
<td></td>
<td>Cuboidal</td>
<td>Sweat glands, developing ovarian follicles</td>
<td>Protection, secretion</td>
</tr>
<tr>
<td></td>
<td>Transitional</td>
<td>Bladder, ureters, renal calyces</td>
<td>Protection, distensibility</td>
</tr>
<tr>
<td></td>
<td>Columnar</td>
<td>Conjunctiva</td>
<td>Protection</td>
</tr>
</tbody>
</table>
Epithelial cells that function mainly to produce and secrete various macromolecules may occur in epithelia with other major functions or comprise specialized organs called glands.

Products to be secreted are generally stored in the cells within small membrane-bound vesicles called secretory granules.

Secretory epithelial cells may synthesize, store, and release proteins (e.g., in the pancreas), lipids (e.g., adrenal, sebaceous glands), or complexes of carbohydrates and proteins (e.g., salivary glands). Epithelia of mammary glands secrete all three substances.

The cells of some glands (e.g., sweat glands) have little synthetic activity and secrete mostly water and electrolytes (ions) transferred from the blood.
The secretory portion may be *multicellular* or has scattered cells, sometimes called *unicellular* glands.

Unicellular glands are common in *simple cuboidal*, *simple columnar*, and *pseudostratified* epithelia of many organs e.g., *goblet cell* in the lining of the *small intestine* and *respiratory tract*, which secretes lubricating mucus that aids the function of these organs.

*Glands develop from covering epithelia during fetal life.*
Figure 4-19

Proliferation of cells and their downgrowth into the subjacent connective tissue

Disappearance of duct cells

Exocrine glands

Endocrine glands

Epithelium
Basal lamina
Connective tissue

Duct
Secretery portion

Capillaries
Secretery portion
Glands can be simple (ducts not branched) or compound (ducts with two or more branches).

Secretory portions can be tubular (either short or long and coiled) or acinar (rounded and saclike); either type of secretory unit may be branched, even if the duct is not branched.

Compound glands can have branching ducts and can have multiple tubular, acinar, or tubuloacinar secretory portions.
### TABLE 4-4

**Structural classes of exocrine glands, features of each class, and examples.**

**SIMPLE Glands (Ducts Do Not Branch)**

<table>
<thead>
<tr>
<th>Class</th>
<th>Simple Tubular</th>
<th>Branched Tubular</th>
<th>Coiled Tubular</th>
<th>Acinar (or Alveolar)</th>
<th>Branched Acinar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>Secretory portion</td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
</tr>
</tbody>
</table>

| Features             | Elongated secretory portion; duct usually short or absent | Several long secretory parts joining to drain into 1 duct | Secretory portion is very long and coiled | Rounded, saclike secretory portion | Multiple saclike secretory parts entering the same duct |
| Examples             | Mucous glands of colon; intestinal glands or crypts (of Lieberkühn) | Glands in the uterus and stomach | Sweat glands | Small mucous glands along the urethra | Sebaceous glands of the skin |
### COMPOUND Glands (Ducts from Several Secretory Units Converge into Larger Ducts)

<table>
<thead>
<tr>
<th>Class</th>
<th>Tubular</th>
<th>Acinar (Alveolar)</th>
<th>Tubuloacinar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Features</strong></td>
<td>Several <em>elongated</em>, coiled secretory units and their ducts converge to form larger ducts</td>
<td>Several <em>saclike</em> secretory units with small ducts converge at a larger duct</td>
<td>Ducts of both tubular and acinar secretory units converge at larger ducts</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Submucosal mucous glands (of Brunner) in the duodenum</td>
<td>Exocrine pancreas</td>
<td>Salivary glands</td>
</tr>
</tbody>
</table>
Secretory Epithelia & Glands (cont’d)

- Exocrine glands can be classified according to mode of secretion into:

  1. **Merocrine secretion**: This is the most common method of protein secretion and involves typical exocytosis of proteins or glycoproteins from membrane-bound vesicles.

  2. **Holocrine secretion**: In this process cells accumulate product as they mature and undergo terminal cell differentiation, culminating in complete cell disruption with release of the product and cell debris into the gland’s lumen. This is best seen in the sebaceous glands of skin.

  3. **Apocrine secretion**: Here product accumulates at the cells’ apical ends, portions of which are then extruded to release the product together with a bit of cytoplasm and plasma membrane. This is the mechanism by which droplets of lipid are secreted in the mammary gland.
(a) Merocrine gland

- Secretory contents
- Secretory vesicle
- Nucleus
- Secretory vesicles releasing their contents via exocytosis

(b) Holocrine gland

- Disintegrating cells with contents becoming the secretion
- Cells dividing

(c) Apocrine gland

- Secretions
- Nucleus of secretory cell
- Pinching off of apical portion of secretory cell

Figure 4-21
Medical Application

- The holocrine sebaceous glands are the primary structure involved in the common form of acne, acne vulgaris.
- Excessive holocrine secretion of sebum and keratin triggered by the surge of the steroid hormone testosterone that occurs in both genders at puberty frequently leads to blocked ducts within the gland.
- Activity of the normal commensal skin bacterium Propionibacterium acnes within the blocked duct commonly produces localized inflammation.
Secretory Epithelia & Glands (cont’d)

- Exocrine glands with merocrine secretion can be further categorized according to the nature of their secretory products into **serous**, **mucous** and **seromucous** glands:

1. **Serous cells**: synthesize proteins that are non-glycosylated, such as digestive enzymes.
   - The cells have **well-developed RER** and **Golgi complexes** and are **apical secretory granules**.
   - Serous cells therefore stain intensely with basophilic or acidophilic stains.
   - Examples: **Acini of the pancreas** and **parotid salivary glands**.
2. **Mucous cells**: such as goblet cells, also have RER and Golgi complexes and are filled apically with secretory granules, but these contain heavily glycosylated proteins called mucins.

- When mucins are released from the cell, they become hydrated and form mucus.
- Most of mucins are washed from cells during routine histological preparations, causing the mucin granules to stain poorly with eosin.
- Sufficient oligosaccharides usually remain, allowing mucous cells to be stained by the periodic acid-Schiff (PAS) method.
3. **Seromucous glands**: e.g., some salivary glands.

- They have **both serous acini** and **mucous tubules** capped by groups of serous cells.
- The product of such glands is a mixture of **digestive enzymes** and **watery mucus**.
Myoepithelial Cells

- Are **contractile cells** located inside the basal lamina around the basal ends of secretory or duct cells of many exocrine glands (e.g., sweat, lachrymal, salivary, and mammary glands).
- They have **long processes** that embrace an acinus as an octopus.
- Along ducts, they are more longitudinally arranged.
- They are connected to each other and to the other epithelial cells by both **gap junctions** and **desmosomes**.
- Myoepithelial cells are **rich in actin** filaments and **myosins**.
- Their contractions serve to **help propel secretory products** into and up the duct system.
Myoepithelial Cells (cont’d)
Transport Across Epithelia

- Some epithelial cells transfer ions and fluid across the epithelium, this is known as transcellular transport.
  
  A. The direction of transport is from the lumen to the blood vessel, as in the gallbladder and intestine. This process is called absorption.
  
  B. Transport is in the opposite direction, as in the choroid plexus, ciliary body, and sweat gland. This process is called secretion.
Figure 4-28
Figure 4-29

Protein digestion by lysosome

Pinocytosis

Junctional complexes

Site of lateral membrane interdigitation

Na⁺
Transport Across Epithelia (cont’d)

- All cells can also internalize extracellular molecules and fluid using **endocytosis**.
- This activity is clearly observed in the **endothelia** or **mesothelia**.
- These thin cells have few organelles & abundant pinocytotic vesicles, which cross the cells in both directions and release their contents on the opposite side by **exocytosis**.
- This process of **transcytosis** also occurs between the apical and basolateral membranes domains in cells of **simple cuboidal** and **columnar epithelia** and is important in many physiologic processes.
Transport Across Epithelia (cont’d)
Renewal of Epithelial Cells

- Epithelial tissues are relatively labile structures whose cells are renewed continuously by mitotic activity and stem cell populations.

- The rate of renewal varies widely; it can be fast in tissues such as the intestinal epithelium, which is replaced every week, or slow, as in the large glands.
Renewal of Epithelial Cells (cont’d)

- Epithelia are normally capable of rapid repair and replacement of apoptotic or damaged cells.

- In the liver, mitotic activity is normally rare but is actively renewed following major damage to the organ.

- When a portion of liver tissue is removed surgically or lost by the acute effects of toxic substances, cells of undamaged regions quickly begin active proliferation and a mass of liver tissue with normal function is regenerated.
Epithelial Tumors

- Both **benign** and **malignant** tumors can arise from most types of epithelial cells.
- Malignant tumors of epithelial origin are called **carcinomas** (gr. karkinos, cancer + oma, tumor).
- Malignant tumors derived from **glandular epithelial** tissue are called **adenocarcinomas** (gr. adenos, gland + karkinos).
- Adenocarcinomas are by far the **most common tumors** in adults after age 45.
Abnormal Growth of Epithelial Tissue

- Some epithelial cells are prone to abnormal growth or dysplasia, which can progress to precancerous growth called neoplasia.
- Early neoplastic growth is often reversible and does not always result in cancer.
- Under certain abnormal conditions, one type of epithelial tissue may undergo transformation into another type in another reversible process called metaplasia.
- In heavy cigarette smokers, the ciliated pseudostratified epithelium lining the bronchi can be transformed into stratified squamous epithelium.
Abnormal Growth of Epithelial Tissue (cont’d)

- In individuals with chronic vitamin A deficiency, epithelial tissues of the type found in the bronchi and urinary bladder are gradually replaced by stratified squamous epithelium.
Thank You!