Chapter 4

Tissue: The Living Fabric

Part A
Tissues

- Groups of cells similar in structure and function
- The four types of tissues
  - Epithelial
  - Connective
  - Muscle
  - Nerve
Epithelial Tissue

- Cellularity – composed almost entirely of cells
- Special contacts – form continuous sheets held together by tight junctions and desmosomes
- Polarity – apical and basal surfaces; basal surface in contact with basement membrane - the layer of tissue that attaches epithelial tissue to the underlying connective tissue
- Supported by connective tissue – reticular and basal laminae
- Avascular but innervated – contains no blood vessels but supplied by nerve fibers
- Regenerative – rapidly replaces lost cells by cell division
Classification of Epithelia

- **Simple**: one layer; all in contact with basement membrane

- **Stratified**: many layers; several layers of cells above the basement membrane—all are not in contact with basement membrane

Figure 4.1a
Classification of Epithelia

- **Squamous**: thin, flat, irregular shaped (like puzzle pieces)

- **Cuboidal**: hexagonal shaped boxes, round nuclei

- **Columnar**: long, slender, oval nuclei
Epithelia: Simple Squamous

• Single layer of thin, flattened, irregularly shaped cells with disc-shaped nuclei and sparse cytoplasm

• Most delicate type of tissue in the body

• Functions
  • Diffusion and filtration (secretion and absorption)
  • Provide a slick, friction-reducing lining in body cavities (serous membranes-mesothelium) and cardiovascular system (lining of blood vessels-endothelium)

• Present in the kidney glomeruli, lining of heart, blood vessels, lymphatic vessels, and serosa
Epithelia: Simple Squamous

(a) Simple squamous epithelium

**Description:** Single layer of flattened cells with disc-shaped central nuclei and sparse cytoplasm; the simplest of the epithelia.

**Function:** Allows passage of materials by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosas.

**Location:** Kidney glomeruli; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosas).

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Epithelia: Simple Squamous

(a) Simple squamous epithelium

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**Function:** Allows passage of materials by diffusion and filtration in sites where protection is not important; secretes lubricating substances in serosae.

**Location:** Kidney glomeruli; air sacs of lungs; lining of heart, blood vessels, and lymphatic vessels; lining of ventral body cavity (serosae).

**Photomicrograph:** Simple squamous epithelium forming part of the alveolar (air sac) walls (400X).
Epithelia: Simple Cuboidal

- Single layer of cubelike cells with large, spherical central nuclei
- Function in secretion and absorption, limited protection
- Present in kidney tubules, ducts and secretory portions of small glands (salivary and thyroid), pancreas, and ovary surface
Epithelia: Simple Cuboidal

**Description:** Single layer of cubelike cells with large, spherical central nuclei.

**Function:** Secretion and absorption.

**Location:** Kidney tubules; ducts and secretory portions of small glands; ovary surface.

**Photomicrograph:** Simple cuboidal epithelium in kidney tubules (400×).
Epithelia: Simple Columnar

• Single layer of tall cells with oval nuclei
• Goblet cells are often found in this layer
• Function in absorption and secretion
• Line digestive tract (esp. stomach, small and large intestine) and gallbladder
• Line small bronchi, uterine tubes, and some regions of the uterus
Epithelia: Simple Columnar

(c) Simple columnar epithelium

**Description:** Single layer of tall cells with oval nuclei; some cells bear cilia; layer may contain mucus-secreting unicellular glands (goblet cells).

**Function:** Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.

**Location:** Nonciliated type lines most of the digestive tract (stomach to anal canal), gallbladder and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.

Figure 4.2c
Epithelia: Simple Columnar

(c) Simple columnar epithelium

**Description:** Single layer of tall cells with round to oval nuclei; some cells bear cilia; layer may contain mucus-secreting unicellular glands (goblet cells).

**Function:** Absorption; secretion of mucus, enzymes, and other substances; ciliated type propels mucus (or reproductive cells) by ciliary action.

**Location:** Nonciliated type lines most of the digestive tract (stomach to anal canal), gallbladder, and excretory ducts of some glands; ciliated variety lines small bronchi, uterine tubes, and some regions of the uterus.

**Photomicrograph:** Simple columnar epithelium of the stomach mucosa (1300×).
Epithelia: Pseudostratified Columnar

- Single layer of cells with different heights; all cells in contact with the basement membrane; some do not reach the free surface; always have cilia
- Nuclei are seen at different layers
- Function in secretion and propulsion of mucus
- Present in the male sperm-carrying ducts, fallopian tubes, and respiratory tract (nasal cavity, trachea, bronchii)

Figure 4.2d
Epithelia: Pseudostratified Columnar

**Description:** Single layer of cells of differing heights, some not reaching the free surface; nuclei seen at different levels; may contain goblet cells and bear cilia.

**Function:** Secretion, particularly of mucus; propulsion of mucus by ciliary action.

**Location:** Nonciliated type in male's sperm-carrying ducts and ducts of large glands; ciliated variety lines the trachea, most of the upper respiratory tract.

*Photomicrograph:* Pseudostratified ciliated columnar epithelium lining the human trachea (400x).

- Cilia
- Mucus of goblet cell
- Pseudostratified epithelial layer
- Basement membrane
- Connective tissue

Figure 4.2d
Epithelia: Stratified Squamous

• Thick membrane composed of several layers of cells
• Function in protection of underlying areas subjected to chemical and mechanical stresses
• Forms the external part of the skin’s epidermis (keratinized cells), and linings of the esophagus, mouth, and vagina (nonkeratinized cells).
Epithelia: Stratified Squamous

(e) Stratified squamous epithelium

**Description:** Thick membrane composed of several cell layers; basal cells are cuboidal or columnar and metabolically active; surface cells are flattened (squamous); in the keratinized type, the surface cells are full of keratin and dead; basal cells are active in mitosis and produce the cells of the more superficial layers.

**Function:** Protects underlying tissues in areas subjected to abrasion.

**Location:** Nonkeratinized type forms the moist linings of the esophagus, mouth, and vagina; keratinized variety forms the epidermis of the skin, a dry membrane.

**Photomicrograph:** Stratified squamous epithelium lining of the esophagus (300x).
Epithelia: Stratified Cuboidal and Columnar

- **Stratified cuboidal**
  - Quite rare in the body
  - Only superficial layers are cuboidal
  - Found in some sweat and mammary glands
  - Typically two cell layers thick
  - Functions in protection, secretion, and absorption

- **Stratified columnar**
  - Limited distribution in the body
  - Only superficial layers are columnar
  - Found in the pharynx, male urethra, anus, and lining some glandular ducts
  - Also occurs at transition areas between two other types of epithelia
Epithelia: Stratified Columnar

- Several cell layers with cuboidal basal cells and columnar superficial cells
- Functions in protection and secretion
- Present in large ducts of some glands, and in portions of the male urethra
Epithelia: Transitional

- Several cell layers, basal cells are cuboidal, surface cells are dome shaped to permit expansion and recoil.
- Stretches to permit the expansion of the urinary bladder.
- Lines the urinary bladder, ureters, and part of the urethra.

**Description:**
Resembles both stratified squamous and stratified cuboidal; basal cells cuboidal or columnar; surface cells dome shaped or squamouslike, depending on degree of organ stretch.

**Function:**
Stretches readily and permits distension of urinary organ by contained urine.

**Location:**
Lines the ureters, bladder, and part of the urethra.
**Epithelia: Transitional**

(f) **Transitional epithelium**

- **Description:** Resembles both stratified squamous and stratified cuboidal; basal cells cuboidal or columnar; surface cells dome shaped or squamous-like, depending on degree of organ stretch.

- **Function:** Stretches readily and permits distension of urinary organ by contained urine.

- **Location:** Lines the ureters, bladder, and part of the urethra.

**Photomicrograph:** Transitional epithelium lining of the bladder, relaxed state (500×); note the bulbous, or rounded, appearance of the cells at the surface; these cells flatten and become elongated when the bladder is filled with urine.
Epithelia: Glandular

• A gland is one or more cells that makes and secretes an aqueous fluid

• Classified by:
  • Site of product release – endocrine or exocrine
  • Relative number of cells forming the gland – unicellular or multicellular
Endocrine Glands

- Ductless glands that produce hormones
- Release their secretions directly into their surrounding environment. These secretions then enter circulation for distribution throughout the body.
- Secretions include amino acids, proteins, glycoproteins, and steroids
Exocrine Glands

• More numerous than endocrine glands
• Secrete their products onto epithelial surfaces (ex. body surfaces (skin) or into body cavities)
• Examples include mucous, sweat, oil, and salivary glands
• The only important unicellular gland is the goblet cell
• Multicellular exocrine glands are composed of a duct and secretory unit
Multicellular Exocrine Glands

- Classified according to:
  - Mode of secretion
  - Type of secretion
  - Structure of the secretory unit
Mode of Secretion

1. Merocrine secretion: product is released through exocytosis. This is the most common mode of secretion

Examples: mucus: a lubricant, protective barrier, and sticky trap that coats the passages of the digestive and respiratory tracts

sweat
2. Apocrine secretion: involves the loss of cytoplasm as well as the intended secretion.

Example: underarm sweat, breast milk (is a merocrine and apocrine secretion)

Both merocrine and apocrine secretion leave the cell intact and able to continue secreting.
3. Holocrine secretion: destroys the gland cell

The cell becomes so packed with secretions that it bursts open (called lysis). This releases the secretions but kills the cell.

Example: oil produced by sebaceous (oil) glands
Types of Secretion

1. Serous gland: secretion is watery and contains enzymes
2. Mucous gland: secretion is a thick mucous
3. Mixed exocrine gland: may produce serous and mucous secretions

One of our salivary glands is a mixed exocrine gland.
Structure of secretory unit

Shape:
- Tubular: glandular cells form tubes
- Alveolar: glandular cells form pockets (circular)
- Tubuloalveolar: glandular cells form tubes and pockets

Branching Pattern
- Simple: duct does not divide on its way to the secretory unit
- Compound: duct does divide on its way to the secretory unit

If several secretory areas share the same duct, the gland is said to be branched
## Structural Classification of Multicellular Exocrine Glands

<table>
<thead>
<tr>
<th>Simple duct structure (duct does not branch)</th>
<th>Tubular secretory structure</th>
<th>Alveolar secretory structure</th>
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<tbody>
<tr>
<td>(a) Simple tubular</td>
<td></td>
<td></td>
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<tr>
<td>Example: intestinal glands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Simple branched tubular</td>
<td></td>
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<tr>
<td>Example: stomach (gastric) glands</td>
<td></td>
<td></td>
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<tr>
<td>(c) Simple alveolar</td>
<td></td>
<td></td>
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<tr>
<td>Example: No important example in humans</td>
<td></td>
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<tr>
<td>(d) Simple branched alveolar</td>
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<tr>
<td>Example: sebaceous (oil) glands</td>
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</tbody>
</table>

**Key:**
- ![Surface epithelium](image)
- ![Duct](image)
- ![Secretory epithelium](image)
Structural Classification of Multicellular Exocrine Glands

- **Compound duct structure (duct branches)**
- **Tubular secretory structure**
  - (e) Compound tubular
    - Example: Brunner’s glands of small intestine
- **Alveolar secretory structure**
  - (f) Compound alveolar
    - Example: mammary glands
  - (g) Compound tubuloalveolar
    - Example: salivary glands

**Key:**
- = Surface epithelium
- = Duct
- = Secretory epithelium

Figure 4.3e-g