Chapter 3

The Tissue Level of Organization

Introduction: Tissue Organization

Epithelial Tissue

- Includes all epithelia & glands
- An Epithelium is a sheet of cells that cover an exposed surface or line internal cavity passageway
- Epithelial Characteristics:
  - Cellularity = very densely packed cells; little extracellular material
  - Polarity basal vs apical cells/layers
    - Basal lamina
      - Produced by basal surface & underlying CT
    - Avascular
  - High regenerative capacity

Epithelial Tissue Functions

- Provide physical protection
- Control permeability
- Provide sensation
  - neuronal endings
- Secretion
Maintaining Epithelial Integrity

- Intercellular connections (cell junctions)
- Attachment to **basal lamina**: Lamina lucida & lamina densa
- Epithelia regenerate themselves

Classification of Epithelia

- **Based on # of layers and shape at apical surface:**
  - *Simple*: one layer of cells.
  - *Stratified*: several layers of cells.
  - *Squamous*: thin flat cells.
  - *Cuboid*: height = width.
  - *Transitional*: changes shape.
  - *Columnar*: height = 3-4 times width
- **NOTE**: epithelial names are combinations: e.g., simple squamous, stratified columnar

Simple Squamous Epithelia

- **Simple squamous** = most delicate
  - Slick surface = reduces friction or thin lining for gas exchange.
- Locations:
  - Exchange surfaces in lungs
  - Serous membranes of ventral cavity (mesothelium)
    - Pleura, Pericardium, Peritoneum
  - Endothelium (lining of heart & blood vessels)

Stratified Squamous Epithelia

- **Stratified squamous**
  - Locations: Surface of skin; lining of mouth, throat, esophagus, rectum, anus, and urethra
  - Functions: Provides physical protection against abrasion, pathogens, and chemical attack
Cuboidal Epithelia

- **Cuboidal epithelial** cells are hexagonal, when viewed at apical surface
  - Height equal to width
  - Nuclei near center of cell
- **Simple cuboidal**:  
  - High absorptive & secretory capabilities.
  - Locations: kidney tubules, pancreas, salivary glands, thyroid follicles, etc.
- **Stratified cuboidal epithelia** = rare  
  - May line largest ducts of a gland

Simple Columnar Epithelium

- **Simple columnar epithelium**: good protection + excellent absorptive capacities.
- Line stomach, intestinal tract, uterine tubes, & excretory duct.

Stratified Columnar Epithelium

- **Stratified columnar** = rare  
  - Found in pharynx, urethra, anus and some excretory ducts.
Pseudostratified Columnar Epithelium

- *Pseudostratified ciliated columnar* = specialized columnar epithelium with multiple cell types.
  - All cells touch the basal lamina = simple
  - Nuclei do not form a single layer (looks stratified, but isn’t).
  - Cilia
- Locations = upper respiratory passages & male reproductive tract.

Transitional Epithelia

- *Transitional epithelia* = stratified
  - Stretch & change shape due to expansion of the lumen (open space) they surround.
- Locations: renal pelvis, ureters, & urinary bladder

Glandular Epithelia

- *Exocrine glands* secrete materials onto an epithelial surface, via *ducts*
  - *Serous glands* : watery fluid w/ enzymes
  - *Mucous glands* secrete mucins (absorb water to form mucus)
  - *Mixed exocrine* = both serous & mucous secretions.
- *Endocrine glands* release *hormones* into extracellular fluid
  - Ductless

Mucous and Mixed Epithelia
Mechanisms of Glandular Secretion

Connective Tissues (CT)
- Found throughout body
  - Never exposed to external environment, under normal conditions
- 3 main components:
  - Cells
  - Extracellular protein fibers
  - Ground substance
- **Matrix** = extracellular part of CT = protein fibers + ground substance.

Connective Tissues Classification

Functions of Various Connective Tissues
- Forms structural framework of body.
- Transports fluid & dissolved materials.
- Protects organs.
- Supports, surrounds, & connects other tissues.
- Stores energy.
- Defends body from microorganisms.
**Connective Tissue Proper: Cell Types**

<table>
<thead>
<tr>
<th>Cell Types</th>
<th>Functions</th>
</tr>
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<tbody>
<tr>
<td>FIXED CELLS</td>
<td></td>
</tr>
<tr>
<td>Fibroblasts</td>
<td>Produce connective tissue fibers</td>
</tr>
<tr>
<td>Fibrocytes</td>
<td>Maintain connective tissue fibers and matrix</td>
</tr>
<tr>
<td>Fixed macrophages</td>
<td>Phagocytize pathogens and damaged cells</td>
</tr>
<tr>
<td>Adipocytes</td>
<td>Store lipid reserves</td>
</tr>
<tr>
<td>Mesenchymal cells</td>
<td>Connective tissue stem cells that can differentiate into other cell types</td>
</tr>
<tr>
<td>Melanocytes</td>
<td>Synthesize melanin</td>
</tr>
<tr>
<td>WANDERING CELLS</td>
<td></td>
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<tr>
<td>Free macrophages</td>
<td>Mobile/traveling phagocytic cells (derived from monocytes of the blood)</td>
</tr>
<tr>
<td>Mast cells</td>
<td>Stimulate local inflammation</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>Participate in immune response</td>
</tr>
<tr>
<td>Neutrophils and eosinophils</td>
<td>Small, phagocytic blood cells that mobilize during infection or tissue injury</td>
</tr>
</tbody>
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**Connective Tissue Proper: Fibers**

- **Collagen fibers** = long, coiled, cylindrical fibers
  - Most common & strongest
- **Reticular fibers** = single unit of collagen protein = thin.
  - Branching; form networks
- **Elastic fibers** contain elastin
  - Stretch & rebound

**CT Proper: Loose Connective Tissue Types**

- **Areolar tissue** = least specialized CT
  - Contains all cell types & all fiber types.
  - Ground substance = most of volume
  - Separates skin from underlying structures.
    - Extensive blood supply
  - Found under all other epithelia of body.
CT Proper: **Loose Connective Tissue Types**

- **Adipose tissue**: similar to areolar CT but, has many adipocytes
  - **Adipocytes** = cells that compose most of adipose tissue volume
  - Adipose tissue cushions shock, stores energy (lipids), insulates body
    - Commonly found under skin of groin, sides, buttocks & breasts; behind eyes.
    - Also: surrounding kidneys, heart, & abdominal structures (**visceral fat**)

- **Reticular tissue** has many **reticular fibers**
  - Contains more macrophages than other loose CT.
  - Locations include the stroma of bone marrow, spleen, liver, and lymph nodes.

CT Proper: **Dense CT Types**

- **Dense CTs** are **Collagenous tissues**
  - Mainly protein fibers, mostly **collagen**.
- 2 types:
  - **Dense Regular CT**: tightly packed collagen fibers aligned parallel to applied forces.
  - **Dense Irregular CT**: mostly collagen fibers
    - Arranged in an interwoven meshwork

- **Dense regular** CT is in 4 types of structures:
  - **Tendons** – long, relatively thin connections of muscle to bone.
  - **Aponeuroses** – broad, flat; connects muscles to other structures.
  - **Elastic tissue** – contains collagen & elastic fibers: stretchable
  - **Ligaments** – long, thin attachments of bone to bone.
CT Proper: Dense CT Types

- **Dense irregular** CT has strength in all directions and is found in several locations:
  - Dermis of skin.
  - Surrounding cartilage (*perichondrium*) & bone (*periosteum*).
  - Surrounding internal organs as a fibrous capsule.
  - Liver, spleen, kidneys
  - Cavities of synovial joints

Fluid Connective Tissues

- **Blood**
  - Liquid matrix = *plasma*
  - Various types of cells, or *formed elements*.
- **Lymph**: formed from interstitial fluid collected into *lymphatic vessels*

Supporting Connective Tissues

- **Supporting CT** contains:
  - Few cells, but high amounts of fiber
  - A *ground substance*
- 2 types of supporting CT:
  - **Cartilage**: matrix similar to a firm gel
    - Hyaline cartilage
    - Elastic cartilage
    - Fibrocartilage
  - **Bone (osseous tissue)**: solid matrix (ground substance & collagen fibers) + cells.

Supporting CT: Hyaline Cartilage

- **Hyaline cartilage** = most common cartilage type
  - Collagen is very abundant.
    - Tough & flexible, but weakest cartilage.
- Found in 3 major areas of the body:
  - **Costal cartilage** – between ribs & sternum.
  - **Respiratory cartilage** – conducting portion of respiratory tract.
  - **Articular cartilage** – covering ends of bones at joints.
Supporting CT: **Elastic Cartilage**

- **Elastic cartilage** contains many elastic fibers = resilient.
- **Locations:**
  - Flap (auricle/pinna) of external ear
  - Epiglottis
  - Airway to middle ear (auditory tube)
  - Some cartilages of the larynx.

Supporting CT: **Fibrocartilage**

- **Fibrocartilage** = strongest cartilage type
  - Matrix = little ground substance; abundant collagen fibers
    - Resists compression, absorbs shock, & prevents bone-to-bone damage.
  - Located between vertebrae, bones of pelvis, and in some joints.

Supporting CT: **Bone**

- **Bone** (osseous tissue): ~2/3 solid ground substance
  - **Calcium salts** (calcium phosphate & calcium carbonate)
    - Resist compression.
  - **Collagen fibers** allow bone to flex under pressure
    - Flex
      - Collagen + Calcium Salts = very strong tissue
  - **Osteocytes** = Mature cells
    - Located in lacunae
      - **Canaliculi** = passageways between lacunae
        - Exchange of nutrients & wastes between osteocytes & blood.
  - **Periosteum** = 2-layered covering of bone tissue.
    - Outer layer = dense irregular CT.
      - Attachment site for tendons and ligaments
    - Inner layer = osteoblasts (immature bone cells)
Membranes: Epithelia + CT

- **Mucous membranes** = wet membranes
  - Continuous with exterior
- **Serous membranes** line ventral body cavity
- **Cutaneous membrane** = thick, dry, water-resistant membrane
- **Synovial membranes** = areolar tissue with incomplete layer of overlying epithelium

CT Framework of the Body

- **SUPERFICIAL FASCIA**
  - Between skin and underlying organs
  - Areolar tissue and adipose tissue
  - Also known as subcutaneous layer of hypodermis
- **DEEP FASCIA**
  - Forms a strong, fibrous internal framework
  - Dense connective tissue
  - Bound to capsules, tendons, ligaments, etc.
- **SUBSEROUS FASCIA**
  - Between serous membranes and deep fascia
  - Areolar tissue

Neural Tissue

- **Neural tissue** (nervous tissue) is specialized to conduct electrical signals
  - **Neurons** = transmit electrical signals.
  - **Neuroglia** = “supporting cells”