Chapter 4:

Histology - The Study of Tissues

• The human body is similar to a car: it consists of many parts which are made of materials consistent with their specialized function.
• Thus:
• You can’t use the rubber from a tire to make a windshield and vice versa
• Knowledge of tissue structure & function is important in understanding organs, organ systems, & the complete organism
Chapter 4 Outline

I. Tissues & Histology
II. Embryonic Tissues
III. Epithelial Tissues
IV. Connective Tissues
V. Muscle Tissue
VI. Nervous Tissue
VII. Tissue Membranes
VIII. Tissue Damage and Inflammation
IX. Tissue Repair
X. FX of aging on tissues
I. Tissues and Histology
I. Tissues and Histology

• Collections of specialized cells & the extracellular substances surrounding them (Tissue level of organization)

• Tissue classification based on:
  a. Structure of the cells
  b. Composition of the extra cellular matrix (XCM)
  c. Fxns of the cells

• 4 Primary Types of Tissue:
  1. Epithelial Tissue
  2. Connective Tissue
  3. Muscular Tissue
  4. Nervous

• All tissues are interdependent on each other

• **Histology**: microscopic study of tissues (tissue examination → diagnosis → therapy prescription based on results)

• **Biopsy**: removal of tissue samples from a patient for diagnostic purposes

• **Autopsy**: an examination to determine cause of death or determine changes caused by a disease
II. Embryonic Tissue
II. Embryonic Tissue

• ~ 13-14 days after fertilization unspecialized stem cells begin to differentiate into 3 layers of tissue
  – The Germ Layers that give rise to all other tissues.

1. Endoderm
   – Inner layer
   – Lining of digestive tract & its derivatives

2. Mesoderm
   – Middle layer
   – Muscle, bone, & blood vessels

3. Ectoderm
   – Outer layer
   – Skin and neuroectoderm which will become the nervous system.
   – Groups of cells will also separate becoming the neural crest cells which give rise to the parts of the PNS, skin pigment cells, medulla of the adrenal gland & many facial tissues
III. Epithelial Tissue (epithelium [epi])

Protective covering for inner and outer body surfaces
III. Epithelial Tissue

- Characteristics common to Epithelium

1. Mostly composed of cells with little XCM
2. Covers body surfaces
   - Both inner & outer
   - Also gives rise to glands from surface tissue
3. 3 distinct cell surfaces
   - Apical- Free surface
   - Basal- Attached to basement membrane
   - Lateral- Attached to neighbor
4. Cell & matrix Connections
   - Special cell contacts bind cells together, to the basement membrane, or to the XCM
5. Nonvascular
   - Blood vessels do not go past the basement membrane, meaning diffusion is important
6. Capable of regeneration
   - Cells retain their ability to divide so they can replace damaged cells with new ones
III. Epithelial Tissue

5 Fxns of Epi Tissues

1. Protecting underlying structures from abrasion (ex/skin, oral cavity)

2. Acting as a barrier to microorganisms & water loss

3. Permits the passage of substances (Lungs $X\Delta O_2$ & $CO_2$)

4. Secreting substances (mucus glands & sweat glands)

5. Absorbing substances (carrier proteins in apical surfaces of cells allow for absorption)
## III. Epithelial Tissue
### Classification of Epithelial Tissue
**Based on 2 things:**

<table>
<thead>
<tr>
<th>Shape of superficial cells</th>
<th># of layers of cells</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Squamous</strong></td>
<td><strong>Simple</strong></td>
</tr>
<tr>
<td>- Flat and scale-like (squished)</td>
<td>- 1 layer of cells</td>
</tr>
<tr>
<td><strong>Cuboidal</strong></td>
<td><strong>Stratified</strong></td>
</tr>
<tr>
<td>- Cube-shaped</td>
<td>- Multiple layers of cells</td>
</tr>
<tr>
<td>- Length of height = width</td>
<td>- Keratinized vs Non keratinized</td>
</tr>
<tr>
<td><strong>Columnar</strong></td>
<td><strong>Pseudostratified</strong></td>
</tr>
<tr>
<td>- Column shaped</td>
<td>- Pseudo (Fake)</td>
</tr>
<tr>
<td>- Taller than wide</td>
<td>- Only one layer of cells all attached to basement membrane but the odd shape of the cells makes it look like more than 1 layer</td>
</tr>
</tbody>
</table>
III. Epithelial Tissue

Functional Characteristics

- Structural specialization of epi cells are consistent with fxn they perform
  - Arrangements of organelles
  - Cell Shape
  - Organization of cells w/in epi

1. Cell Layers & Shape
2. Cell Surfaces
3. Cell Connections
III. Epithelial Tissue

Functional Characterization

1. **Cell Layers & Shape**
   - **Fxn of Layers:**
     - Simple: covers surfaces and allows for:
       - Gas Diffusion ➔ Lungs
       - Filters Blood ➔ Kidneys
       - Secretes products ➔ Glands
       - Absorbs nutrients ➔ Intestine
     - Stratified: major fxn is protection
   - **Fxn of Shape:**
     - Flat/Thin Cells: diffusion or filtration
     - Cube/Column: Secretion or absorption (> cytoplasm vol because of organelles)

2. Cell Surfaces
3. Cell Connections
III. Epithelial Tissue

Functional Characterization

1. Cell Layers & Shape

2. Cell Surfaces
   - The free surface can have:
     - Smooth edge (reduction of friction)
     - Microvilli (increase surface area Small Intestine)
     - Ciliated (move things along the surface Lining Lungs)
     - Folded (Transitional epithelium changing shape)

3. Cell Connections: holds cells to cells or cells to basement membrane
   - 3 fxns:
     A. Mechanically bind cells together
     B. Help form a permanent barrier
     C. Provide a mechanism for intercellular communication
   - Types
     a. Desmosomes
     b. Hemidesmosomes
     c. Tight Jxns
     d. Gap Jxns
III. Epithelial Tissue
Functional Characterization

a. Desmosomes
   - Disk-shaped structures w/adhesive glycoproteins
   - Bind cells together & intermediate filaments that extend into the cytoplasm of the neighboring cells

b. Hemidesmosomes
   - ½ a desmosomes and binds cells to the basement membrane

c. Tight Jxns
   - Hold cells together and form a barrier
   - 2 parts:
     a. Right Junction: tight seal near surface of cells
     b. Adhesion Belt: weak glue to hold cells together

d. Gap Jxns
   - Small contact points between cells that allow for intercellular communication
III. Epithelial Tissue

- **Glands:**
  - secretory organs
  - Many composed primarily of epithelium with a supporting network of CT.

- **2 types:**
  - **Endocrine**
    - Become separated from the epithelium of origin with no ducts but have extensive blood vessels (products= hormones)
  - **Exocrine**
    - Gland that maintains an open contact with the epithelium with a duct present
    - Ducts are lined with epithelium can be multi or single celled
    - Multicellular are classified by ducts & secretory regions (Single or compound/ tubular, acini, alveolar)
III. Epithelial Tissue

Glands of Epi Tissue

Exocrine Glands can also be classified based on how product leaves the cell.
III. Epithelial Tissue

Simple Epithelium
(a) Simple Squamous Epithelium

Structure: Single layer of flat, often hexagonal cells; the nuclei appear as bumps when viewed as a cross section because the cells are so flat

Function: Diffusion, filtration, some secretion, and some protection against friction

Location: Lining of blood vessels and the heart, lymphatic vessels (endothelium) and small ducts, alveoli of the lungs, portions of the kidney tubules, lining of serous membranes (mesothelium) of the body cavities (pleural, pericardial, peritoneal), and inner surface of the tympanic membranes

(b) Simple Cuboidal Epithelium

Structure: Single layer of cube-shaped cells; some cells have microvilli (kidney tubules) or cilia (terminal bronchioles of the lungs)

Function: Secretion and absorption by cells of the kidney tubules; secretion by cells of glands and choroid plexuses; movement of particles embedded in mucus out of the terminal bronchioles by ciliated cells

Location: Kidney tubules, glands and their ducts, choroid plexuses of the brain, lining of terminal bronchioles of the lungs, surfaces of the ovaries

(c) Simple Columnar Epithelium

Structure: Single layer of tall, narrow cells; some cells have cilia (bronchioles of lungs, auditory tubes, uterine tubes, and uterus) or microvilli (intestines)

Function: Movement of particles out of the bronchioles of the lungs by ciliated cells; partially responsible for the movement of oocytes through the uterine tubes by ciliated cells; secretion by cells of the glands, the stomach, and the intestines; absorption by cells of the small and large intestines

Location: Glands and some ducts, bronchioles of the lungs, auditory tubes, uterus, uterine tubes, stomach, intestines, gallbladder, bile ducts, ventricles of the brain
III. Epithelial Tissue

Stratified Epithelium
(a) Stratified Squamous Epithelium

**Structure:** Multiple layers of cells that are cube-shaped in the basal layer and progressively flattened toward the surface; the epithelium can be nonkeratinized (moist) or keratinized; in nonkeratinized stratified squamous epithelium, the surface cells retain a nucleus and cytoplasm; in keratinized stratified epithelium, the cytoplasm of cells at the surface is replaced by a protein called keratin, and the cells are dead.

**Function:** Protection against abrasion, a barrier against infection, reduction of water loss from the body.

**Location:** Keratinized—primarily in the skin; nonkeratinized—mouth, throat, larynx, esophagus, anus, vagina, inferior urethra, cornea.

(b) Stratified Cuboidal Epithelium

**Structure:** Multiple layers of somewhat cube-shaped cells.

**Function:** Secretion, absorption, protection against infection.

**Location:** Sweat gland ducts, ovarian follicular cells, salivary gland ducts.

(c) Stratified Columnar Epithelium

**Structure:** Multiple layers of cells with tall, thin cells resting on layers of more cube-shaped cells; the cells are ciliated in the larynx.

**Function:** Protection, secretion.

**Location:** Mammary gland ducts, larynx, a portion of the male urethra.
III. Epithelial Tissue

Pseudostratified Epithelium & Transitional Epithelium
(a) Pseudostratified Columnar Epithelium

**Structure:** Single layer of cells; some cells are tall and thin and reach the free surface, and others do not; the nuclei of these cells are at different levels and appear stratified; the cells are almost always ciliated and are associated with goblet cells that secrete mucus onto the free surface.

**Function:** Synthesize and secrete mucus onto the free surface; move mucus (or fluid) that contains foreign particles over the surface of the free surface and from passages.

**Location:** Lining of the nasal cavity, nasal sinuses, auditory tubes, pharynx, trachea, bronchi of the lungs.

(b) Transitional Epithelium

**Structure:** Stratified cells that appear cube-shaped when the organ or tube is not stretched and squamous when the organ or tube is stretched by fluid; the number of layers also decreases on stretch.

**Function:** Accommodate fluctuations in the volume of fluid in organs or tubes; protect against the caustic effects of urine.

**Location:** Lining of the urinary bladder, ureters, superior urethra.
IV. Connective Tissue (CT)

• This tissue has cells separated by abundant XCM
  • It varies widely in structure
  • Performs a variety of fxns
• Can be found in every organ in the body
IV. Connective Tissue

Fxns of the CT

1. Enclosing & separating
   – Encapsulates organs separate arteries, veins, muscles, & nerves from one another

2. Connecting tissues to one another
   – Ex/ tendons & ligaments

3. Supporting & moving parts of the body
   – Bones cartilage give shape & support
   – Joints allow movement

4. Storing compounds
   – Adipose & bone tissue

5. Cushioning and Insulating
   – Adipose tissue around kidneys & under the skin

6. Transporting
   – Blood transports gases, nutrients, enzymes, hormones, & cells of the immune system

7. Protecting
   – Cells of the immune system & blood protect against toxins and tissue injury
   – Bones create a cage to protect internal organs
IV. Connective Tissue

Cells of CT

3 main cell types that deal with the XCM:
1. blasts: create the matrix
2. cytes: maintain the matrix
3. clasts: breakdown matrix

Cells that may be found in CT:

a. Adipose cells: adipocytes (fat cells) cells that house such a large amount of lipid that all cell organelles are pushed to the periphery
b. Mast Cells: commonly found beneath membranes in loose CT & along small bld vessels of organs
   – Contain chemicals released in response to injury (heparin, histamine, proteolytic enz)
c. WBC’s/Leukocytes: move in & out of CT all the time
d. Macrophages: transformed WBC’s (monocytes) that can be fixed or wandering
   – Actively phagocytize foreign or injured cells to protect from infection
e. Undifferentiated Mesenchymal Cells: embryonic cells that remain in adult CT
   – They have the potential to become specialized CT cell types
### IV. Connective Tissue

#### Extracellular Matrix

#### 3 major components:
1. **Protein Fibers**
2. **Ground substance**
3. **Fluid**

**Non-protein fibers & other molecules**

**The combination of these 3 components gives each CT their separate characteristics**

#### Protein Fibers of the Matrix
1. **Collagen Fibers**
   - Strong & flexible not elastic
   - Tendons, ligaments, skin, bone
2. **Reticular Fibers**
   - Not strong but fills spaces between tissues and organs
3. **Elastic Fibers**
   - Can stretch & return to the original shape

#### Ground Substance

**Major Components**

1. **Hyaluronic Acid**
   - Makes fluid slick & perfect for lubrication of joints
2. **Proteoglycan**
   - Aggregates that trap water which give tissues the capacity to return to its original shape when compressed or deformed
3. **Adhesive molecules:**
   - Hold proteoglycan aggregates together & to structures (i.e. PM’s)
IV. Connective Tissue

Classification

• Actually quiet random
• Influenced by:
  1. Types & proportions of cells
  2. XCM components

### TABLE 4.6 Classification of Connective Tissue

<table>
<thead>
<tr>
<th>Embryonic Connective Tissue</th>
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<tbody>
<tr>
<td>Mesenchyme</td>
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<tr>
<td>Mucous connective tissue</td>
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</tr>
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<td>Loose (fewer fibers, more ground substance)</td>
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Embryonic CT

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3\textsuperscript{rd} or 4\textsuperscript{th} week of development it forms by 8 wks most becomes specialized Adult CT

### TABLE 4.7 Embryonic Connective Tissue

<table>
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<th>(a) Mesenchyme</th>
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<tr>
<td><strong>Structure:</strong> The mesenchymal cells are irregularly shaped; the extracellular matrix is abundant and contains scattered reticular fibers</td>
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<td><strong>Location:</strong> Mesenchyme is the embryonic tissue from which connective tissues, as well as other tissues, arise</td>
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![Mesenchyme image](image)

<table>
<thead>
<tr>
<th>(b) Mucous Connective Tissue</th>
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<tbody>
<tr>
<td><strong>Structure:</strong> Mucous tissue is mesenchymal tissue that remains unspecialized; the cells are irregularly shaped; the extracellular matrix is abundant and contains scattered reticular fibers</td>
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<tr>
<td><strong>Location:</strong> Umbilical cord of newborn</td>
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![Mucous Connective Tissue image](image)

*a.k.a. Wharton’s jelly*
### IV. Connective Tissue

#### Adult CT Classification

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Loose CT

- relatively few protein fibers that form a lacy network with numerous spaces filled with ground substance & fluid

- 3 Types:
  1. Areolar
  2. Adipose
  3. Reticular

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</table>
Connective Tissue Proper: Loose Connective Tissue

(a) Areolar Connective Tissue

**Structure:** Cells (e.g., fibroblasts, macrophages, and lymphocytes) within a fine network of mostly collagen fibers; often merges with denser connective tissue

**Function:** Loose packing, support, and nourishment for the structures with which it is associated

**Location:** Widely distributed throughout the body; substance on which epithelial basement membranes rest; packing between glands, muscles, and nerves; attaches the skin to underlying tissues

(b) Adipose Tissue

**Structure:** Little extracellular matrix surrounding cells; the adipocytes are so full of lipid that the cytoplasm is pushed to the periphery of the cell

**Function:** Packing material, thermal insulation, energy storage, and protection of organs against injury from being bumped or jarred

**Location:** Predominantly in subcutaneous areas, in mesenteries, in renal pelvis, around kidneys, attached to the surface of the colon, in mammary glands, in Loose connective tissue that penetrates spaces and crevices

(c) Reticular Tissue

**Structure:** Fine network of reticular fibers irregularly arranged

**Function:** Provides a superstructure for lymphatic and hemopoietic tissues

**Location:** Within the lymph nodes, spleen, bone marrow
Dense CT

- Relatively large number of protein fibers which form thick bundles & fill nearly all of the extracellular space

- 2 major groups:
  1. Regular
     a) Dense regular collagenous CT
     b) Dense regular elastic CT
  2. Irregular
     a) Dense irregular collagenous CT
     b) Dense irregular elastic CT

### Adult Connective Tissue

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TABLE 4.9  Connective Tissue Proper: Dense Connective Tissue

Regular

(a) Dense Regular Collagenous Connective Tissue

Structure: Matrix composed of collagen fibers running in somewhat the same direction
Function: Able to withstand great pulling forces exerted in the direction of fiber orientation; great tensile strength and stretch resistance
Location: Tendons (attach muscle to bone) and ligaments

(b) Dense Regular Elastic Connective Tissue

Structure: Matrix composed of regularly arranged collagen fibers and elastic fibers
Function: Able to stretch and recoil like a rubber band, with strength in the direction of fiber orientation
Location: Vocal folds and elastic ligaments between the vertebrae and along the dorsal aspect of the neck
Irregular

(c) Dense Irregular Collagenous Connective Tissue

**Structure:** Matrix composed of collagen fibers that run in all directions or in alternating planes of fibers oriented in a somewhat single direction

**Function:** Tensile strength capable of withstanding stretching in all directions

**Location:** Sheaths; most of the dermis of the skin; organ capsules and septa; outer covering of body tubes

(d) Dense Irregular Elastic Connective Tissue

**Structure:** Matrix composed of bundles and sheets of collagenous and elastic fibers oriented in multiple directions

**Function:** Capable of strength, with stretching and recoil in several directions

**Location:** Elastic arteries
IV. Connective Tissue

Adult CT Classification

- **Cartilage:**
  - Cells within an extensive and relatively ridged matrix.

- **Bone**
  - Living cells and a mineralized matrix.

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# Supporting Connective Tissue: Cartilage

## (a) Hyaline Cartilage

**Structure:** Collagen fibers are small and evenly dispersed in the matrix, making the matrix appear transparent; the cartilage cells, or chondrocytes, are found in spaces, or lacunae, within the firm but flexible matrix.

**Function:** Allows the growth of long bones; provides rigidity with some flexibility in the trachea, bronchi, ribs, and nose; forms rugged, smooth, yet somewhat flexible articulating surfaces; forms the embryonic skeleton.

**Location:** Growing long bones, cartilage rings of the respiratory system, costal cartilage of ribs, nasal cartilages, articulating surface of bones, embryonic skeleton.

## (b) Fibrocartilage

**Structure:** Collagen fibers similar to those in hyaline cartilage; the fibers are more numerous than in other cartilages and are arranged in thick bundles.

**Function:** Somewhat flexible and capable of withstanding considerable pressure; connects structures subjected to great pressure.

**Location:** Intervertebral disks, symphysis pubis articular disks (e.g., knee and temporomandibular [jaw] joints).

## (c) Elastic Cartilage

**Structure:** Similar to hyaline cartilage, but matrix also contains elastic fibers.

**Function:** Provides rigidity with even more flexibility than hyaline cartilage because elastic fibers return to their original shape after being stretched.

**Location:** External ears, epiglottis, auditory tubes.
**TABLE 4.11 Supporting Connective Tissue: Bones**

(a) **Spongy Bone**

**Structure:** Latticelike network of scaffolding characterized by trabeculae with large spaces between them filled with hemopoietic tissue; the osteocytes, or bone cells, are located within lacunae in the trabeculae

**Function:** Acts as scaffolding to provide strength and support without the greater weight of compact bone

**Location:** In the interior of the bones of the skull, vertebrae, sternum, and pelvis; in the ends of the long bones

![Spongy Bone Diagram]

(b) **Compact Bone**

**Structure:** Hard, bony matrix predominates; many osteocytes (not seen in this bone preparation) are located within lacunae that are distributed in a circular fashion around the central canals; small passageways connect adjacent lacunae

**Function:** Provides great strength and support; forms a solid outer shell on bones that keeps them from being easily broken or punctured

**Location:** Outer portions of all bones, the shafts of long bones

![Compact Bone Diagram]
IV. Connective Tissue

Adult CT Classification

- Fluid CT.
  - Blood
    - is unusual among the CT’s because the matrix between the cells is liquid.
  - Hemopoietic Tissue
    - 2 types one produced blood cells the other is a storage site for fat.

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</tr>
<tr>
<td>White blood cells</td>
</tr>
<tr>
<td>Platelets</td>
</tr>
<tr>
<td>Hemopoietic tissue</td>
</tr>
<tr>
<td>Red marrow</td>
</tr>
<tr>
<td>Yellow marrow</td>
</tr>
</tbody>
</table>
### TABLE 4.12  
**Fluid Connective Tissue: Blood and Hemopoietic Tissue**

#### (a) Blood  
**Structure:** Blood cells and a fluid matrix  
**Function:** Transports oxygen, carbon dioxide, hormones, nutrients, waste products, and other substances; protects the body from infections and is involved in temperature regulation  
**Location:** Within the blood vessels; white blood cells frequently leave the blood vessels and enter the interstitial spaces

#### (b) Bone Marrow  
**Structure:** Reticular framework  
**Function:** Produces new blood cells (red marrow); stores lipids (yellow marrow)  
**Location:** Within marrow cavities of bone; two types: (1) red marrow (hemopoietic, or blood-forming, tissue) in the ends of long bones and in short, flat, and irregularly shaped bones and (2) yellow marrow, mostly adipose tissue, in the shafts of long bones

---

*Images and diagrams illustrating various cells and tissues mentioned.*
V. Muscle Tissue

- A tissue than can shorten forcefully causing movement which is accomplished by the interaction of contractile proteins

- These can move the entire body, pump blood, change blood vessel size, or decrease the size of hollow organs

- **3 types of muscle tissue:**
  1. Skeletal muscle
     - Voluntary; body movement
  2. Cardiac Muscle
     - Involuntary; pumping the blood
  3. Smooth Muscle
     - Involuntary; changing hollow organ size, and blood vessel diameter
### Muscle Tissue

#### (a) Skeletal Muscle

- **Structure:** Skeletal muscle cells or fibers appear striated (banded); cells are large, long, and cylindrical, with many nuclei located at the periphery.
- **Function:** Moves the body; is under voluntary (conscious) control.
- **Location:** Attached to bone or other connective tissue.

![Muscle Cells](image)

#### (b) Cardiac Muscle

- **Structure:** Cardiac muscle cells are cylindrical and striated and have a single, centrally located nucleus; they are branched and connected to one another by intercalated disks, which contain gap junctions.
- **Function:** Pumps the blood; is under involuntary (unconscious) control.
- **Location:** In the heart.

![Cardiac Muscle Cells](image)

#### (c) Smooth Muscle

- **Structure:** Smooth muscle cells are tapered at each end, are not striated, and have a single nucleus.
- **Function:** Regulates the size of organs, forces fluid through tubes, controls the amount of light entering the eye, and produces “goose flesh” in the skin; is under involuntary (unconscious) control.
- **Location:** In hollow organs, such as the stomach and small and large intestines.

![Smooth Muscle Cells](image)
VI. Nervous Tissue

A. Brain, Spinal Cord, & Nerves
B. Characterized by its ability to conduct electrical signals called action potentials
# VI. Nervous Tissue

Consists of 2 Cell Types

<table>
<thead>
<tr>
<th>1. Neuron</th>
<th>2. Neuroglia Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Conducting cells</td>
<td>• Supporting cells for neurons</td>
</tr>
<tr>
<td></td>
<td>• Nourish, protect, &amp; insulate neurons</td>
</tr>
</tbody>
</table>

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**Diagram:**
- Neuron: Nucleus, Axon hillock, Axon, Myelin sheath, Presynaptic terminals, Dendritic spines, Soma, Muscle fiber
- Neuroglia Cells: Bipolar (Interneuron), Unipolar (Sensory Neuron), Multipolar (Motoneuron)

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**AP1 Chapter 4**
## Table 4.15: Types of Neurons

**A) Multipolar Neuron**

**Structure:** The neuron consists of dendrites, a cell body, and a long axon; neuroglia, or support cells, surround the neurons.

**Function:** Neurons transmit information in the form of action potentials, store “information,” and integrate and evaluate data; neuroglia support, protect, and form specialized sheaths around axons.

**Location:** In the brain, spinal cord, ganglia.

![Multipolar Neuron Diagram](image)

- **Dendrite**
- **Cell body of neuron**
- **Nucleus of neuron**
- **Nuclei of neuroglia cells**
- **Neuroglia cells**
- **Axon**
**Types of Neurons**

(b) **Pseudo-Unipolar Neuron**

**Structure:** The neuron consists of a cell body with one axon.

**Function:** Conducts action potentials from the periphery to the brain or spinal cord.

**Location:** In ganglia outside the brain and spinal cord.

![Diagram of a Pseudo-Unipolar Neuron](image)
VII. Membranes

Thin sheet/layer of tissue that covers a structure or lines a cavity
Normally: CT + Epi
VII. Membranes

A. External Membrane

• Skin

B. Internal Membrane

1. Mucous
2. Serous
3. Synovial
VII. Membranes

Internal Membrane

1. Mucous Membrane

- **Anatomy**
  - Epi cells, basement membrane, lamina propria, sometimes a layer of smooth muscle

- **Physiology**
  - Specific to location.
  - Main fxns include:
    - Protection
    - Absorption
    - Secretion

- **Location**
  - Line cavities or canals that open to the outside of the body

2. Serous Membrane

- **Anatomy**
  - Mesothelium, basement membrane, delicate layer of loose CT
  - Serous Fluid: prod’ed by serous membrane to act as lubricant

- **Physiology**
  - Protects organs from friction
  - Helps hold organs in place
  - Act as a selectively permeable barrier to prevent fluid accumulation in serous cavities

- **Location**
  - Lines cavities
VII. Membranes

Internal Membrane

3. Synovial Membrane

- **Anatomy**
  1. Modified CT intermixed w/part of dense CT of the joint capsule
  2. Modified CT separated from capsule by areolar/adipose tissue

- **Physiology**
  - Produce synovial fluid rich in hyaluronic acid
    - It is slippery and thus it facilitates smooth movement of joints

- **Location**
  - Line freely mobile joints
VIII. Inflammation

Occurs when:
1. Tissues are damaged
2. Associated w/immune response
VIII. Inflammation

- Mobilizes the body’s defenses, isolates & destroys microorganisms & other injurious agents
- Removes foreign materials & damaged cells so tissue repair can proceed

5 Major Manifestations

1. Redness
2. Heat
3. Swelling
4. Pain
5. Disturbance of fxn
*Injury*

- Chemical mediators are released & activated in the tissues and adjacent blood vessels (includes things like histamine, kinins, prostaglandins, leukotrienes…)
- Some induce blood vessel dilation & produce redness and heat which is beneficial because it speeds the WBC’s arrival to the site of injury
- Some stimulate pain receptors & increase blood vessel permeability which allows clotting proteins & WBC’s to move from the blood vessel to the tissue to deal directly with the injury
- Proteins also move into the tissues which water flows causing edema
  - Increased pressure in the tissue, stimulates neurons, causing pain.
- Clotting proteins help to isolate injurious agents preventing them from causing further injury
- Pain & edema cause a disruption in fxn, thus the person is careful with the injured area preventing further damage.
- Meds can be given to manage symptoms and in some cases antibiotics are needed
VIII. Inflammation

1. A splinter in the skin causes damage and introduces bacteria. Mediators of inflammation are released or activated in injured tissues and adjacent blood vessels. Some blood vessels are ruptured, causing bleeding.

2. Mediators of inflammation cause capillaries to dilate, causing the skin to become red. Mediators of inflammation also increase capillary permeability, and fluid leaves the capillaries, producing swelling (arrows).

3. White blood cells (e.g., neutrophils and macrophages) leave the dilated blood vessels and move to the site of bacterial infection, where they begin to phagocytize bacteria and other debris.
IX. Tissue Repair
Substitution of living for dead cells
IX. Tissue Repair can occur in 2 ways

**Regeneration**
- New cells of the type that were lost are put in place
- Normal fxn is usually restored

**Replacement**
- New type of tissue develops and eventually scar is prod’d and loss of some tissue

Which path it takes depends on the tissues involved/nature & extent of the wound

Cell Classification

1. **Labile Cells**
   - Cells continue to divide thru life (Skin)

2. **Stable Cells**
   - Don’t divide after growth stops, but retain the ability to divide thus they are capable of regeneration after an injury

3. **Permanent Cells**
   - Very limited regeneration if killed they are usually replaced by different cell type (neurons)
IX. Tissue Repair

Primary Union (Intension)
• Edges of the wound are close together
• Ex/ Slice by scalpel

Secondary Union (Intension)
• Edges of the wound are far apart or an extensive loss of tissue
IX. Tissue Repair

• Primary Union
  1. Wound fills w/bld
  2. Clot forms w/fibrin & binds wound's edges together
  3. Clot surface dries forming scab (seals wound) & prevents infection
  4. Inflammatory Response:
     • Vasodilatation induction, ↑ bld cell # & other substances to injury area, Bld vessel permeability ↑ causing edema
       – Fibrin & bld cells move to injured areas
       – Acts as blockage isolating microorganisms & foreign matter
       – WBC Neutrophils ingest bacteria, debris, clear area for repair
       – Pus → Dead neutrophils & fluid
IX. Tissue Repair

- Primary Union continued.
  5. Fibroblasts from surrounding CT
     - Migrate to clot & make XCM components
  6. Capillaries grow from bld vessels at ends of wound revascularizing the area
     - Fibrin in clot is broken down & removed
     - Result ➔ replace clot w/delicate CT (aka granulation tissue ➔ fibroblasts, collagen, & capillaries
     - Granulation tissue is converted into a scar (dense irregular collagenous CT)
  7. Scar- initially appears red b/c of vascularization b/c WBC & collagen accumulation causing compression of vascular channels
IX. Tissue Repair

Secondary Union
1. B/c of large distance clot may not close gap completely
2. Longer epi cell regeneration & cover wound
   - ↑ tissue damage
   - ↑ inflammation
   - ↑ # of cell debris to clean-up
   - ↑ risk of infection
3. More granulation tissue development, wound contraction (disfiguring & debilitating scars)
   - Suture to induce primary healing & reduce chance of infection & of scarring
1. A fresh wound cuts through the epithelium (epidermis) and underlying connective tissue (dermis), and a clot forms.

2. Approximately 1 week after the injury, a scab is present, and epithelium (new epidermis) is growing into the wound.

3. Approximately 2 weeks after the injury, the epithelium has grown completely into the wound, and granulation tissue has formed.

4. Approximately 1 month after the injury, the wound has completely closed, the scab has been sloughed, and the granulation tissue is being replaced with dermis.
X. Tissues & Aging

• Age related $\Delta$’s result from rate of cell division & $\Delta$’s to extracellular fibers
• Collagen is less flexible thus there is reduced strength
• Elastic tissues become fragmented & less elastic