The Tissue Level of Organization

Objectives

• Identify the structure and function of the four major tissue types.
• Be able to identify each of the major tissue types and subtypes using light microscopy.
• Describe how injury and aging affect tissues.

Tissues of the Body

Tissues: collections of specialized cells with specific functions.

Histology: the study of tissues.

There are 4 basic types of tissues:
1. Epithelial tissue covers surfaces exposed to the environment (skin, airways, digestive tracts, glands)
   • simple and stratified
   • squamous, cuboidal columnar
   • pseudostratified, transitional
2. Connective tissue fills internal spaces, supports other tissues, transports materials and stores energy.
   • Connective Tissue Proper: Loose CT Proper, Dense CT Proper
   • Blood, lymph, adipose, bone, cartilage (hyaline, elastic, fibrocartilage),
3. Muscle tissue is specialized for contraction (skeletal muscle, cardiac muscle, smooth muscle).
4. Neural tissue carries electrical signals from one part of the body to another. Neurons and neuroglia

Epithelial Tissue

Epithelial tissue includes:
- epithelia: layers of cells that cover internal or external surfaces.
- glands: structures that produce fluid secretions.

Epithelia line digestive, respiratory, urinary and reproductive tracts. Also fluid or gas-filled internal cavities and passageways such as the chest cavity, inner surfaces of blood vessels and chambers of heart.

Epithelia have 5 important characteristics:
1. Cellularity: cells are tightly bound together by cell junctions.
2. Polarity: the structural and functional differences between the exposed (apical) and attached (basal) surfaces of the tissue.
3. Attachment: the base of the epithelia is bound to a basal lamina or basement membrane.
4. Avascularity: epithelia are avascular (lacking blood vessels)
5. Regeneration: a high rate of cell replacement by stem cells in the epithelium.
Classification of Epithelia

- Epithelia are sorted into categories by cell shape (squamous = flat, cuboidal = square, columnar = tall) and number of cell layers.
  - One cell layer is simple epithelium, more than one layer is stratified epithelium.

Be able to identify the bolded tissues below:

I. Squamous Epithelia
   1. Simple squamous epithelium is thin and flat. Only 1 layer thick
      - Mesothelium: simple squamous epithelium lining ventral body cavities (pleura, peritoneum, pericardium).
      - Endothelium: simple squamous epithelium lining heart and blood vessels.
   2. Stratified squamous epithelium forms many layers which protect against chemical and physical attacks. It is found lining the mouth, esophagus and anus, and on exposed body surfaces.

II. Cuboidal Epithelia
   1. Simple cuboidal epithelium occurs where secretion or absorption takes place (e.g. lining of kidney tubules).
   2. Stratified cuboidal epithelia are relatively rare

III. Transitional epithelia tolerate repeated cycles of stretching without damage (e.g. urinary bladder). It is called transitional because cell layers change appearance (from stratified to simple) as they stretch.

IV. Columnar Epithelia
   1. Simple columnar epithelium is found where absorption or secretion occur (e.g. stomach, small intestine, large intestine).
   2. Pseudostratified columnar epithelium appears stratified but is actually simple. Cilia-bearing cells found in portions of the respiratory tract (e.g. nasal cavity, trachea and bronchi) and portions of the male reproductive tract.
   3. Stratified columnar epithelia are relatively rare.

Glandular Epithelia

- Glands are cells, or collections of cells, specialized for secretions ranging from sweat to hormones.

- Endocrine glands (endo = in) release hormonal secretions into interstitial fluids.
  - The bloodstream carries hormones throughout the body.
  - Hormones control specific tissues, organs and organ systems.
  - Examples of endocrine glands are the thyroid gland and pituitary gland.
  - Endocrine glands have no ducts.
• **Exocrine glands** (*exo* = out) release secretions into **ducts** which carry the secretions onto an epithelial surface such as the skin, or an internal passageway that communicates with the outside environment.
- Examples of exocrine secretions are digestive enzymes, sweat, tears and milk.

**Connective Tissues**
- Connective tissue connects the epithelium. Other connective tissues provide structure (e.g. bone), store energy (e.g. fat), and transport materials throughout the body (e.g. blood).
- Though there are many different kinds of connective tissues, all have three basic characteristics:
  1. Specialized cells, usually widely scattered
  2. Extracellular **protein fibers**
  3. A fluid, extracellular **ground substance**

**Classification of Connective Tissues**
- **Connective Tissue Proper**:
  - Loose CT Proper – areolar tissue
  - Dense CT Proper – dense regular CT
- Blood, (and lymph)
- Adipose tissue
- Bone (osseous tissue)
- Cartilage
  - Hyaline – most common, growth plates, articular ends of bones
  - Elastic – external ear, larynx
  - Fibrocartilage – IV discs, pads in knee joint

**Muscle Tissue**
- **Muscle tissue** is specialized for contraction. All body movement is produced by muscle tissue.
- There are three types of muscle tissues (skeletal, cardiac and smooth) each with its own special structures and functions.
  - Muscle cells can be **striated** (muscle cells with a banded appearance) or **nonstriated** (not banded).
  - Muscle cells can have a single nucleus or be **multinucleate**.
  - Muscle cells can be controlled **voluntarily** (consciously) or **involuntarily** (automatically).

6. **Skeletal muscle tissue** forms the large body muscles responsible for major body movements such as walking. Skeletal muscle cells:
  - are long and thin, and are usually called **muscle fibers**.
  - do not divide, new fibers are produced by stem cells called **satellite cells**.
  - are striated, voluntary, and multinucleated.
7. **Cardiac muscle tissue** is found only in the heart. Cardiac muscle cells:
   - are called **cardiocytes**.
   - form a branching network connected at **intertcalated disks**.
   - are regulated by pacemaker cells.
   - are striated, involuntary, and have a single, central nucleus.

8. **Smooth muscle tissue** is found within the walls of hollow organs that contract (blood vessels; urinary bladder; respiratory, digestive and reproductive tracts). Smooth muscle cells:
   - are small and tapered.
   - can divide and regenerate.
   - are nonstriated, involuntary, and have a single nucleus.

**Neural Tissue**

- Neural tissue (nervous or nerve tissue) is specialized for conducting electrical impulses that rapidly sense the internal or external environment, process information and control responses.

- Most neural tissue is concentrated in the brain and spinal cord, which make up the central nervous system.

- There are 2 kinds of neural cells:
  1. neurons, the nerve cells that do the electrical communicating, and
  2. neuroglia, the support cells that repair and supply nutrients to neurons.

- Neurons are made up of 3 parts:
  1. the cell body contains the nucleus and nucleolus.
  2. dendrites are short branches extending from the cell body to receive incoming signals.
  3. the axon (nerve fiber) is a long, thin extension of the cell body that carries outgoing electrical signals to their destination.

**Tissue Injuries and Repair**

- The restoration of homeostasis after a tissue has been injured involves 2 processes: **inflammation** and **regeneration**.

  1. **Inflammation** is the tissue’s first response to injury. Signs of inflammatory response include swelling, redness, heat, and pain at the site of the injury.

    The presence of harmful bacteria (pathogens) in a tissue (an infection) also causes an inflammatory response.

  2. When the injury or infection has been cleared up, the **regeneration** or healing phase begins.
- Fibroblasts move into the necrotic area, laying down collagen fibers that bind the area together (scar tissue).
- New cells migrate into the area, or are produced by mesenchymal stem cells.
- Not all tissues can regenerate. Epithelia and connective tissues regenerate well. Cardiac cells and neurons do not regenerate.

**Aging and Tissue Structure**

- The speed and effectiveness of tissue repairs decreases as people age. Contributing factors include:
  - a slower rate of energy consumption (metabolism).
  - changes in hormonal activity.
  - reduced physical activity.

- The cumulative effects of chemical and structural tissue changes associated with age include:
  - thinning of epithelia and connective tissues.
  - increased bruising and bone brittleness.
  - joint pain and broken bones.
  - cardiovascular disease.
  - mental deterioration.

**Aging and Cancer Incidence**

- Cancer rates increase with age.
- About 1 in 4 people in the United States develop cancer.
- Cancer is the #2 cause of death in the United States.
- Most cancers result from chemical exposure and environmental factors such as cigarette smoke; and genetic predisposition.