Chapter 4 Outline

I. INTRODUCTION

A. A *tissue* is a group of similar cells that usually have a similar embryological origin and are specialized for a particular function.

1. The nature of the extracellular material that surrounds the connections between the cells that compose the tissue influence the structure and properties of a specific tissue.
2. The science that deals with the study of tissues is called *histology*.

II. TYPES OF TISSUES AND THEIR ORIGINS

A. Depending on their function and structure, the various tissues of the body are classified into four principal types.

1. *Epithelial tissue* covers body surfaces, lines hollow organs, body cavities, and ducts; and forms glands.
2. *Connective tissue* protects and supports the body and its organs, binds organs together, stores energy reserves as fat, and provides immunity.
3. *Muscle tissue* is responsible for movement and generation of force.
4. *Nervous tissue* initiates and transmits action potentials (nerve impulses) that help coordinate body activities.

III. CELL JUNCTIONS

A. *Cell junctions* are points of contact between adjacent plasma membranes.

B. Depending on their structure, cell junctions may serve one of three functions.

1. Some cell junctions form fluid-tight seals between cells.
2. Other cell junctions anchor cells together or to extracellular material.
3. Still others act as channels, which allow ions and molecules to pass from cell to cell within a tissue.

C. The five most important kinds of cell junctions are tight junctions, adherens junctions, desmosomes, hemidesmosomes, and gap junctions.

1. *Tight junctions* form fluid-tight seals between cells and are common among epithelial cells that line the stomach, intestines, and urinary bladder.
2. *Adherens junctions* are made of plaque and anchor cells together.
3. *Desmosomes* are composed of plaque and are linked by transmembrane glycoproteins that extend across a gap between adjacent cell membranes and link the cytoskeletons of cells together.
4. *Hemidesmosomes* connect cells to extracellular material such as the basement membrane.
5. *Gap junctions* allow cells in a tissue to rapidly communicate through transmembrane protein channels that connect cells together.

IV. EPITHELIAL TISSUES

A. General Features of Epithelial Tissues

1. Following are the general features of epithelial tissues.
    a. Epithelial cells are arranged in sheets, in either single or multiple layers.
    b. Epithelium consists mostly of packer cells with little extracellular material.
    c. Many cell junctions are present, providing secure attachments among cells.
    d. An epithelial cell has an *apical surface* and a *basal surface* attached to a base membrane.
    e. Epithelia adhere firmly to nearby connective tissue via a thin extracellular layer, the basement membrane.
    f. Epithelial tissue is avascular; exchange of materials between epithelium and adjacent connective tissue is by diffusion.
    g. Epithelia have a nerve supply.
    h. Epithelia have a high capacity for renewal (a high mitotic rate).
2. Functions of epithelia include protection, filtration, secretion, absorption, and excretion.

3. The subtypes of epithelium include covering and lining epithelium and glandular epithelium.

B. Covering and Lining Epithelium

1. Classification
    a. The eight types of covering and lining epithelial tissue are classified according to the way the cells are arranged in layers.
    b. Epithelial tissue is also classified by the characteristic shape of cell.
2. Layers are arranged as *simple* (one layer), *stratified* (several layers), and *pseudostratified* (one layer that appears as several).
3. Cell shapes include *squamous* (flat), *cuboidal* (cube-like), *columnar* (rectangular), and *transitional* (variable).
    a. Covering and lining epithelia may be classified as a combination of arrangement of layers and shape of the cells. The name of the specific type of stratified epithelium depends on the shape of the surface cells.
    b. Simple Epithelium
        1) *Simple squamous epithelium* consists of a single layer of flat, scalelike cells.
            a) It is adapted for diffusion and filtration and is found in lungs and kidneys.
            b) It is found in parts of the body that are subject to little wear and tear.
        3) *Simple cuboidal epithelium* consists of a simple layer of cube-shaped cells and performs the functions of secretion and absorption.
        4) *Simple columnar epithelium* consists of a single layer of rectangular cells and can exist in two forms: nonciliated simple columnar epithelium and ciliated simple columnar epithelium.

a) *Nonciliated simple columnar epithelium* contains microvilli (Figure 3.2) to increase surface are and the rate of absorption and goblet cells that secrete mucus.

b) *Ciliated simple columnar epithelium* contains cells with cilia, motile, hair-like processes that help to move fluids or particles along a surface.

c. Stratified Epithelium

1) Epithelia have at least two layers of cells.

a) This is a more durable and protective tissue.

b) The name of the specific kind of stratified epithelium depends on the shape of the surface cells.

2) *Stratified squamous epithelium* consists of several layers of cells in which the top layer of cells is flat and the deeper layers of cells vary in shape.

a) The basal cells replicate by mitosis and ultimately work their way to the surface.

b) In *keratinized stratified squamous epithelium*, a tough layer of keratin (a protein resistant to friction and repels bacteria) is deposited in the surface cells.

c) *Nonkeratinized stratified squamous epithelium* does not contain keratin and remains moist.

3) *Stratified cuboidal epithelium* is a rare tissue consisting of two or more layers of cube-shaped cells .

4) *Stratified columnar epithelium* consists of several layers of cells of which only the top layer is columnar. It is somewhat rare.

5) *Transitional epithelium* consists of several layers of cells whose appearance is variable.

a) It is capable of stretching and thus permits distention of an organ.

b) It lines the urinary bladder and portions of the ureters and the urethra.

c. *Pseudostratified epithelium* has only one layer but gives the appearance of many.

1) All cells are attached to the basement membrane but some do not reach the apical surface.

2) In *pseudostratified ciliated columnar epithelium*, the cells that reach the surface either secrete mucus (goblet cells) or bear cilia that sweep away mucus and trapped foreign particles.

3) *Pseudostratified nonciliated columnar epithelium* contains no cilia or goblet cells.

C. Glandular Epithelium

1. A *gland* is a single cell or a mass of epithelial cells adapted for secretion.
2. *Endocrine glands* are ductless; their secretory products (hormones) enter the extracellular fluid and diffuse into the blood.
3. *Exocrine glands* (sweat, oil, and digestive glands) secrete their products into ducts that empty at the surface of covering and lining epithelium or directly onto a free surface.
4. Structural Classification of Exocrine Glands
    a. Unicellular glands are single-celled, such as the goblet cell.
    b. Multicellular glands are composed of cells that form a distinctive microscopic structure or macroscopic organ, such as sweat, oil, and salivary glands.

1) They occur in several different forms including tubular glands, acinar glands, tubuloacinar glands, simple glands, and compound glands.

2) Combining the shapes of the secretory portion with the degree of branching of the duct gives the structural classification for multicellular glands.

6. Functional classification of exocrine glands is based on whether a secretion is a product of a cell or consists of entire or partial glandular cells themselves.
    a. Merocrine *glands* form the secretory products and discharge it by exocytosis.
    b. Apocrine *glands* accumulate their secretary product at the apical surface of the secreting cell; that portion then pinches off from the rest of the cell to form the secretion with the remaining part of the cell repairing itself and repeating the process.
    c. Holocrine *glands* accumulate the secretory product in the cytosol; when the cell dies, it and its products are discharged as the glandular secretion, with the discharged cell being replaced by a new one.

V. CONNECTIVE TISSUE

A. *Connective tissue* is the most abundant and widely distributed tissue in the body.

B. General features of connective tissue

1. Connective tissue consists of three basic elements: cells, ground substance, and fibers (the latter two of which combine to form the *matrix*). Matrix is abundant with relatively few cells and tends to prevent tissue cells from touching one another.
2. The matrix of a connective tissue, which may be fluid, semifluid, gelatinous, fibrous, or calcified, is usually secreted by the connective tissue cells and adjacent cells and determines the tissue's qualities.

3. Unlike epithelia, connective tissues do not occur on free surfaces.
4. Unlike epithelium, connective tissue is highly vascular (except for cartilage and tendons).
5. Except for cartilage, connective tissue, like epithelium, has a nerve supply.

C. Connective Tissue Cells

1. Cells in connective tissue are derived from *mesenchyme.*
    a. Immature cells have names that end in -*blast*(e.g., fibroblast, chondroblast) while mature cells have names that end in -*cyte* (e.g., osteocyte).
    b. Most mature cells have reduced capacity for cell division and matrix formation and are mostly involved in maintaining the matrix.
2. Types of cells found in various connective tissues include *fibroblasts* (which secrete fibers and matrix), *macrophages* (which develop from monocytes and are phagocytic), *plasma cells* (which develop into antibody-producing B lymphocytes, or B cells), *mast cells* (which are abundant alongside blood vessels and produce histamine), *adipocytes* (or fat cells, which store energy in the form of fat), and *white blood cells* (or leukocytes).

D. Connective Tissue Matrix

1. The ground substance and fibers, deposited in the space between the cells, comprise the matrix of connective tissue.
    a. Substances found in the ground substance include hyaluronic acid, chondroitin sulfate, dermatan sulfate, and keratan sulfate.
    b. The function of ground substance is that it supports, binds, and provides a medium for the exchange of materials between the blood and cells, and is active in influencing cell functions.
2. Fibers
    a. Fibers in the matrix provide strength and support for tissues.

b. Three types of fibers are embedded in the matrix between cells of connective tissues.

1) *Collagen fibers*, composed of the protein collagen, are very tough and resistant to stretching, yet allow some flexibility in tissue; they are found in bone, cartilage, tendons, and ligaments.

2) *Elastic fibers*, composed of the protein elastin, provide strength and stretching capacity and are found in skin, blood vessels, and lungs.

3) *Reticular fibers*, consisting of collagen and glycoprotein, provide support in the walls of blood vessels and form a strong, supporting network around fat cells, nerve fibers, and skeletal and smooth muscle fibers.

E. Classification of Connective Tissue

1. Embryonic Connective Tissue

a. Connective tissue that is present primarily in the embryo or fetus is called *embryonic connective tissue*.

b. *Mesenchyme*, found almost exclusively in the embryo, is the tissue form from which all other connective tissue eventually arises.

c. *Mucous connective tissue* (Wharton's jelly) is found in the umbilical cord of the fetus.

2. Types of Mature Connective Tissue

a. Mature connective tissue exists in the newborn, has cells differentiated from *mesenchyme*, and does not change after birth. It is subdivided into several kinds: connective tissue proper, cartilage, bone tissue, and blood. Subtypes include loose connective tissue, dense connective tissue, cartilage, bone, and blood.

b. Loose connective tissue consists of all three types of fibers, several types of cells, and a semifluid ground substance.
    1) *Areolar connective tissue* is a prime example of loose connective tissue. It shows all of the typical loose connective tissue features.
        a) The ground substance aids the passage of nutrients from the blood vessels of the connective tissue into adjacent cells and tissues.
        b) It is found in the subcutaneous layer.
    2) *Adipose tissue* consists of adipocytes which are specialized for storage of triglycerides.
        a) It is found wherever areolar connective tissue is located.
        b) It reduces heat loss through the skin, serves as an energy reserve, supports, protects, and generates considerable heat to help maintain proper body temperature in newborns (brown fat).
    3) *Reticular connective tissue* consists of fine interlacing reticular fibers and reticular cells.
        a) It forms the stroma of certain organs.
        b) It helps to bind together the cells of smooth muscle.
c. Dense connective tissue contains more numerous, thicker, and dense fibers but considerably fewer cells than loose connective tissue.
    1) *Dense regular connective tissue* consists of bundles of collagen fibers in a regular and orderly, parallel arrangement that confers great strength.

2) *Dense irregular connective tissue* contains collagen fibers that are irregularly arranged and is found in parts of the body where tensions are exerted in various directions.
    a) It usually occurs in sheets, such as the dermis of the skin.
    b) It is also found in heart valves, the perichondrium, the tissue surrounding cartilage, and the periosteum.
3) *Elastic connective tissue* consists of elastic fibers and fibroblasts.
    a) It is quite strong and can recoil back to its original shape after being stretched.
    b) It is found in lung tissue and elastic arteries.

d. *Cartilage* consists of a dense network of collagen fibers and elastic fibers embedded in chondroitin sulfate.
    1) Its strength is due to its collagen fibers; its resilience, to the chondroitin sulfate.
    2) Chondrocytes occur with spaces called lacunae in the matrix.
    3) It is surrounded by a dense irregular connective tissue membrane called the *perichondrium.*
    4) Unlike other connective tissues, cartilage has no blood vessels or nerves (except in the perichondrium).
    5) There are three major types of cartilage.
        a) *Hyaline cartilage* is the most abundant but weakest type of cartilage and has fine collagen fibers embedded in a gel-type matrix. It affords flexibility and support and, at joints, reduces friction and absorbs shock. The matrix has a glassy, opaque appearance.

b) *Fibrocartilage* contains bundles of collagen fibers in its matrix. It does not have a perichondrium. Combining strength and rigidity, it is the strongest of the three types of cartilage.

c) *Elastic cartilage* contains a threadlike network of elastic fibers within the matrix. A perichondrium is present. It provides strength and elasticity and maintains the shape of certain organs.

6) The growth of cartilage is accomplished by interstitial (endogenous) growth (expansion from with) and appositional (exogenous) growth (from without).

e. *Bone* (osseous tissue) consists of a matrix containing mineral salts and collagen fibers and cells called osteocytes. It will be discussed in detail in a later chapter.

f. *Blood* has a fluid matrix (plasma) with various blood cells. It will be discussed in detail in a later chapter.

VI. MEMBRANES

A. Membranes are flat sheets of pliable tissue that cover or line a part of the body.

1. Epithelial membranes consist of an epithelial layer and an underlying connective tissue layer and include *mucous membranes*, *serous membranes*, and the *cutaneous membrane* or skin.
2. *Synovial membranes* line joints and contain only connective tissue.

B. Epithelial Membranes

1. *Mucous membranes* (mucosae) line cavities that open to the exterior, such as the gastrointestinal tract.

a. The epithelial layer of a mucous membrane is an important aspect of the body's defense mechanisms, acting as a barrier to pathogens and a trapping surface for particles.

b. The connective tissue layer of a mucous membrane is called the *lamina propria*.

2. A *serous membrane*, or serosa, lines a body cavity that does not open directly to the exterior and covers the organs that lie within the cavity. Examples include the pleura, pericardium, and peritoneum.

    a. These membranes consist of parietal and visceral portions.

    b. The epithelial layer secrets a lubricating serous fluid that reduces friction between organs and the walls of the cavities in which they are located.

C. Synovial *membranes* line joint cavities, bursae, and tendon sheaths and do not contain epithelium; they also secrete a lubricating synovial fluid.

VII. MUSCLE TISSUE will be discussed in detail in a later chapter.

VIII. NERVOUS TISSUE will be discussed in detail in a later chapter.