

BIO 211; Anatomy and Physiology I
REFERENCE: CHAPTER 05

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INTRODUCTION to HISTOLOGY

EPITHELIUM and CONNECTIVE TISSUE

TOPICS OUTLINE

I. The Study of Tissues

A. Interpretation of Tissue Sections

1. Specimens are first preserved in fixative, then cut into histological sections. Last, they are stained and observed.
2. Various angles of observation include longitudinal, cross, transverse, and oblique sections.

B. The Primary Tissue Classes

All tissues consist of **extracellular material** (matrix), and cells.

Spaces between **cells** and **fibers** within a tissue are filled with tissue (**interstitial**) **fluid**.

II. Epithelial Tissue

1. Epithelial tissue covers the **body surface, lines body cavities, and covers many organs**.
2. It adheres to underlying tissue by means of a **basement membrane** made up of **collagen** and **glycoproteins**.
3. Epithelial tissues are classified as **simple or stratified**, plus distinguished by whether all cells touch the basement membrane.

Types of Epithelia follow:

A. Simple Epithelia

1. **Simple epithelium** is made up of **one layer of cells, all adhering to the basement membrane**.
2. **Simple Squamous Epithelium**
 - a. **Simple squamous epithelium is one cell layer thick.**
Well-adapted to transporting substances across it. It has a single, centrally-located nucleus.
 - b. It lines the **alveoli**. The walls of capillaries are made up of the same tissue, but it is called **endothelium**.
 - c. Moist simple squamous epithelium is called **mesothelium**, and covers the **external surfaces of many body organs and cavities**.
3. **Simple Cuboidal Epithelium**
 - a. This type of tissue is made up of a single layer of **cube-shaped** cells with a centrally located nucleus.
 - b. It is common in **glands, and lines kidney tubules and lung bronchioles** (where it is ciliated).
4. **Simple Columnar Epithelium**
 - a. Simple columnar epithelium is a **single layer of vertically elongated, thin cells**.
Nuclei are present in the basal one-third of the cell.
 - b. This tissue **often has a secretory function**, but **absorbs nutrients in the small intestine**.
It is also found **lining the uterine tubes, and in the uterus, stomach, and large intestine**.
5. **Pseudostratified Epithelium**
 - a. In pseudostratified epithelium, **every cell reaches the basement membrane. (different sizes; appears layered)**.
 - b. It is abundant in the **respiratory tract** where it is **ciliated and produces mucus**.
It is also found within the male reproductive tract, and often contains **goblet cells**.

B. Stratified Epithelia

1. **Stratified Squamous Epithelium**
 - a. The surface cells of stratified **squamous** epithelium are **flattened**, while **deeper cells take on a variety of shapes**. It is the tissue of the **epidermis** of the skin.
 - b. Within the epidermis, older cells become **keratinized**.
 - c. **Nonkeratinized stratified squamous epithelium** found: on the **tongue, esophagus, vagina, and anal canal**.
2. **Stratified Cuboidal Epithelium**
Stratified cuboidal epithelium **lines the follicles in the ovary**, and **seminiferous tubules in the testes**. **Sweat ducts** are also lined with this type of tissue.
3. **Stratified Columnar Epithelium**
 - a. This **rare** tissue is found in short transitional zones where one type of epithelium grades into another, such as in the pharynx, larynx, anal canal, and male urethra.
4. **Transitional Epithelium**
 - a. Transitional epithelium is found in the **urinary system where it is capable of distention**.
 - b. When not stretched, it appears to have many cell layers. When distended, there are 2 to 3 layers of cells.

III. Intercellular Junctions, Glands, and Membranes

Intercellular Junctions

1. Intercellular junctions occur **between adjacent cells** and help maintain **structural integrity** of tissue as well as allow **communication between cells**.
2. **Tight Junctions**
 - a. Tight junctions are formed by a zipper-like fusion of membrane proteins of adjacent cells.
 - b. In the intestine, tight junctions keep bacteria out and ensure that nutrients are absorbed into cells, rather than passing between them.
3. **Desmosomes**
A desmosome is a "**spot weld**" between cells that holds them together to help the tissue resist mechanical stress.
4. **Gap (Communicating) Junctions**
Gap junctions are formed by a **ring like structure** made up of membrane proteins.
Chemical communication and **nutrients** can pass from one cell to the next through gap junctions.

IV. Glands

1. Glands are made up of individual cells or organs that produce a substance and secrete it elsewhere.
Glands are made mostly of epithelium.
2. **Endocrine and Exocrine Glands**
 - a. **Endocrine glands** secrete their products (**hormones**) **into the bloodstream**.
 - b. **Exocrine glands have ducts** that convey their secretions to their destinations.
 - c. **Goblet cells** are **unicellular glands** found among **nonsecretory epithelium**.
3. **Exocrine Gland Structure**
 - a. Most exocrine glands are enclosed in a capsule that extends into the interior of the gland, dividing it into **lobes**. Lobes are further subdivided into **lobules**.
 - b. Cells that produce the secretions are called **parenchyma cells**.
 - c. Ducts leaving exocrine glands can be **simple or compound**, and **glands are tubular or acinar**.
4. **Types of Secretions**
 - a. **Serous glands** produce a thin, watery fluid (perspiration, milk, tears, digestive juices).
 - b. **Mucous glands** secrete a glycoprotein (**mucin**) that, combined with water, produces **mucus**.
 - c. **Mixed glands** produce a mixture of the other two types of secretions.
 - d. **Cytogenic glands** (testes and ovaries) produce cells.
5. **Methods of Secretion**
 - a. **Merocrine (eccrine)** glands have **secretory vesicles** and release products by **exocytosis**. These include tear glands, pancreas, gastric glands, and others.
 - b. **Holocrine glands** accumulate a product and secrete it as the **gland cells rupture (oil glands)**.
 - c. **Apocrine glands** produce **merocrine-type** secretions (certain sweat glands, mammary glands) and were once mistakenly thought to represent a third type of gland.

V. Membranes

1. The comparatively **dry cutaneous membrane**, composed of **stratified squamous epithelium** with a layer of fibroconnective tissue, makes up the **SKIN**. *To be studied more completely during Integumentary chapter!*
2. **Mucous membranes**, lining passageways that open to the exterior, are made up of **epithelium**, **areolar connective tissue (lamina propria)**, and **sometimes a muscle layer (muscularis mucosae)**.
3. **Serous membranes** are made up of simple squamous epithelium and **areolar connective tissue**. They produce serous fluid, and line the insides of body cavities and cover some of the organs inside.
4. Certain joints are lined with **synovial membrane** that lacks epithelium but secretes a lubricating synovial fluid.

VI. Tissue Transformations

- A. Unspecialized tissues undergo **differentiation** during embryonic development.
- B. **Hypertrophy** is the enlargement of existing cells.
- C. **Hyperplasia** is cell multiplication.
- D. **Neoplasia** is growth of abnormal, nonfunctional cells.
- E. **Metaplasia** is transformation of one tissue into another.
- F. **Atrophy** is shrinkage of existing tissue.

CONNECTIVE TISSUE

VII. Fibrous Connective Tissues

A. Overview of Connective Tissue

Functionally diverse, connective tissue: binds organs, provides support, facilitates movement, protects, provides immune defense, stores energy and minerals, helps to produce heat, and transports within the bloodstream.

B. Embryonic Connective Tissue

1. Early embryonic tissue gives rise to **mesenchyme**, which in turn, produces most of the permanent **connective tissue**, as well as **muscle**.
2. A second embryonic connective tissue is **mucous connective tissue** that is limited to **Wharton's jelly** that fills and supports tissues of the umbilical cord. It is a temporary tissue.

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VII. Fibrous Connective Tissues (CONT.)

C. Components of Fibroconnective Tissue

1. Cells

- a. **Fibroblasts** are the most common cells of connective tissue. They are large, flat, branching cells that produce **fibers** and **ground substance**.
- b. **Histiocytes** are the **macrophages of connective tissue**.
- c. **Leukocytes**, esp. **neutrophils**, reside in connective tissue and react against bacteria, toxins, and foreign matter.
- d. **Plasma cells** produce **antibodies** and are **only found in inflamed tissue** and the **wall of the digestive tract**.
- e. **Mast cells**, found near blood vessels, produce **heparin** and **histamine**.
- f. **Adipocytes** (fat cells) appear in some types of fibroconnective tissues.

2. Fibers

- a. Fibers are made of protein. Three types are found in connective tissue.
- b. **Collagenous fibers** are tough, flexible, and resist stretching. Collagen constitutes 25% of the body's protein. These are also called **white fibers**.
- c. **Reticular fibers** are **thin collagen fibers** in reticular connective tissue.
- d. **Elastic fibers** are made of the stretchy protein **elastin**. These are also called **yellow fibers**.

3. Ground Substance

The components of ground substance are **tissue fluid, minerals, and proteoglycans**, the especially large colloidal particles that form a viscous tissue gel.

In **bone**, tissue gel is made up of **chondroitin sulfate**;

In fibroconnective tissue, **hyaluronic acid** comprises the gel tissue.

D. Types of Fibroconnective Tissue

1. There are two broad types of fibroconnective tissue: **loose connective tissue (areolar, adipose, and reticular)** and **dense connective tissue (dense regular and dense irregular)**.
2. **Areolar Tissue**
 - a. Areolar tissue has loosely organized fibers and all six cell types. Most of the space is fluid-filled and highly vascular.
 - b. Areolar tissue surrounds blood vessels and nerves, supports epithelium, attaches skin to underlying organs, and forms the lamina propria.
3. **Adipose Tissue**
 - a. Adipose tissue is **areolar tissue** with clusters of **adipocytes**.
 - b. Most fat is located between the skin and muscle (**subcutaneous fat**), as well as **in bone marrow**, and around **the eyes, heart, kidneys, and the spinal cord**.
 - c. Obesity is a significant health risk. most **adults have white fat**. Infants may also have **brown fat that generates heat**.
4. **Reticular Tissue**

Reticular tissue is a mesh of **reticular fibers and fibroblasts**, found in the walls of lymph nodes, spleen, thymus, and bone marrow.
5. **Dense Regular Connective Tissue**
 - a. **Dense regular connective tissue** is the tissue of **tendons and ligaments**. All its fibers run parallel to each other, lending strength to tendons but allowing them to pull in one direction only.
 - b. **Yellow elastic tissue**, a variant of dense regular connective tissue, is found in the vocal cords, and ligaments of the spinal column and penis. This type of tissue also imparts **elasticity to walls of arteries**.
6. **Dense Irregular Connective Tissue**
 - a. This type of tissue has **dense bundles of collagen fibers, and little ground substance**. The bundles run in random directions, so this tissue can resist stretching in many directions.
 - b. This type of tissue forms **most of the dermis** and makes a **protective capsule** around the spleen, kidneys, testes, as well as bones, cartilage, and nerves.

VIII. Supportive and Fluid Connective Tissues

A. Cartilage

1. Cartilage cells are called **chondroblasts** while they are secreting the gel-like matrix that surrounds them, **then turn into chondrocytes** when they are trapped in depressions called **lacunae**.
2. **Hyaline Cartilage**
 - a. Hyaline cartilage has a **smooth, glassy appearance** due to its **thin collagen fibers**.
 - b. It is found at the **ends of bones, in moveable joints, and in the fetal skeleton**.
3. **Elastic Cartilage**
 - a. Elastic cartilage is **yellow**, and covered with a **perichondrium**.
 - b. It is found in the **outer ear, epiglottis, and auditory tube**.
4. **Fibrocartilage**
 - a. Fibrocartilage is **transitional between dense fibroconnective tissue and hyaline cartilage**. It has parallel fibers, but no perichondrium.
 - b. It is found in **intervertebral discs** and the **pubic symphysis**. Pads of fibrocartilage are located in the knee.

B. Bone (Osseous Tissue)

1. **Spongy bone** fills the heads and shafts of long bone and has a spongy appearance.
2. Compact bone is **dense tissue, forming the exterior of all bones**. It is arranged into microscopic **osteons** with a **central (Haversian) canal**. Layers (**lamellae**) of matrix (lamellae). **Lacunae** house **osteocytes**.
3. Whole bones are surrounded by a tough, fibrous **periosteum**.

C. Dental Tissues

Teeth are composed of bone-like tissues, and are made up of **dentin** and **cementum**.

D. Blood and Lymph

1. Blood consists of a **ground substance (plasma)** and **formed elements, erythrocytes** (red blood cells), **leukocytes** (white blood cells), and **platelets**.
2. Lymph is the straw-colored fluid that flows through lymphatic vessels. It joins the bloodstream via large veins in the upper chest region.

IX. Excitable Tissues *will be covered during Muscle/Nervous systems sections of the course!*

A. Muscular Tissue

Muscular tissue is specialized for locomotion and movement of substances through the body, speech, respiration, and heat production.

1. **Skeletal**
 - a. Skeletal muscle consists of cylindrical fibers, usually attached to bones. Some skeletal muscles form a ring-like sphincter.
 - b. **Striations** appear, thus this form of muscle is striated muscle. It is also **voluntary** and **multinucleate**.
2. **Cardiac Muscle**
 - a. This type of muscle comprises the heart and nearby major blood vessels.
 - b. It is also **striated but involuntary**; cells are called **myocytes**. These cells branch and join each other by **intercalated discs** to enable electrical communication between cells.
3. **Smooth**
 - a. Smooth muscle is **involuntary** and its cells are **short and fusiform**, with **one centrally located nucleus**.
 - b. It is located within the viscera, lining the alimentary canal, blood vessels, and the urinary tract.

B. Nervous Tissue

1. Nervous tissue consists of cells conducting impulses (**neurons**) and helper cells (**neuroglia**).
2. Neurons are made up of a **soma (cell body)**, **dendrites** (fibers that receive the message), and **one axon** (nerve fiber) that conveys the message away from the soma. brittle.