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# *Structure, location, classification and functions of Epithelial and Connective tissue*

- Epithelial tissue is a highly cellular tissue that overlies body surfaces, lines cavities, and forms glands. In addition, specialized epithelial cells function as receptors for special senses (smell, taste, hearing, and vision).
- Epithelial cells are numerous, exist in close apposition to each other, and form specialized junctions to create a barrier between connective tissues and free surfaces.
- Free surfaces of the body include the outer surface of internal organs, lining of body cavities, exterior surface of the body, tubes and ducts. The extracellular matrix of epithelial tissue is minimal and lacks additional structures. Although epithelial tissue is avascular, it is innervated.

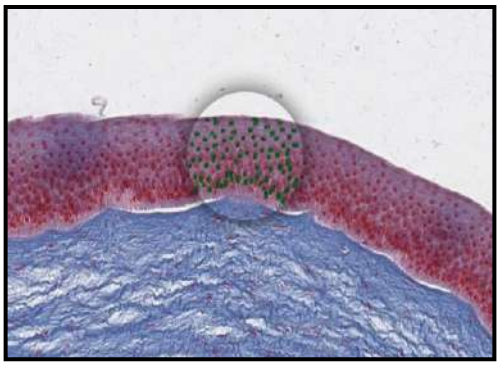

**Figure 1 Epithelial cells nuclei**

## Cell surfaces

- The cells of epithelial tissue have three types of surfaces differentiated by their location and functional specializations: basal, apical, and lateral.

## Basal surface

- The basal surface is nearest to the basement membrane. The basement membrane itself creates a thin barrier between connective tissues and the most basal layer of epithelial cells. Specialized junctions called hemidesmosomes secure the epithelial cells on the basement membrane.
- The apical surface of an epithelial cell is nearest to the lumen or free space. Apical cell surfaces may display specialized extensions. Microvilli are small processes projecting from the apical surface to increase surface area. They are heavily involved in diffusion in the proximal convoluted tubule of the nephron and in the lumen of the small intestines.

**Figure 2 Microvilli**

## Apical surface

- Cilia are small processes found in the respiratory tract and female reproductive tract. Their complex structure facilitates movement that brushes small structures through the lumen of either the trachea or Fallopian tubes. Stereocilia are similar to cilia in size and shape, however they are immotile and more frequently found in the epithelium of the male reproductive tract, specifically in the ductus deferens and the epididymis.

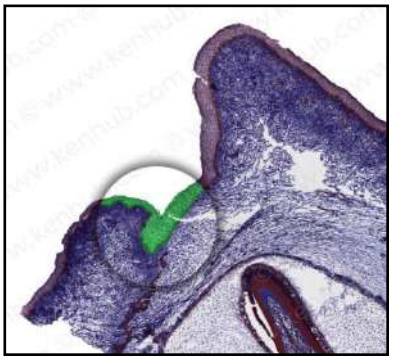

**Figure 3 Squamous epithelium of the mouth**

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## Lateral surfaces

- The lateral surfaces of epithelial cells are located between adjacent cells. The most notable lateral surface structures are junctions. Adhering junctions link the cytoskeleton of neighbouring cells to produce strength in the tissue. Desmosomes can be thought of as spot-welding for epithelial tissues. They are usually located deep to adhering junctions and are found in locations subject to stresses. For example in the stratified epithelium of the skin.

- Tight junctions form a solid barrier to prevent movement of molecules between adjacent epithelial cells. Tight junctions are found in the simple columnar epithelium of the gut tube to regulate absorption of nutrients. Finally, gap junctions perform the opposite function. Gap junctions allow small molecules and structures to pass freely between cells. For example, gap junctions in cardiac muscle tissue allow for coordinated contraction of the heart.

**Summary of epithelial tissue surfaces and characteristics**

| | |
|---|---|
| **Characteristics** | Highly cellular, function as receptors, form a barrier, minimal extracellular matrix, avascular, innervated, |
| **Basal surface** | Basement membrane, hemidesmosomes |
| **Apical surface** | Microvilli, cilia, stereocilia |
| **Lateral surface** | Adhering junctions, desmosomes, tight junctions, gap junctions |

# Tissue structure

- Two major characteristics of epithelial tissue divide it into subclasses: the shape of the cells and the presence of layers.
- Shape of cells:
- Squamous – cells are flattened, can be keratinized or nonkeratinized, involved in protection and diffusion, found in capillary walls and skin
- Cuboidal – cells are cube-shaped, can be found forming tubes in the nephrons of the kidney, involved in secretion and absorption
- Columnar – cells are rectangular, cilia are often present, involved in absorption, secretion, protection, and lubrication, form the inner lining of the gut tube

## Layers:

- Simple – one layer of cells
- Stratified – two or more layers of cells
- Pseudostratified – simple epithelia that appear to be stratified when viewed in cross-section though they are only one layer of cells

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## Specialized epithelial tissue

- Transitional epithelium – distends tissues of urinary tract
- Keratinized stratified squamous epithelium – makes up the epidermis of skin
- Nonkeratinized stratified squamous epithelium – found in regions subject to abrasion, for example oral mucosa and vaginal lining
- Pseudostratified ciliated columnar epithelium – lines the inner surface of the trachea
- Endothelium - lines the inner surface of blood vessels
- Ependymal cells - present in the nervous system.

# Connective tissue

- Connective tissue is the most abundant tissue type in the body. In general, connective tissue consists of cells and an extracellular matrix. The extracellular matrix is made up of a ground substance and protein fibers. So, in a more detailed way, all connective tissue apart from blood and lymph consists of three main components: cells, ground substance and fibers.

**Summary of connective tissue**

| | |
|---|---|
| **Cell types** | Structural, immunological, defense, energy reservoir |
| **Fibers** | Collagen, reticular, elastic |
| **Classification** | Proper: Loose; dense (regular, irregular) connective tissue<br>Embryonic: Mesenchymal; mucous connective tissue<br>Specialized: Cartilage; adipose; bone; blood |

# Connective tissue cells

- The cells originate from mesenchyme, a loosely organized embryonic tissue featuring elongated cells in a viscous ground substance. Connective tissue cells do not oppose each other but rather are separated by a large extracellular matrix.

## Cell Types:

- Structural – fibroblasts, chondroblasts, osteoblasts, odontoblasts
- Immunological – plasma cell, leukocytes, eosinophils
- Defense – neutrophils, mast cells, basophils, macrophages
- Energy re
- servoir – adipose cells

**Figure 4 Ground substance**

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## Connective tissue fibers

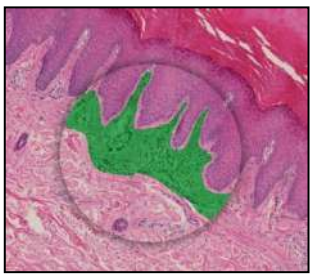

**Figure 5 Loose connective tissue**

- The ground substance of connective tissue contains structural proteins called fibers. There are three types of connective tissue fibers:
- Collagen fibers are the most abundant fiber type. They have a high tensile strength but are also flexible. Collagen fibers are made up of many subunits, called collagen fibrils, that appear striated under electron microscopy. There are many types of collagen and the collagen types present in a tissue give it unique characteristics. For example, type I collagen provides resistance to stretch in bone tissue, while type IV collagen makes up the suprastructure of the basement membrane.
- Reticular fibers are thinner than collagen fibers. They are found in extensive networks and provide structural support and framework. Reticular fibers do not stain with regular H&E stain and a silver stain is needed to stain fibers black, making them visible.
- Elastic fibers are also thinner than collagen. They are strong but can be stretched up to 150% of their original length without breaking. When tension is released they are able to return to their original shape. Elastic fibers are found in skin, blood vessels and lung tissue.
- Classification of connective tissue is based upon two characteristics: the composition of its cellular and extracellular components and its function in the body. Tissues are either classified as proper, embryonic, or specialized.

## Proper connective tissues

- Proper connective tissues include loose connective tissue, often referred to as areolar tissue, and dense connective tissue. Loose connective tissue consists of thin, loosely arranged collagen fibers in a viscous ground substance.
- Dense connective tissue can be further classified into dense regular connective tissue and dense irregular connective tissue. Dense regular connective tissue makes up tendons and ligaments. Fibers are densely packed and organized in parallel to create a strong tissue capable of withstanding the pull of muscle and bone in movement. Dense irregular connective tissue also contains abundant fibers but lacks the directionality of dense regular connective tissue fibers. The high number of fibers provides strength however the disorganized pattern of fibers allows for flexibility. Dense irregular tissue is associated the hollow organs of the digestive tract.

## Embryonic connective tissue

- Embryonic connective tissue, derived from mesoderm, is the precursor to many connective tissues in the adult body. It is categorized into two subtypes: mesenchyme and mucous connective tissue. Mesenchyme is found within the embryo. Mesenchymal cells are spindle shaped with processes

extending from either end. The cell processes connect to those of other mesenchymal cells through gap junctions. Very thin, scattered collagen fibers are present, but they are not particularly strong reflecting the limited stress placed on the tissues of the developing embryo.

- Mucous connective tissue is found in the umbilical cord. The cells of mucous connective tissue are spindle shaped and relatively sparse. A nearly gelatinized ground substance called Wharton's jelly makes up most of the extracellular matrix between the cells and collagen fibers.

## Specialized connective tissues

- Cartilage, adipose tissue, bone, and blood are specialized connective tissues. Adipose cells, or adipocytes, are specialized cells that store fat and synthesize hormones, growth factors, and some inflammatory mediators. They are located in loose connective tissue either as individual cells or in clusters. When adipocytes are clustered in large numbers they are referred to as adipose tissue.

- Bone tissue is unique in that its extracellular matrix is mineralized. Calcium phosphate, in the form of hydroxyapatite crystals, is responsible for the mineralization of bone and creates a very strong tissue able to support and protect the body.Blood is a fluid connective tissue that transports gases, nutrients, and wastes throughout the body. The fluid extracellular matrix of blood is made up of plasma, which constitutes slightly more than half of the tissue volume. The cells of blood tissue are classified as erythrocytes, leukocytes, and thrombocytes. Erythrocytes, or red blood cells, carry oxygen and carbon dioxide through the cardiovascular system. Leukocytes, or white blood cells, are responsible for the immune and allergic responses. Thrombocytes, or platelets, form clots and initiate the repair of injured blood vessels.

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