RU RMT 2
Anatomy and Physiology
Lecture 6
Cell Bio Tissue Level

The Tissue Level of Organization

* Membranes
* Epithelial Membranes
* Synovial Membranes
* Muscular Tissue
* Nervous Tissue
* Excitable Cells
* Tissue Repair: Restoring Homeostasis
* Aging & Tissues

Tissues: each tissue type will look different under a microscope!

* **They are present in different forms and may be:**
  1. Hard, such as bone
  2. Semisolid, such as fat
  3. Liquid, such as blood

* **Their structure and properties are influenced by:**
  1. Nature, type and arrangement of the cells present
  2. Type of extracellular material surrounding the tissue cells
  3. Connections between the cells that compose the tissue
  4. Presence or absence of fibers

4 Types of Tissue

The tissues in our body are classified into four basic types, according to structure and function:

1. **Epithelial tissue**
    - Covers body surfaces
    - Lines hollow organs, body cavities, and ducts
    - Forms glands
    - Functions: protection (physical barrier), absorption, secretion

4 Types of Tissue

2. Connective tissue

* Examples of connective tissue in the body:
  * bones, ligaments, tendons, intervertebral discs, blood, skin, fat, lymph, etc.
* Protects and supports the body and its organs
* Binds organs together
* Stores energy reserves as fat
* Provides immunity

Types of Tissue

3. Muscle tissue

* Generates physical force for movement of body structures
* Generates body heat
* 3 Types of Muscle in the body:
  * Skeletal
  * Cardiac
  * Smooth

Types of Tissue

4. Nervous tissue

* Detects changes in conditions inside and outside the body
* Initiates and transmits action potentials (nerve impulses) that activate muscular contractions and glandular secretions
* Main tissue type in the brain, spinal cord and peripheral nerves

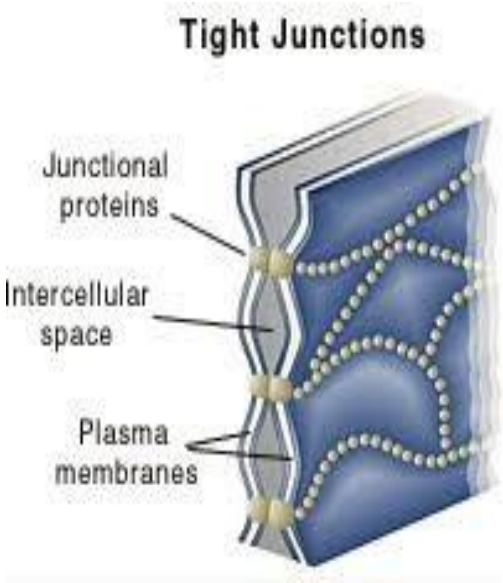
Cell Junctions

* Cell junctions are functional units that provide contact points that connect neighboring cells together
* Cell junctions are present in most tissue types

* Types of cell junctions include:
  1. Tight junctions
  2. Adherens junctions
  3. Desmosomes
  4. Hemidesmosomes
  5. Gap junctions

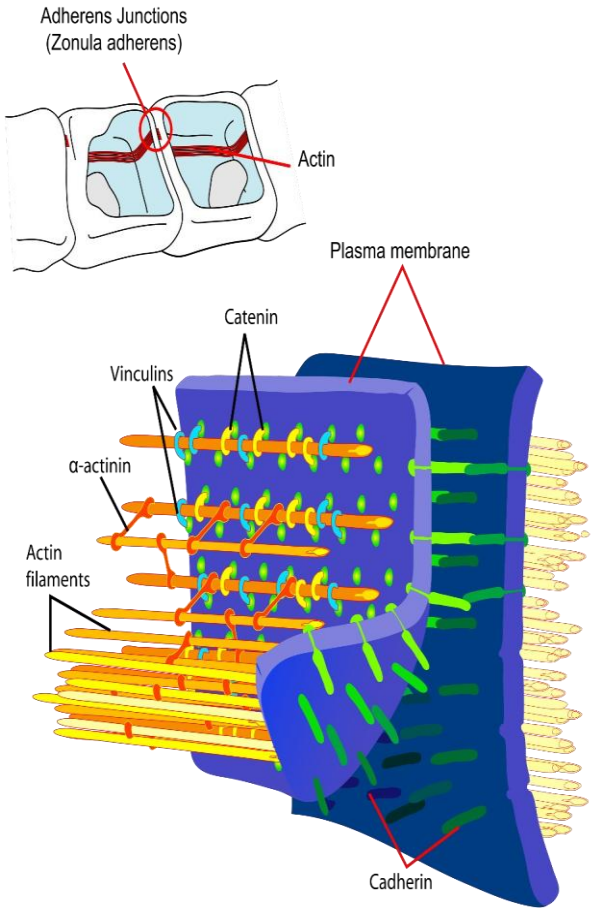
Tight Junctions

* Tight junctions are strong connections between the plasma membranes of adjacent cells
* These connections form an impenetrable barrier ("water tight seal") that prevents the passage of substances
* Tight junctions act as selective barriers that regulate the movement of water and solutes between epithelial layers
* Examples:
  * stomach, bladder



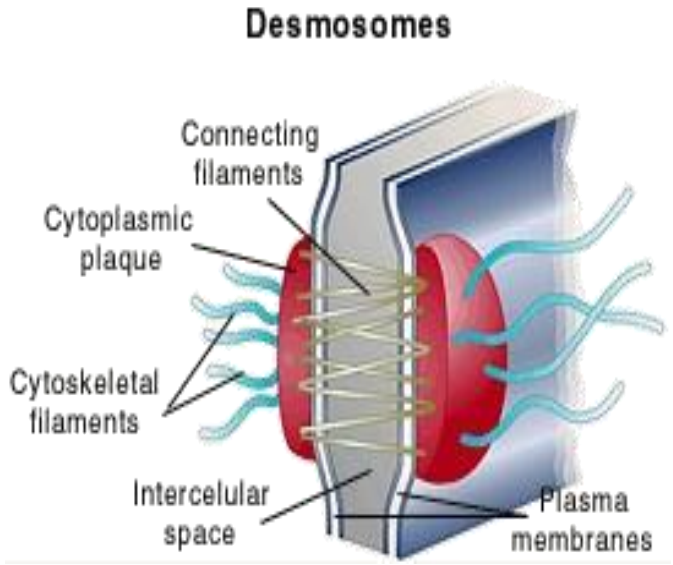
Adherens Junctions

* Adherens junctions attach to both the plasma membranes and microfilaments of adjacent cells
* These junctions help epithelial surfaces to resist slipping, sliding and separation during various contractile activities
  * such as when food passes through the intestines



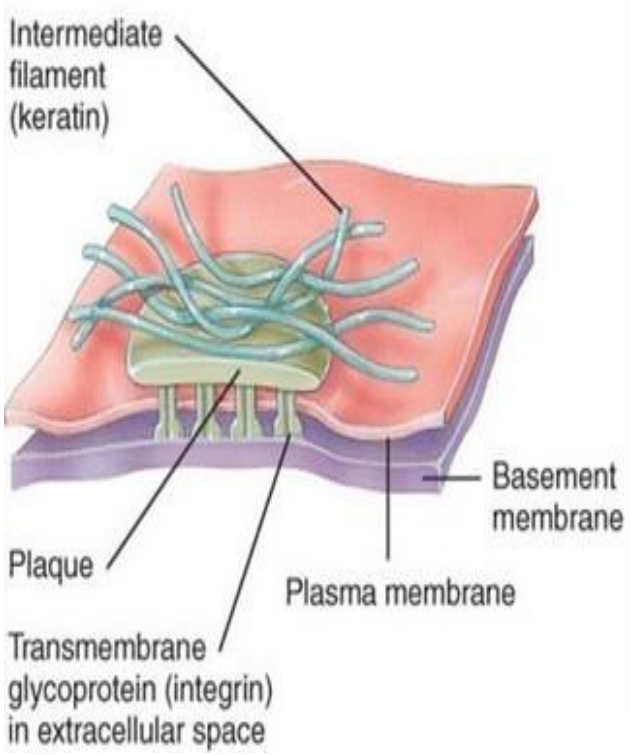
Desmosomes

* Desmosomes contain attach to both to the plasma membrane and the intermediate filaments of the cell
* This structure gives strength to tissues
* Desmosomes prevent epidermal cells from separating under tension and cardiac muscle cells from pulling apart during contraction
* They are present in the outermost layer (epidermis) of the skin and among cardiac muscle cells



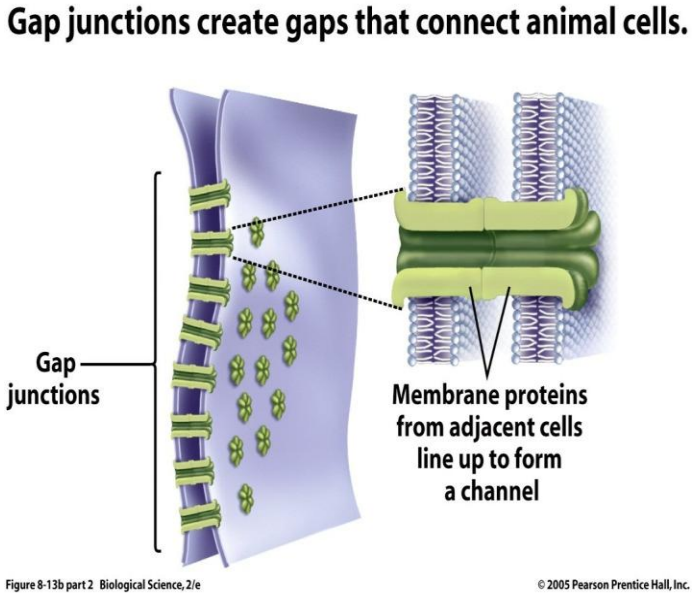
Hemi--desmosomes

* Hemidesmosomes are situated between the plasma membrane and the basement membrane of epithelial cells, thus anchoring cells to the basement membrane
  * Note: the basement membrane anchors epithelial tissue to the underlying tissue



Gap Junctions

* Gap junctions are specialized connections forming tunnels between adjacent cells
* Their function is to allow the transfer of substances between adjacent cells
* Found in cardiac cells and neurons to allow action potentials (propagation of electrical signals passing from cell to cell)



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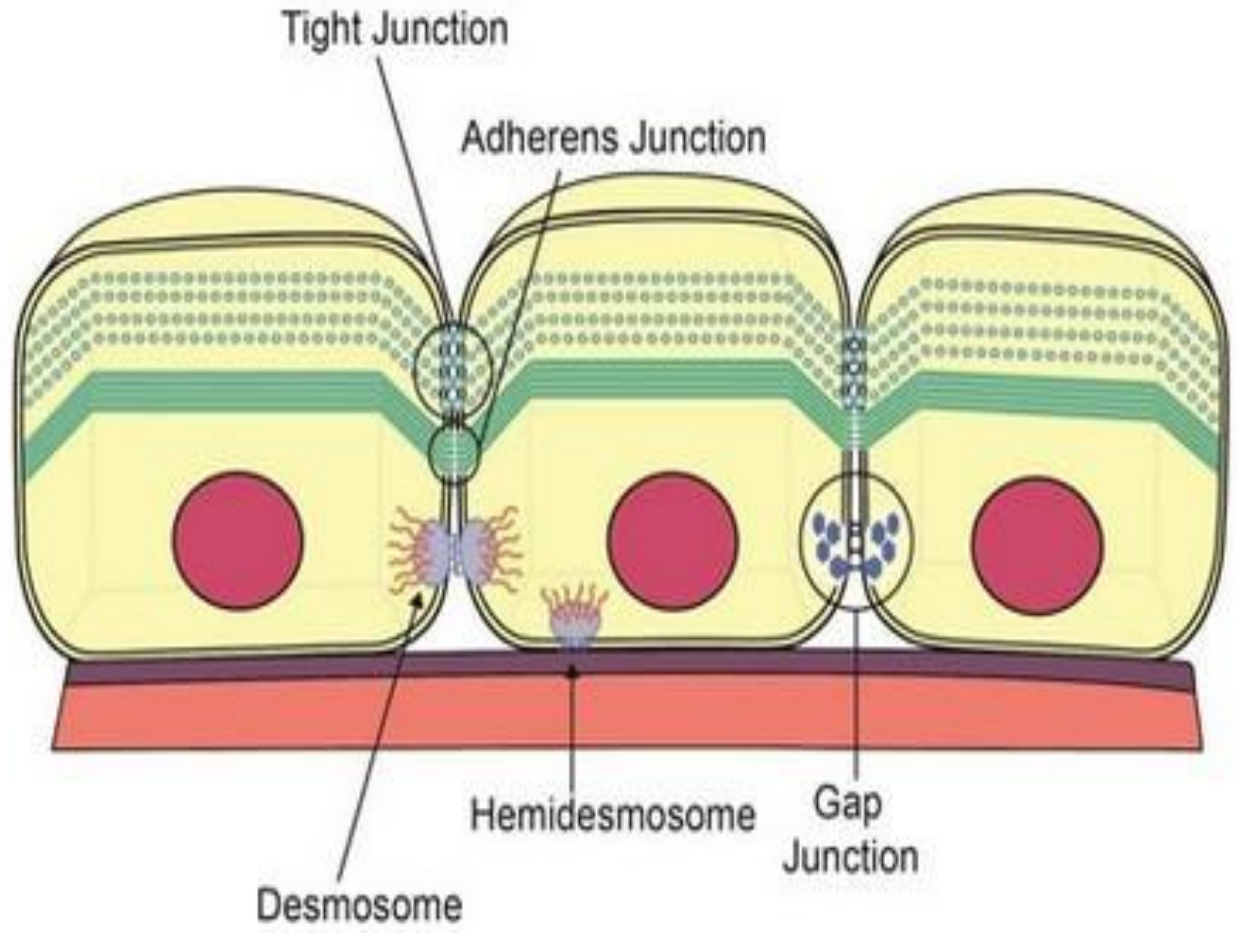
Review of Cell Junctions



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Epithelial Tissue

* Epithelial tissue, or epithelium, consists of cells arranged in continuous sheets, in either single or multiple layers

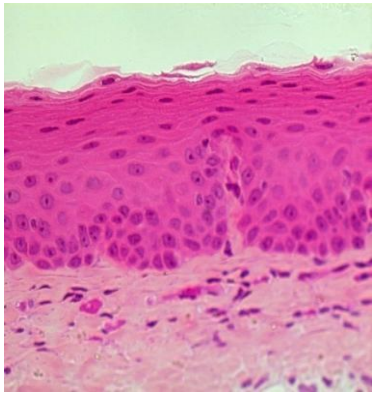
* Epithelial tissues have three major roles:
  1. Protective surfaces: resist the abrasive influences of the environment

  1. Selective barriers: limit or aid transfer of substances in and out of the body

  2. Secretory surfaces: release products produced by the cells

Epithelial Tissue Characteristics

* The cells are closely packed and held tightly together by **cell junctions**
  * hence there is minimal intercellular space between adjacent cells
* The cells are placed on a **basement membrane** which is a thin extracellular layer that functions as a point of attachment and support for the overlying epithelial tissue
* Epithelial tissue is **avascular**
  * the blood vessels are located in the adjacent connective tissue
  * exchange of nutrients and wastes between epithelium and connective tissue occurs by diffusion
* Epitihelial tissue has a very **good nerve supply**

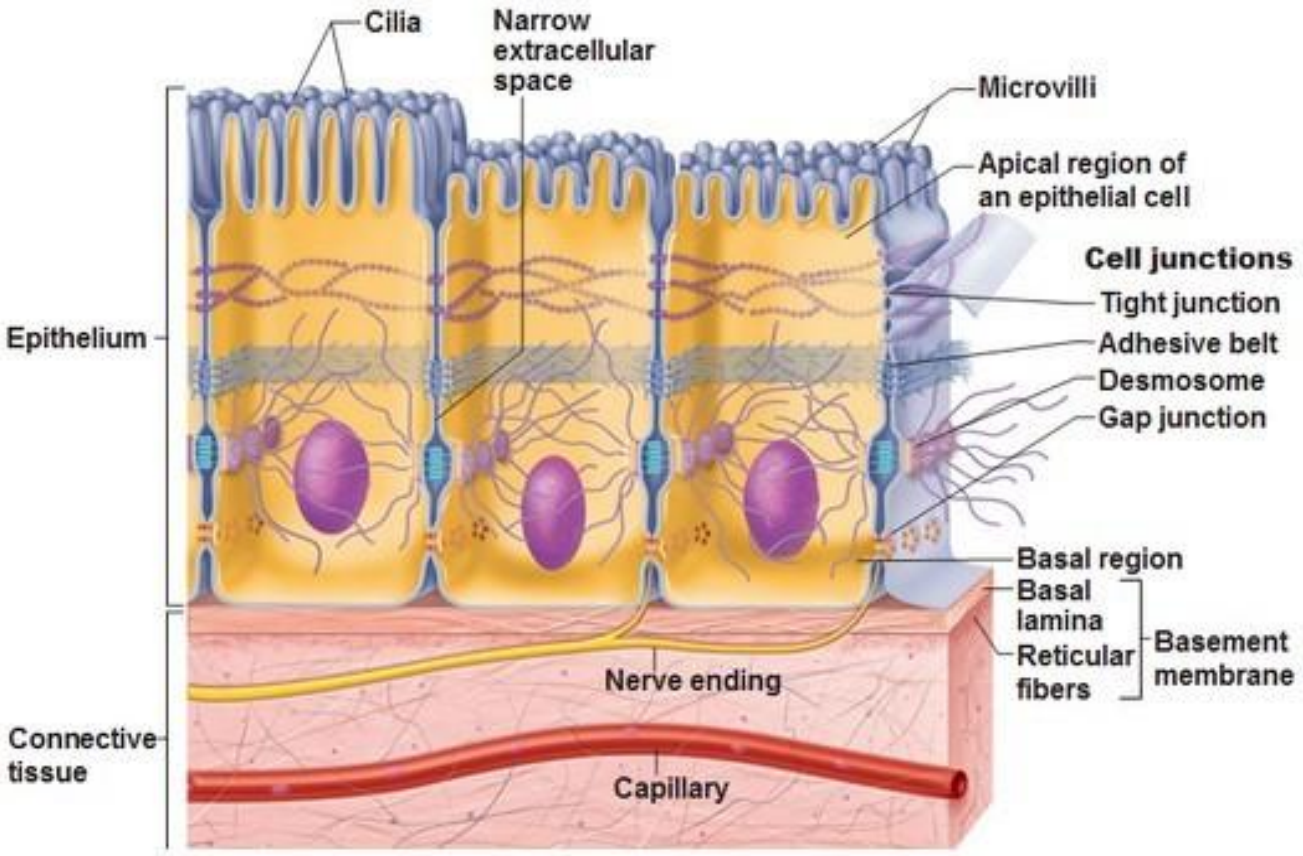


Epithelial tissue

The surfaces of epithelial cells differ in structure and have specialized functions:

* **Apical surface**
    1. Faces the body surface, cavity, lumen, tubular duct
    2. May contain cilia
* **Lateral surfaces**
    1. Face adjacent cells
    2. May have contain cell junctions
* **Basal surface**
    1. Opposite to apical surface
    2. Anchors the epithelium to a basement membrane
* Note: In epithelia with multiple layers, the apical layer is the most superficial layer, and the basal layer is the deepest layer

Epithelial Tissue



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Epithelial Tissue

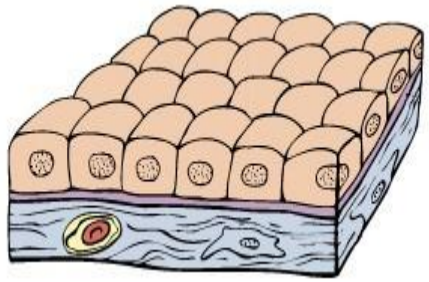
* Epithelial tissue can be classified according to the following two characteristics:

1. Arrangement of cells in layers

1. Shapes of the cells

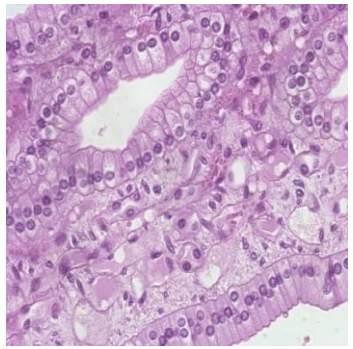
Classification of Epithelial Tissue: Arrangement of Cells in Layers

Arrangement of cells in layers:



* Cells can be arranged in one or more layers, depending on function of the epithelia

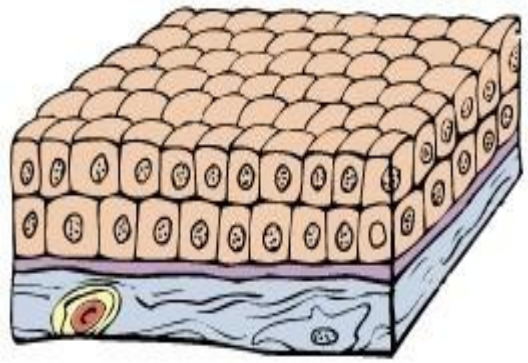
1. Simple Epithelium

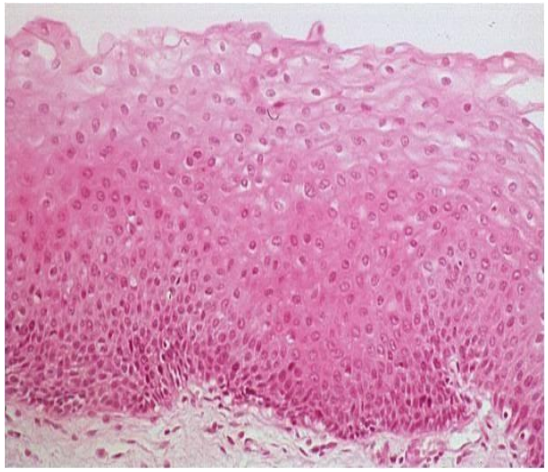


* Single layer of cells that function in diffusion, osmosis, filtration, secretion or absorption

Classification of Epithelial Tissue: Arrangement of Cells in Layers

2. **Stratified Epithelium (stratum = layer)**
    - Consists of two or more layers of cells
    - Protect underlying tissues
    - Involved in secretion





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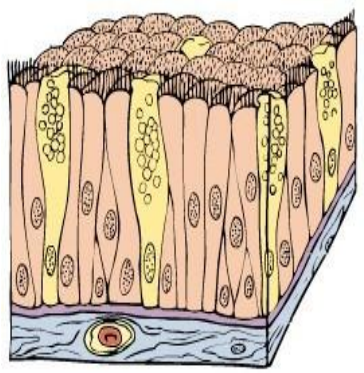
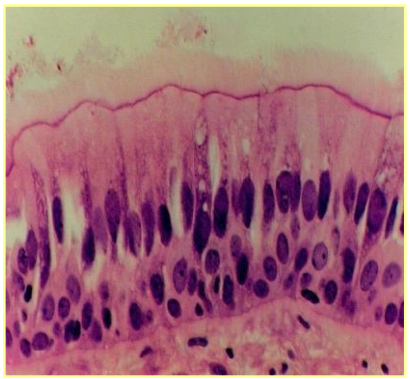
Classification of Epithelial Tissue: Arrangement of Cells in Layers

3. Pseudostratified Epithelium

(pseudo = false)

* Appears to have multiple layers of cells but actually there is only one layer since all cells rest on the basement membrane, but not all cells reach the apical surface
* So the nuclei lie at different levels
* Apical surface cells may contain cilia

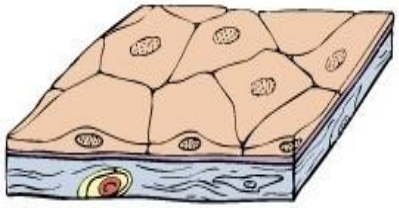




Classification of Epithelial Tissue: Shapes of Cells

Epithelial tissue can also be characterized by cell shape. Cells vary in shape, depending on their function:

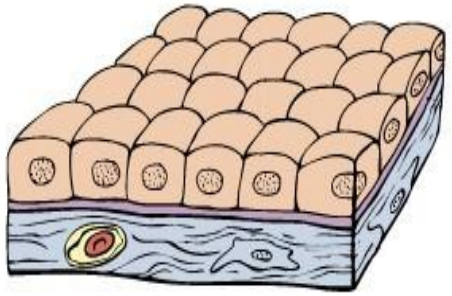
1. **Squamous**
   * Cells are thin, flat and arranged like floor tiles
   * Allow for quick passage of substances



Classification of Epithelial Tissue: Shapes of Cells

2. Cuboidal

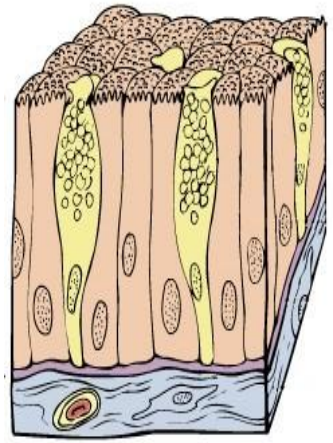
* Cells are cube shaped (as tall as they are wide)
* May have cilia at their apical surface
* Function in either secretion or absorption



Classification of Epithelial Tissue: Shapes of Cells

3. Columnar

* Cells are column shaped (much taller than they are wide)
* Apical surface may have cilia
* Specialized for secretion and absorption

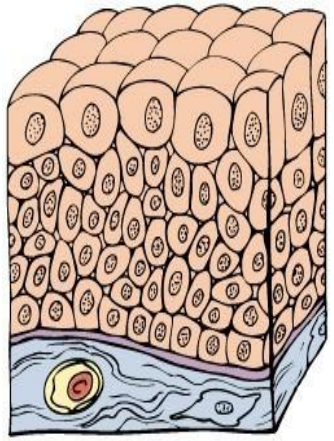


Classification of Epithelial Tissue: Shapes of Cells

4. Transitional

* Cells change shape, from flat to cuboidal and back

* Located in organs such as the urinary bladder that stretch to a larger size and then collapse to a smaller size



Types of Epithelium

* When these two characteristics (layers and shape) are combined, the different types of epithelia are as follows:

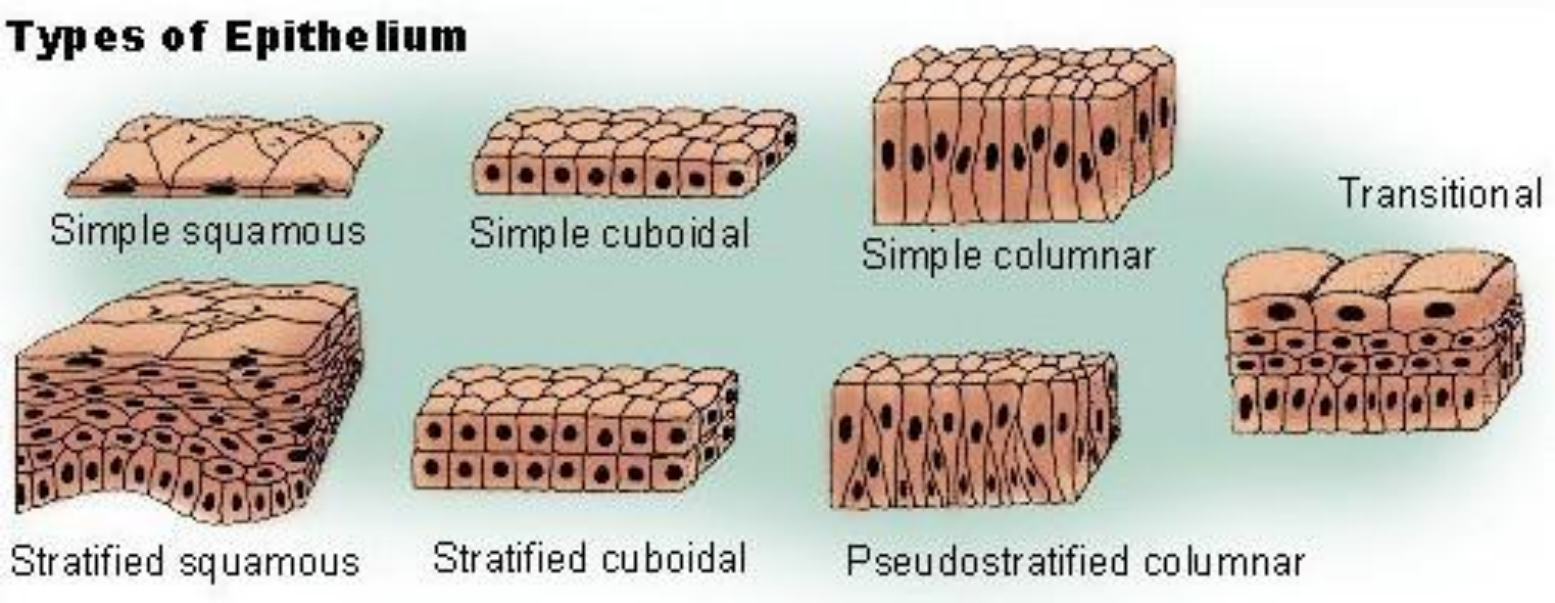
Simple Epithelium

* Simple squamous epithelium
* Simple cuboidal epithelium
* Simple columnar epithelium
* Pseudostratified columnar epithelium

Stratified Epithelium

* Stratified squamous epithelium
* Stratified cuboidal epithelium
* Stratified columnar epithelium
* Transitional epithelium

Types of Epithelium

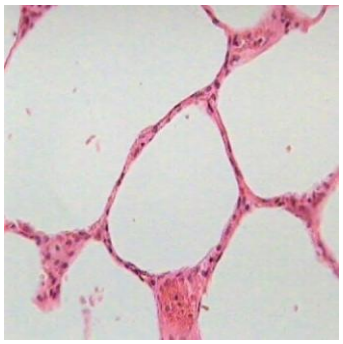


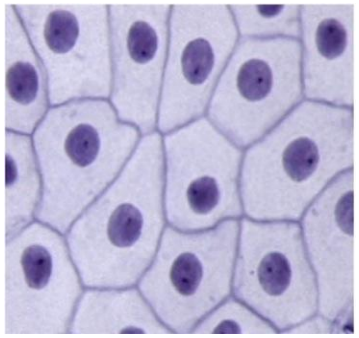
classified based on shape

Simple Squamous Epithelium

Simple Squamous Epithelium

* Consists of a single layer of flat, tile--like cells
* Flattened oval nuclei that are centrally located
* Found where filtration or diffusion occur
* Not found in areas that are subject to mechanical stress





Endothelium & Mesothelium

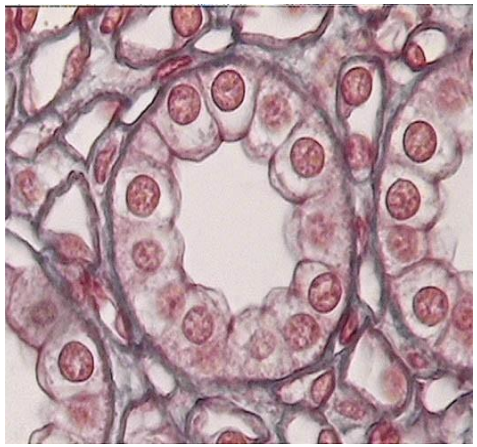
The two types of simple squamous epithelium include:

* **Endothelium:** simple squamous epithelium that lines the heart, blood vessels and lymphatic vessels
* **Mesothelium:** simple squamous epithelium that forms the epithelial layer of serous membranes such as the pericardium, pleura, or peritoneum

Simple Cuboidal Epithelium

Simple Cuboidal Epithelium

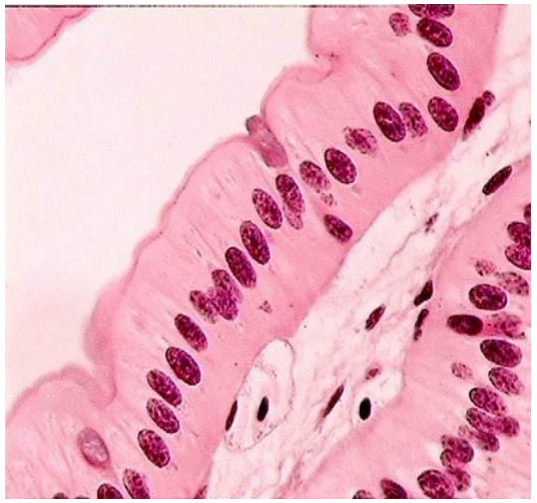
* Simple cuboidal epithelium consists of a single layer of cube--shaped cells
* The cells have round nuclei that are centrally located



* It functions in secretion and absorption
* Found in organs such as th thyroid and kidneys

Simple Columnar Epithelium

Simple Columnar Epithelium

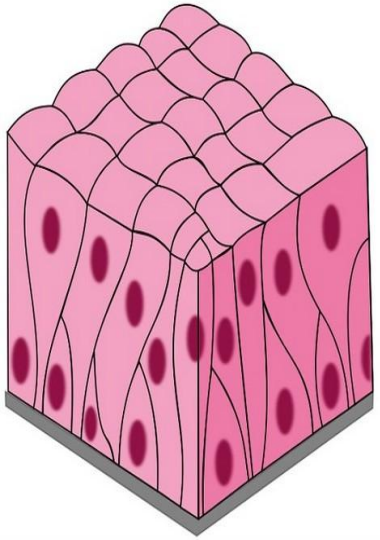


* Simple columnar epithelium consists of a single layer of rectangular, column--like cells
* It functions in secretion and absorption
* Most commonly found in the gastrointestinal tract

Pseudostratified Columnar Epithelium

Pseudostratified Columnar Epithelium

* Pesudostratified columnar epithelium consists of cells that are actually arranged in one layer, but appear to be arranged in multiple layers
* All the cells are attached to the basement membrane but some do not reach the apical surface
* Hence the nuclei at located at various heights
* Found in the respiratory tract



Stratified Epithelium

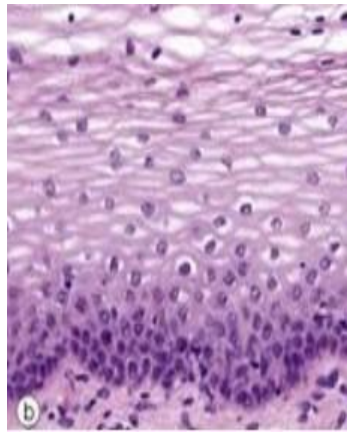
Stratified Epithelium

* Stratified epithelium has two or more layers of cells
* More durable and protects underlying tissue
* Some cells also produce secretions
* The name of the specific kind of stratified epithelium depends on the shape of the cells in the apical layer

Stratified Squamous Epithelium

Stratified Squamous Epithelium

* Stratified squamous epithelium consists of several layers of cells, of which the top layer of cells is flat
* The deeper layers vary in shape from cuboidal to columnar
* The cells in the deeper layers continually undergo cell division and the new cells pushed upward
* As they move farther away from the deeper layer, they become dehydrated, shrink, harden, and then die, and at the apical layer these cells are sloughed off
* Forms the first line of defense against infectious organisms



Stratified Squamous Epithelium

* Exists in two forms:
  * **Keratinized stratified squamous epithelium**
    * Keratinized stratified epithelium forms the superficial layers of the skin
    * The superficial cells contain a tough fibrous protein called keratin and most of the organelles within the cell are dead
    * This arrangement helps to protect the skin from heat, microbes and chemicals and also to resist friction
  * **Nonkeratinized stratified squamous epithelium**
    * Non keratinized stratified squamous epithelium does not contain keratin in the apical layer and hence contains organelles
    * It is found lining wet surfaces such as mouth, esophagus, larynx, pharynx, and tongue

Stratified Columnar Epithelium

* Stratified columnar epithelium is somewhat uncommon
* The basal layers consist of shortened irregular shaped cells
* Only the apical layer is columnar
* It functions in protection and secretion
* Lines parts of the urethra, large excretory ducts of some glands, part of the conjunctiva of the eye, small areas in anal mucous membrane

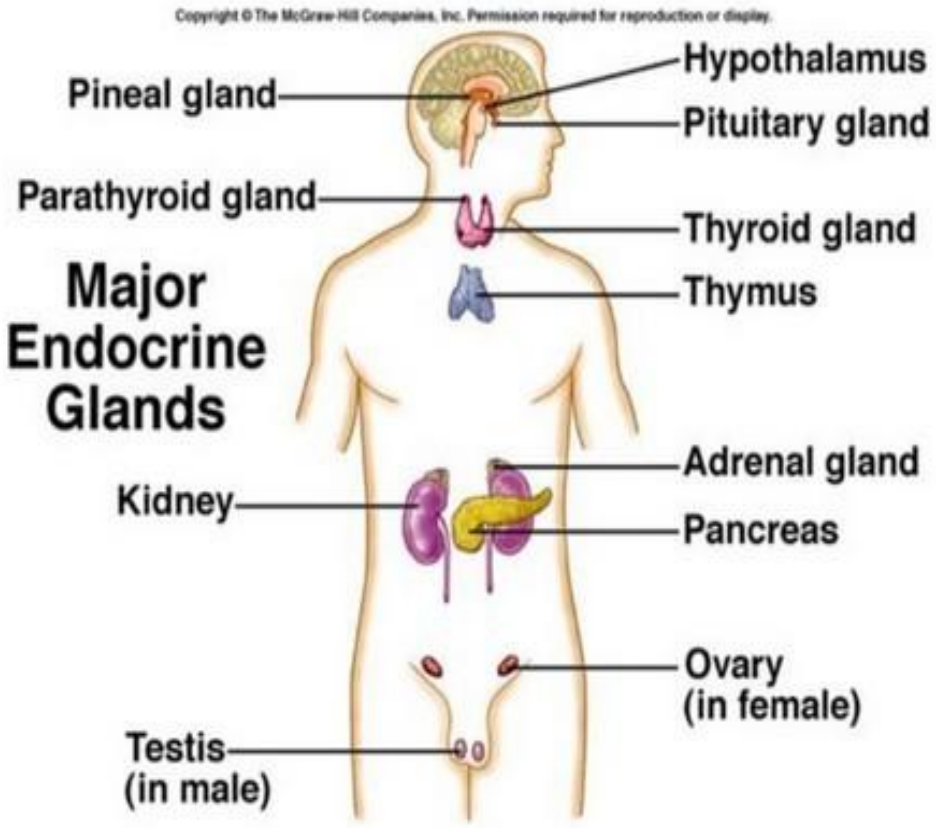
Transitional Epithelium

* Transitional epithelium consists of several layers of cells whose shape is variable
* It is capable of stretching and thus permits distention of an organ
* When relaxed (unstretched), it looks like stratified cuboidal epithelium
* As the tissue is stretched, the cells flatten, and look like stratified squamous epithelium
* Present in the urinary bladder

Glandular Epithelium

* The function of glandular epithelium is to produce secretions and is typically made up of groups of columnar or cuboidal cells that are located in clusters deep to the covering or lining epithelium.
* A gland may consist of a single cell, or a group of cells
* Glands can be of two types namely exocrine or endocrine:
  * **Exocrine glands:**
    * secrete their products into ducts that empty onto the free surface of a covering and lining epithelium, such as the skin or the lumen of a hollow organ
    * exocrine gland secretions include mucus, sweat, saliva, and digestive enzymes
  * **Endocrine glands**
    * these glands do not have ducts and secrete their products directly into the blood
    * the secretions of endocrine glands are also known as hormones
    * examples of endocrine glands include pituitary glands, thyroid glands and adrenal glands

Glands



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Connective Tissue

* Connective tissue is the **most abundant** and widely distributed tissue type in the body
* Examples: bones, ligaments, tendons, blood, fat, etc…!
* It is highly vascular, except for cartilage which is avascular, and tendons which have a scant blood supply
* It has a nerve supply, except for cartilage

Connective Tissue

* Since connective tissue is present in various forms, and has a variety of functions:
  * Binds together, supports, and strengthens other body tissues
  * Serves as the major transport system within the body
  * Primary location of stored energy reserves as adipose tissue
  * Main source of immune responses

Connective Tissue

General Features of Connective Tissue

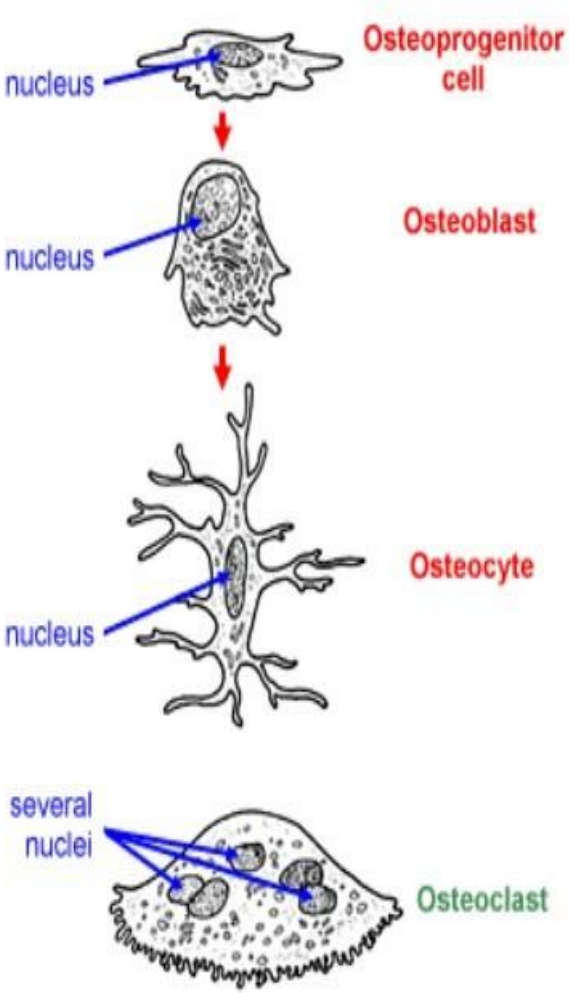
Connective tissue consists of two basic elements:

- **Cells**
  - Types of connective tissue cells vary according to the type of tissue
- **Extracellular Matrix**
  - It is the material located between the tissue cells which consists of:
    - Ground substance (material between cells and fibers)
      - Usually secreted by the connective tissue cells
      - Determines the tissue's qualities
      - For example: cartilage extracellular matrix is firm but pliable while bone extracellular matrix is hard and inflexible
    - Protein fibers

Blast Cells

* Each major type of connective tissue contains an **immature** class of cells with a name ending in **"blast"** suffix blast will always mean immature or baby cells and create matrix
* These cells retain the capacity to divide and **secrete extracellular matrix** characteristic of the tissue
* Examples of blast cells include:
  * Fibroblasts: immature cells in loose and dense connective tissue
  * Chondroblasts: immature cells in cartilage
  * Osteoblasts: immature cells in bone
* In cartilage and bone, once the extracellular matrix is produced, immature cells differentiate into **mature cells** with names ending in **"cyte"**
  * Chondrocytes: mature cells in cartilage
  * Osteocyte: mature cells in bone

Mature Cells



* Have a reduced capacity for cell division and extracellular matrix formation
* Mostly involved in maintaining the matrix

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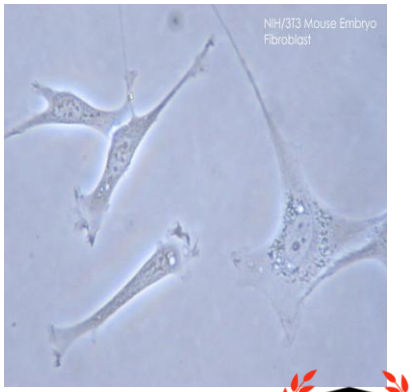
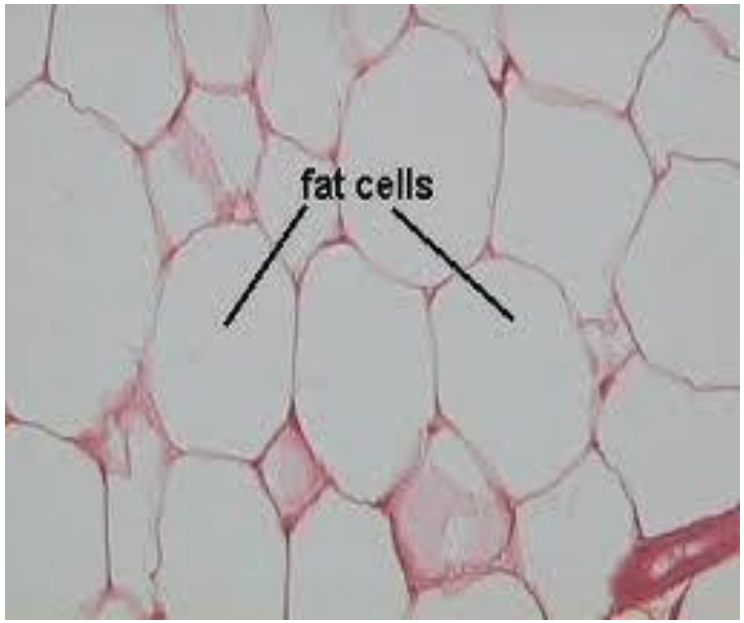
Fibroblasts

* These are the most numerous connective tissue cell types and are present in several connective tissues
* They are large flat cells with branching processes that migrate through the connective tissue and secrete fibers and components of the extracellular matrix



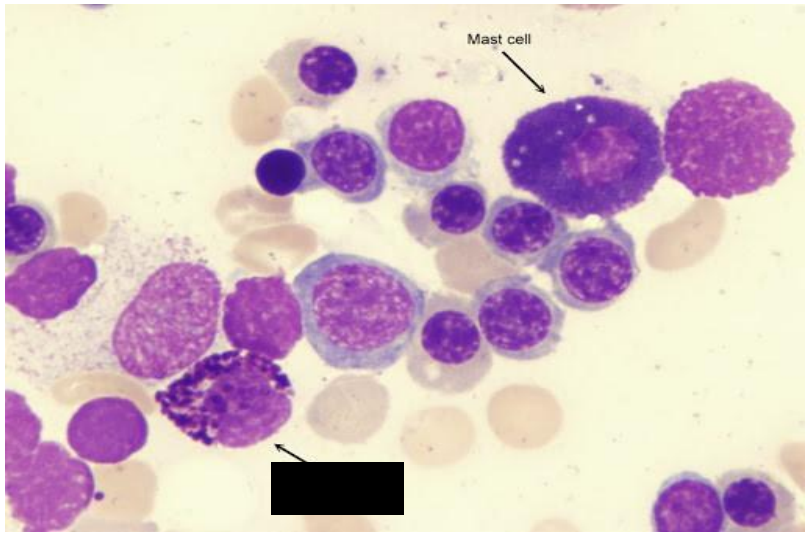
Adipocytes

* They are also known as fat cells or adipose cells
* Found deep to the skin and around organs



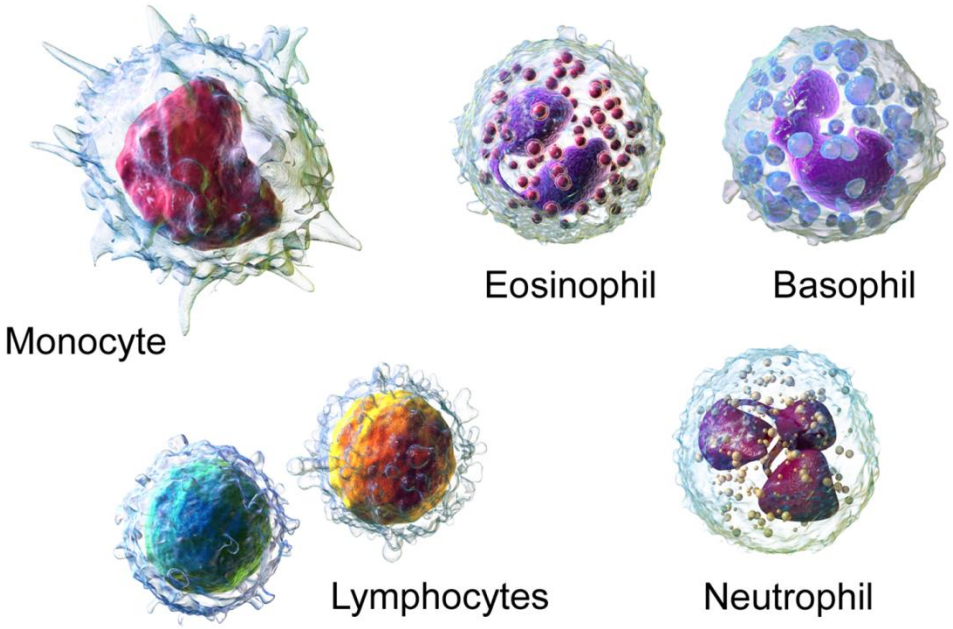
Mast Cells

* Mast cells are abundant around blood vessels that supply connective tissue Mast cells are type of WBCs
* They produce the chemical histamine which dilates small blood vessels in response to injury or infection



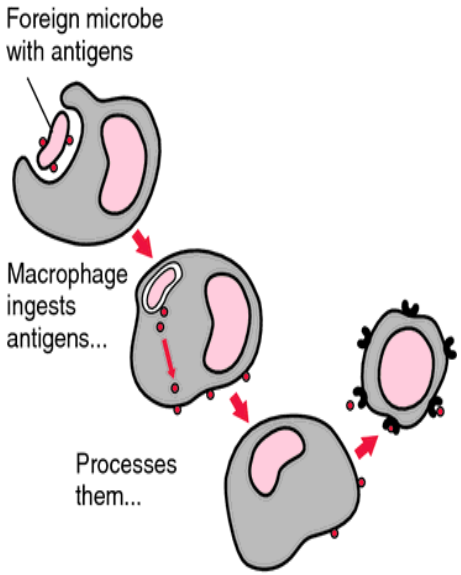
White Blood Cells (Leukocytes)

* Usually not found in significant amounts in normal connective tissue
* Migrate from blood into connective tissues, in response to certain conditions:
* For example:
  * Neutrophils gather at sites of acute infection
  * Eosinophils migrate to sites of parasitic invasion and allergic responses



Macrophages

* Develop from monocytes (type of WBC)
* Irregular shape with short branching projections
* Are phagocytic and migrate to sites of infection or inflammation to perform phagocytosis



Plasma Cells

* These are small cells that develop from lymphocytes (type of WBC) and are found throughout the body
* They secrete antibodies that are an important part of the body's immune response

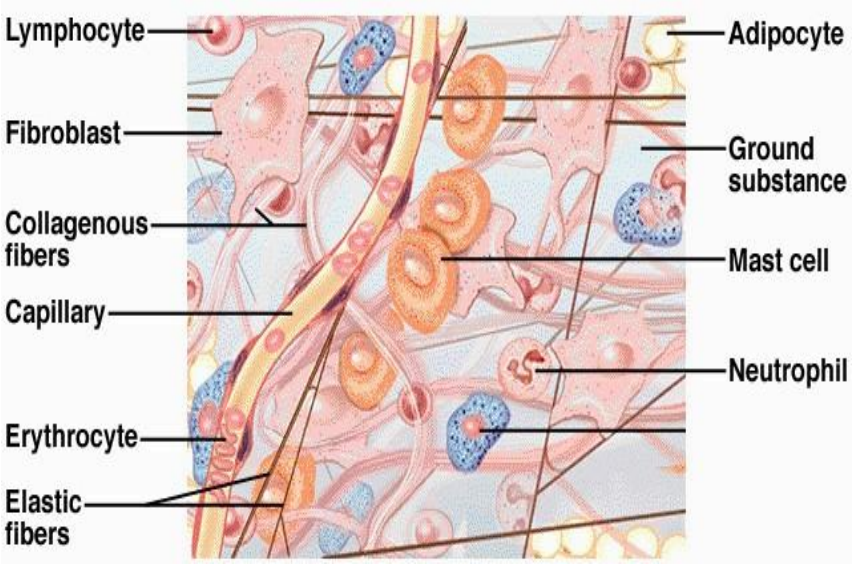
Extracellular Matrix

Each type of connective tissue has its own unique properties, based on the extracellular material between the cells.

* Extracellular matrix consists of two major components:
    * Ground Substance water and sugar
    * Fibers

Ground Substance

* The ground substance is located between the cells and fibers of connective tissue and may be fluid, semifluid or calcified
* It supports cells, binds cells together and stores water
* The ground substance contains water and several large organic polysaccharide molecules that are collectively referred to as glycosaminoglycans or GAGs



Ground Substance

* The common glycosaminoglycans include:
  * Hyaluronic acid: present in synovial fluid
  * Chondroitin sulfate: present in cartilage
  * Dermatan sulfate: present in skin
  * Keratan sulfate: present in skin

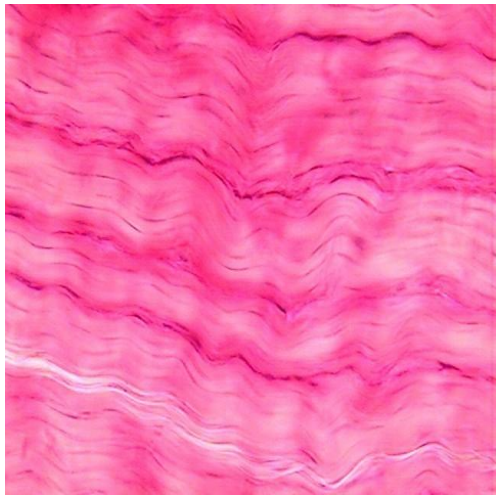
Fibers

* Fibers are embedded in the extracellular matrix and provide strength and support for connective tissues
* The three types of fibers include:
  * Collagen fibers
  * Elastic
  * Reticular

Skin contain all three

Collagen Fibers

* Collagen fibers are very strong and resist pulling forces, but are not stiff and hence allow tissue flexibility
* The fibers consist of the protein collagen and are arranged in parallel bundles which add strength to the tissue
* Collagen is the most abundant protein in the body, and is found in most connective tissue, especially bone, cartilage, tendons, and ligaments



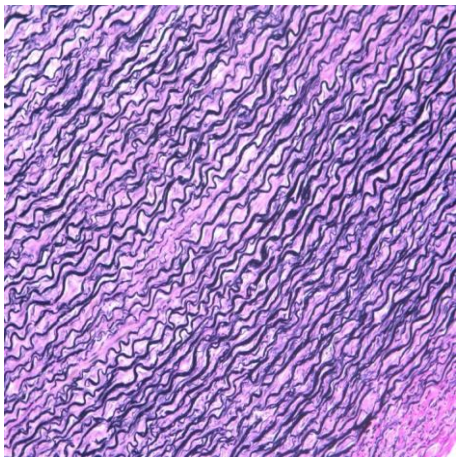
Elastic Fibers

Elastic fibers are smaller in diameter than collagen fibers

They are strong and can be stretched up to 150% of their relaxed length without breaking

Since they are elastic they can return to their original shape and size after being stretched

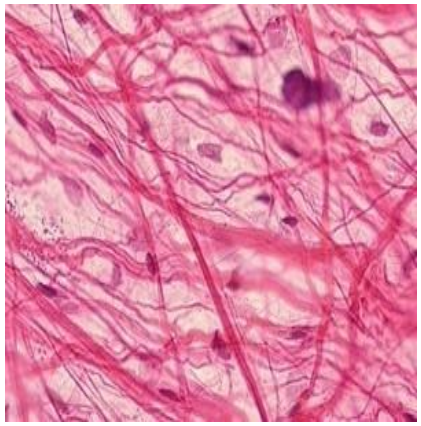
They are most abundant in skin, blood vessel walls, and lung tissue



Reticular Fibers

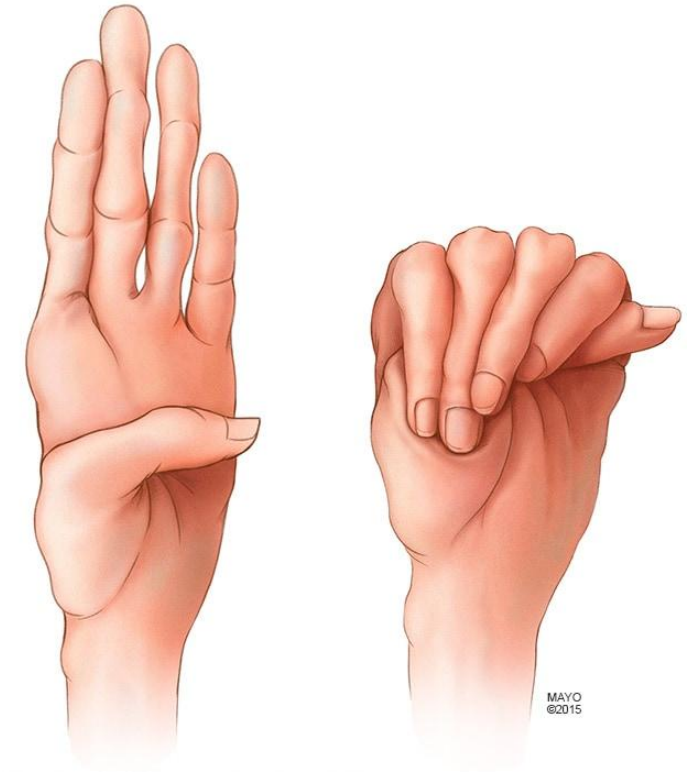
* Reticular fibers crosslink to form a fine meshwork around cells in adipose tissue, smooth muscle and organs

  They are also produced by fibroblasts, though they are thinner than collagen fibers
* Found in the kidney, spleen, lymph and bone marrow



Marfan Syndrome

- Marfan syndrome is a genetic disorder resulting in an abnormal development of elastic fibers
- The structures affected most commonly involved include the periosteum of the bone, the ligament that suspends the lens of the eye, and the walls of large arteries
- People with Marfan's syndrome tend to be tall and have disproportionately long arms, legs, fingers and toes
- A common symptom is blurred vision caused by displacement of the lens of the eyes
- The most life--threatening complication is weakening of the wall of the aorta which can subsequently rupture

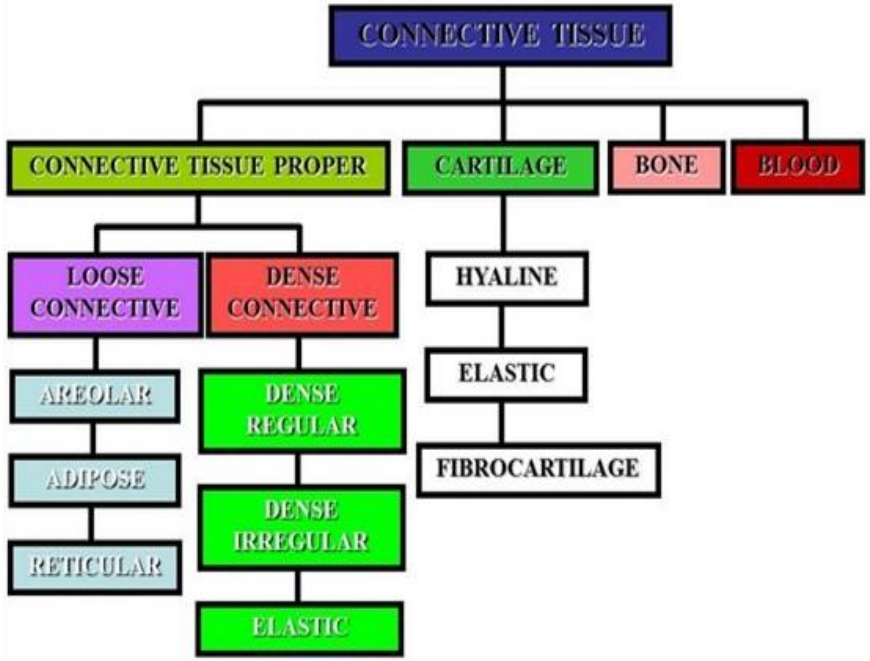


Connective Tissue

Classification of Connective Tissues

The different types of connective tissue include:

* Loose connective tissue
  * Areolar connective tissue
  * Adipose tissue
  * Reticular connective tissue
* Dense connective tissue
  * Dense regular connective tissue
  * Dense irregular connective tissue
  * Elastic connective tissue
* Cartilage
  * Hyaline cartilage
  * Fibrocartilage
  * Elastic cartilage
* Bone tissue
* Liquid connective tissue
  * Blood tissue
  * Lymph



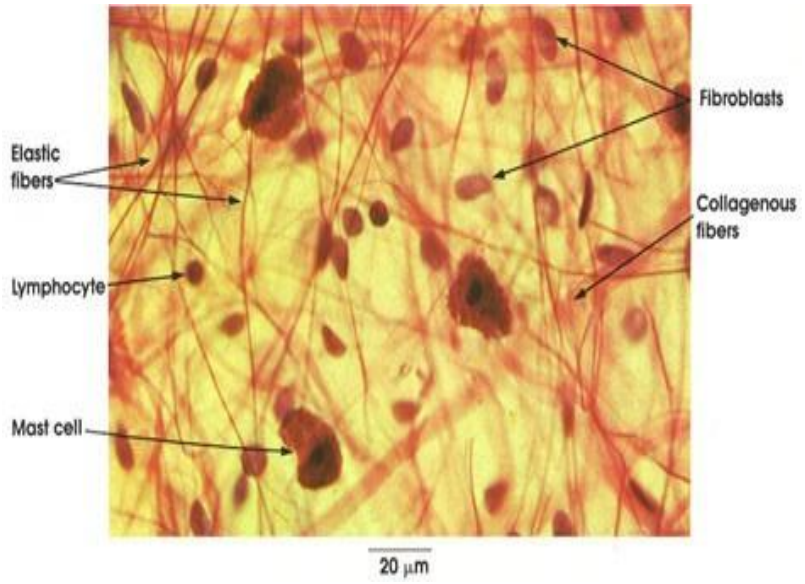
Loose Connective Tissue

* Loose connective tissue is the most common type of connective tissue in vertebrates
* It holds organs in place and attaches epithelial tissue to other underlying tissues
* The fibers are loosely intertwined between cells

* The three types of loose connective tissue are:
    1. Areolar Connective Tissue
    2. Adipose Tissue
    3. Reticular Connective Tissue

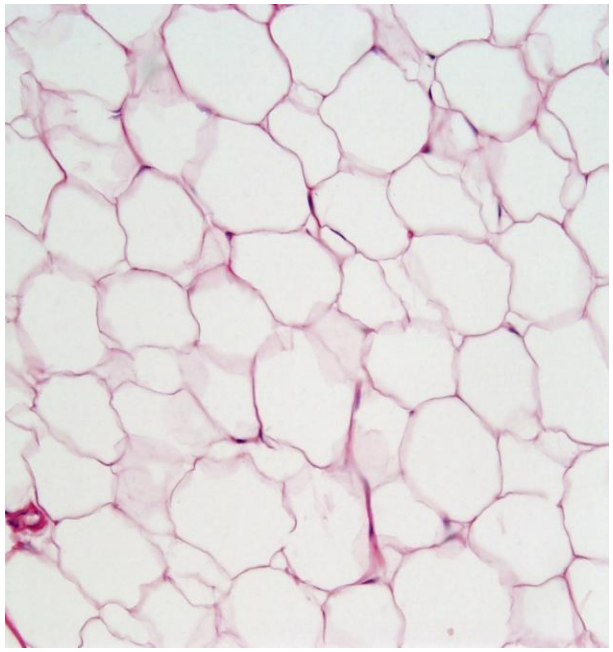
1. Areolar Connective Tissue

* Most widely distributed connective tissue in the body
* Contains several types of cells, including fibroblasts, macrophages, plasma cells, mast cells and adipocytes
* Contains all three types of fibers (elastic, collagen, reticular) randomly arranged throughout the tissue
* Together, with adipose tissue, forms the subcutaneous layer that attaches the skin to underlying tissue and organs



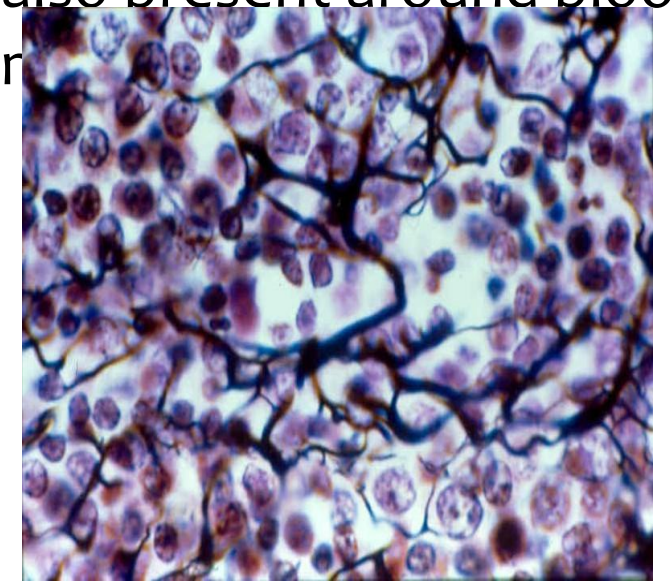
2. Adipose Tissue

* Consists of collections of adipocytes that are held together by reticular fibers



Reticular Connective Tissue

* Consists of fine interlacing reticular fibers and reticular cells
* Forms the supporting framework of organs and is also present around blood vessels, adipose tissue and r



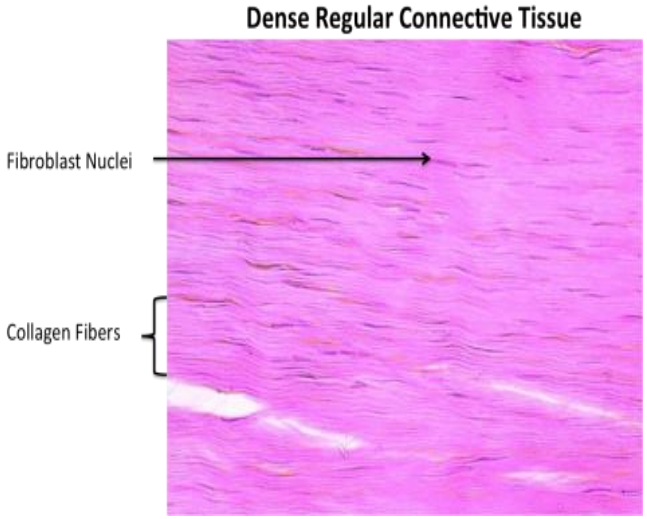
Dense Connective Tissue

* Contains more numerous, thicker, and denser fibers but fewer cells than loose connective tissue

* The three types of dense connective tissue are:
    1. Dense Regular Connective Tissue
    2. Dense Irregular Connective Tissue
    3. Elastic Connective Tissue

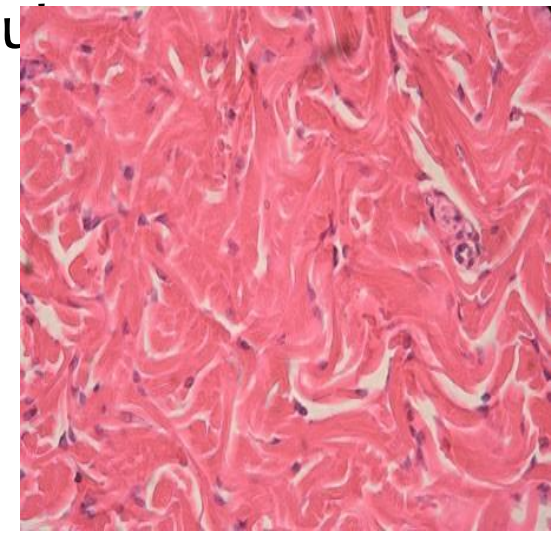
1. Dense Regular Connective Tissue

* Consists of bundles of collagen fibers in a regular and orderly, parallel arrangement
* Parallel patterns of the bundles provide the tissue with great strength that can withstand pulling along the axis of the fibers
* Fibroblasts produce the fibers and ground substance, and appear in rows between the fibers
* Forms tendons, most ligaments, and aponeuroses and provides strong attachment between various structures



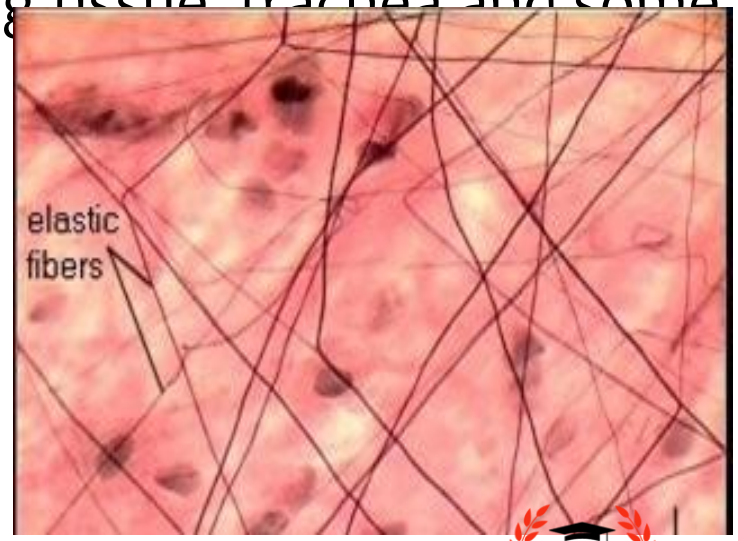
2. Dense Irregular Connective Tissue

* Contains collagen fibers that are irregularly arranged
* Found in parts of the body where tension is exerted in various directions
* Often occurs in sheets, such as the dermis of the skin and joint capsu



3. Elastic Connective Tissue

* Consists of predominately branching elastic fibers
* Quite strong and can recoil back to its original shape after being stretched and hence allows for stretching of organs
* Found in lung tissue, trachea and some ligaments



Cartilage

* Cartilage can endure more stress than loose and dense connective tissues

  It consists of a dense network of collagen fibers and elastic fibers embedded in chondroitin sulfate, a gel--like component of the ground substance
* Cartilage is typically covered by perichondrium which is made up of dense irregular connective tissue
* Cartilage consists of chondrocytes (mature cartilage cells) that occur within tiny spaces called lacunae (=little lakes) situated in the extracellular matrix
* It also has no blood vessels or nerves, except in the perichondrium Since it is avascular, cartilage heals poorly following an injury

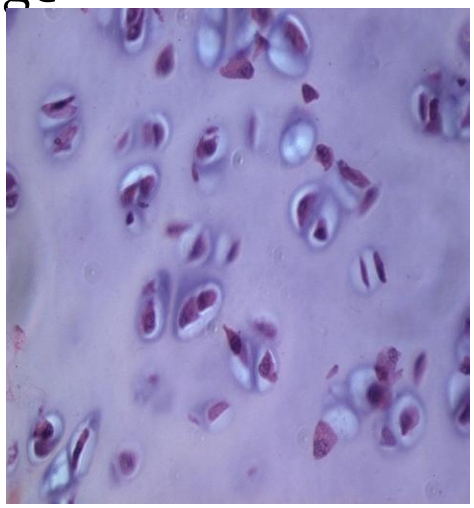
Cartilage

There are three types of cartilage:

1. Hyaline Cartilage
2. Fibrocartilage
3. Elastic Cartilage

1. Hyaline Cartilage

* Hyaline cartilage is the most abundant type of cartilage in the body
* It contains a resilient gel--type ground substance with thin, fine collagen fibers and many chondrocytes embedded in lacunae
* It appears in the body as a bluish--white, shiny substance
* It is the weakest of the three types of cartilage
* Location:
  - Ends of long bones
  - Embryonic and fetal skeleton Articular cartilage in joints
  - Cartilage of the epiphyseal plates



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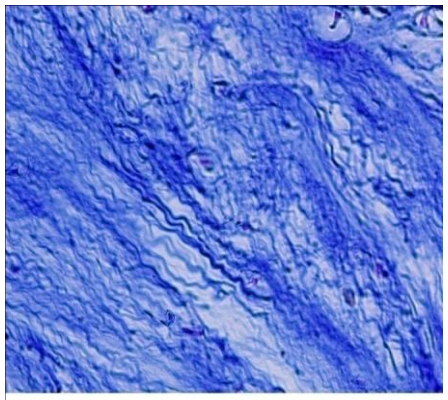
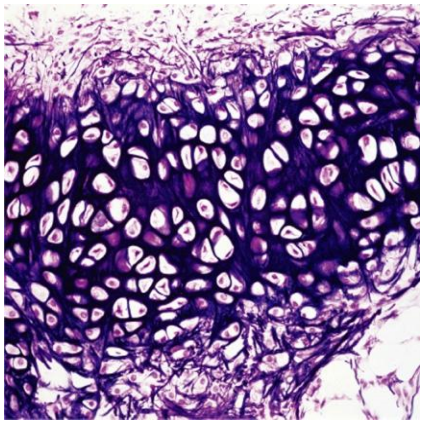
2. Fibrocartilage

* Fibrocartilage consists of chondrocytes scattered among thick bundles of collagen fibers within the extracellular matrix
* With its combined strength and rigidity, it is the strongest of the three types of cartilage
* Location:
  * Intervertebral discs of the vertebrae
  * Pubic symphysis
  * Menisci of the knee



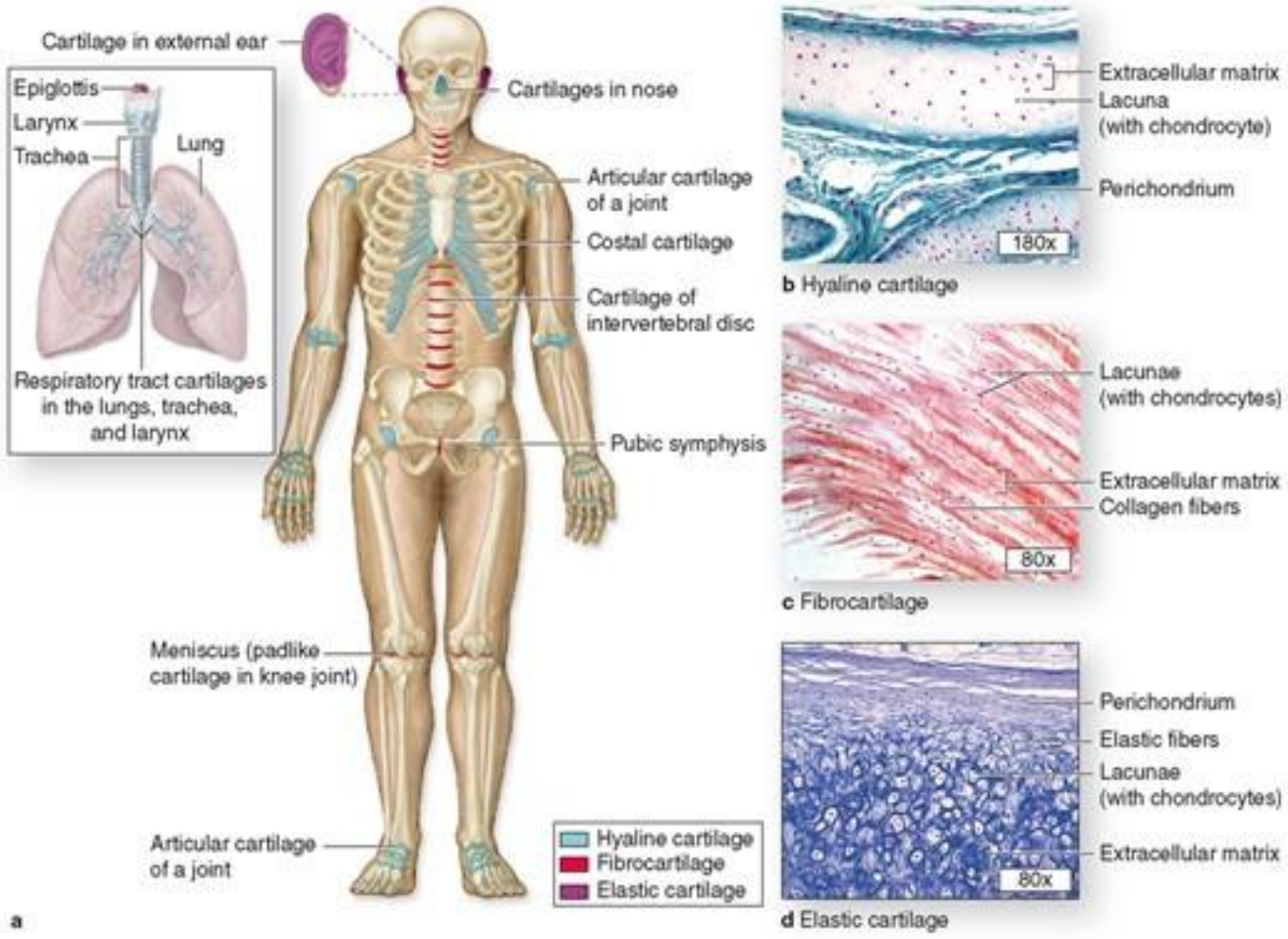
3. Elastic Cartilage

* Elastic cartilage consists of chondrocytes located in a threadlike network of elastic fibers within the extracellular matrix



* Location:
  * Tip of nose
  * External ear
* Function:
  * Provides strength and elasticity
  * Maintains the shape of structures

Cartilage



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Liquid Connective Tissue

1. Blood
2. Lymph

Blood Tissue

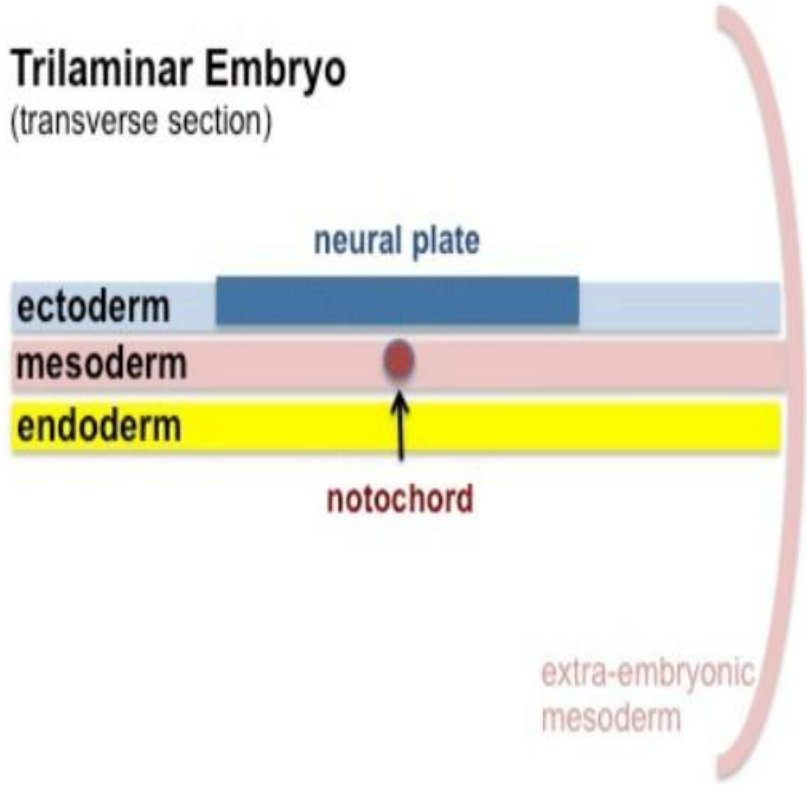
Blood, one of the liquid connective tissues has a liquid extracellular matrix called blood plasma and formed elements. **Blood plasma** is a pale yellow fluid that consists mostly of water with a wide variety of dissolved substances—nutrients, wastes, enzymes, plasma proteins, hormones, respiratory gases, and ions. Suspended in the blood plasma are **formed elements**—red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes) (**Table 4.8**). **Red blood cells** transport oxygen to body cells and remove some carbon dioxide from them. **White blood cells** are involved in phagocytosis, immunity, and allergic reactions. **Platelets** (PLĀT-lets) participate in blood clotting. The details of blood are considered in Chapter 19.

Lymph Plasma

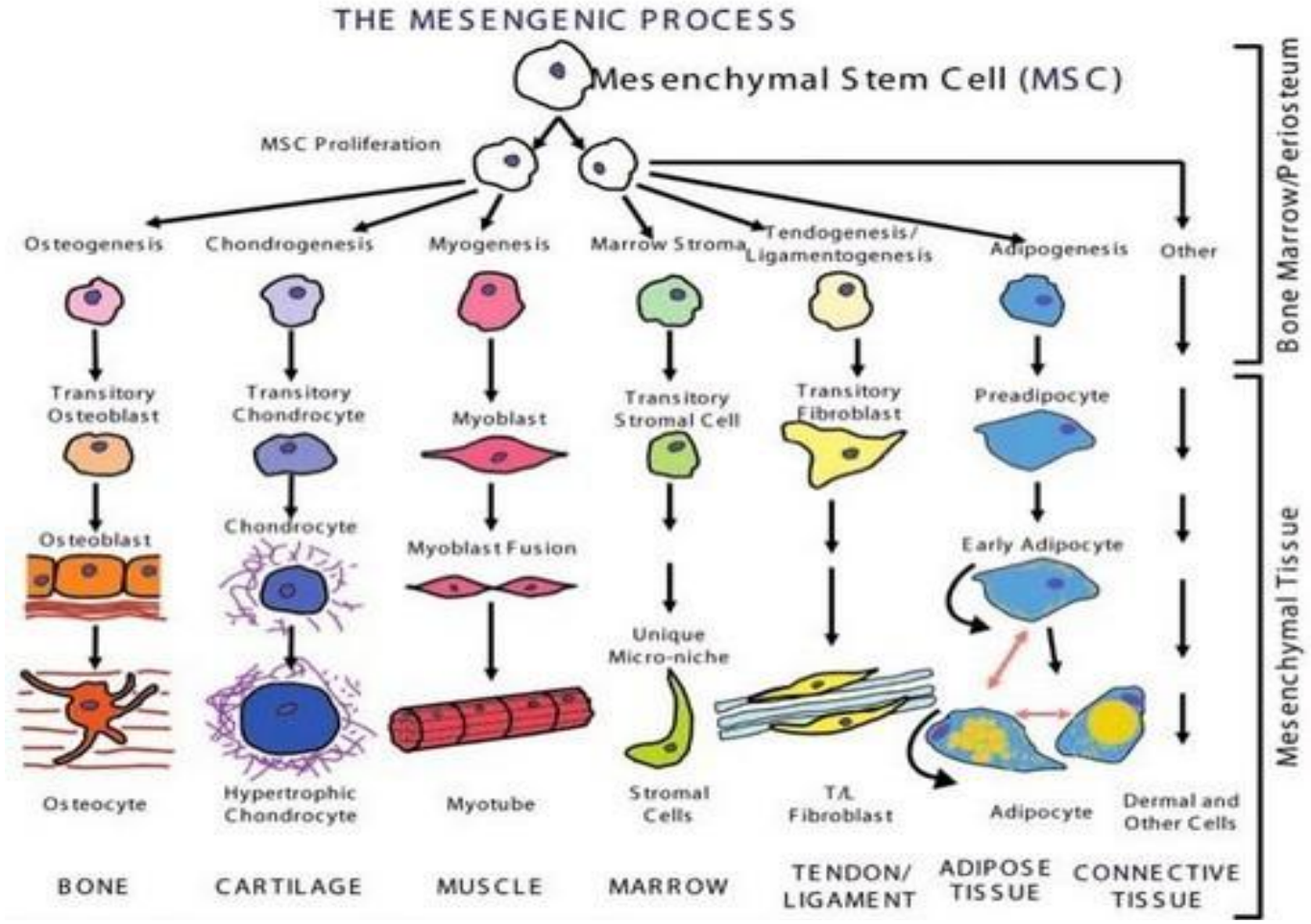
Lymph plasma (*lymph*) is the liquid connective tissue that flows in lymphatic vessels. Lymph plasma consists of several types of cells in a clear liquid extracellular matrix that is similar to blood plasma but with much less protein. The composition of lymph plasma varies from one part of the body to another. For example, lymph plasma leaving lymph nodes includes many lymphocytes, a type of white blood cell, in contrast to lymph plasma from the small intestine, which has a high content of newly absorbed dietary lipids. The details of lymph plasma are considered in Chapter 22.

Embryonic Connective Tissue

* Connective tissue is derived from embryonic **mesoderm**
  * Unlike most epithelial tissue which is derived from ectoderm and endoderm
* **Mesenchyme** consists of loosely packed, unspecialized cells that are set in a gelatinous ground substance, from which bone, cartilage, and the circulatory and lymphatic systems develop.



Embryonic Connective Tissue



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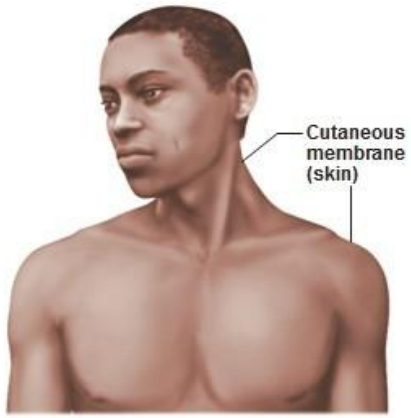
Membranes

* Membranes are flat sheets of pliable tissue that cover or line a part of the body
* They consist of an epithelial layer and an underlying connective tissue layer

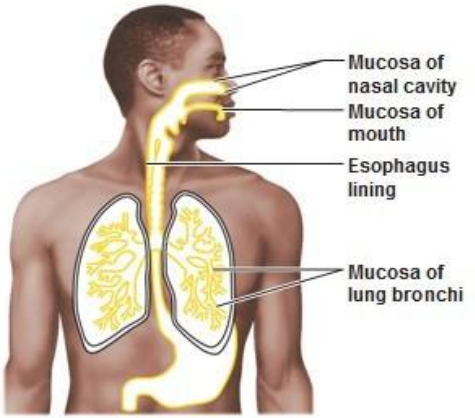
The main types of membranes of the body are:

1. Mucous Membranes
2. Serous Membranes
3. Cutaneous Membranes
4. Synovial Membranes

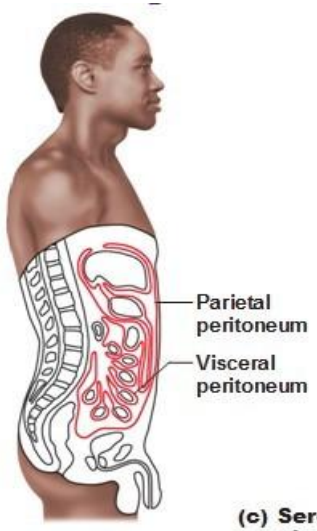
Membranes

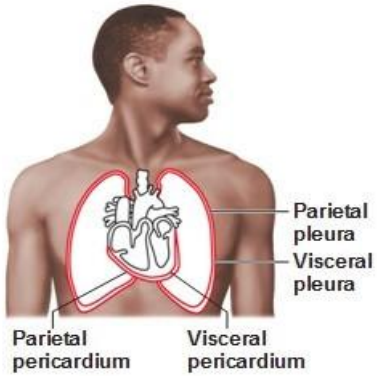


(a) Cutaneous membrane (the skin) covers the body surface.



(b) Mucous membranes line body cavities open to the exterior.





(c) Serous membranes line body cavities closed to the exterior.

Parietal layer lines cavity; Visceral layer covers organs (visceral=inside)

Mucous Membranes

* Mucous Membranes:
  * Mucus membranes line body cavities that open to the exterior such as gastrointestinal tract, respiratory tract and urinary tract
  * It consists of epithelium that secretes mucus which is a thick viscous secretion
  * The mucus membrane is an important aspect of the body's defense mechanisms because it acts as a barrier to pathogens and a trapping surface for particles
  * It is also a site of diffusion for oxygen, nutrients, carbon dioxide and wastes to and from the epithelium

Serous Membranes

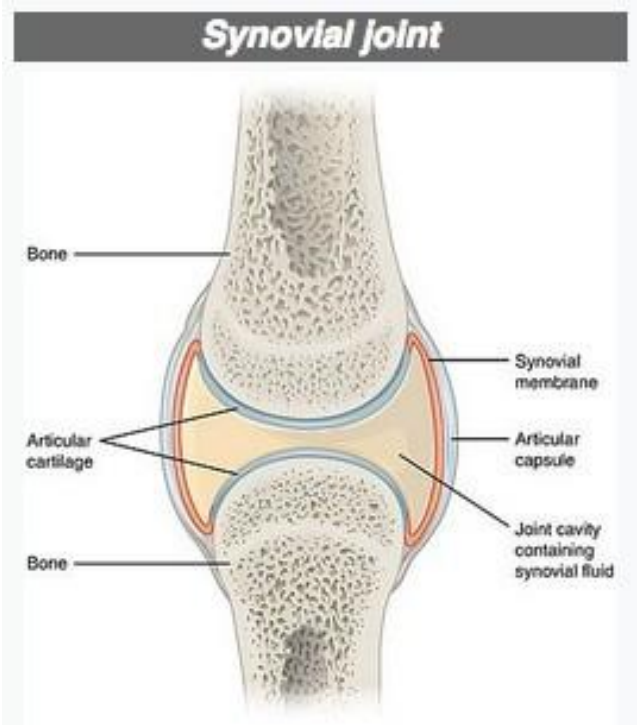
- Serous membranes line a body cavity that does not open directly to the exterior and covers the organs that lie within the cavity
- It consists of epithelium that secretes serous fluid which is a thin secretion
- Serous membranes consist of two layers:
  - Parietal layer: attached to and lines the cavity wall
  - Visceral layer: covers and adheres to the organs within the cavity
- Examples of serous membrane include:
  - Pleura: lines the thoracic cavity and covers the lungs
  - Pericardium: lines the heart cavity and covers the heart
  - Peritoneum: lines the abdominal body and covers the abdominal organs

Cutaneous Membranes

* The cutaneous membrane, or skin, covers the outside surface of the body, and consists of two layers:
  * Epidermis: the superficial portion, which consists of keratinized stratified squamous epithelium that protects underlying tissues
  * Dermis: the deeper portion which consists of areolar and dense irregular connective tissues

Synovial Membrane

* It lines the cavities of synovial joints
* It secretes synovial fluid that lubricates and nourishes the cartilage covering the bones at moveable joints



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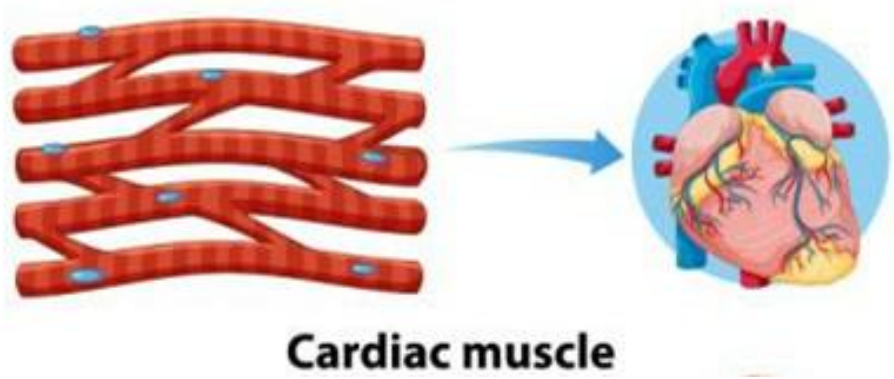
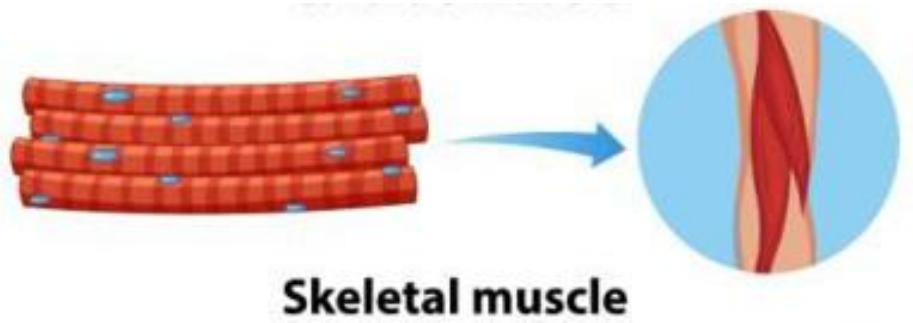
Type of Muscle Cells



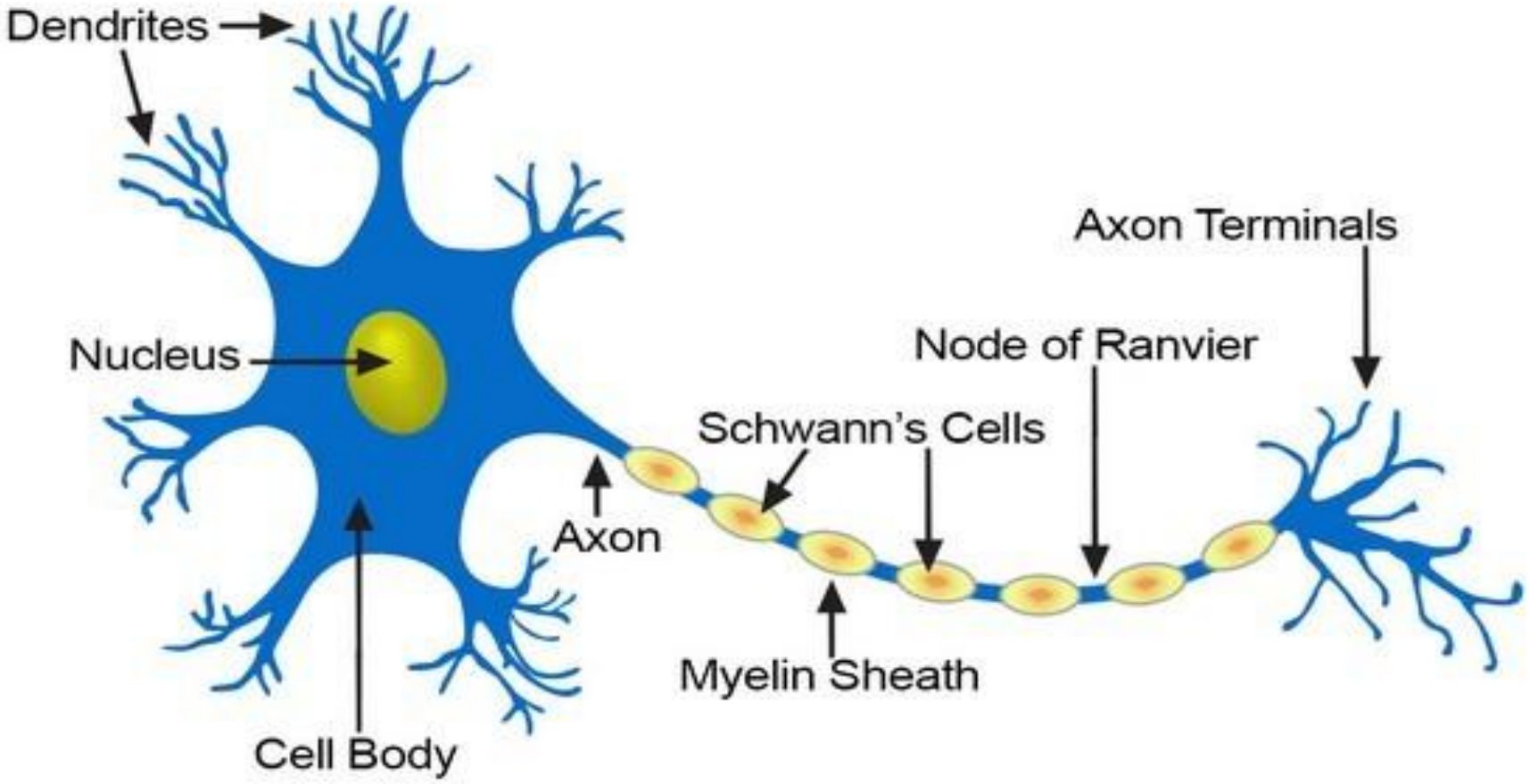


Nervous Tissue

- * **Nervous tissue** is the main **tissue** component of the two parts of the **nervous** system; the brain and spinal cord of the central **nervous** system (CNS), and the branching peripheral **nerves** of the peripheral **nervous** system (PNS), which regulates and controls bodily functions and activity

Excitable Cells

Structure of a Typical Neuron



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Tissue Repair: Restoring Homeostasis

* Tissue repair is the process of replacement of worn--out, damaged or dead cells
* The restoration of an injured tissue or organ to normal structures depends on whether the cells that form tissue or organ are active in the repair process
* If these cells are able to repair the injury tissue regeneration is possible and a near--perfect reconstruction of the injured tissue may occur

Tissue Repair: Restoring Homeostasis

* However, if the healing process is defective the injured region is invaded by **fibroblasts.** These fibroblasts synthesize collagen and other matrix material that aggregate to form **scar tissue.** This process of scar tissue formation is known as **fibrosis.**
* When tissue damage is extensive, as in large open wounds, fibroblasts divide rapidly and blood capillaries sprout new vessels to supply the healing tissue
* This creates actively growing connective tissue that is known as **granulation tissue.** This granulation tissue that forms across a wound or surgical incision to provide a framework that supports the epithelial cells that migrate into the open area and fill it.

Aging and Tissues

Aging:

* Cells divide more slowly
* Collagen fibers become more irregular in structure (though they may increase in number)
  * Tendons and ligaments become less flexible and more fragile
* Elastic fibers fragment
  * Arterial walls and elastic ligaments become less elastic

Aging and Tissues

* Changes in collagen and elastin result in:
  * Atherosclerosis and reduced blood supply to tissues
  * Wrinkling of the skin
  * Increased tendency for bones to break
* Rate of blood cell synthesis declines in the elderly
* Injuries don't heal as rapidly