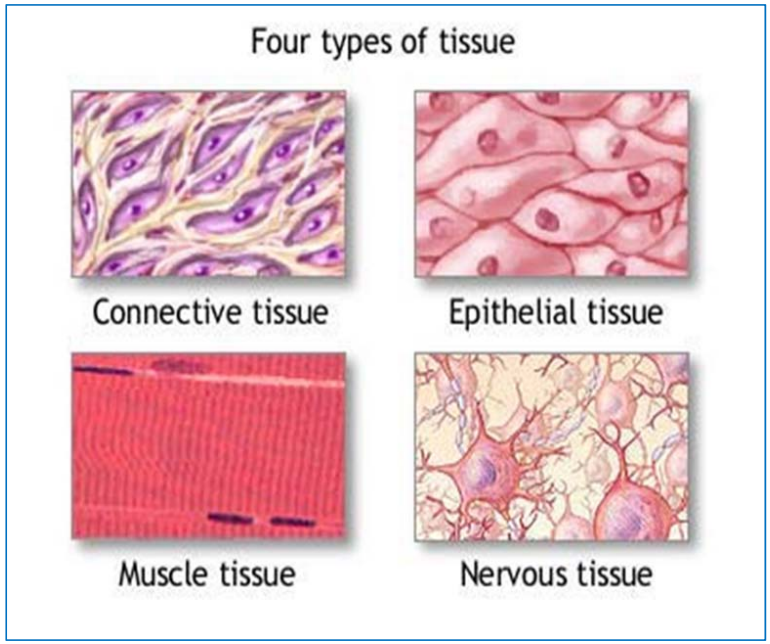
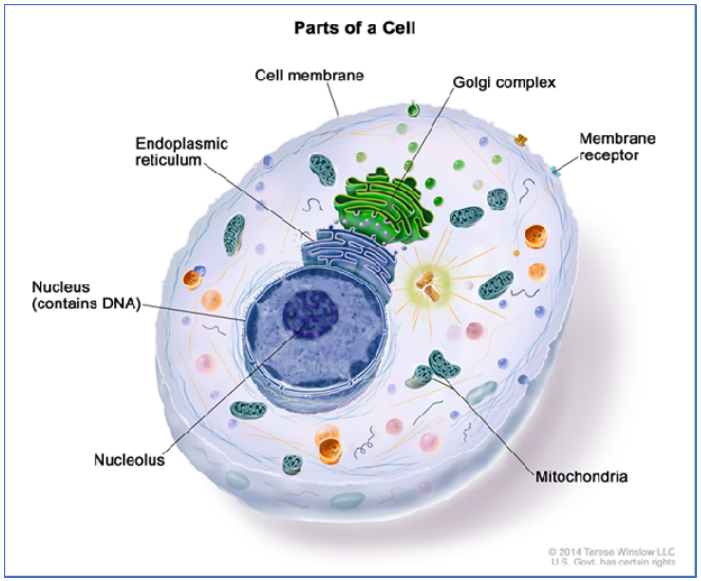
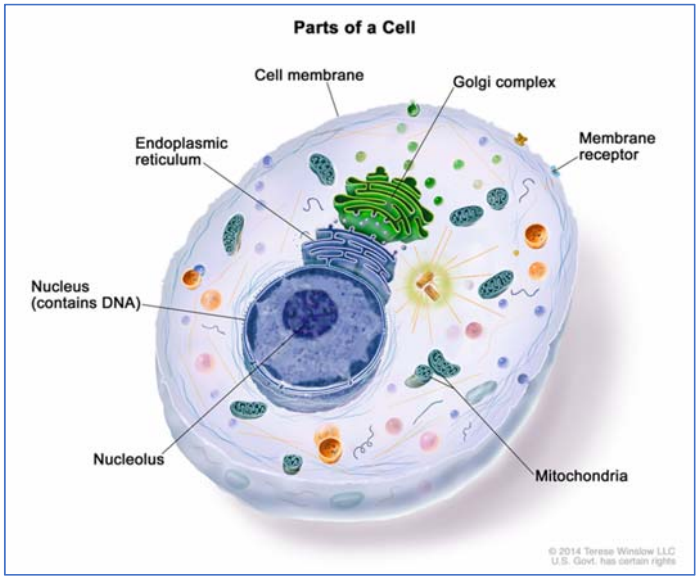
Asst. Lec. Safa Jalil Al-Yassiri
Cell and tissue
Department of occupational Therapy
Techniques





Cell:

Cell: is defined as the structural and functional unit of living organisms. The scientific study of cells is called cell biology or cytology.



Main functions of the cell:

- They provide structure for the body,
- Take in nutrients from food, convert those nutrients into energy, carry out specialized functions.
- Cells also contain the body's hereditary material (DNA) and can make copies of themselves.
- Each living cell carries out the tasks of taking food, transforming food into energy, getting rid of wastes, and reproducing.

- The human body develops from a single cell called the zygote, which results from the fusion of the ovum (female egg cell) and the spermatozoon (male germ cell).

- Individual cells are too small to be seen with the naked eye. However, they can be seen when thin slices of tissue are stained in the laboratory and magnified by a microscope.

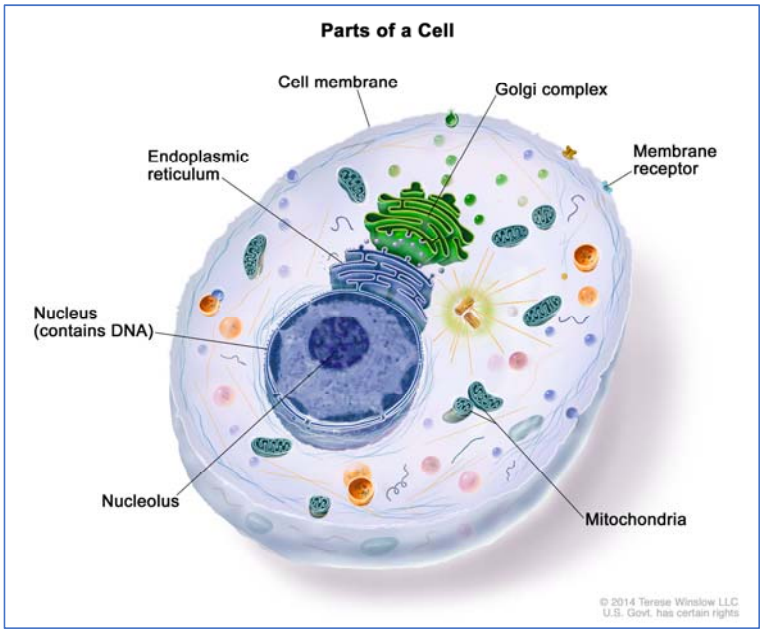
Every living organism falls into one of two groups: eukaryotes or prokaryotes

Prokaryotes: are unicellular organisms that lack membrane-bound structures, the most noteworthy of which is the nucleus. Prokaryotic cells tend to be small, simple cells like bacteria

Eukaryotes: are organisms whose cells have a nucleus and other organelles enclosed by a plasma membrane. They may be unicellular and multicellular organisms. This group includes all animals, plants and fungi.

Most of the body cells have three main parts:

- ❑ Plasma membrane
- ❑ Cytoplasm
- ❑ Nucleus



- **Plasma membrane:** forms the cell's flexible outer surface, separating the cell's internal environment (everything inside the cell) from the external environment (everything outside the cell).

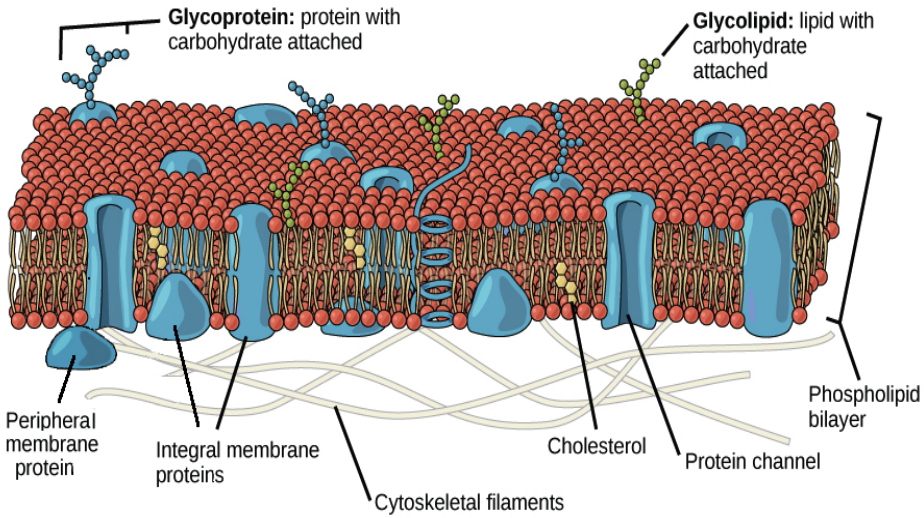
Main functions:

- It is a selective barrier that regulates the flow of materials into and out of a cell (transport nutrients into the cell and also to transport toxic substances out of the cell).
- The plasma membrane also plays a key role in communication among cells and between cells and their external environment.

Structure of the Plasma Membrane:

The plasma membrane consists of:

- **Phospholipid bilayer** (fatty substances). have a head which is electrically charged and hydrophilic (meaning 'water loving') and a tail which has no charge and is hydrophobic (meaning 'water hating').
- **Cholesterol**
- **glycoprotein** means Carbohydrate are attached to proteins
- **Glycolipid** Carbohydrate are attached to lipid



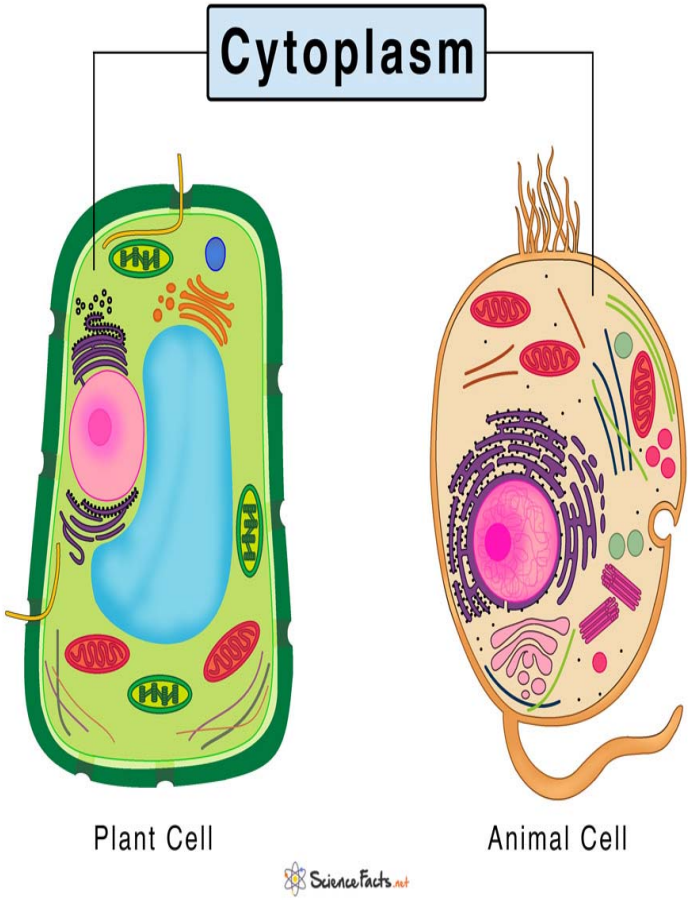
❑ **Cytoplasm:** has two components: cytosol and organelles.

➢ **Cytosol** the fluid portion of cytoplasm (an aqueous gel), also called the cytoplasmic matrix. The matrix consists of a variety of solutes, including inorganic ions (Na^+ , K^+ , and Ca^{2+}) and organic molecules such as carbohydrates, lipids, proteins, and RNAs (ribonucleic acids).

➢ **Organelles** has a characteristic shape and specific functions.
can be divided into two groups:

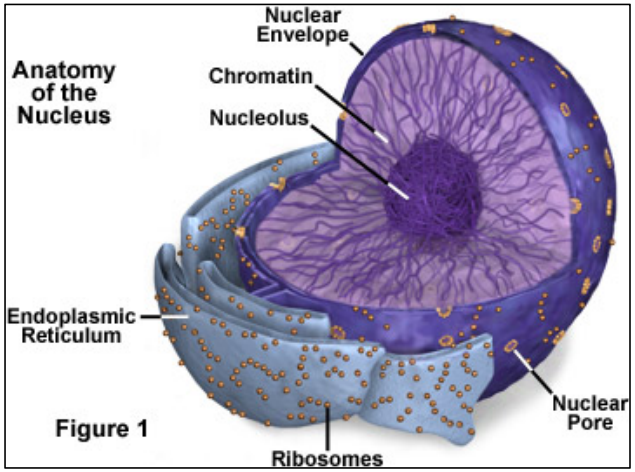
❖ **Membranous organelles** with membranes that separate the internal environment of the organelle from the cytoplasm. For example (Nucleus, Endoplasmic reticulum, Golgi apparatus, Vesicles, Lysosome, Mitochondria and Vacuole).

❖ **Non membranous organelles** without membranes. For example (Cytoskeleton, Ribosomes, Centrosome and Centrioles)



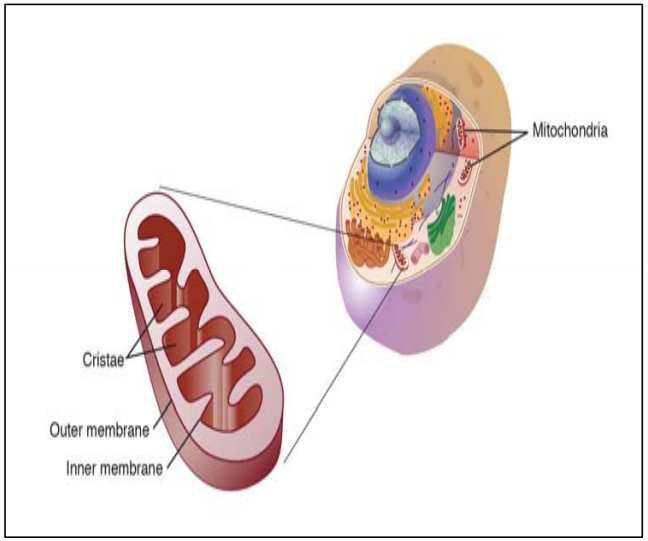
❑ Nucleus

Is typically one nucleus per cell. However, this is not always the case. Skeletal muscle cells, for instance, have two.
The nucleus contains the cell's DNA, The nucleus sends out messages to tell the cell to grow, divide, or die. A membrane called the nuclear envelope separates the nucleus from the rest of the cell. Nuclear pores within the membrane allow small molecules and ions to cross back and forth, while larger molecules need to transport proteins to help them through.



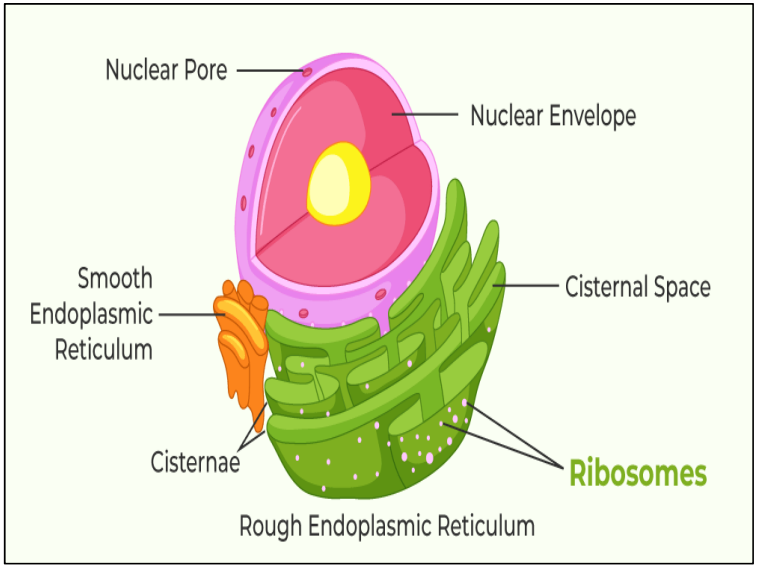
❑ Mitochondria:

Is described as the 'power house' of the cell. They are involved in aerobic respiration, the processes by which chemical energy is made available in the cell in the form of ATP (adenosine triphosphate), which releases energy when the cell breaks it down. Some different cells have different amounts of mitochondria because they need more energy. For example, muscle, liver and kidney.



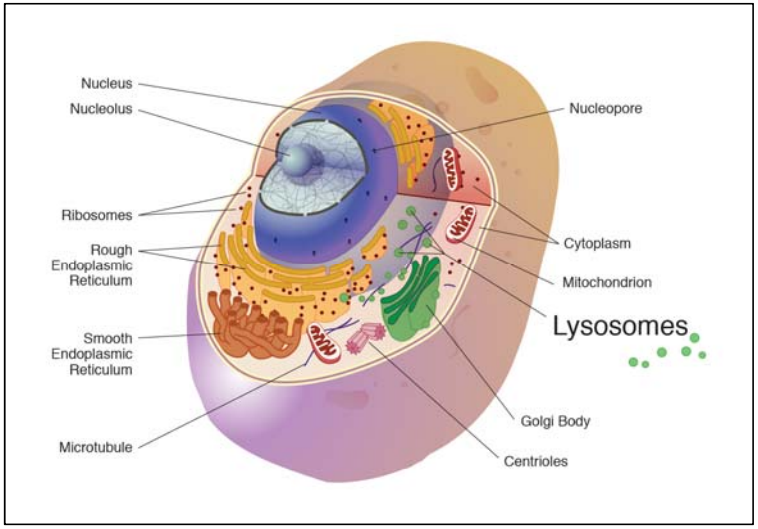
❑ Ribosomes

Are tiny, granular organelles are found inside the cytosol of the cell and play an important role in protein synthesis by translating the genetic information conveyed by messenger RNA (mRNA) into functional proteins. When present in free units or in small clusters in the cytosol, the ribosomes make proteins for use within the cell, and are also found on the outer surface of rough endoplasmic reticulum it will make proteins that will be utilized inside or outside the cell.



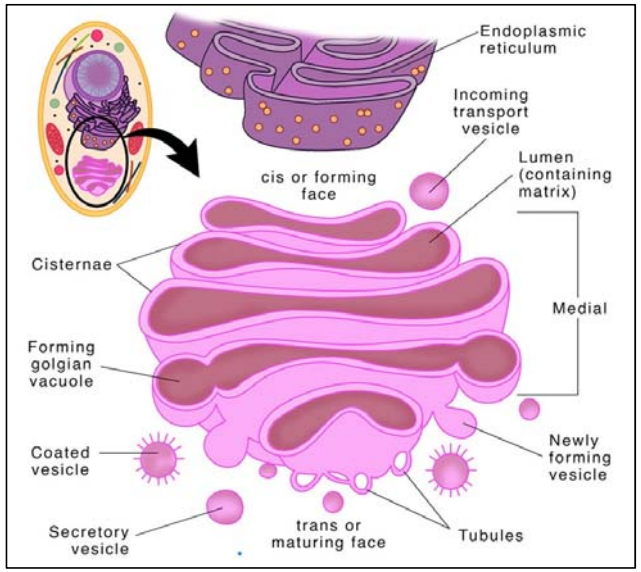
❑ Lysosomes

Are one type of secretory vesicle formed by the Golgi apparatus. They contain a variety of enzymes involved in breaking down fragments of organelles and large molecules (e.g. RNA, DNA, carbohydrates, proteins) inside the cell into smaller particles that are either recycled, or extruded from the cell as waste material. Lysosomes in white blood cells contain enzymes that digest foreign material such as microbes.



❑ Golgi apparatus

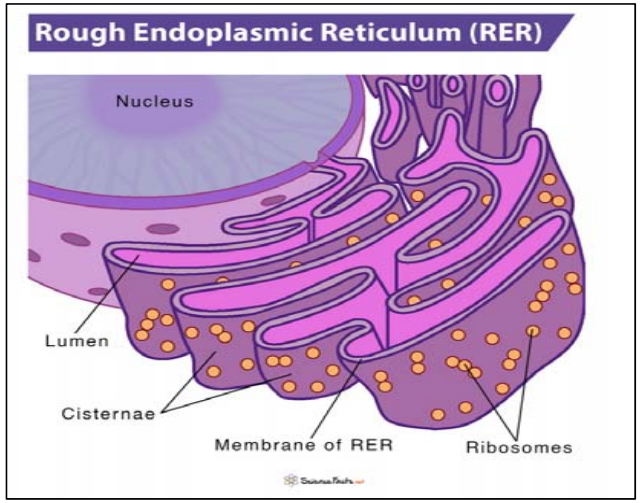
The Golgi apparatus consists of stacks of closely folded flattened membranous sacs. The proteins move from the rough endoplasmic reticulum to the Golgi apparatus where they are 'packaged' into membrane-bound vesicles called secretory granules. The vesicles are stored and, when needed, move to the plasma membrane, through which the proteins are exported.



❑ **Vesicles and Vacuoles:** that function in storage and transport. Vesicles can fuse with other membranes within the cell system while vacuoles are not.

❑ Endoplasmic reticulum (ER)

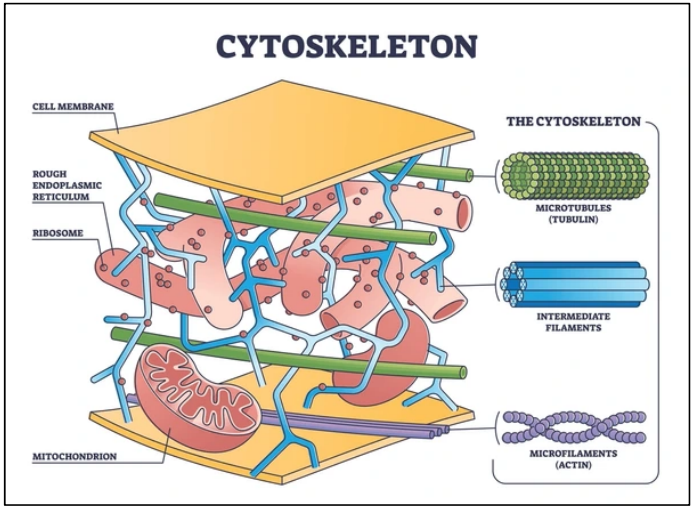
The endoplasmic reticulum is a network of membrane-enclosed sacs or tubules that extend throughout the cytoplasm and connect to the nuclear envelope. There are two types:



❖ **Smooth ER:** synthesis lipids and steroid hormones such as estrogens and testosterone, and also associated with the detoxification of some drugs.

❖ **Rough ER:** the site of synthesis of proteins due to presence of ribosomes .

❑ **Cytoskeleton:** The cytoskeleton is a network of three types of protein filaments microfilaments, intermediate filaments, and microtubules that extend throughout the cytoplasm.

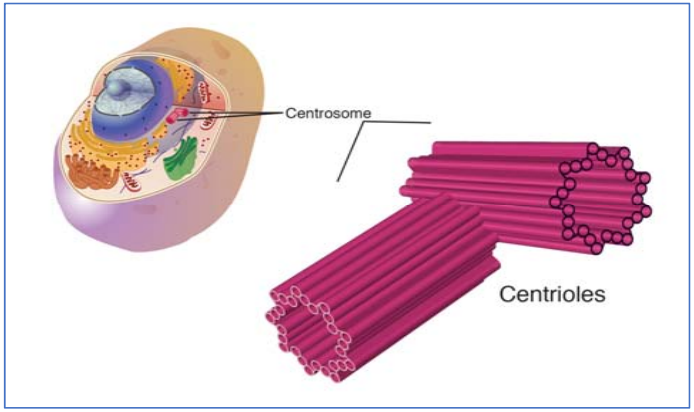


Functions of the Cytoskeleton:

1. Serves as a scaffold that helps determine a cell's shape and organize the cellular contents.
2. Aids movement of organelles within the cell, of chromosomes during cell division, and of whole cells such as phagocytes

❖ **Microfilaments:** These are tiny strands of protein that provide structural support and maintain the characteristic shape of the cell are the thin. they are composed of the proteins actin and myosin and are most prevalent at the edge of a cell.

❖ **Microtubules:** These are contractile protein structures in the cytoplasm involved in the movement of the cell and of organelles within the cell composed mainly of the protein tubulin.

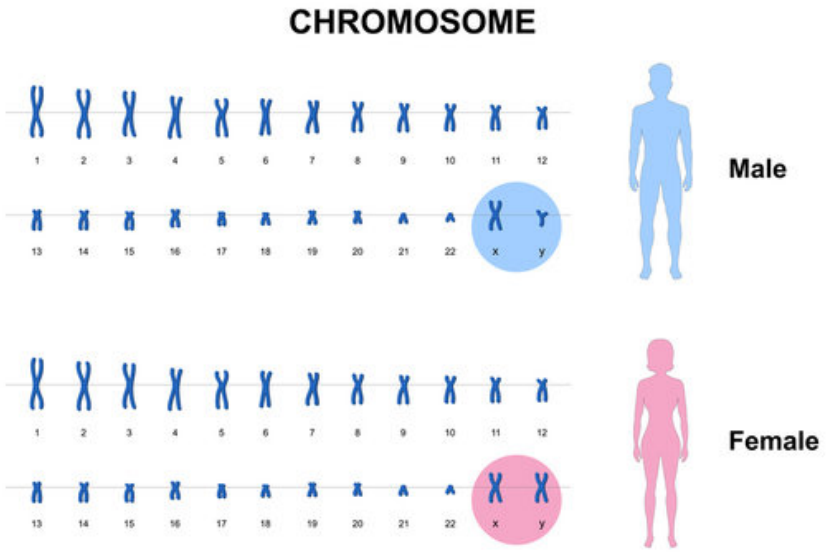


❑ **Centriole and Centrosome:**

Each centriole is a small cylindrical body, consisting mainly of nine parallel tubular structures arranged in the form of a cylinder. The two centrioles of each pair lie at right angles to each other. Each pair of centrioles, along with attached pericentriolar matrix (contains tubulins that build microtubules in non dividing cells), is called a centrosome.

Cell division:

Most cells of the human body undergo cell division, the process by which cells reproduce themselves. The two types of cell division somatic cell division and reproductive cell divisior

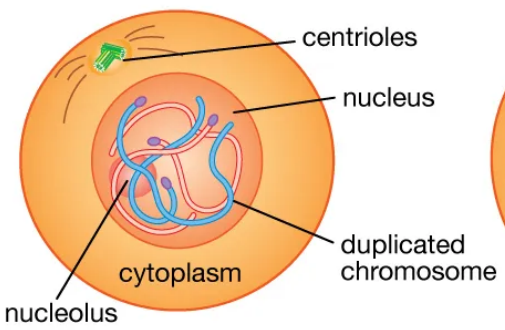


A somatic cell: is any cell of the body other than a germ cell.
A germ cell: is a gamete (sperm or oocyte) or any precursor cell destined to become a gamete.

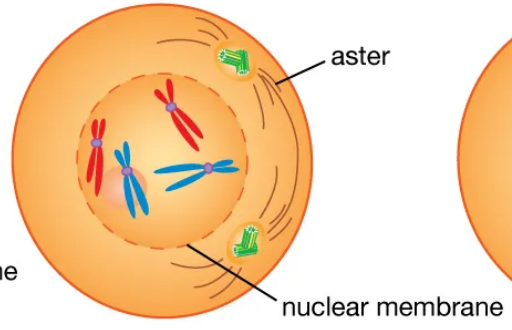
❑ Somatic Cell Division (Mitosis):

- In somatic cell division, a cell undergoes a nuclear division called mitosis and a cytoplasmic division called cytokinesis to produce two genetically identical cells, each with the same number and kind of chromosomes as the original cell. Somatic cell division replaces dead or injured cells and adds new ones during tissue growth.
- Human cells, such as those in the brain, stomach, and kidneys, contain 23 pairs of chromosomes, for a total of 46.
- One member of each pair is inherited from each parent. The two chromosomes that make up each pair are called **homologous chromosomes or homologs**; they contain similar genes arranged in the same (or almost the same) order.
- When examined under a light microscope, homologous chromosomes generally look very similar. The exception to this rule is one pair of chromosomes called the sex chromosomes, designated X and Y.
- In females the homologous pair of sex chromosomes consists of two large X chromosomes; in males the pair consists of an X and a much smaller Y chromosome. Because somatic cells contain two sets of chromosomes, they are called diploid (2n) cells.

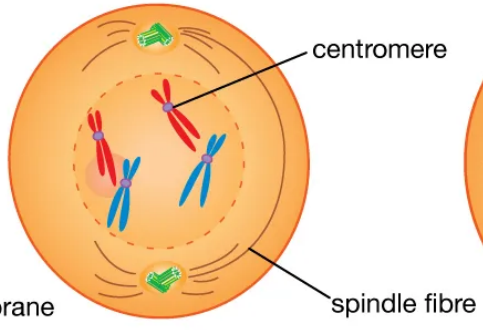
Mitosis, or somatic cell division



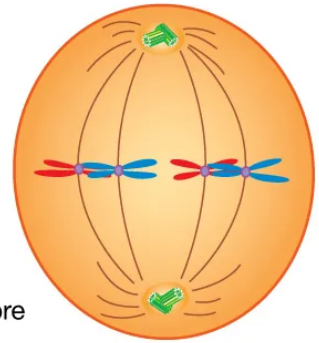
Prior to mitosis, each chromosome makes an exact duplicate of itself. The chromosomes then thicken and coil.



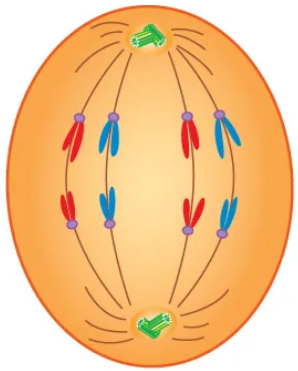
In early prophase the centrioles, which have divided, form asters and move apart. The nuclear membrane begins to disintegrate.



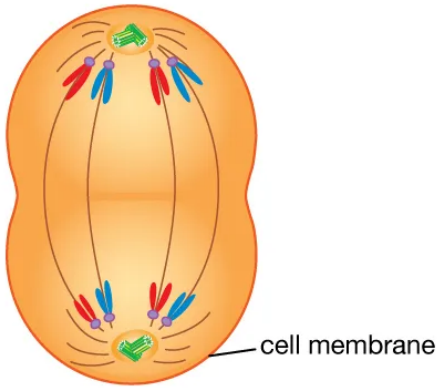
In late prophase the centrioles and asters are at opposite poles. The nucleolus and nuclear membrane have almost completely disappeared.



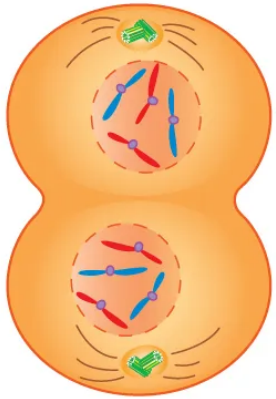
The doubled chromosomes—their centromeres attached to the spindle fibres—line up at mid-cell in metaphase.



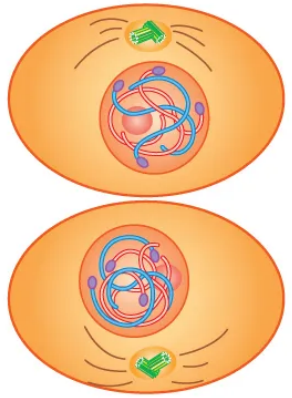
In early anaphase the centromeres split. Half the chromosomes move to one pole, half to the other pole.



In late anaphase the chromosomes have almost reached their respective poles. The cell membrane begins to pinch at the centre.



The cell membrane completes constriction in telophase. Nuclear membranes form around the separated chromosomes.



At mitosis completion, there are two cells with the same structures and number of chromosomes as the parent cell.

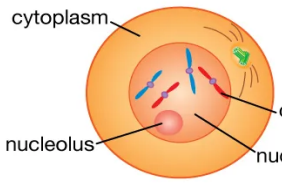
❑ Reproductive Cell Division (Meiosis):

- ❑ In the process called sexual reproduction, each new organism is the result of the union of two different gametes (fertilization), one produced by each parent.

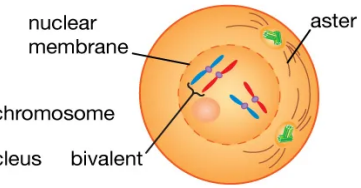
- ❑ Meiosis, the reproductive cell division that occurs in the gonads (ovaries and testes), produces gametes in which the number of chromosomes is reduced by half.

- ❑ As a result, gametes contain a single set of 23 chromosomes and thus are haploid (n) cells. Fertilization restores the diploid number of chromosomes.

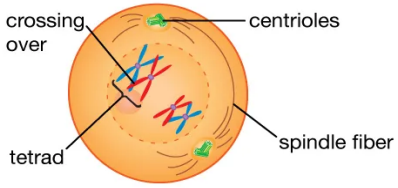
Meiosis, or sex cell division



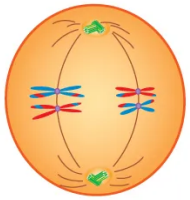
At the onset of meiosis, DNA strands thicken into chromosomes. Homologous, or like, chromosomes begin to approach each other.



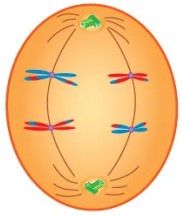
Homologous chromosomes pair to form bivalents. The centrioles divide and move to opposite poles of the cell.



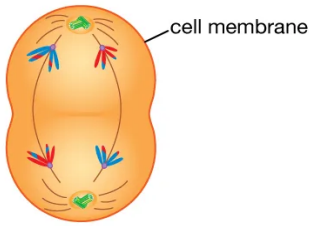
The bivalents duplicate to form tetrads, or four-chromatid groups. The nuclear membrane disintegrates. Crossing over (recombination) occurs.



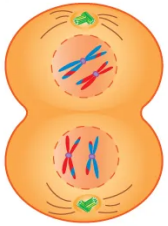
In metaphase I, the tetrads, attached to spindle fibers at their centromeres, line up at mid-cell.



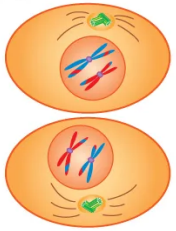
In early anaphase I, the tetrads separate, and the paired chromatids move along the spindle to their respective centrioles.



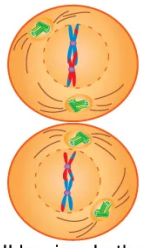
In late anaphase I, the chromatids have almost reached the spindle poles. The cell membrane begins to constrict.



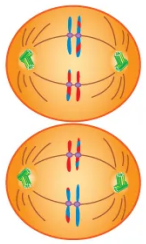
In telophase I, nuclear membranes enclose the separated chromatids. The cell membrane completes its constriction.



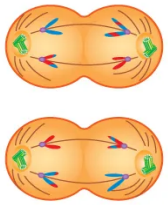
The first meiotic division ends. There are now two cells, each with the same number of chromatids as the parent cell.



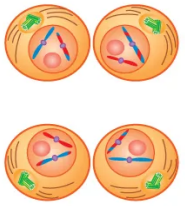
Prophase II begins. In the second meiotic division, homologous chromatids do not duplicate but merely separate.



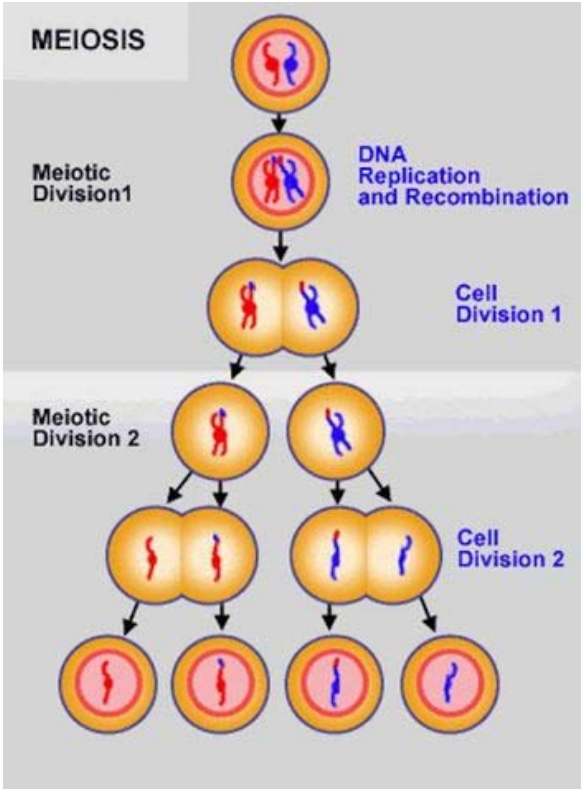
In metaphase II, the chromatids line up at mid-cell. The centrioles and asters are at the poles. A spindle has formed.



In anaphase II, the now-separated chromatids approach their respective poles. The cell membrane begins to constrict.



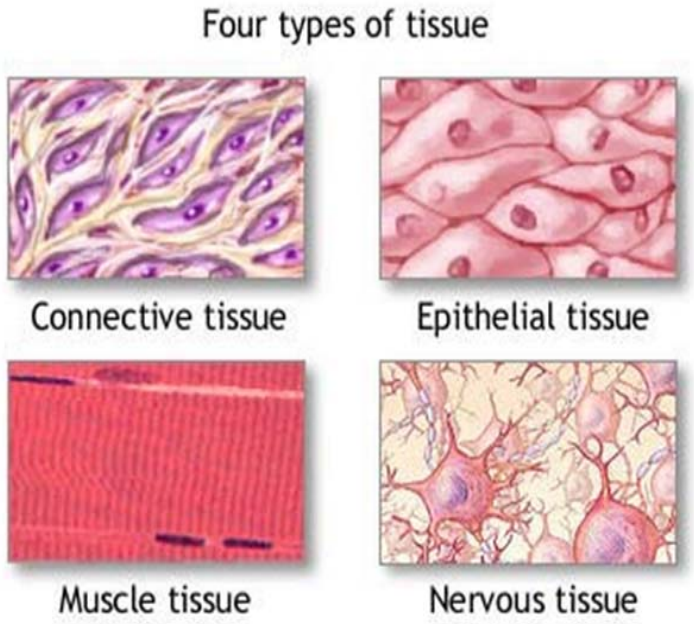
Telophase II has been completed. There are now four cells, each with half the number of chromosomes of the parent cell.



Tissues: Is a group of cells that have similar structure and that function together as a unit.

❖ **Main types of tissues:**

1. **Epithelial tissue: provides covering or lining.**
2. **Connective tissue: supports, links and cushions.**
3. **Muscular tissue: helps in movement.**
4. **Neural tissue: responds to stimuli**



Epithelial tissue or epithelium: consists of cells arranged in continuous sheets, in either single or multiple layers. Because the cells are closely packed and are held tightly together by many cell junctions, there is little intercellular space. Epithelial tissue may be divided into two types.

- **Surface epithelium**: forms the outer covering of the skin and some internal organs. It also forms the inner lining of blood vessels, ducts, body cavities, and the interior of the respiratory, digestive, urinary, and reproductive systems.
- **Glandular epithelium:** makes up the secreting portion of glands such as the thyroid gland, adrenal glands, sweat glands, and digestive glands.

Functionally, epithelial tissue **protects**, **secretes** (mucus, hormones, and enzymes), **absorbs** (nutrients in the gastrointestinal tract), and **excretes** (various substances in the urinary tract)

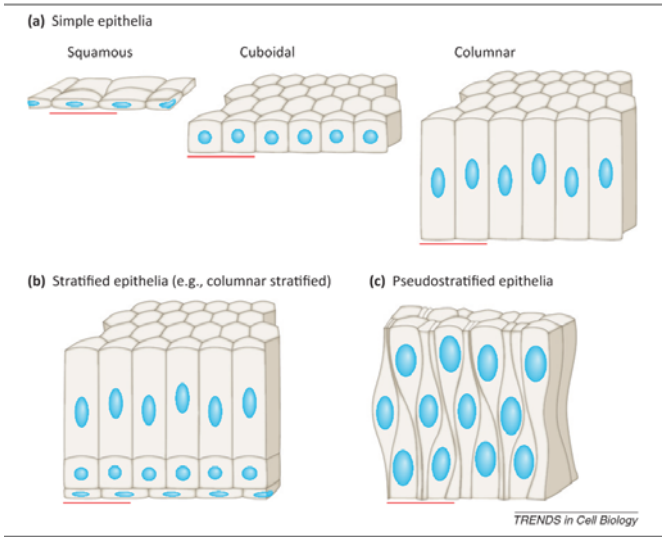
Classification of Epithelial Tissue

1. **Arrangement of cells in layers**: The cells are arranged in one or more layers depending on function:

a. **Simple epithelium:** is a single layer of cells that functions in diffusion, filtration, secretion, or absorption.
b. **Stratified epithelium :** consists of two or more layers of cells that protect underlying tissues in locations where there is considerable wear and tear.
c. **Pseudostratified epithelium:** appears to have multiple layers of cells because the cell nuclei lie at different levels.

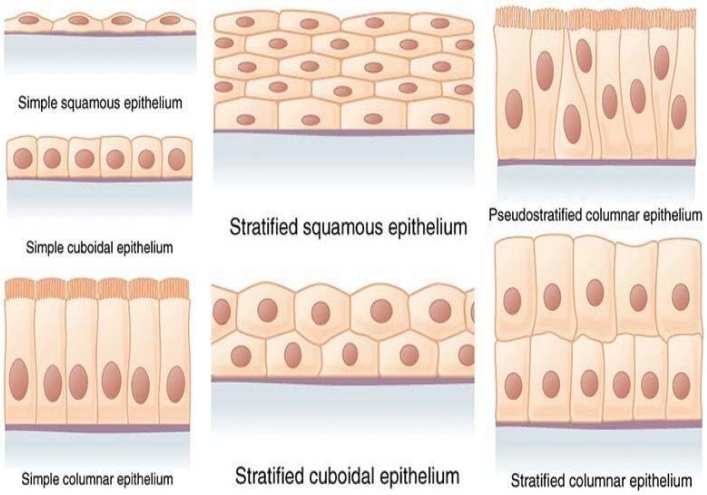
2. Cell shapes: Epithelial cells vary in shape depending on their function:

a. Squamous epithelium
b. Cuboidal epithelium
c. Columnar epithelium
d. Transitional epithelium



3. When we combine the two characteristics (arrangements of layers and cell shapes), we come up with the following types of epithelial tissues:

1. Simple squamous epithelium
2. Simple cuboidal epithelium
3. Simple columnar epithelium
4. Stratified squamous epithelium
5. Stratified cuboidal epithelium
6. Stratified columnar epithelium
7. Pseudostratified columnar epithelium



❑ Simple squamous epithelium

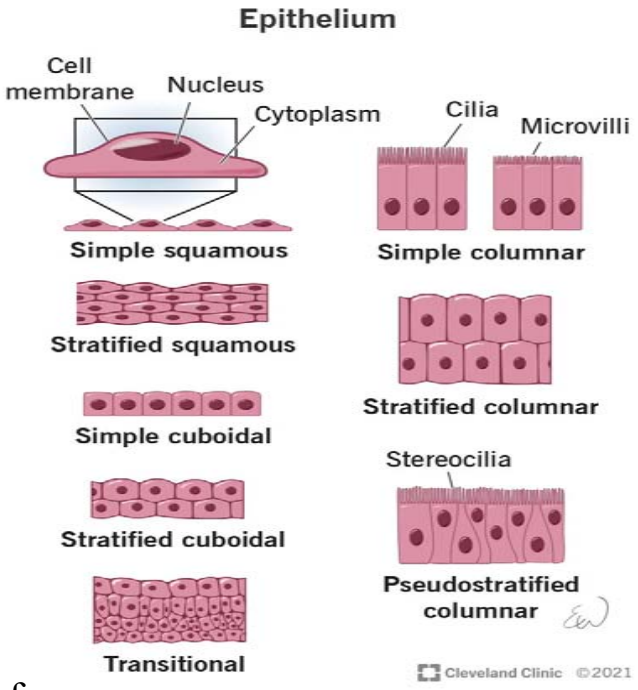
Description: is a single layer of flat cells centrally located nucleus that is flattened and oval or spherical in shape.
Location: cardiovascular and lymphatic system (heart, blood vessels, lymphatic vessels).

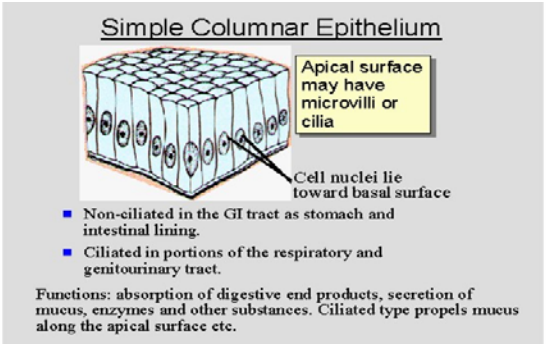
❑ Simple cuboidal epithelium

Description: is a single layer of cube-shaped cells; round, centrally located nucleus.
Location : in many glands and ducts

❑ Simple columnar epithelium

Description: Single layer of tall, column-shaped cells with oval nuclei near base of cells, the columnar epithelial cells contains **microvilli at apical surface and goblet cells.**
Microvilli Cells often modified for specialized functions.
Goblet cells (secretion), cilia (movement), microvilli (absorption) Often lines hollow visceral structures





❑ Pseudostratified columnar epithelium

appears to have several layers because the nuclei of the cells are at various levels. Even though all the cells are attached to the basement membrane in a single layer, some cells do not extend to the apical surface

❖ Ciliated: cells that extend to surface and secrete mucus (goblet cells) or bear cilia.
Location lines airways of most of upper respiratory tract.

❖ Non-ciliated: cells without cilia and also lacks goblet cells.
Location lines epididymis, larger ducts of many glands, and parts of male urethra.

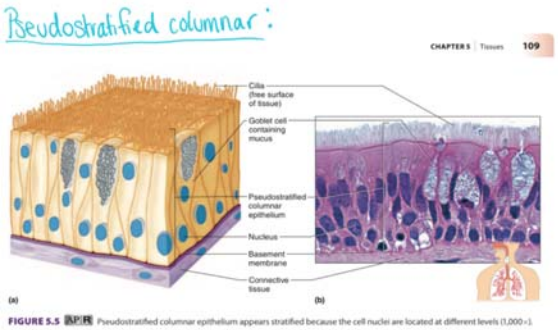


FIGURE 5.5 AP|R Pseudostratified columnar epithelium appears stratified because the cell nuclei are located at different levels (1,000×).

❑ Stratified squamous epithelium

Has two or more layers of cells; cells in apical layer and several layers deep to it are squamous; cells in deeper layers vary from cuboidal to columnar

❖ **Keratinized stratified squamous epithelium**: develops tough layer of keratin in apical layer of cells and several layers deep to it (Keratin is a tough, fibrous intracellular protein that helps protect skin and underlying tissues from heat, microbes, and chemicals). Location: superficial layer of skin

❖ **Non-keratinized stratified squamous epithelium:** lacks of keratin in apical layer and several layers deep and is constantly moistened by mucus from salivary and mucous glands. Location: lining of mouth, esophagus, part of epiglottis, part of pharynx, and vagina.

❑ Stratified cuboidal epithelium

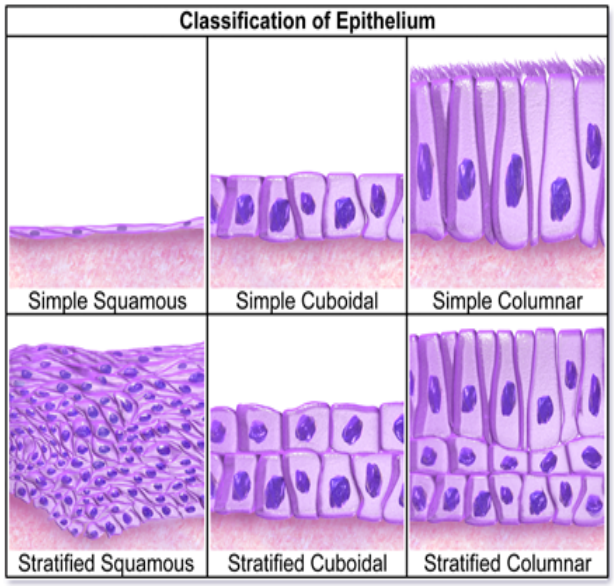
Description: has two or more layers of cells; cells in apical layer are cube-shaped.
Location: Ducts of adult sweat glands and esophageal glands, part of male urethra

❑ Stratified columnar epithelium

Description: Basal layers in stratified columnar epithelium usually consist of shortened, irregularly shaped cells; only apical layer has columnar cells; uncommon.
Location: Lines part of urethra; large excretory ducts of some glands, such as esophageal glands; small areas in anal mucous membrane; part of conjunctiva of eye

❑ Transitional epithelium or urothelium (lines most of urinary tract)

Description: Has a variable appearance (transitional). In relaxed or unstretched state, consist of multiple layers and elasticity make it ideal for lining hollow structures (urinary bladder).
Location: Lines urinary bladder and portions of ureters and urethra.



Connective Tissue: Is one of the most abundant and widely distributed tissues in the body. In its various forms, connective tissue has a **variety of functions:**

- It binds together, supports, and strengthens other body tissues.
- serves as the major transport system within the body (blood).
- primary location of stored energy reserves (adipose or fat tissue).
- main source of immune responses.

Structurally, connective tissue is formed by three components: cells, fibers, and ground substance..

Connective tissue cells vary according to the type of tissue and include the following:

1. Fibroblasts: are large flat cells secrete fibers and ground substance.

2. Macrophages: develop from monocytes and destroy bacteria and cell debris by phagocytosis.

3. Plasma cells: develop from B lymphocytes, they secrete antibodies that attack and neutralize foreign substances.

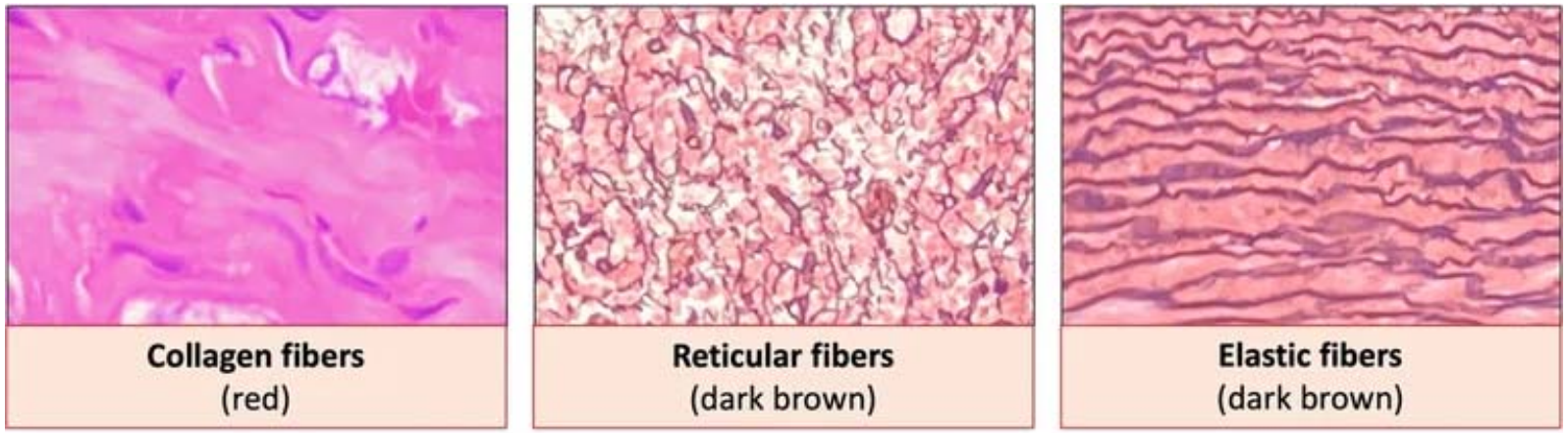
4. Mast cells: are abundant along blood vessels, they produce histamine which dilates small blood vessels during inflammation and kills bacteria.

5. Adipocytes: are fat cells that store fats, they are found below the skin and around organs (heart, kidney).

6. Leukocytes (white blood cells): are not found in significant numbers in normal connective tissue. However, in response to certain conditions they migrate from blood into connective tissue. For example, neutrophils gather at sites of infection, and eosinophils migrate to sites of parasitic invasions and allergic responses

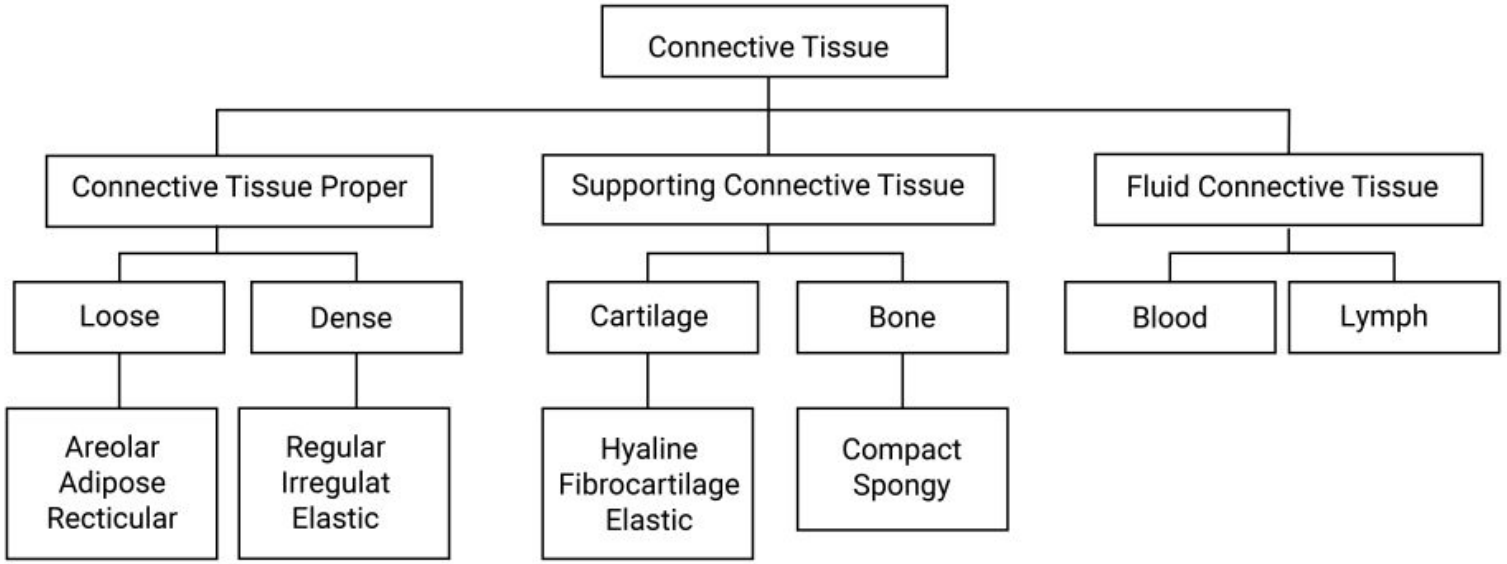
Connective tissues contain three types of fibers: collagen, elastic and reticular

- **Collagen fibers** are the most widespread and made up of fibrous protein, collagen. Collagen fibers are flexible and have high tensile strength.
- **Elastic fibers:** They are made up of protein elastin. They retain their original shape and size once the force is removed.
- **Reticular fibers:** consist of collagen and glycoproteins. They are thin and form a delicate network. They join connective tissues to neighboring tissues



Types of connective tissue fibers

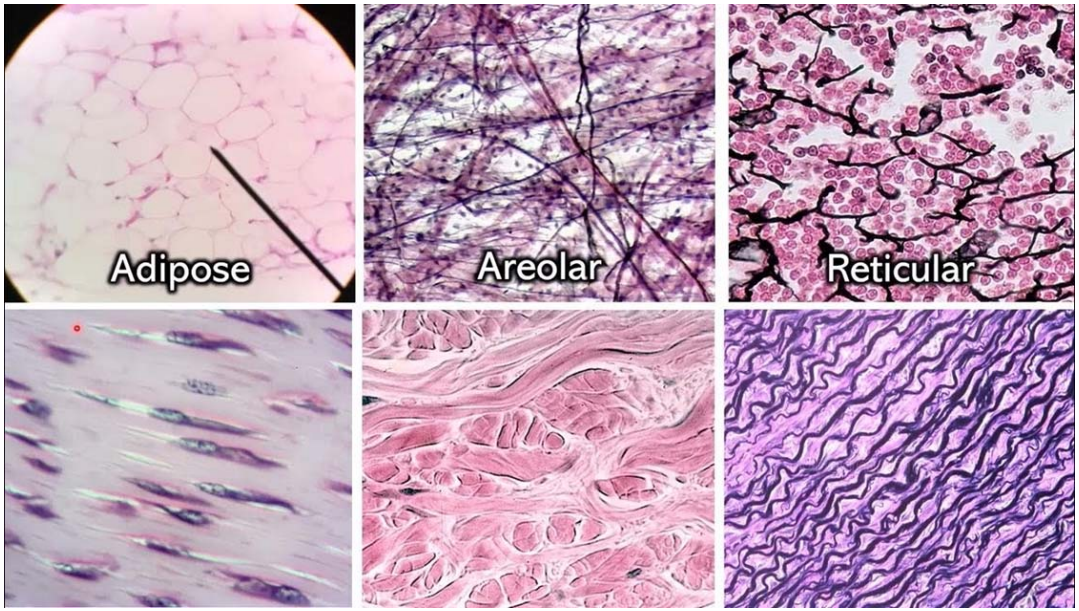
Classification of connective tissue



1. **Loose connective tissue:** The fibers of loose connective tissue are loosely arranged between cells.

a. **Areolar connective tissue:** is one of the most widely distributed connective tissues; consists of fibers (collagen, elastic, reticular), located in subcutaneous layer deep to skin; dermis of skin; around blood vessels, nerves, and body organs.

b. **Adipose tissue :** has cells derived from fibroblasts (called adipocytes) that are specialized for storage of triglycerides (fats) as a large, centrally located droplet. **Location:** subcutaneous layer deep to skin, around heart and kidneys, around joints and behind eyeball in eye socket. **Function:** Reduces heat loss through skin; serves as an energy reserve; supports and protects organs.

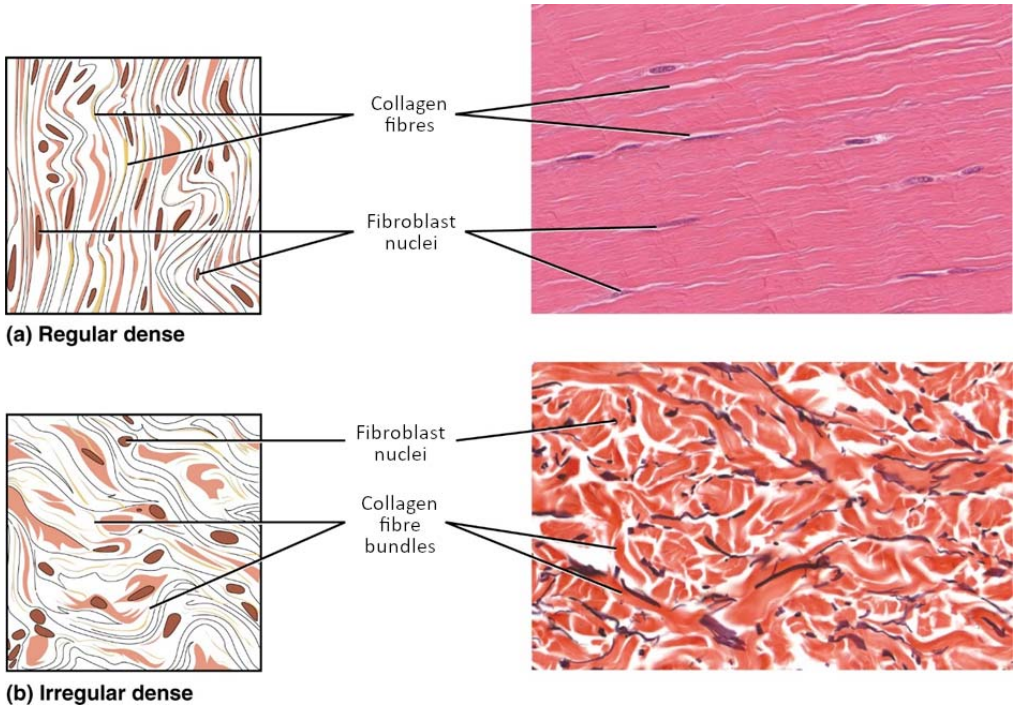


c. **Reticular connective tissue:** is a fine interlacing network of reticular fibers (thin form of collagen fiber) and reticular cells. **Location:** spleen, lymph nodes, red bone marrow, around blood vessels and muscles. **Function:** binds smooth muscle tissue cells, filters and removes worn-out blood cells in spleen and microbes in lymph nodes

2. **Dense connective tissue** contains more fibers, which are thicker and more densely packed, but have considerably fewer cells than loose connective tissue.

a. **Dense regular connective tissue:** collagen fibers regularly arranged in bundles with fibroblasts in rows between them. **Location:** Forms tendons (attach muscle to bone) and most ligaments (attach bone to bone).

b. **Dense irregular connective tissue:** is made up of collagen fibers; usually irregularly arranged with a few fibroblasts. **Location:** joint capsules, membrane capsules around various organs (kidneys, liver, testes, lymph nodes) also in heart valves.



c. **Elastic connective tissue:** contains predominantly elastic fibers with fibroblasts between them.
Location: Lung tissue, walls of elastic arteries, trachea, bronchial tubes and some ligaments between vertebrae.
Function: Allows stretching of various organs; is strong and can recoil to original shape after being stretched.