

# The Cells

- 1-The cell is composed of two basic parts: **cytoplasm** and **nucleus**. Cells and extracellular material together comprise all the tissues that make up the organs of multicellular animals. In all tissues, cells themselves are the basic structural and functional units, the smallest living parts of the body.
- 2- Animal cells are **eukaryotic** with distinct membrane-limited nuclei surrounded by cytoplasm containing many varied membrane-limited organelles.
- 3-In contrast the small **prokaryotic** cells of bacteria typically have a cell wall around the plasmalemma, lack other membranous structures including an envelope around the genetic material (DNA).
- 4- Different cells of the animal become specialized by concentrating specific organelles and greatly developing specific cellular activities which can generally be found to more limited extents in all animal cells.

## Cell Differentiation.

- 1-The human organism presents about 200 different cell types, all derived from the zygote, the single cell formed by fertilization of an oocyte with a spermatozoon.
- 2-The first cellular divisions of the zygote produce cells called **blastomeres** and as part of the **inner cell mass** blastomeres give rise to all tissue types of the adult. Explanted to tissue culture such cells have been termed **embryonic stem cells**.
- 3-During their specialization process, called **cell differentiation**, the cells synthesize specific proteins, change their shape, and become very efficient in specialized functions. For example, muscle cell precursors elongate into fiber-like cells that synthesize and accumulate large arrays of actin and myosin. The resulting cell is specialized to efficiently convert chemical energy into contractile force.

**The main cellular functions are:**

Cellular functions in some specialized cells.	
<b>Function</b>	<b>Specialized Cell(s)</b>
1-Movement	Muscle and other contractile cells
2-Form adhesive and tight junctions between cells	Epithelial cells
3-Synthesize and secrete components of the extracellular matrix	Fibroblasts, cells of bone and cartilage
4-Convert physical and chemical stimuli into action potentials	Neurons and sensory cells
5-Synthesis and secretion of enzymes	Cells of digestive glands
6-Synthesis and secretion of mucous substances	Mucous-gland cells
7-Synthesis and secretion of steroids	Some adrenal gland, testis, and ovary cells
8-Ion transport	Cells of the kidney and salivary gland ducts
9-Intracellular digestion	Macrophages and some white blood cells
10-Lipid storage	Fat cells
11-Metabolite absorption	Cells lining the intestine

## The Cytoplasm:

### Cytoplasmic Organelles:

The **cytosol** contains hundreds of enzymes, such as those of the glycolytic pathway, that produce building blocks for larger molecules and break down small molecules to liberate energy. All the machinery converging on the ribosomes for protein synthesis (mRNA, transfer RNA, enzymes, and other factors) is also contained within the cytosol. Oxygen, CO<sub>2</sub>, electrolytic ions, low molecular weight substrates, metabolites, waste products, all diffuse through the cytosol, either freely or bound to proteins, passing to or leaving the organelles where they are used or produced.

### Plasma Membrane: plasmalemma.

All eukaryotic cells are enveloped by a limiting membrane composed of phospholipids, cholesterol, proteins, and chains of oligosaccharides covalently linked to phospholipid and protein molecules.

#### Functions of plasma membrane :

**A-** a selective barrier that regulates the passage of certain materials into and out of the cell and facilitates the transport of specific molecules.

**B-** One important role of the cell membrane is to keep constant the ion content of cytoplasm, which is different from that of extracellular fluid.

**C-**Membranes also carry out a number of specific recognition and regulatory functions .

**D-** playing an important role in the interactions of the cell with its environment.

## Mitochondria:

**Mitochondria** are membrane-enclosed organelles, Each mitochondrion is seen to have two separated and very different membranes which together create two compartments:

**A-** The **inner membrane** is folded to form a series of long infoldings called **cristae**, which project into the matrix and greatly increase the membrane's surface area . The number of cristae in mitochondria also corresponds to the energy needs of the cell.

**B-** The innermost **matrix** and a narrow **intermembrane space** .

**C-**The **outer membrane** is sieve-like, containing many transmembrane proteins called **porins** that form channels through which small molecules

readily pass to enter the intermembrane space from the cytoplasm.

**D-**Both mitochondrial membranes contain a large number of protein molecules compared with other membranes in the cell and have reduced fluidity.

### **Functions of Mitochondria:**

**1-Mitochondria** are membrane-enclosed organelles with enzyme arrays specialized for aerobic respiration and production of **adenosine triphosphate (ATP)**, which contains energy stored in high-energy phosphate bonds and is used in most energy-requiring cellular activities.

**2-Glycolysis** converts glucose anaerobically to pyruvate in the cytoplasm, releasing some energy.

### **Ribosomes:**

**1-Ribosomes** found in the cytosol are composed of four segments of rRNA and approximately 80 different proteins. All ribosomes are composed of two different-sized subunits.

**2-In eukaryotic cells**, the RNA molecules of both subunits are synthesized within the nucleus. Their numerous proteins are synthesized in the cytoplasm but then enter the nucleus and associate with rRNAs. The assembled large and small subunits then leave the nucleus and enter the cytoplasm to participate in protein synthesis.

### **Functions of Ribosomes:**

**1-** The large and small ribosomal subunits come together by binding an mRNA strand and typically numerous ribosomes are present on an mRNA as **polyribosomes** (or **polysomes**).

**2-Proteins** synthesized for use within the cell cytosol (eg, glycolytic enzymes) are synthesized on polyribosomes existing as isolated clusters within the cytoplasm.

**3-Polyribosomes** that are attached to the membranes of the endoplasmic reticulum (via their large subunits) translate mRNAs that code for proteins that are sequestered across the membranes of this organelle .

### **Endoplasmic Reticulum:**

There are two types of endoplasmic reticulum: **rough** and **smooth**.

#### **I-Rough Endoplasmic Reticulum:**

- 1-Rough endoplasmic reticulum (RER) is prominent in cells specialized for protein secretion, such as pancreatic acinar cells (digestive enzymes).
- 2-The RER consists of sac-like as well as parallel stacks of flattened cisternae, limited by membranes that are continuous with the outer membrane of the nuclear envelope.
- 3-The name "rough endoplasmic reticulum" refers to the presence of polyribosomes on the cytosolic surface of this structure's membrane.

### **Function of the RER:**

- 1-The principal function of the RER is to segregate proteins for the cytosol. Additional functions include the initial glycosylation of glycoproteins, the synthesis of phospholipids. All protein synthesis begins on polyribosomes that are not attached to the ER.
- 2- Proteins synthesized in the RER can have several destinations: intracellular storage (eg, in lysosomes), provisional intracellular storage of proteins before exocytosis (eg, in the pancreas, some endocrine cells), and as integral membrane proteins.

## **II- Smooth Endoplasmic Reticulum:**

- 1-Regions of ER that lack bound polyribosomes make up the smooth endoplasmic reticulum (SER), which in most cells is less abundant than RER but is continuous with it.
- 2-SER cisternae are often more tubular and more likely to appear as a profusion of interconnected channels of various shapes and sizes than as stacks of flattened cisternae.

### **Function of the SER:**

- 1- A major role of SER is the synthesis of the various phospholipid molecules that constitute all cellular membranes.
- 2- In cells that synthesize steroid hormones (eg, cells of the adrenal cortex).
- 3-SER is abundant in liver cells, where it contains enzymes responsible for the oxidation, conjugation, and methylation processes that degrade certain hormones and neutralize noxious substances such as alcohol and barbiturates.
- 4-The SER of liver cells also contains the enzyme glucose-6-phosphatase, which is involved in the utilization of glucose originating from glycogen.
- 5- The SER is to sequester and release  $\text{Ca}^{2+}$  in a controlled manner, which is part of the rapid response of cells to various external stimuli.

## Golgi Apparatus:

- 1-Then packages and addresses proteins synthesized in the RER. This organelle is composed of smooth membranous **sac** in which these functions occur .
- 2-The Golgi apparatus generally shows two distinct sides structurally and functionally, the entry or *cis* face. On the opposite side of the Golgi network, which is the exit or *trans* face.
- 3-These structures bud from the maturing saccules and generate vesicles that carry completed protein products to organelles away from the Golgi.

## Lysosomes:

- 1-Lysosomes are sites of intracellular digestion and turnover of cellular components. Lysosomes are membrane-limited vesicles that contain about 40 different hydrolytic enzymes and are particularly abundant in cells with great phagocytic activity (eg, macrophages, neutrophils).
- 2- The nature and activity of lysosomal enzymes vary depending on the cell type, the most common are acid hydrolyases such as proteases, nucleases, phosphatase, phospholipases, sulfatases .Lysosomal enzymes are capable of breaking down most macromolecules.

## Proteasomes.

- 1-**Proteasomes** are abundant cytoplasmic protein complexes not associated with membrane, each approximately the size of the small ribosomal subunit.
- 2-They function to degrade denatured or nonfunctional polypeptides. Proteasomes also remove proteins no longer needed by the cell and provide an important mechanism for restricting activity of a specific protein to a certain window of time.

## Peroxisomes or Microbodies:

- 1-Peroxisomes are spherical membrane-limited organelles,They utilize oxygen but do not produce ATP and do not participate directly in cellular metabolism.
- 2- Peroxisomes oxidize specific organic substrates by removing hydrogen atoms that are transferred to molecular oxygen (O<sub>2</sub>). This produces hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), a substance potentially damaging to the cell which is immediately broken down by **catalase**, another enzyme in all peroxisomes.

## The Cytoskeleton:

The cytoplasmic cytoskeleton is a complex network of **(1)** microtubules, **(2)** microfilaments (actin filaments), and **(3)** intermediate filaments. These protein structures determine the shape of cells, play an important role in the movements of organelles and cytoplasmic vesicles, and also allow the movement of entire cells.

### I-Microtubules.

**A-**Within the cytoplasmic matrix of eukaryotic cells are fine tubular structures known as **microtubules**. Microtubules are also found in cytoplasmic processes called cilia and flagella.

**B-**Microtubules are variable in length, but they can become many micrometers long. Occasionally, two or more microtubules are linked by protein arms or bridges, which are particularly important in cilia and flagella.

### II-Microfilaments (Actin Filaments).

**A-**Contractile activity in cells results primarily from an interaction between **actin** and its associated protein, **myosin**.

**B-** There are several types of actin and this protein is present in all cells. Actin is usually found in cells as polymerized filaments of F-actin mingled with free globular G-actin subunits.

**C-**Actin filaments or microfilaments are helical two-stranded polymers assembled from **globular actin subunits**. The filaments are flexible structures.

### III-Intermediate Filaments.

**A-**In addition to microtubules and the thin actin filaments, eukaryotic cells contain a class of filaments intermediate in size between the other two cytoskeletal components.

**B-** In comparison with microtubules and actin filaments, **intermediate filaments** are much more stable and vary in their protein subunit structure in different cell types.

**C-** More heterogeneous protein classes that form such intermediate filaments.

### **Inclusions:**

**A**-Cytoplasmic **inclusions** are composed mainly of accumulated metabolites or other substances and are often transitory components of the cytoplasm.

**B**-Non motile and with little or no metabolic activity, inclusions are not considered organelles. Important and commonly seen inclusions include:

- 1- **Fat droplets.**
- 2- **Glycogen granules.**
- 3- **Lipofuscin granules.**

### **The Cell Nucleus :**

**A**-The nucleus frequently appears as a rounded or oval structure, usually in the center of the cell . Its main components are the **nuclear envelope**, **chromatin** consisting of DNA and associated proteins, and a specialized region of chromatin called the **nucleolus** .

**B**-The size and morphologic features of nuclei in a specific normal tissue tend to be uniform. In contrast, the nuclei in cancer cells often have irregular shapes, variable sizes, and atypical chromatin patterns.