

# Cell and Molecular Biology

## Cell Structure

Lec: 3

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### 2-Nucleus

Nucleus is the largest and most easily seen of the components within the eukaryotic cell (4-10  $\mu\text{m}$  in diameter). It contains the majority of the cell's genetic material. This material is organized as DNA molecules, along with a variety of proteins, to form chromosomes.

Nuclei are roughly spherical, although some are oval or irregular in shape. They are typically located in the central region of the cells. The majority of cells have one nucleus, but some cells or unicellular animals have two or more nuclei. Mammalian RBCs lose their nucleus when they mature and hence they lose their ability to grow, change and divide and become merely passive vessels for the transport of hemoglobin

The nucleus is composed of four parts:

- 1-nuclear envelope
- 2-nucleoplasm
- 3- chromatin
- 4-nucleolus

#### **1-Nuclear Envelope:**

The nuclear envelope or nuclear membrane represents the surface of the nucleus, which is bounded by two phospholipid bilayer membranes similar in structure with that of plasma membrane. The outer membrane of the nuclear envelope is occasionally continuous with the endoplasmic reticulum. The outer and inner membranes fuse together to form gaps, known as the nuclear pores. Nuclear pores are filled with proteins that act as molecular channels, permitting certain molecules to pass into and out of the nucleus. The space between both membranes (perinuclear cisterna) is filled with a fluid. The inner membrane is firmly attached to clumps of heterochromatin.

#### **2- Nucleoplasm:**

The nucleoplasm, karyoplasm or nuclear sap is a fluid filling the inside of the nucleus. Within this fluid both nucleolus (or sometimes nucleoli) and the chromatin are found.

### 3- Nucleolus:

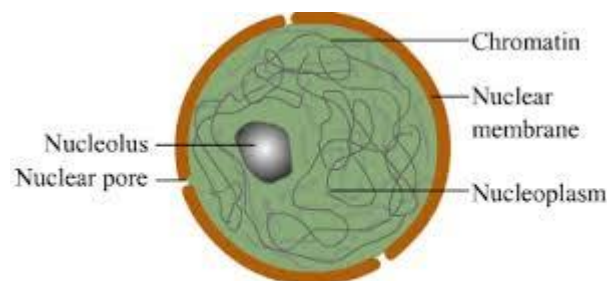
Nucleolus appears as a small dense body immersed in the nucleoplasm. Two nucleoli are sometimes present in the nucleus. The nucleolus is considered as the ribosomal factory as it consists of RNA and protein (ribosomal subunits) in the process of maturation. These subunits are synthesized in the nucleolus and then move through the nuclear pores to the cytoplasm, where they assemble. Ribosomes serve as the site of protein synthesis.

### 4- Chromatin:

The chromatin is the nuclear material which is made up of DNA and large protein molecules (histones). This is basophilic in staining. It can be distinguished into two types:-

A- Euchromatin or noncondensed chromatin which is loosely packed and thus is very lightly basophilic. This is metabolically active with regard to RNA synthesis.

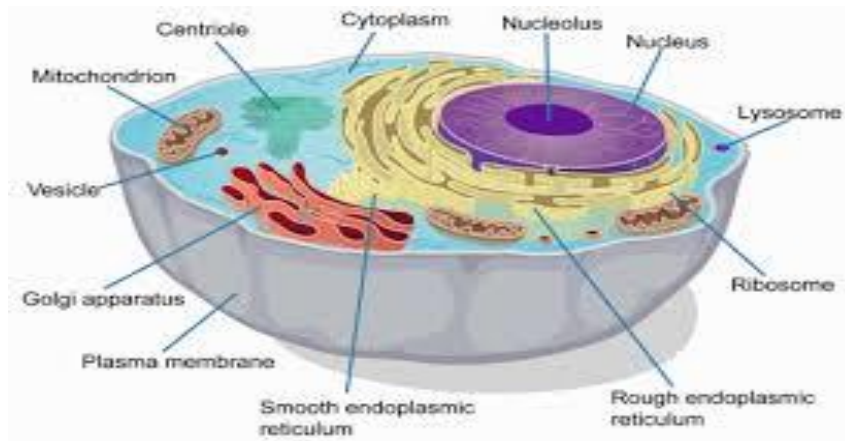
B- Heterochromatin or condensed chromatin which is tightly packed and thus is intensively basophilic. This is relatively inactive metabolically and consists of chromosomes.



Structure of a Nucleus

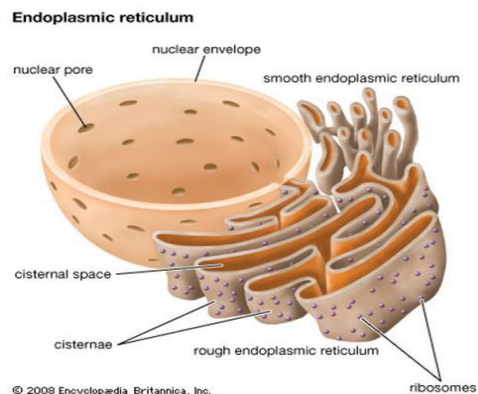
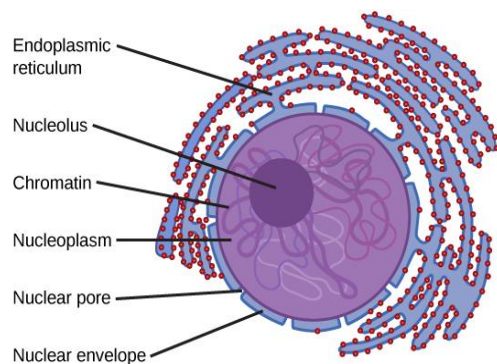
### 3- Cytoplasm

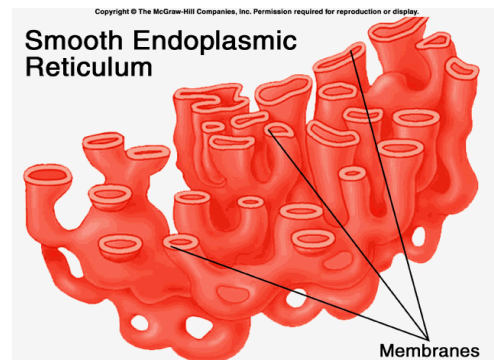
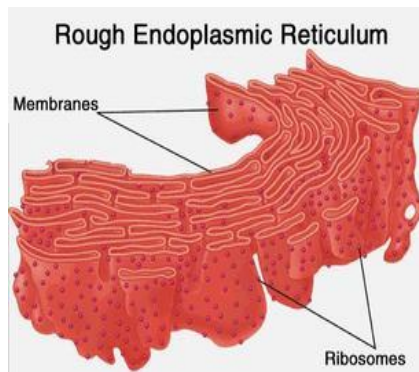
Cytoplasm is the space between the nucleus and cell membrane, which fills with the cytosol (fluid in which organelles reside). It is mainly composed of water, salts, and proteins. In eukaryotic cells, the cytoplasm includes all of the material inside the cell and outside of the nucleus. All of the organelles in eukaryotic cells, such as the nucleus, endoplasmic reticulum, and mitochondria, are located in the cytoplasm. Although cytoplasm may appear to have no form or structure, it is actually highly organized. A framework of protein scaffolds called the cytoskeleton provides the cytoplasm and the cell with their structure.



#### 4- Endoplasmic reticulum

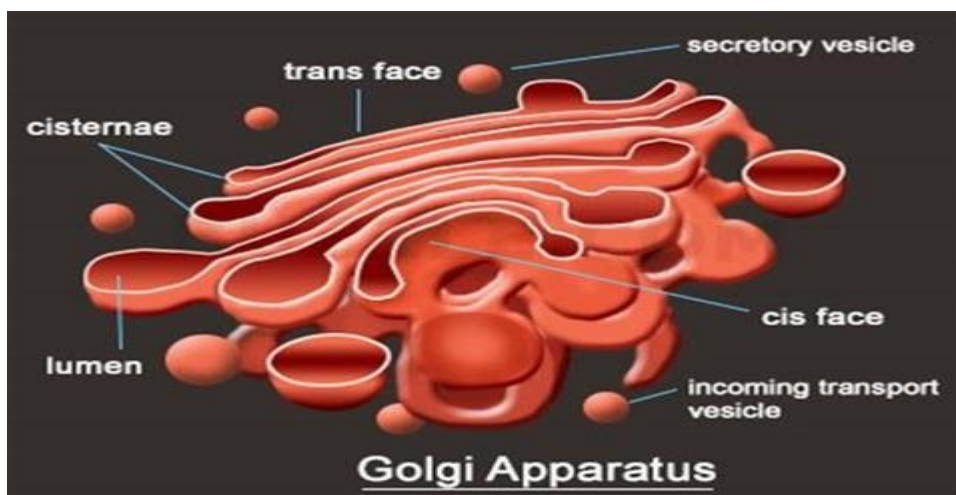
The endoplasmic reticulum is a network of double-membrane tubular canals running throughout the cytoplasm. It is continuous with the nuclear membrane. Regions of the endoplasmic reticulum without bounded ribosomes are referred to as smooth endoplasmic reticulum which represent the site of synthesis of lipid and a variety of carbohydrates, while those heavily studded with ribosomes are known as rough endoplasmic reticulum which is the site of protein synthesis. Dangerous chemicals are destroyed (detoxified) by enzymes, located on membranes of endoplasmic reticulum. Various products are transported from one portion of the cell to another via the endoplasmic reticulum. Finally, it gives support to the cell.





### 5- Golgi apparatus;

Golgi apparatus or Golgi complex or Golgi body is a small, irregular structure as flattened stacks of flattened membranes situated near the middle of the cell. This complex is known as the delivery system of the cell as it collects, packages and distributes molecules that are synthesized at one location within the cell and used at another. Transport vesicles bring the concerned material from the endoplasmic reticulum to Golgi apparatus. The formed material inside this apparatus are transported outside this apparatus through secretory vesicles. The number of these bodies in the cell depends on the activity of that cell. Golgi apparatus also forms lysosome bodies (lysosomes).

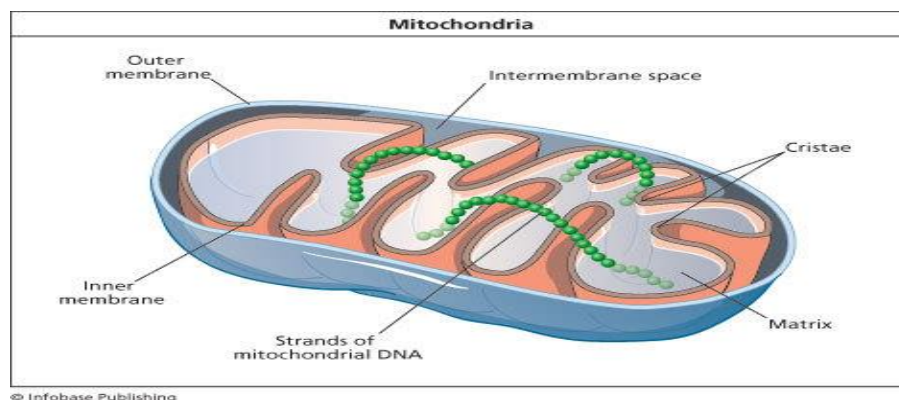


### 6- Mitochondria:

Mitochondria are typically tubular or sausage-like organelles, 1 to 3  $\mu\text{m}$  long, found in all types of eukaryotic cells.

Mitochondrion is bounded by two membranes: the outer one is smooth and the inner one is folded into numerous contiguous layers called cristae. The cristae partition the mitochondrion into two compartments: a matrix lying inside the inner membrane and an outer compartment or inter membrane space lying between the two mitochondrial membranes. On the surfaces of the inner membrane and also submerged within it, are the proteins that carry out oxidative metabolism, the oxygen-requiring process by which the energy in macromolecules is stored in ATP.

Mitochondria are frequently called the power houses of the cell or the cell's chemical furnaces as in which the high energy ATP is produced. ATP is produced in mitochondria by breakdown of organic compounds such as glucose and is sent to other parts of cell for providing energy. Active cells such as muscles and liver cells have a large number of mitochondria due to their high energy demands.



## 7- Ribosomes

Are small, complex assemblies of protein (35%) and ribosomal RNA (65%). The rRNA is manufactured by the DNA in the nucleolus. The ribosome consists of a large and a small subunit. Some ribosomes are scattered, singly or in clusters, in the cytoplasm and they are concerned with synthesizing protein for use inside the cell, while other ribosomes are attached to the rough endoplasmic reticulum and hence they are concerned with the synthesis of the proteins for export from the cell.

## 8- Centrioles:

Centrioles are cylindrical structures that are composed of groupings of microtubules, each centriole consists of a bundle of microtubules arranged as threes in a circle of nine (9 + 3 pattern). Found in animals

cell, they occur in pairs near the nuclear membrane. The pair together is referred to as a centrosome.

The centrioles play a major role in cell division, Centrioles are also important to the formation of cell structures know as cilia and flagella



### **9-Lysosomes**

Lysosomes are membrane-enclosed organelles that contain an array of enzymes capable of breaking down all types of biological polymers— proteins, nucleic acids, carbohydrates, and lipid. Lysosomes function as the digestive system of the cell, serving both to degrade material taken up from outside the cell in a process called heterophagy and to digest old cellular organelles as debris of the cell itself in a process called autophagy. when cells get old, lysosomes autolysis the cell and therefore known as suicide bags

### **10-Peroxisomes**

Peroxisomes also called microbodies: are enzyme –bearing, membrane bounded vesicles similar in structure to lysosomes but they are smaller. The name peroxisome refers to hydrogen peroxide that is produced as by-product of the activities of many of oxidative enzymes.  $H_2O_2$  is dangerous to cell and peroxisome contain catalase enzymes that breaks down hydrogen peroxide into harmless water and oxygen for this reason, peroxisomes are known as detoxifiers for hydrogen peroxide.

### **11-Cilia and flagella**

Cilia are short cellular projection from the cell membrane often organized in rows. Cilia are more numerous on cell surface than flagella which are more longer. Both cilia and flagella have the same internal structure as they consist of a circle of nine peripheral microtubule pairs surrounding two central microtubules. This arrangements is known as 9+2 structure. Cilia line human oviduct

and hence they drive the fluid in which egg is transported all so trachea is lined with cilia which move the slimy mucous that traps dust particles and prevents getting into lung

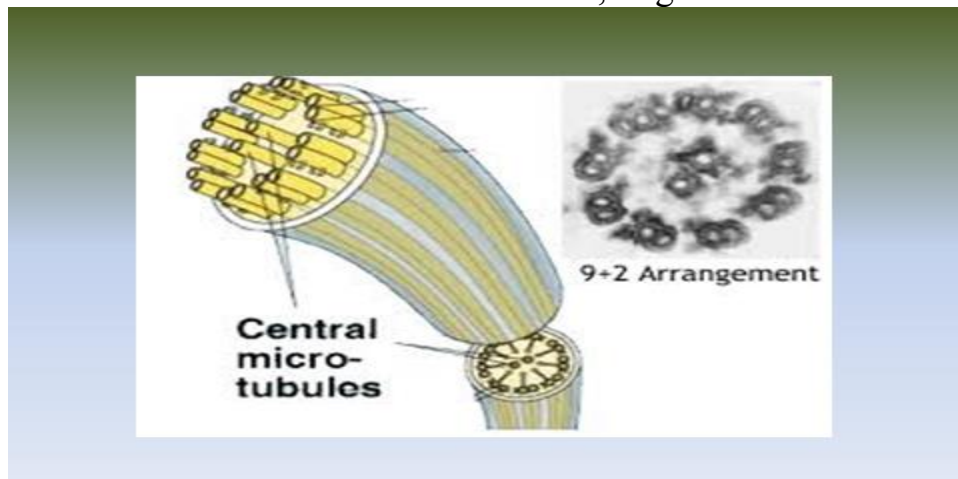
## 12- Microfilaments and microtubules

The cytoplasm of all eukaryotic cells is crossed by a network of protein fibers that supports the shape of the shape of the cell and anchors organelles to fixed location. This network is known as cytoskeleton or the interior framework of the cell

**A- Microfilaments** are rod-like structure of variable length and may occur in bundles, they are randomly scattered throughout the cytoplasm or arranged in a meshwork. Some microfilaments consist of proteins called actin, while other consist of myosin. In muscles the actine(thin myofilament) and myosin(thick myofilament) are involved in the contraction of the muscle cells.

In other cells microfilaments help to provide support and shape and assist in the movement within cells.

**B-Microtubules** are relatively straight, slender and cylindrical structures .They are consist of tubulin protein. Microtubules are found in the cytoplasm together with Microfilament, this help to provide support and shape for cells. Also, they form conducting channels through which various substances can move throughout the cytoplasm as in nerve cells. Microtubules form the structure of cilia, flagella and centrioles



## 13- Cytoplasmic inclusions

In addition to the living organelles found in the cytoplasm, other cellular components are found. Inclusions, considered to be nonliving components of the cell that do not possess metabolic activity and are not bounded by membranes. The most common inclusions are glycogen, lipid droplets, crystals and pigments. These may be synthesized by the cell itself or taken up from surrounding.