Nucleus

The nucleus is the largest cellular organelle that contains the genetic information that directs on all of the metabolic activities of the cell. The nucleus contains all of the cell's genome, that organized as multiple long linear DNA molecules in a complex with a large variety of proteins, such as **histones**, to form chromosomes. The genes within these chromosomes are structured in such a way to promote cell function.

The main function of the nucleus is to control gene expression and mediate the replication of DNA during the cell cycle, and directing on growth, metabolism, and reproduction of the cell.

The shape of nucleus differs with the cell shaped, it is may be rounded or elongated but it is usually spherical in shape. The nucleus is usually located in the center of the cell. They differ in diameter between (5-10µm) and some cells have nucleus could be reach more than (25µm) in diameter like ovum.

The nucleus presents in all cells except the red blood cells (RBC) of blood where they lose their nuclei when becoming mature. Most cells have one nucleus but others may have binucleate like cardiac muscle cells or multi nucleated like skeletal muscle cells and osteoclasts.

The nucleus is surrounded by **nuclear envelope** that separating the nucleus from surrounding cytoplasm in the cell. The nucleus is filled with nuclear matrix (Nucleoplasm) and contains nuclear **chromatin** and a **nucleolus** (Figure.1). The nucleus stain blue when using basic dye such as hematoxylin, where the nucleus is basophilic in nature due to its content of nucleic acid (DNA). The **hematoxylin** is basic dye that reacts and binds with

acidic components in the cell such as DNA (**basophilic**). While the **eosin** is acidic dye that reacts and binds with the basic components in the cell such as proteins and other components in the cytoplasm (**acidophilic**).

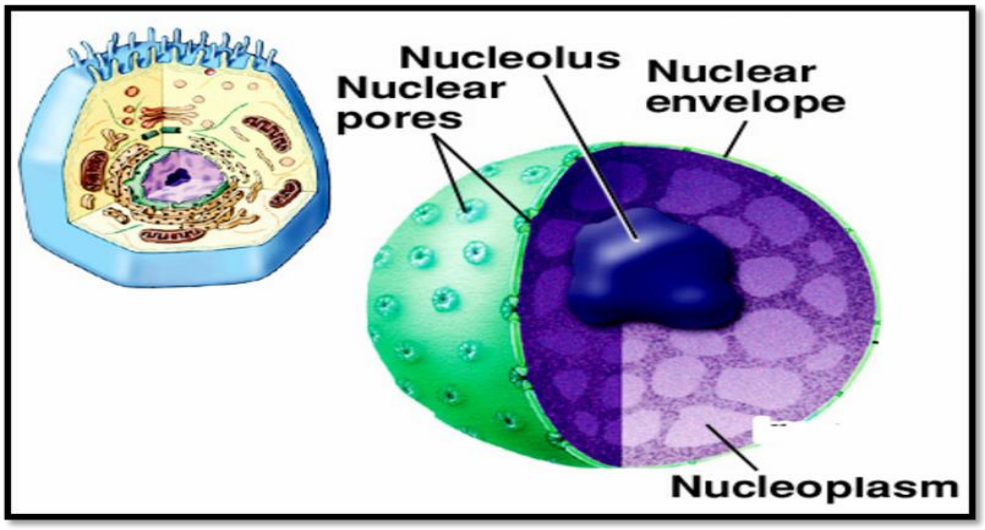

Figure (1): The structure of nucleus

The Nuclear Envelope

The surface of nucleus is bounded by nuclear envelope (Karyolemm) separating the contents of the nucleus from the cytoplasm and serving as a barrier to prevent macromolecules from diffusing freely between the nucleoplasm and the cytoplasm. Under the light microscope the nuclear envelope appears as thin line darkly staining surrounding the nucleus. Under the electron microscope, the nucleus is surrounded by phospholipid bilayer membrane that called nuclear envelope composed of **inner** and **outer** membranes, separated by narrow space (wide 20-80 nm) called **perinuclear space** (Figure.2)

The **outer membrane** of nuclear envelope is frequently attached with ribosomes, this membrane is associated with rough endoplasmic reticulum

(RER). This give the nucleus functions as RER where involve in protein synthesis.

The **inner membrane** of nuclear envelope is attached with a network of protein filaments called nuclear lamina. This lamina composed of polypeptides called **lamins t**hat form a part of nuclear matrix. Like all proteins, lamins are synthesized in the cytoplasm and later transported to the existing network of nuclear lamina in the nucleus. The **nuclear lamina** supports the nucleus where play a role in maintaining the spherical shape of the nucleus.

The nuclear envelope shows the presence of **nuclear pores**. These pores pass through both the outer and inner membranes of the nuclear membrane. At the nuclear pores, the inner and outer membranes of nuclear envelope fuse together to produce circular gaps about (70nm) in diameter. They are made up of large complexes of proteins about 30 different proteins termed nucleoporins. These pores consist of cylindrical **annulus**, each annula composed of ring of eight granules (subunits) that made of several proteins arranged in octagonal pattern (Figure 3). This provide pathway to facilitate and regulate the exchange of materials between the nucleus and the cytoplasm.

The number of **nuclear pore** varies from cell to cell, increasing in cell activities involved in protein synthesis. During cell division, more nuclear pores are formed in the nuclear membrane in preparation for cell division. The nuclear membrane eventually breaks down and is reformed around the nuclei of each of the two daughter cells. The nucleus of typical mammalian cell contains 3000-4000 pores in its nuclear envelopes The nuclear pores are permeable to some macromolecules, such as mRNA and ribosomes units that formed in the nucleus and then exported to the cytoplasm. Also the

cytoplasmic proteins moving through these pores into the nucleus where it is essential for DNA replication and gene expression.

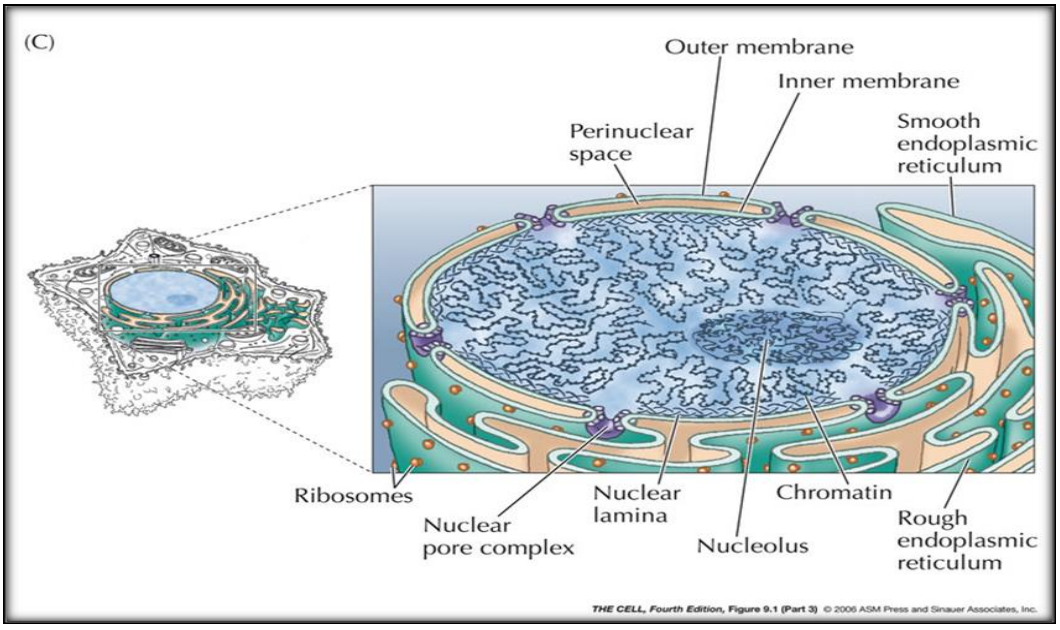

Figure (2): The structure of nuclear envelope

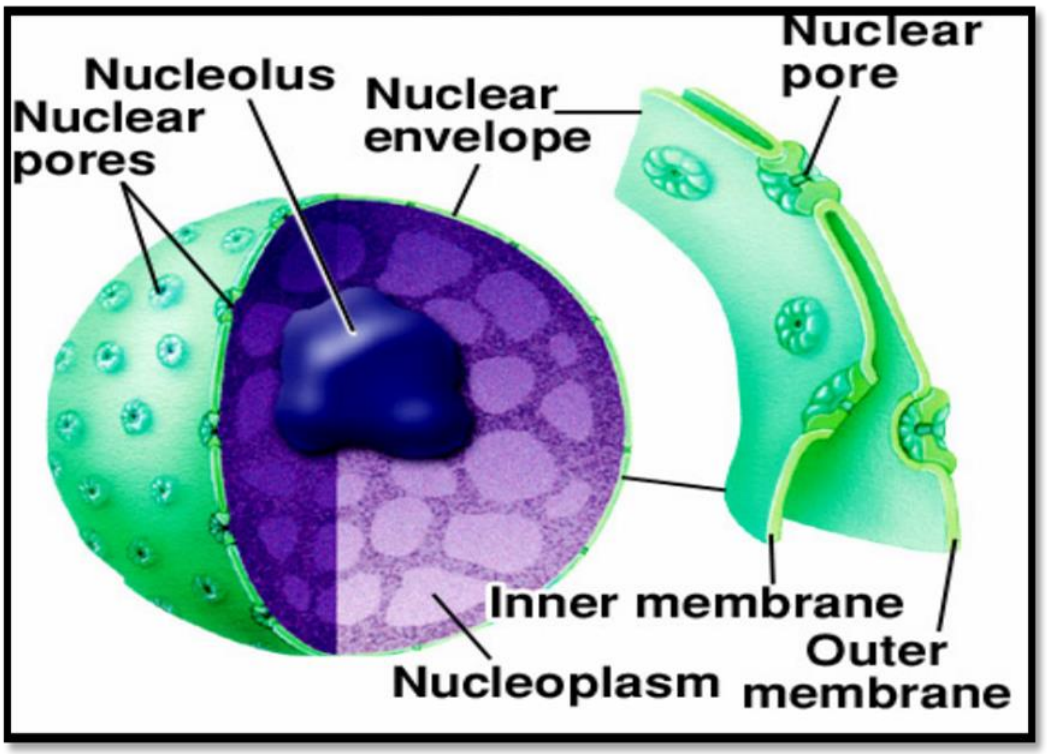

Figure (3): The structure of nuclear pores

The Nucleolus

Is the largest structure in the cell nucleus, it is spherical or ovoid structure (1-3 µm) in diameter, composed of proteins and rRNA and small amount of DNA. It is basophilic in nature when stained with hematoxylin due to presence of densely concentrated rRNA . The nucleolus is the site for synthesis of subunits of ribosomes. The nucleolus is involved with ribosomal RNA synthesis and formation of ribosomes.

The nucleus contains one nucleolus but as in some cases two or more nucleoli in the nucleus. They are usually multiple in cell metabolically active in protein synthesis. The size of nucleolus varies but is usually large nucleolus where found in cells actively synthesizing proteins, also in embryonic cells during proliferation and rapidly growing malignant tumors.

The nucleolus consists of three distinct regions (Figure.4)**:**

1- **nucleolar organizer DNA –sequences** of bases, from one to several pale-staining regions which harbor the genes that coding for rRNA.

2- **Pars fibrosa** which composed of (5-10nm) ribonucleoprotein fibers. It consists of primary transcripts of rRNA genes.

3- **Pars granulosa** which consist of dense granules (15-20nm). It is containing maturing ribosomal subunits particles.

The network formed by pars granulosa and pars fibrosa is called nucleonema, and the DNA that is responsible for the synthesis of the ribosomal subunits is localized in the interstices of that network. The function of the nucleolus is to transcripts DNA into ribosomal RNA and assembles rRNA into ribosomal subunits.

The creation of rRNA is important because rRNA makes up ribosomes which are responsible for protein synthesis in the cell.

When nucleolus produce rRNAs they combined with proteins that produced in the cytoplasm (that move through the nuclear pores of the nucleus into the nucleolus) to form ribosomal subunits. These subunits are then exported from the nucleolus to the cytoplasm where join to form ribosomes in endoplasmic reticulum. Therefor the nucleus responsible for making ribosomes.

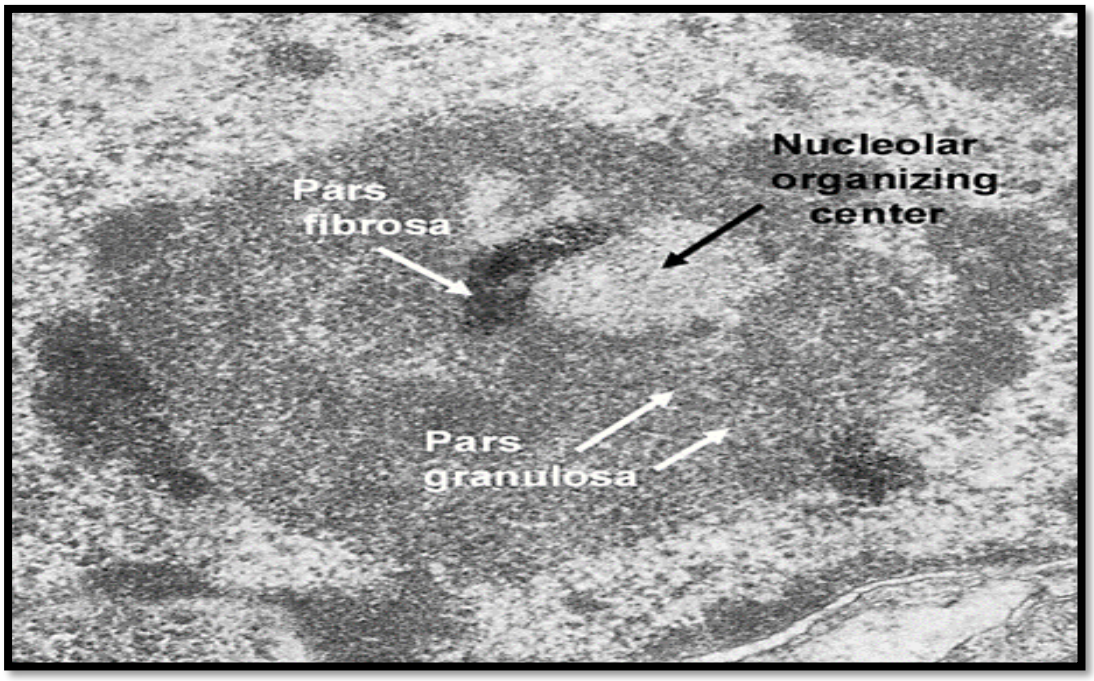

Figure (4): The structure of nucleolus