Medical Biology

Cell structure

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All living organisms are made from cells, it's a fundamental unit of life, whether, the organism is a single cell or with trillions of cells.

There are two different forms of cells,

prokaryotic

- 1-10$_{\mu m}$ (bacteria) which relatively simple cells
- lack nuclear membrane and many organelles.

eukaryotic

- 10-100 µm
- For example: plants, animals, fungus and etc….
- more complex cells, have a nucleus and many organelles

❖ The cell theory

In 1838 M.J. Schleiden and Theodore Schwann formulated the "cell theory." Which maintains that:

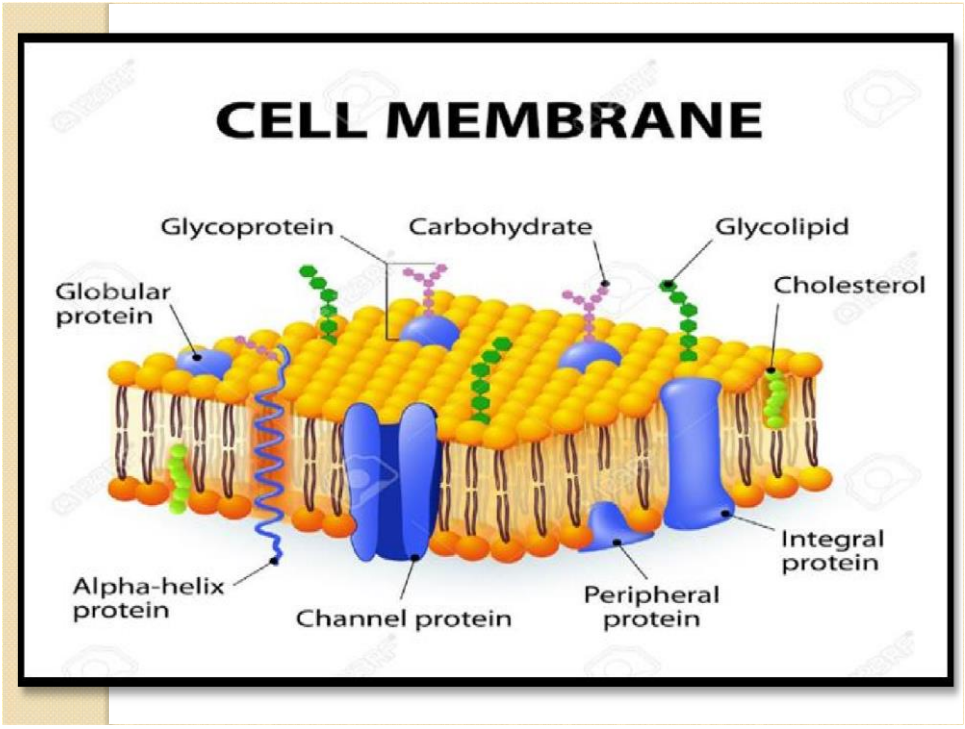
- **All organisms are composed of cells.**
- **Cell is the structural and functional unit of life, and cells arise from pre-existing cells.**
- **The cells vary considerably, in shapes and sizes.**

- **Nerve cells of animals have long extensions. They can be several centimeter in length.**
- **Muscle cells are elongated in shape.**
- **Some plant cells have thick walls. There is also wide variation in the number of cells in different organisms**

Robert Hooke (1665) by early microscope viewed cork and saw many repeating box-like structure and called theme cells. All cells are enclosed by cell membrane (or plasma membrane or cytoplasmic membrane) which is separates the inside of the cell from the outside or it encloses the protoplasm (include nucleus and cytoplasm with its organelles).

The Plasma Membrane

A cell membrane consists of two phospholipid layers with proteins. The phospholipid molecule has a polar head and nonpolar tails, the polar heads are charged, they are hydrophilic (water-loving) and face outward, where they are likely to encounter a watery environment. The nonpolar tails are hydrophobic (water fearing) and face inward. This makes it easier for small, neutrally-charged molecules to pass through the cell membrane as opposed to charged and larger molecules. Protein channels float through the phospholipids, and, collectively, this model is known as the fluid mosaic model.



The types of protein in cell membrane including: integral protein and peripheral protein, addition to other certain proteins in the outer surface of cell membranes.

Carbohydrate molecules are found on the surface of the cell membrane. There are two types, glycoproteins and glycolipids.

The main function of the cell membrane is

- **to protect the cell from its surrounding substances,**
- **regulate cell growth through the balance of endocytosis and exocytosis (selective permeable to ions and organic molecules) and**
- **consider as location of cell markers, cell receptors, cell adhesion and cell signaling.**

Nucleus

The nucleus (plural:nuclei) is of primary importance because it stores the genetic information that determines the characteristics of the body's cells and the metabolic functioning (protein synthesis, cell division, growth and differentiation).

Nuclei are spherical, oval, elongated, disc, irregular or disc shaped depending on the type of cell. Nucleus is present in all eukaryotic cells, but they may be absent in few cells like the mammalian RBCs. Nucleus has chromatin which contains DNA and much protein, as well as some RNA.

Nucleus is composed of four parts:

1-Nuclear Envelope (nuclear membrane)

2- Nucleoplasm (Nuclear sap)

3- Nucleolus

4- Chromatin

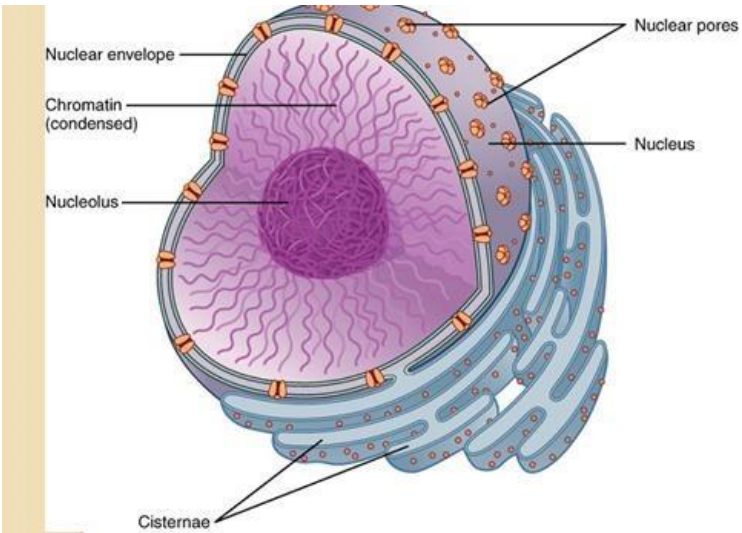
1-Nuclear Envelope (nuclear membrane)

- **It is made up of two membranes the outer membrane and the inner membrane. The outer membrane of the nucleus is continuous with the membrane of the rough endoplasmic reticulum.**
- **The space between these layers is known as the perinuclear space.**

- **The nuclear envelope encloses the nucleus and separates the genetic material of the cell from the cytoplasm of the cell and serves as a barrier to prevent passage of macro-molecules freely between the nucleoplasm and the cytoplasm**
- **The nuclear envelope is perforated with numerous pores called nuclear pores. They are composed of many proteins known as nucleoproteins which act as molecular channels, permitting certain molecules to pass into and out of the nucleus.**

2- Nucleoplasm (Nuclear sap)

It colorless fluid which contain nucleic acid, protein and inorganic acid (Mg and Ca), it act as substance reservoir for protein synthesis.



3- Nucleolus

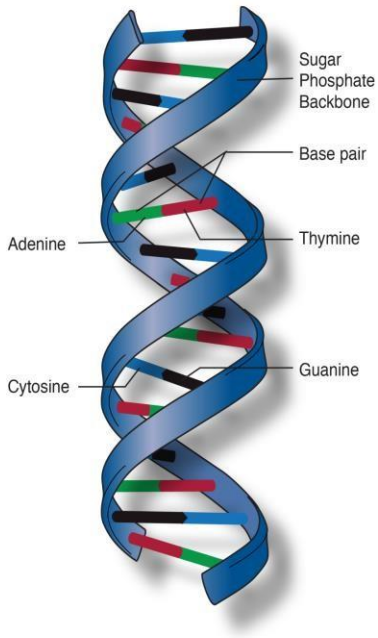
- **It is a densely stained and spherical structure found in the nucleus and surrounded by a membrane.**
- **It composed of protein and RNA.**
- **During early stage of cell division, the nucleolus disappears and reappear during final stages of division.**

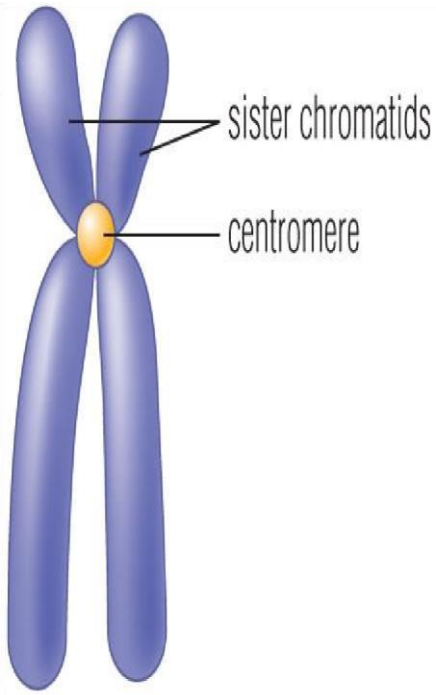
4- Chromatin

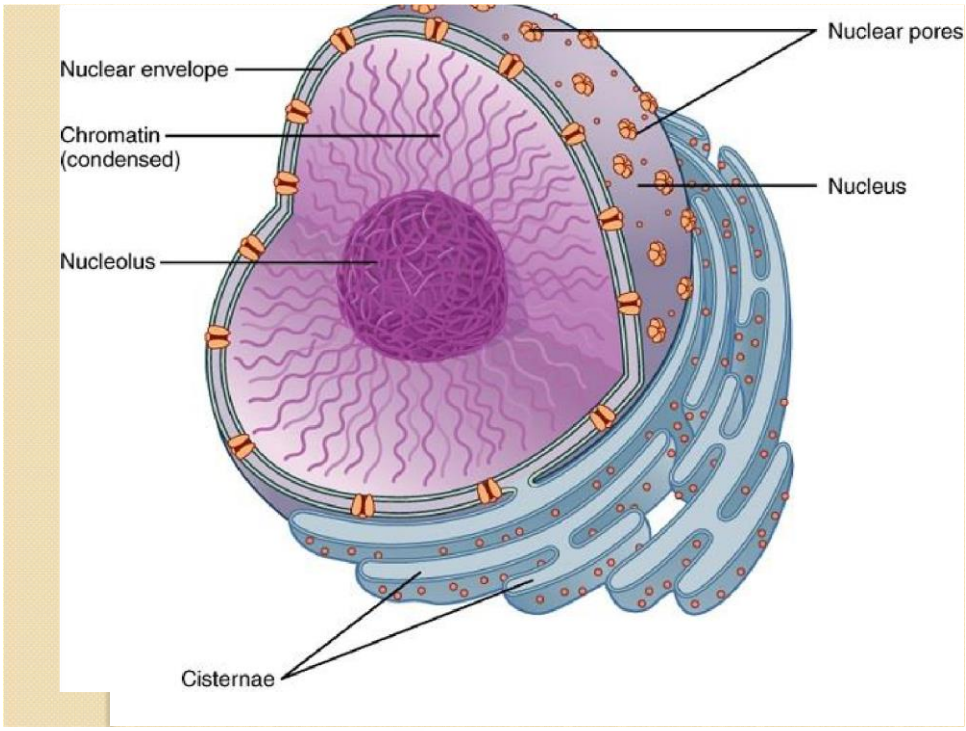
- **DNA is organized into structures called chromosomes and each chromosome is composed of a pair of sister chromatids which links by centromere.**
- **DNA wraps around proteins called histones. The resulting DNA-protein complex is called chromatin**

•In prokaryotic cells, chromosomes are circular, whereas in eukaryotic cells, they are linear strands.

- **Different organisms have different numbers of chromosomes: human cells usually have 46.**






Nuclear pores
Nuclear envelope
Chromatin
(condensed)
Nucleus
Nucleolus
Cisternae

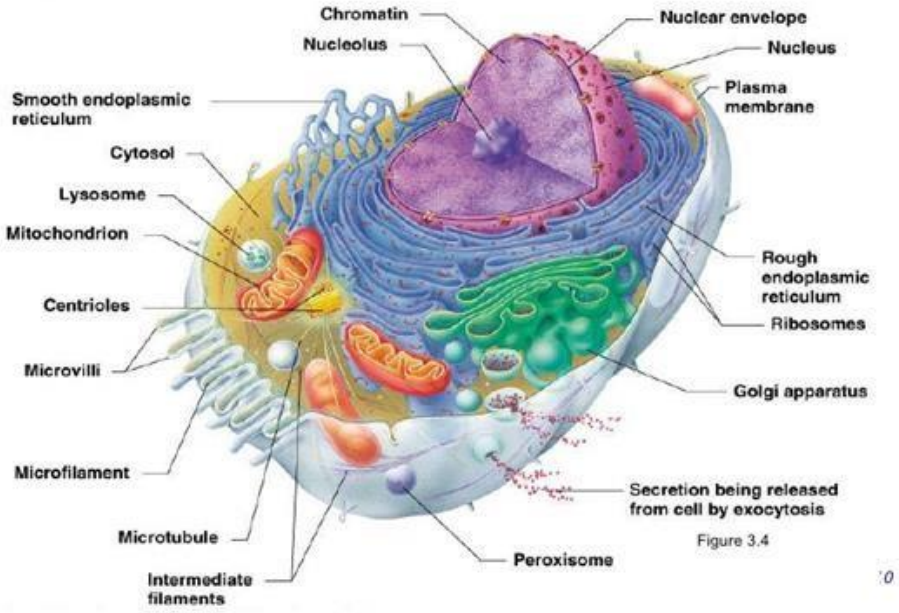

Chromatin
Nuclear envelope
Nucleolus
Nucleus
Plasma membrane
Smooth endoplasmic reticulum
Cytosol
Lysosome
Mitochondrion
Rough endoplasmic reticulum
Ribosomes
Centrioles
Microvilli
Golgi apparatus
Microfilament
Secretion being released from cell by exocytosis
Microtubule
Peroxisome
Intermediate filaments

Figure 3.4

Cytoplasm and cytoplasmic organelles

Cytoplasm is the space inside the cell membrane but outside the nucleus, it gel-like fluid and contains water, salts, proteins and other organic particles. Cytosol is part of the cytoplasm but does not contain membranes, organelles or the nucleus.