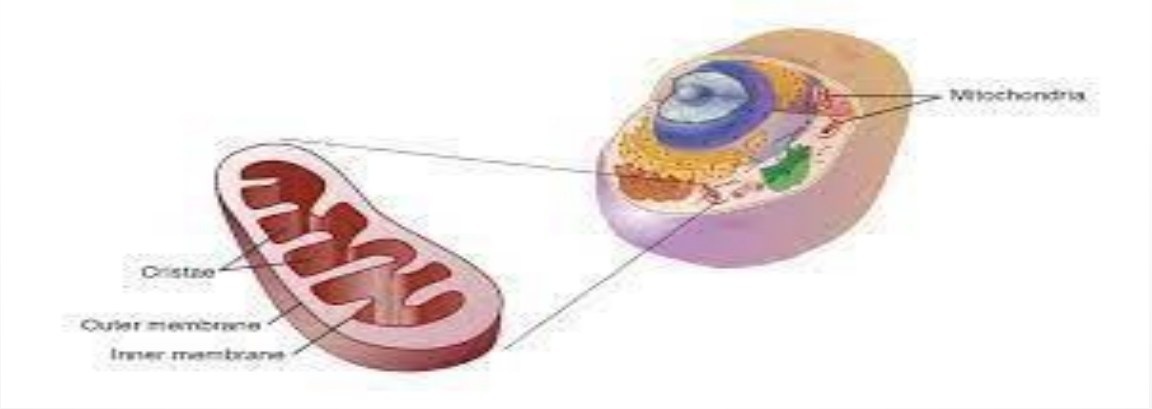
Composition of The cell

The Mitochondria , Lysosome &Nucleus

Mitochondria (power houses)

- Mitochondria are spherical or filamentous organelles 0.5-1µ in width and length about 10 µm their distribution in cell differs, they tend to accumulate in parts of the cytoplasm where **metabolic activity is more**, such as the apical ends of ciliated cells
- About 50% of this energy is stored as high energy phosphate bounds in ATP molecules , ATPase releases energy when required by the cell to perform type of work.



mitochondria contain two major membranes.

1-The outer mitochondrial membrane

fully surrounds the inner **membrane**, with a small intermembrane space in between The outer **membrane** has many protein-based pores that are big enough to allow the passage of ions and molecules as large as a small protein.

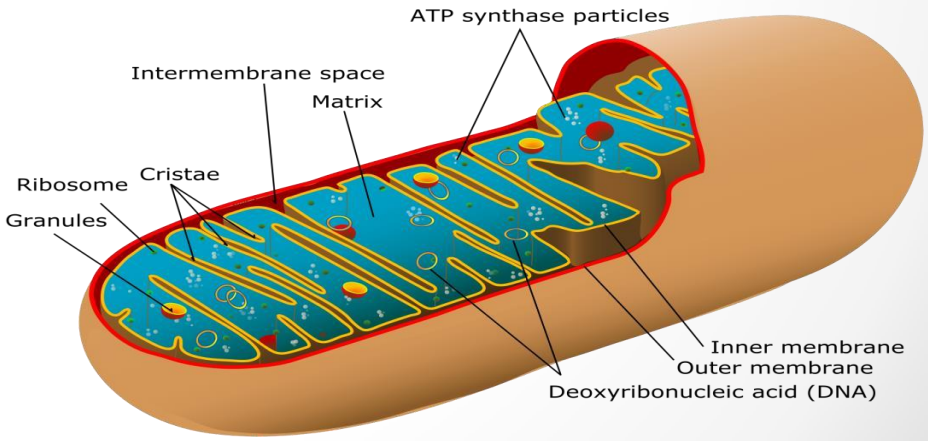
2-the inner membrane

projects folds called cristae , between inner and outer mitochondrial membrane , the space called (inter membrane space).

- cristae increase the internal surface area of mitochondria and contains enzyme and other components of oxidative phosphorylation and electron transport system.

Mitochondrial permeability:

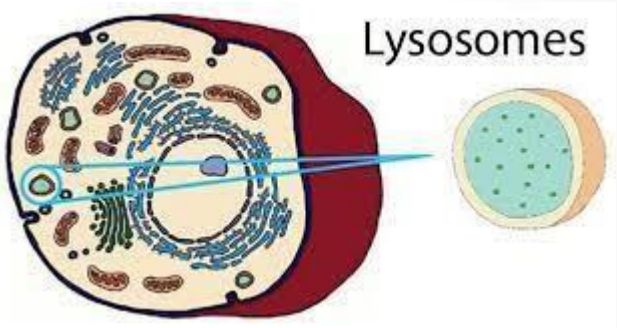
1. The outer membrane is freely permeable .
2. The inner membrane is rather impermeable ions and metabolites, therefore it must use carrier for passage of these material.
3. Mitochondrial swelling is induced by several agents
4. new mitochondria originate by division.

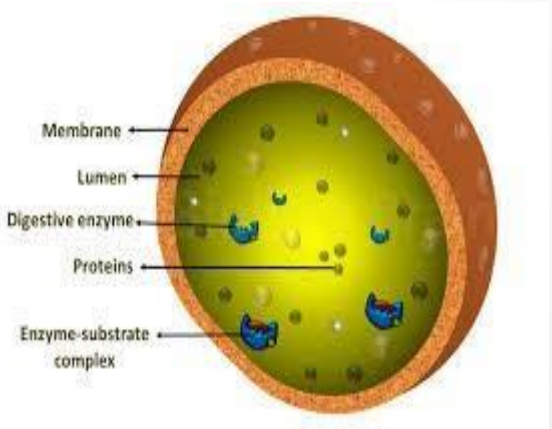


Lysosomes

Lysosomes are the membrane bounded vesicle produced by Golgi apparatus in animal cells and plant cells , lysosomes contains about **50 different degradative enzymes** that **can hydrolyze** proteins , nucleic acids , carbohydrates and lipids , the most common enzymes are :

- ribonuclease.
- deoxyribonuclease.
- phosphatase.
- Phosphoprotien phosphatase.
- Proteases.
- Lipase.

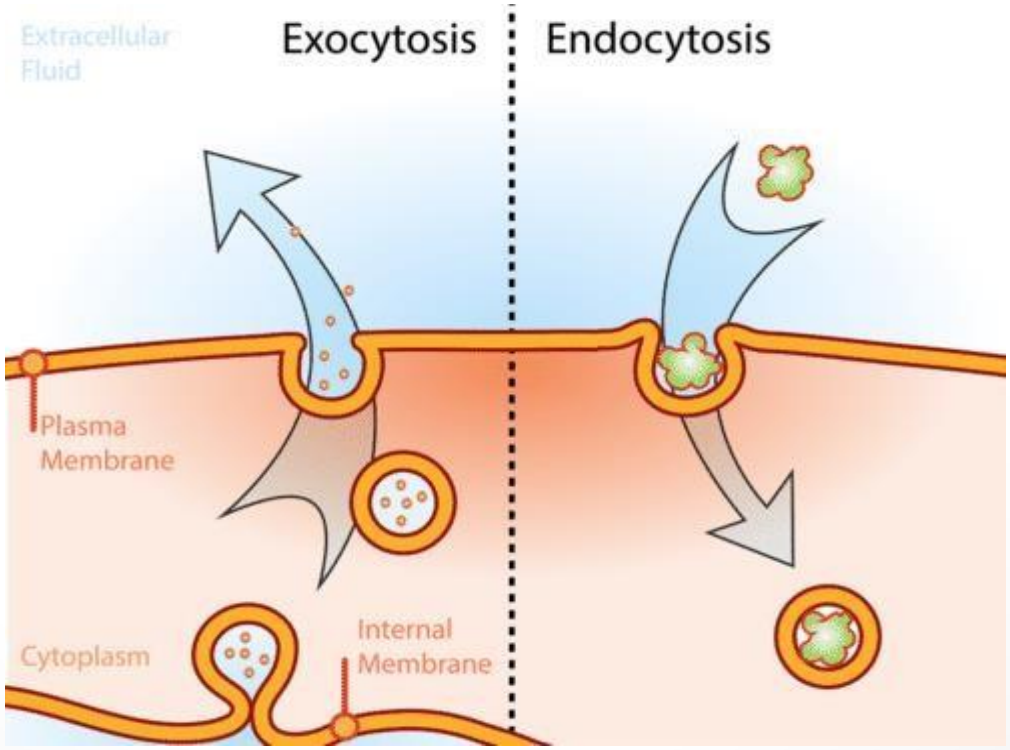




Lysosome as the **digestive system** of the cell ,

1-degrade materials taken up from outside the cell (**endocytosis**).

2-digest absolute components of the cell itself called (**auto digestion**) example : the finger of a human embryo are at first webbed but they are freed from one another as a result of lysosome action.



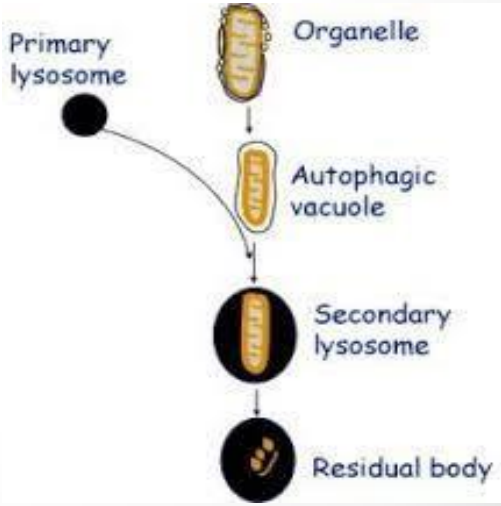
- **4-Residual bodies**: are formed if the digestion incomplete. In some cells, ex: amoeba and other protozoa.
- lysosomes having undigested material or debris are called **residual bodies** , These bodies are formed due to lack of certain enzymes in lysosomes.
- These are rejected from the cell by exocytosis and some time in certain cells these bodies remain in cells for long time causing **ageing**.
- These residual bodies also **cause diseases in man** such as

✓ fever

✓ hepatitis

✓ hypertension

✓ congested heart failure



Function of Lysosomes:

1-The lysosome enzyme can break all types of macromolecules into micro molecules such as: proteins into peptides.

2-During development and body growth , Lysosomes are responsible for the **removal** of an unwanted tissue and waste product.

3-Digestion of extracellular materials ex: during bone development osteoclasts ((which are one type of cells present in bone tissue))

release enzyme of secondary Lysosomes by exocytosis to **remolding** the bone.

4-Lysosomes in the white blood cells and macrophages are essential in the **defense** against bacteria and viruses

The Nucleus

- The main distinguishing feature of the eukaryotic cell is the **nucleus** it has a diameter of about 5 µm, depending on cell type Nucleus shape mostly depends on the shape of cells. Basic shape is spherical, but it may be oval, flattened, irregular or fragmented.

- It is an important structure because it's function which is to contain the **genetic material** that determines the characteristics of the body's cells and their metabolic functioning.

- Enclosing this structure are two concentric lipid bilayer membranes: the **inner membrane** and the **outer membrane.** These membranes make up the **nuclear envelope.**
- Most of eukaryotic cells contain only one nucleus. Some cells lose nucleus in the process of differentiation (e.g. mammalian erythrocytes).
- On the other hand, some cells of plants or Protista may have two or more nuclei.
- Nucleus is the control center of the cell.

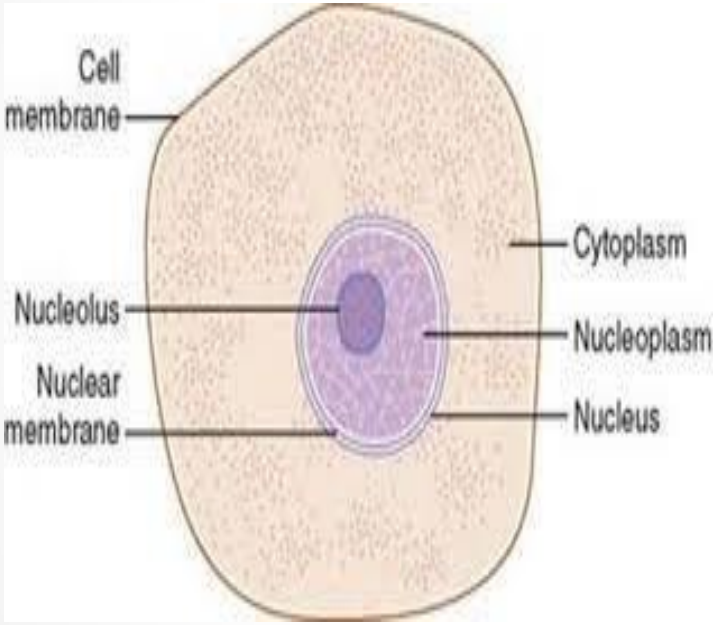
The nucleus consist of

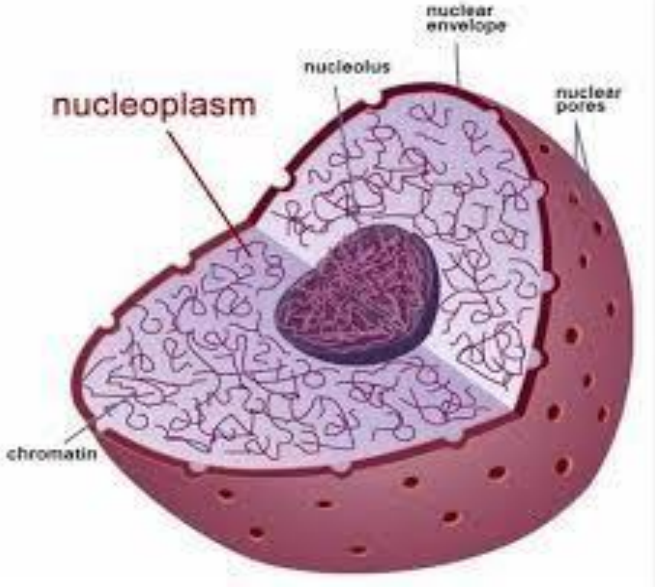
1- the nuclear envelope

2- nucleoplasm

3- chromatin

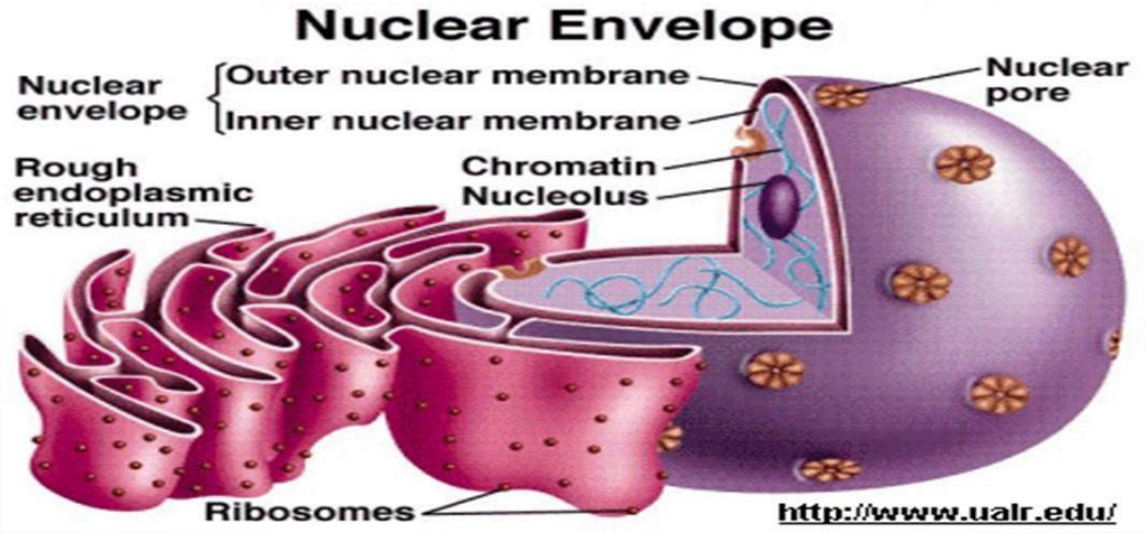
4- nucleolus





1- Nuclear envelope:

- The nucleus is separated from the cytoplasm by a double membrane, known as the nuclear envelope , this envelope consist of two layers , outer layer is the layer of protein fibers called the nuclear lamina which associated with the inner layer.



Functions of nuclear lamina:

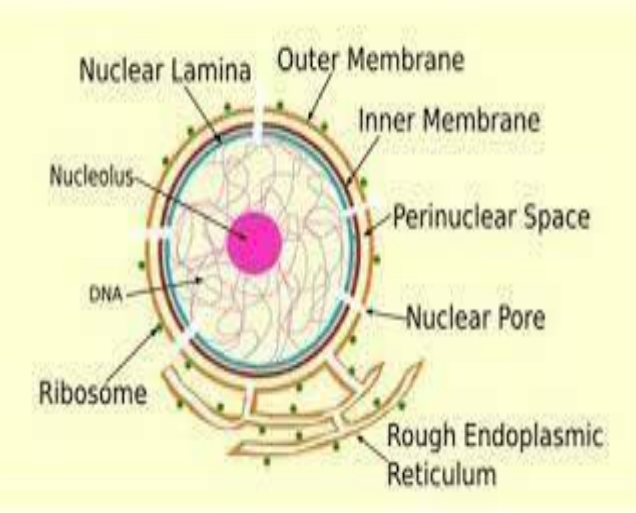
1- help to maintain the shape of the nucleus.

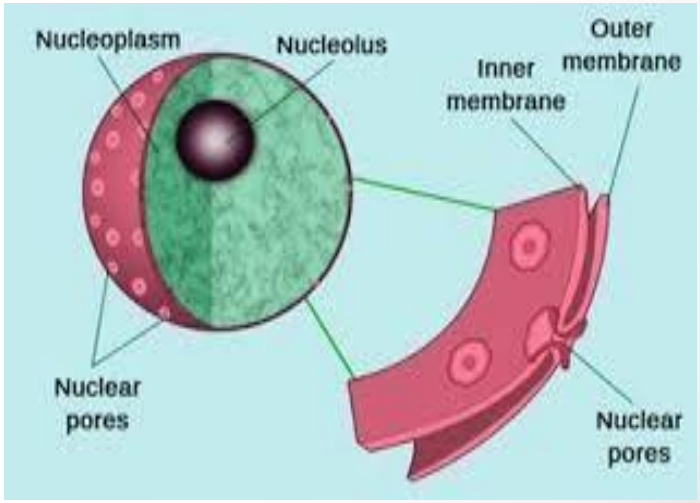
2- organizes chromatin by providing chromatin attachment sites.

3-it may play as funnel substances toward or away from the nuclear pores.

- The nuclear envelope has nuclear pores of sufficient size (100 nm) to permit the passage of proteins into the nucleus and ribosomal subunits out of the nucleus.

- The inner nuclear membrane encloses the nucleoplasm, and is covered by the nuclear lamina , a mesh of **intermediate filaments** which stabilizes the nuclear membrane as well as involved in chromatin function and entire expression. It is connected to the outer membrane by **nuclear pores** which penetrate the membranes .

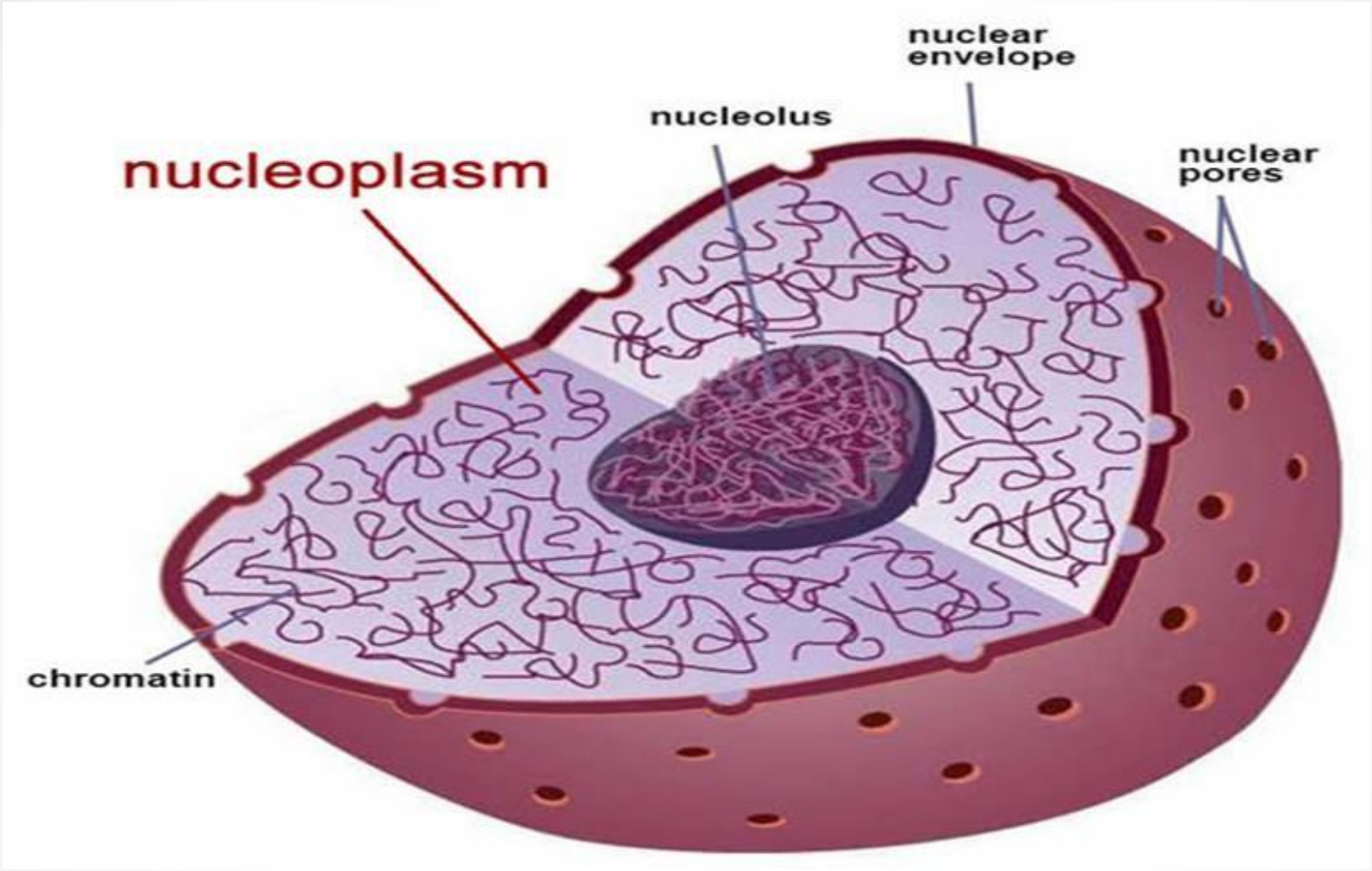




- Nuclear pores provide **active transport of substances** from the nucleus to the cytoplasm (especially RNA subunits) and from the cytoplasm to the nucleus (e.g. transport of histones, nutrients and regulatory proteins).
- While the two membranes and the endoplasmic reticulum are linked, and the outer later has selective permeability feature as cell membrane.

2- Nucleoplasm

- Is an semi-fluid medium which chromatin immersed in it, it contain several material like phosphorus compounds, sugar or CHO and nitrogenic compounds, other compounds presented are nucleoprotein, and it's a protein discovered in the nucleus for first time and therefore called by this name" **nucleoproteins**" are conjugated proteins resulted from nucleic acid connected with protein.


nuclear envelope
nucleolus
nuclear pores
nucleoplasm
chromatin

3- Chromatin

- Chromatin is a complex of macromolecules composed of DNA, RNA, and protein, which is found inside the nucleus of eukaryotic cells. Chromatin exists in two forms:

1- heterochromatin (condensed)

2- euchromatin (extended).

- The primary protein components of chromatin are histones that help to organize DNA into “bead-like” structures called nucleosomes by providing a base on which the DNA can be enfolded around.

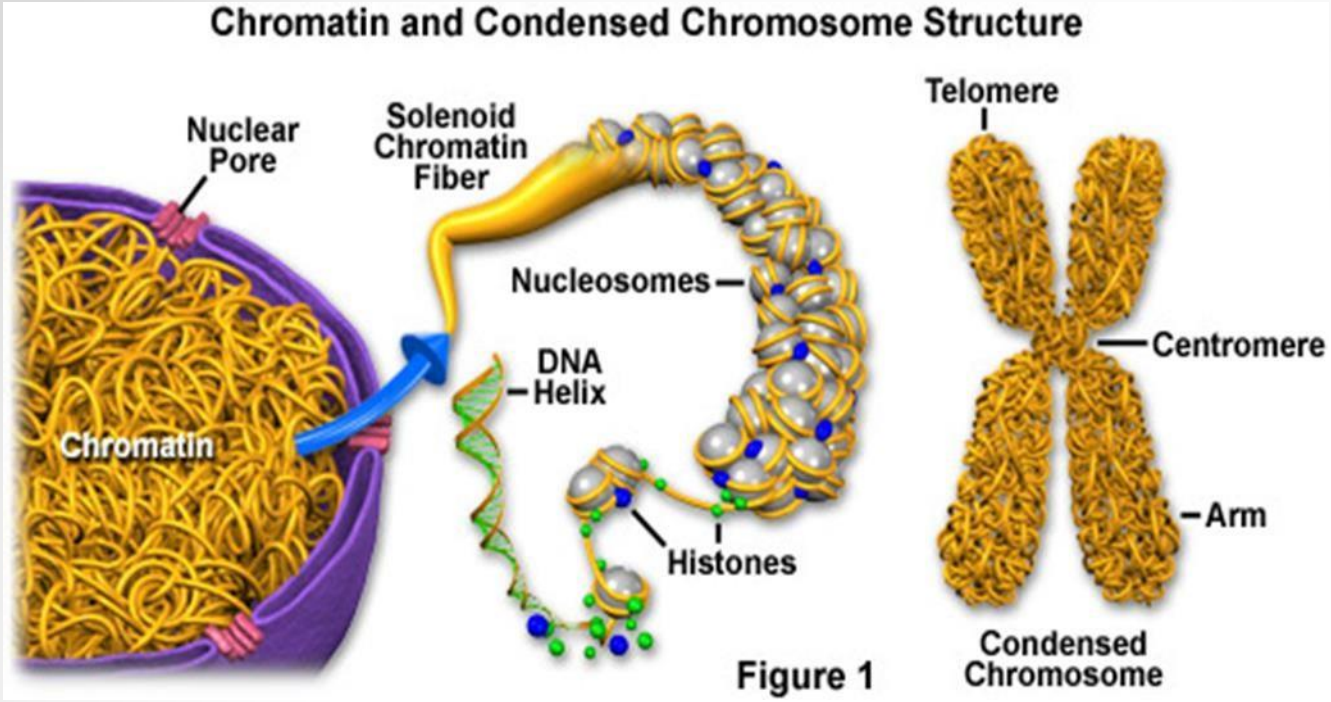
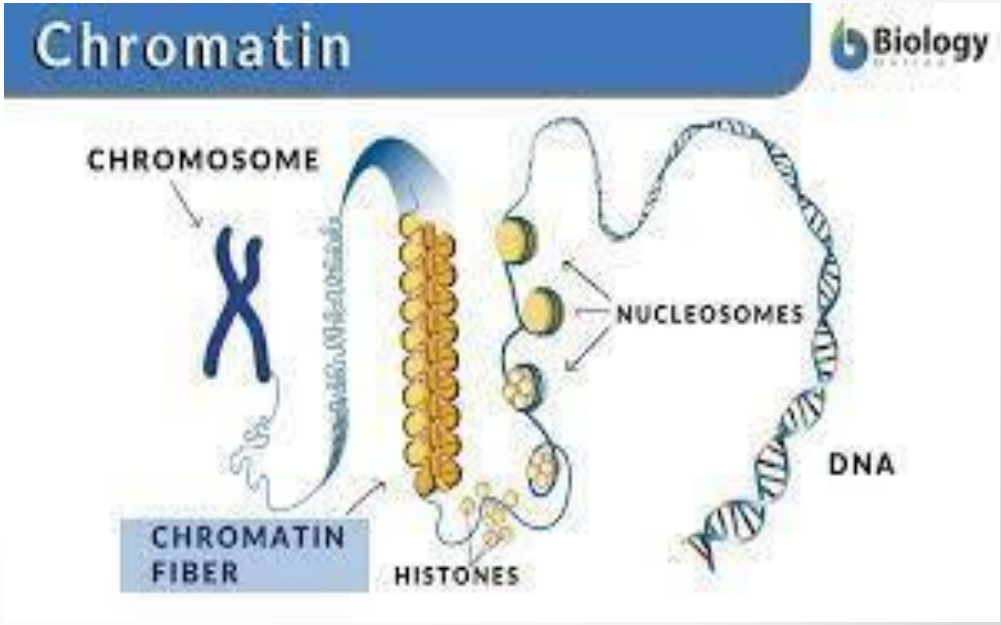
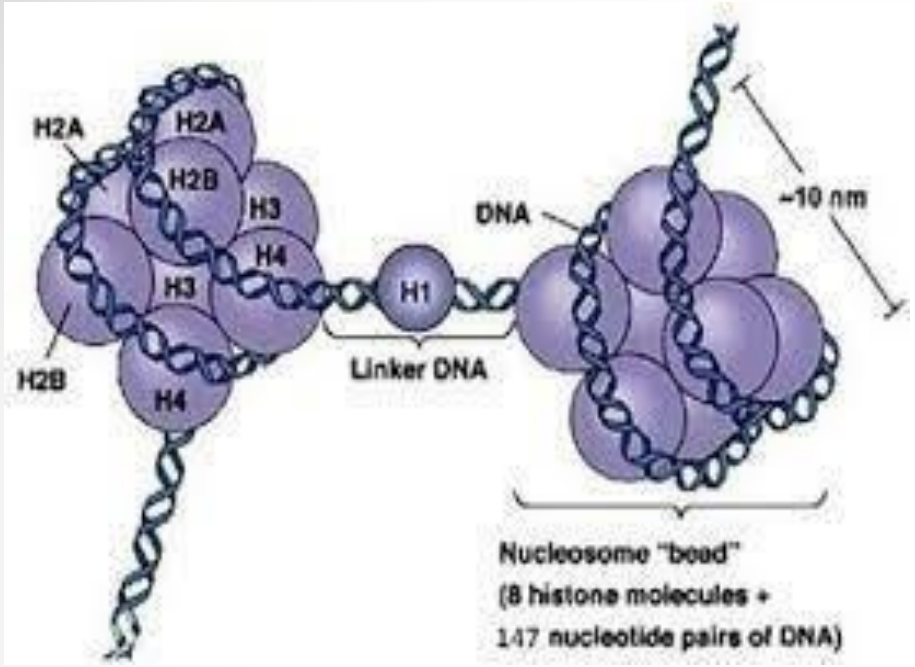
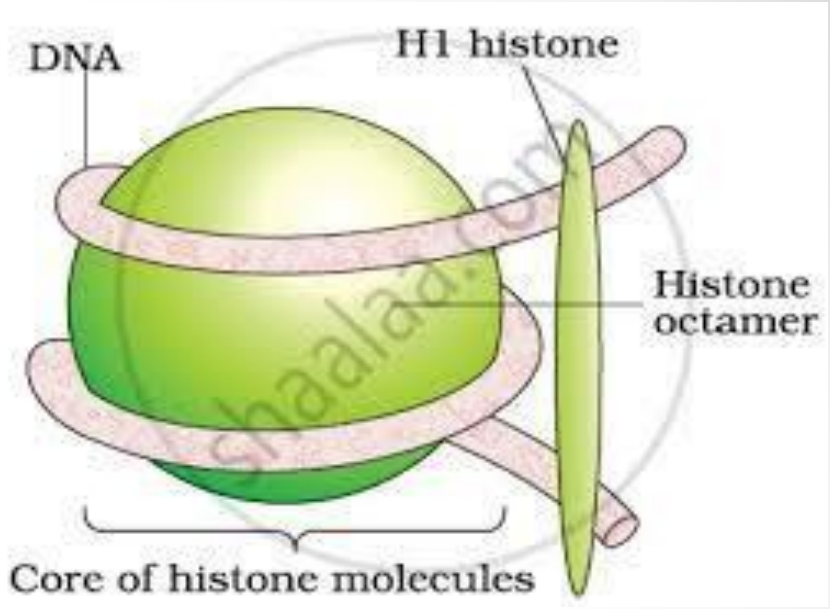

Chromatin and Condensed Chromosome Structure
Nuclear Pore
Solenoid Chromatin Fiber
Nucleosomes
DNA Helix
Chromatin
Histones
Telomere
Centromere
Arm
Condensed Chromosome

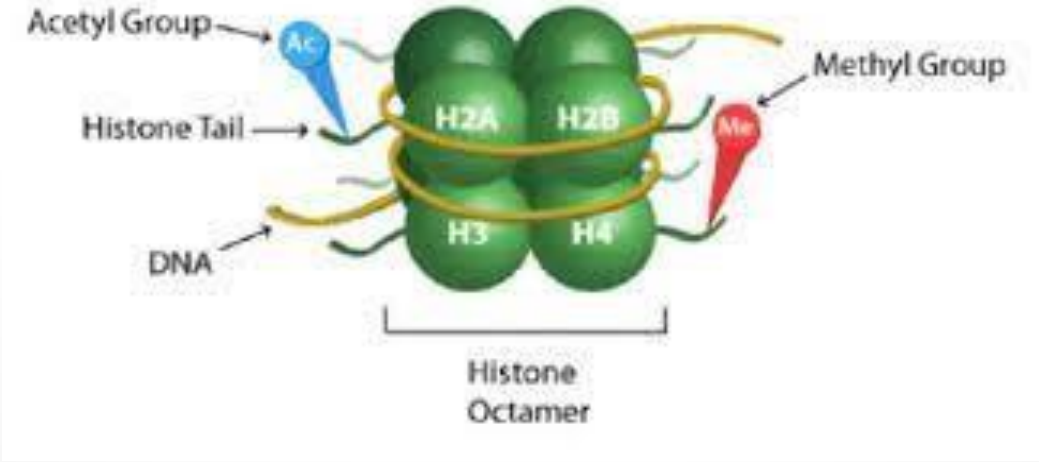
Figure 1


Chromatin
Biology
CHROMOSOME
NUCLEOSOMES
DNA
CHROMATIN FIBER
HISTONES

- A nucleosome consists of 147 base pairs of DNA that is enfolded around a set of 8 histones called an octomer .
- The nucleosome can be further folded to produce the chromatin fiber. Chromatin fibers are coiled and condensed to form chromosomes.
- Chromatin makes it possible for a number of cell processes to occur including DNA replication, transcription, DNA repair, genetic recombination, and cell division.


H2A
H2A
H2B
H3
H4
H3
H2B
H4
H1
Linker DNA
DNA
~10 nm
Nucleosome "bead"
(8 histone molecules +
147 nucleotide pairs of DNA)

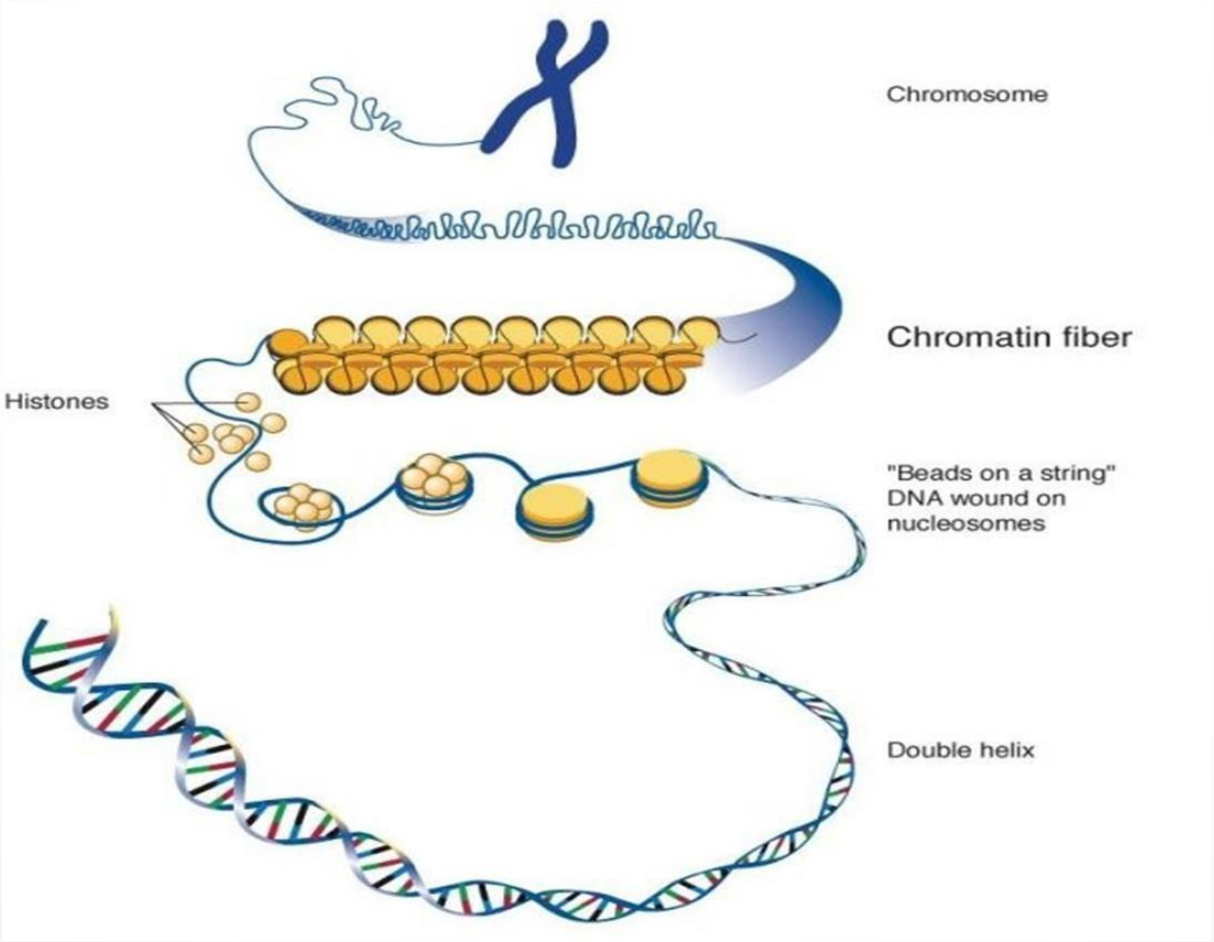

DNA
H1 histone
Histone
octamer
Core of histone molecules

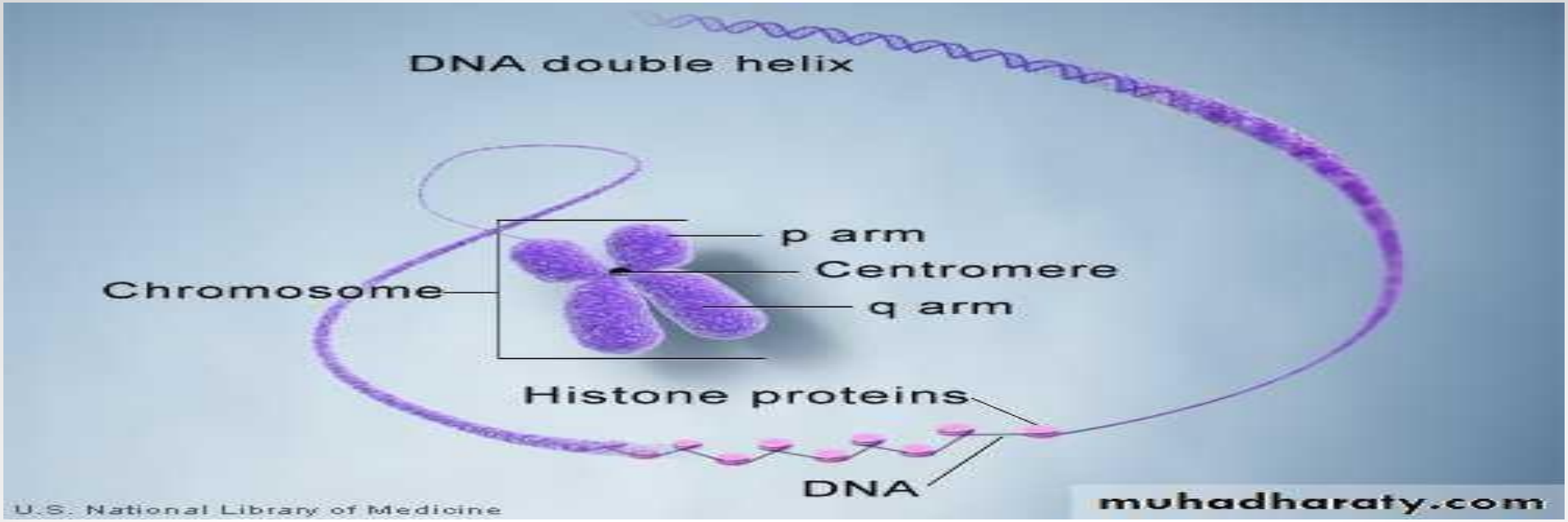

Acetyl Group
Ac
Histone Tail
Methyl Group
Me
H2A
H2B
H3
H4
DNA
Histone
Octamer

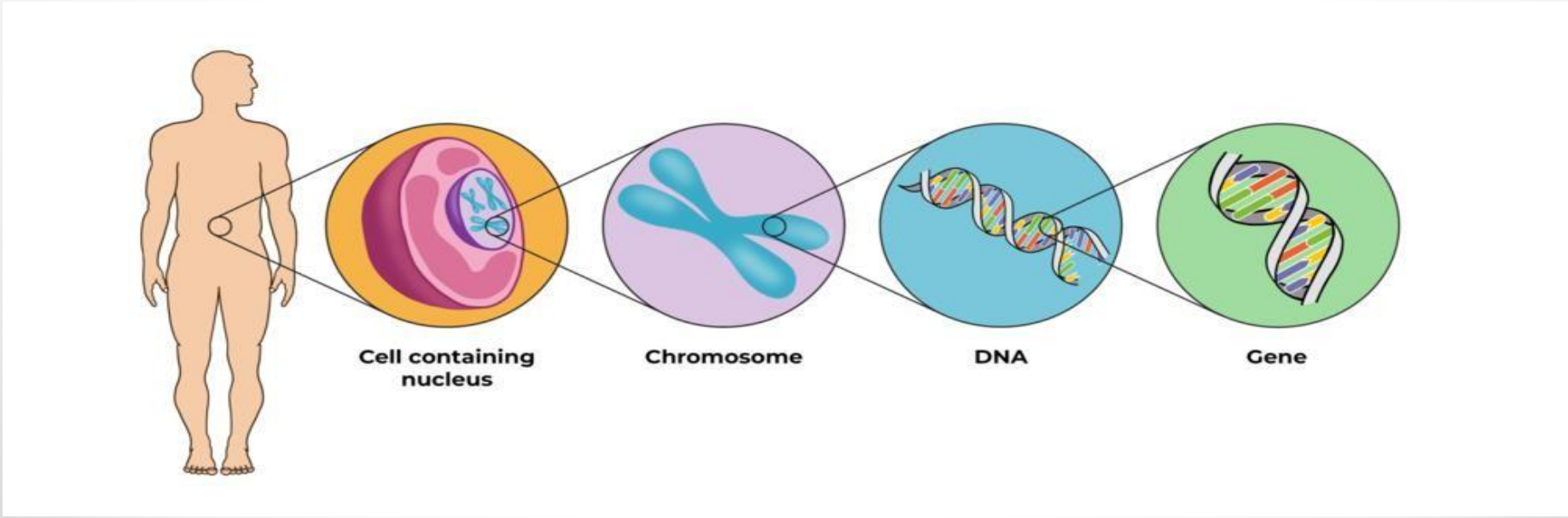
- During the cell division processes of mitosis and meiosis, chromosomes replicate to ensure that each new daughter cell receives the correct number of chromosomes.
- A duplicated chromosome is double-stranded. The two strands are identical and connected at a central region called the centromere.
- A chromatid is either of the two strands of a replicated chromosome.
- Chromatids connected by a centromere are called sister chromatids.

- People often confuse these three terms: **chromatin**, **chromosome**, and **chromatid**. While all of those three structures are composed of DNA and proteins within the nucleus
- **chromatin** is composed of DNA and histones that are packaged into thin, stringy fibers. The chromatin undergoes further condensation to form the **chromosome**.
- So the chromatin is a lower order of DNA organization, while chromosomes are the higher order of DNA organization.

- At the end of cell division, sister chromatids separate and become daughter chromosomes in the newly formed daughter cells.

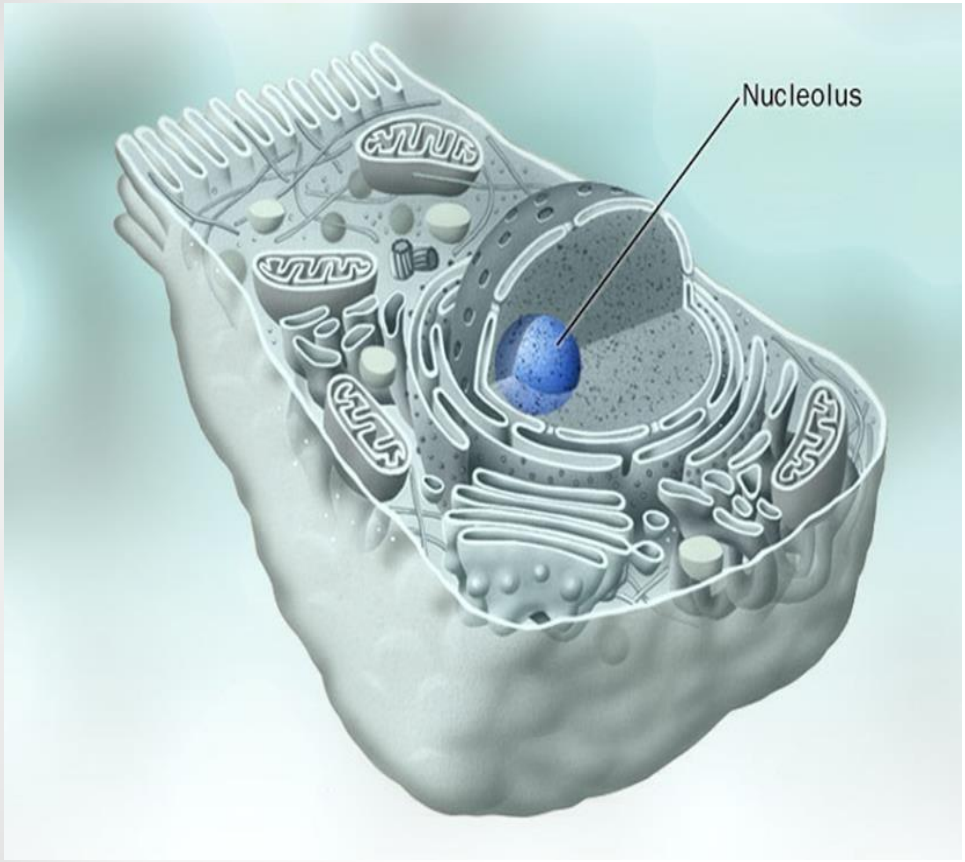


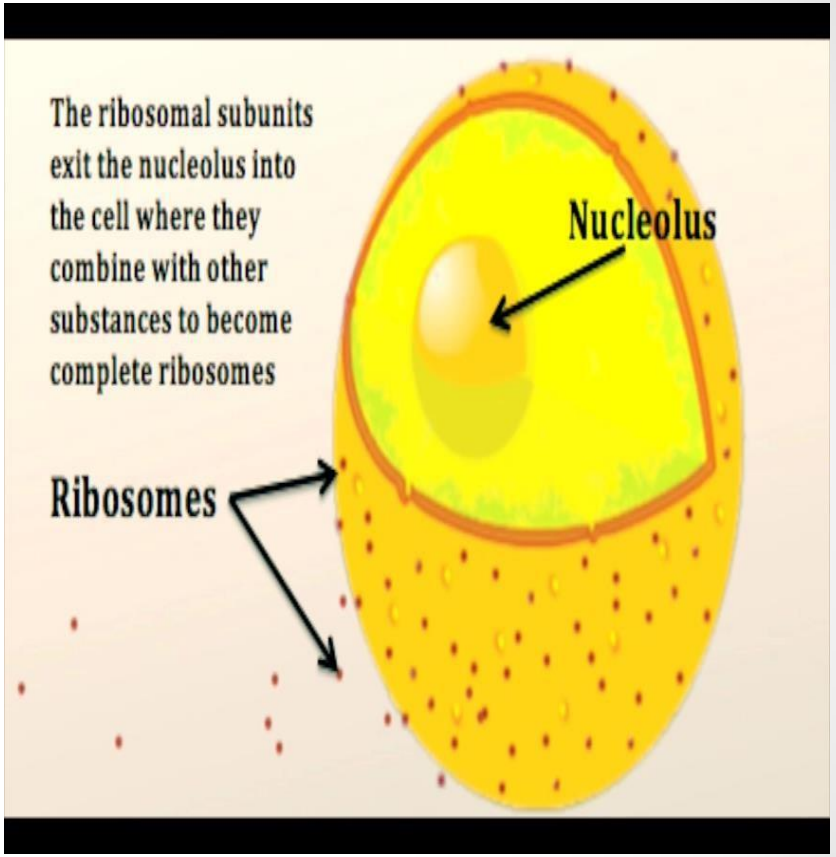

DNA double helix
p arm
Centromere
q arm
Chromosome
Histone proteins
DNA
U.S. National Library of Medicine
muhadharaty.com


Cell containing nucleus
Chromosome
DNA
Gene

4- Nucleolus

- is a round body located inside the nucleus of a eukaryotic cell. It is not surrounded by a membrane but sits in the nucleus. The nucleolus makes ribosomal subunits from proteins and ribosomal RNA, also known as rRNA.
- It then sends the subunits out to the rest of the cell where they combine into complete ribosomes. Ribosomes make proteins; therefore, the nucleolus plays a vital role in making proteins in the cell.


Nucleolus


The ribosomal subunits exit the nucleolus into the cell where they combine with other substances to become complete ribosomes
Nucleolus
Ribosomes