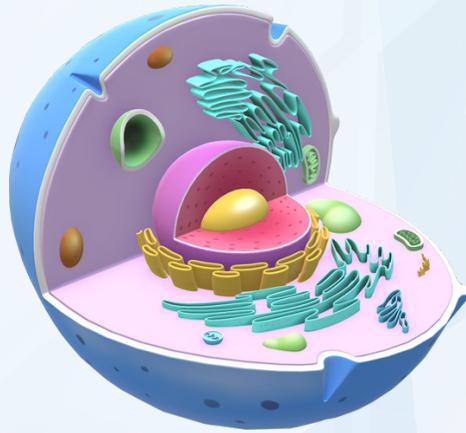


Doctor 2023
Medicine - MU



Cell biology Sheet

Nucleus

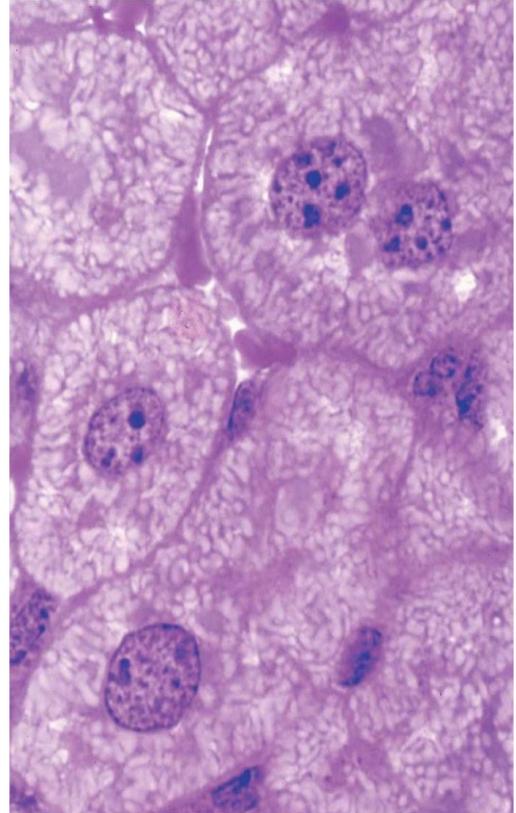
Doctor :
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Done by :
Fatimah atawi

Nucleus

Note that all the figures are only for illustrative purposes, you won't be asked about any in the exam.

Nucleus:

- The Nucleus is the largest a membrane-enclosed organelle which house **most** of the genetic information (why most? Because there is some of the genetic material in the mitochondria) and regulatory machinery responsible for providing the cell with its unique characteristics.
- It is only found in eukaryotic cells, where the cells are the unit structure of the organisms.
- Golgi apparatus, rER and nucleus are the regulatory machinery responsible for producing secretory proteins, where nucleolus will produce rRNA → protein (from cytoplasm to inside the nucleus) → fusing of formed subunits → goes to the cytoplasm where the ribosomes are formed.

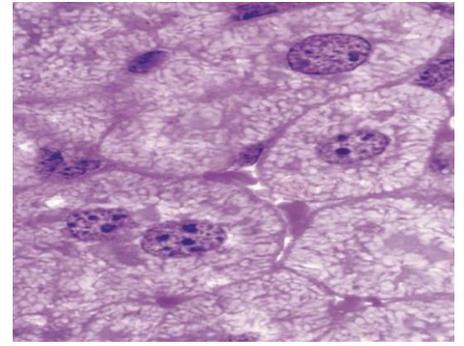
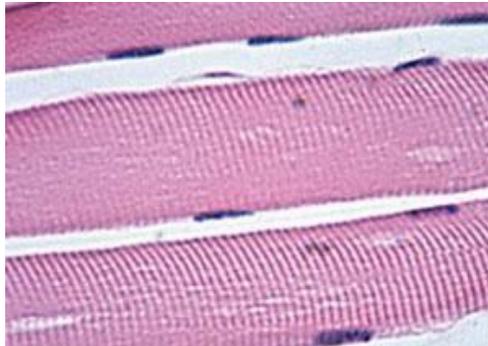
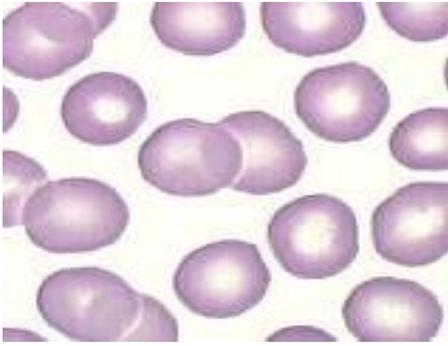


Functions:

- The nucleus (controls all cell activity):
 - It stores the cell's hereditary material (DNA), **genetic material archive**.
 - Site of DNA replication.
 - Site of DNA transcription to mRNA.
 - Ribosomal formation:
Nucleolus: RNA & protein required for ribosomal synthesis.
 - It coordinates the cell's activities, which include growth, metabolism, protein synthesis, and reproduction (cell division) by regulating gene expression

LM: (light microscopy)

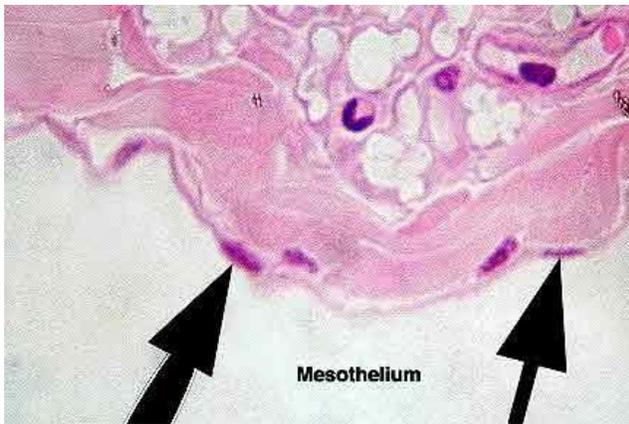
- Basophilic (**blue in color**)
- It is the most obvious organelle
- Variable in number:
 - a. **One**= Mononucleated cells
 - b. **Two**= Binucleated cells (**like 25% of liver cells**)
 - c. **Multiple**= Multinucleated cells (**like muscle cells**)
 - d. **No**= Anucleated
- **RBCs (red blood cells)** used to have a nucleus to fill the cytoplasm with hemoglobin to do its functions.



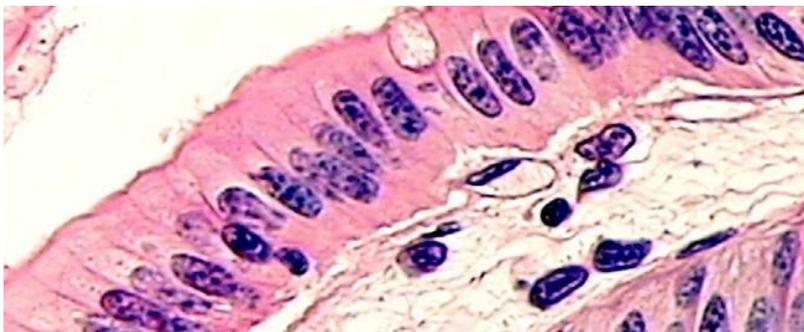
Variable in Shape:



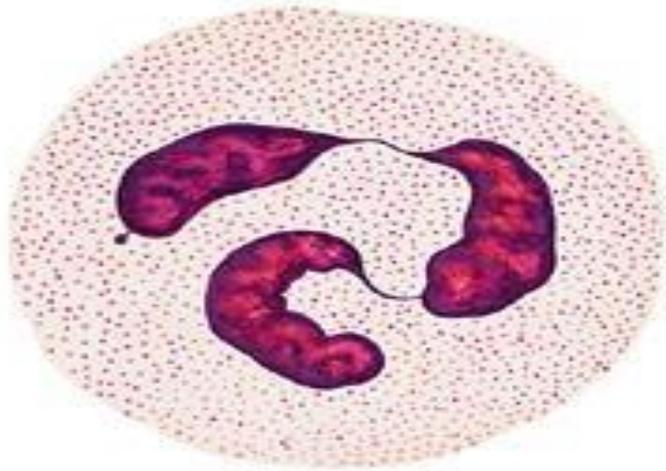
Rounded



Flat



Oval



Neutrophilic granulocyte

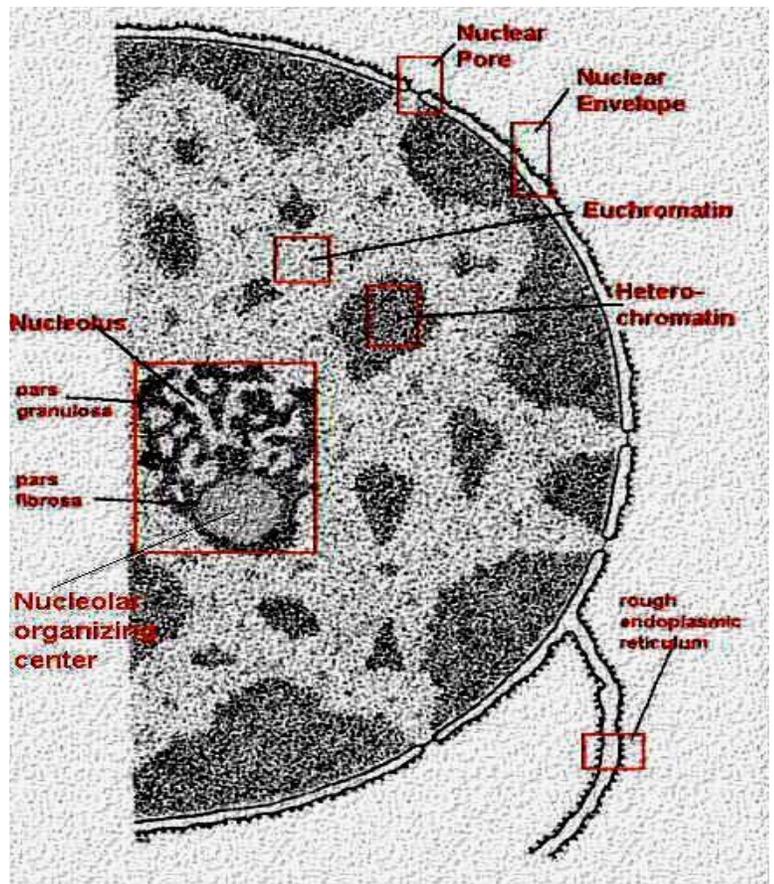
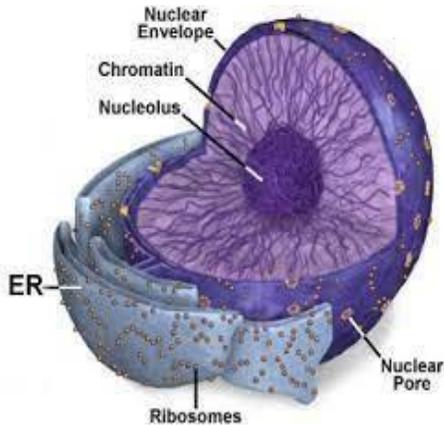
Lobulated:

- Lobulated means it is formed of lobules.
- Neutrophilic granulocyte is lobulated nucleated type of white blood cells (WBCs).
- Lobulated= neutrophils of blood cells.

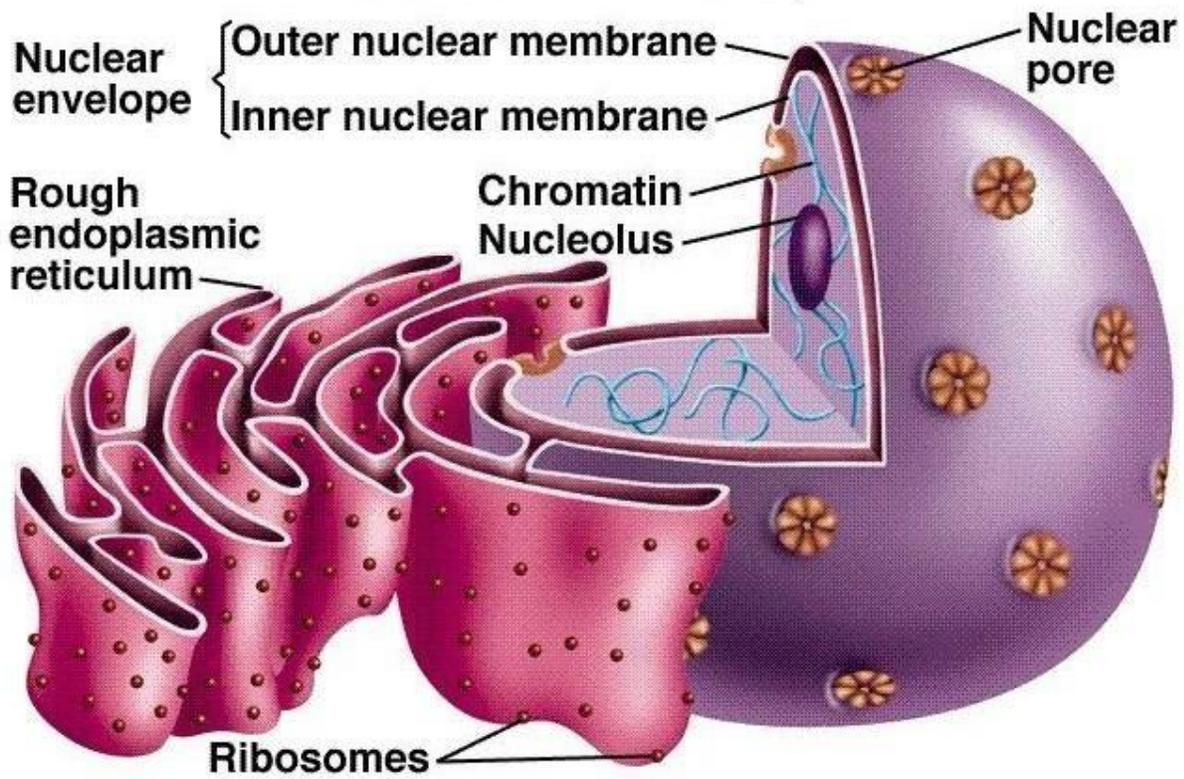
- Note that different shapes can have different number of nucleus (none, one, two, three, ...).
- It is possible to find 8 cartilage cells – known as chondrocytes- with only one nucleus.
- Muscle cells – known as myocytes- are multiple cells who were fused together to form fibers.

EM: (electron microscopy)

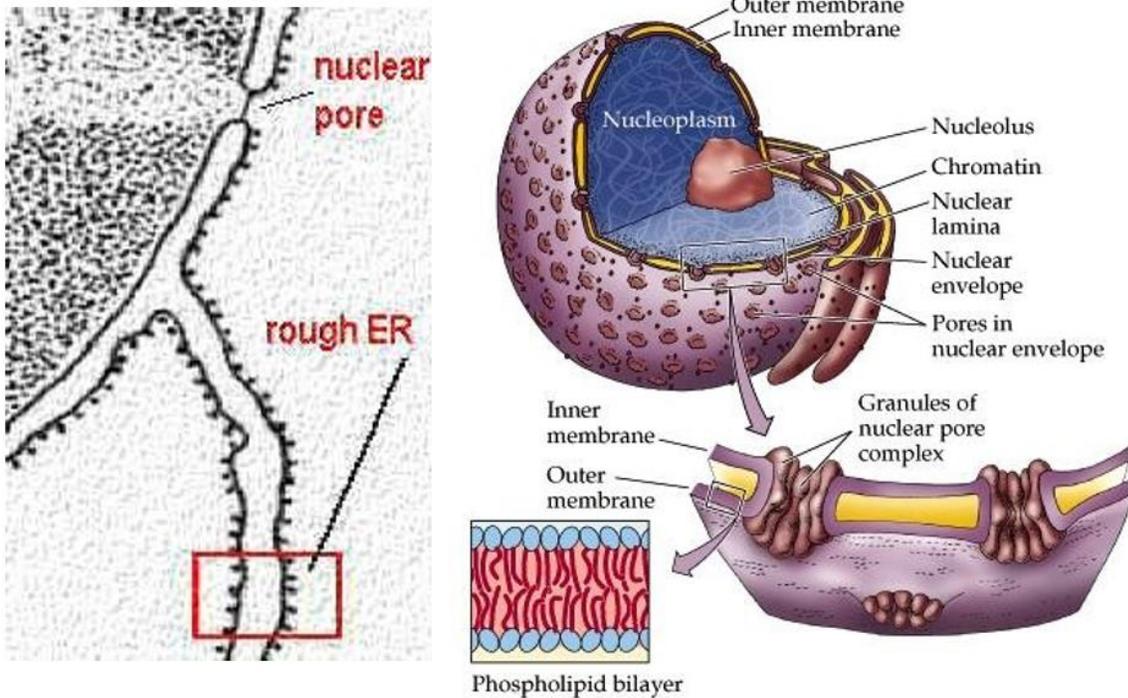
- Nucleus is formed of:
 - a. Nuclear envelope: double membrane and nuclear pores.
 - b. Chromatin.
 - c. Nucleolus.
 - d. Nuclear sap= Nucleoplasm= **karyoplasm**



Nuclear Envelope



Nuclear envelope



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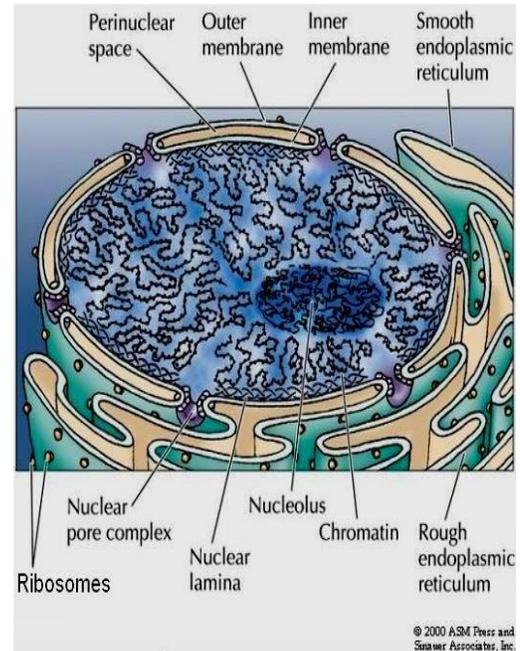
A. Nuclear envelope= nuclear membrane= nucleolemma:

Structure:

1. External (outer) nuclear membrane with ribosomes.
2. Perinuclear space.
3. Internal (inner) nuclear membrane with nuclear lamina.
4. Nuclear pores

Function:

- Separates the enclosed nuclear compartment from cytoplasm.
- Maintains the shape of nucleus.
- Controls exchanges between nucleus and cytoplasm.
- Important role in organization of nucleus content.



1. External nuclear membrane:

- Visible only by electron microscopy.
- Ribosome attached on external face.
- It continues with rER membrane.

2. The perinuclear space:

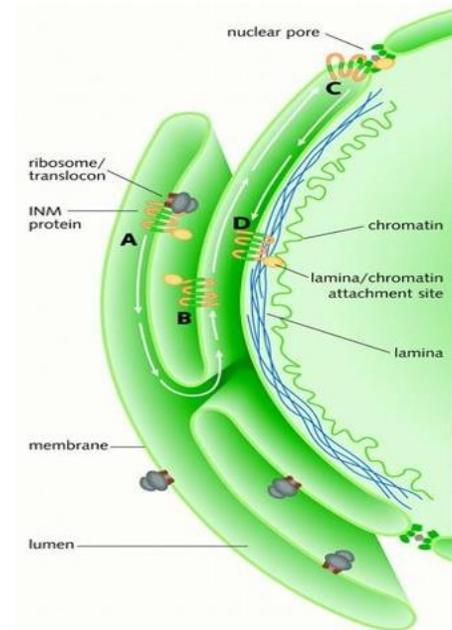
- It communicates with the rER internal space.
- Contains the same molecules as rER.

3. Internal nuclear membrane:

- Visible only by electron microscopy.
- The inner surface of the nuclear envelop is bound to a thin (compared to thick chromatins) filamentous network (*lamins polypeptides*) called the nuclear lamina that supports chromosomes distribution and function.
- This membrane fixates chromatins in the membrane to allow its participation in transduction process.

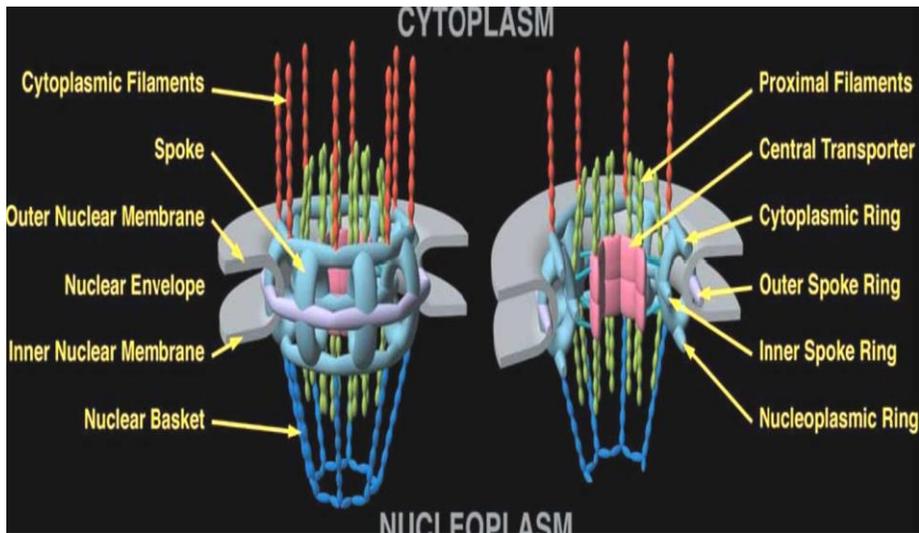
4. The nuclear pore:

- Openings in the nuclear envelope, area where nuclear envelope is interrupted.



- Regulated exchanges between nucleus and cytoplasm.
- Ensures the selective transport for big molecules.
- Dynamic structures- their number grows if it's necessary.
- The nuclear pores are the gateways across which movement of RNAs and proteins takes place between the nucleus and cytoplasm in both directions.
- Proteins synthesized in the cytoplasm cross the nuclear envelop to initiate replication and transcription of genetic material. Similarly, mRNA, tRNA and ribosomal subunits built in the nucleus cross through the nuclear pores to the cytoplasm.
- **Remember:**
 - **Mitochondria has two membranes:**
 1. **Outer membrane for non- selective transport.**
 2. **Inner membrane for selective transport.**
 - **Nuclear pores: only selective transport.**

Nucleoplasm	Nuclear Membrane	Cytoplasm
Nuclear Basket	Central Transporter	Cytoplasmic Ring
Nuclear Ring	Spoke Ring (inner & outer)	Cytoplasmic Filaments
Filaments	Central transporter and spoke ring are one thing	



Nuclear lamina:

- A network of intermediate filaments composed of various lamins.
- The lamina acts as a site of attachment for chromatin and provides structural stability to the nucleus.
- The lamins have been associated with various genetic disorders collectively termed laminopathies (e.g. a rare form of muscular dystrophy).

B. Chromatin:

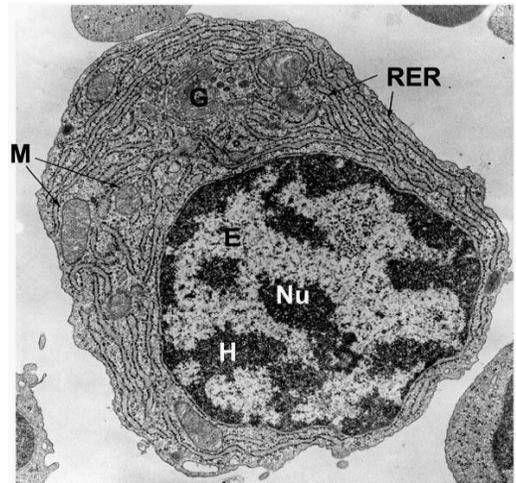
- Is the combination of DNA and Histone proteins that make up the contents of the nucleus of a cell, that is usually dispersed in the interphase and condensed to form chromosomes in mitosis and meiosis. **Once division starts, it condensates.**

Functions:

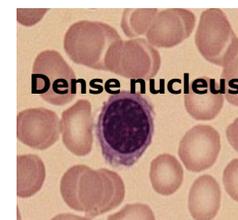
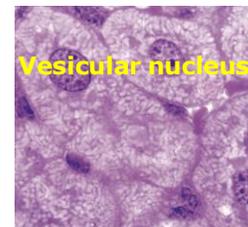
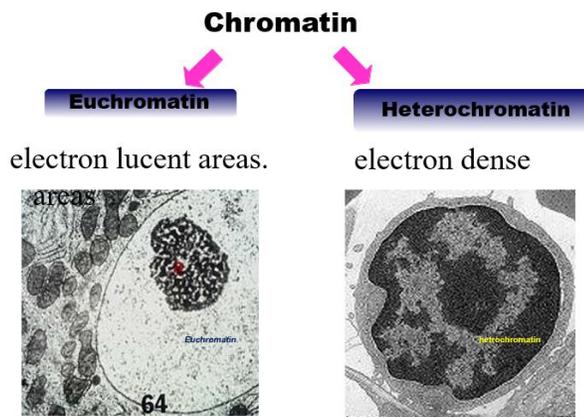
- Package DNA into a smaller volume to fit in the cell.
- Strengthen the DNA to allow mitosis and meiosis i.e. prevents DNA damage.
- Control gene expression and DNA replication.

Types: (during interphase // no cell division)

1. **Euchromatin:** is a lightly packed (less dense) form of chromatin that is rich in gene concentration, and is often under active transcription. It is found in both eukaryotes and prokaryotes.
 2. **Heterochromatin:** is a tightly packed (dense) form of DNA that is inactive (no transcription) and remains compact during interphase. Heterochromatin plays a role in gene regulation and the protection of the integrity of chromosomes
- **Summary of types of chromatin:**
 - Good: euchromatin (extended chromatin). It is active chromatin, more of it: active cell. The nucleus will have "open face" or can be seen as vesicular nucleus.
 - Other: Heterochromatin (condensed chromatin). It is inactive chromatin, more of it: less active cell. The nucleus will have "closed face" or can be seen as dense nucleus.



Nu-nucleus, E-euchromatin, H-heterochromatin, M-mitochondria, RER-rough endoplasmic reticulum, G-golgi complex



Distribution of heterochromatin:

- Peripheral heterochromatin, it will be fixated by lamins.
- Islands chromatin
- Nucleolus associated chromatin.

C. The nucleolus:

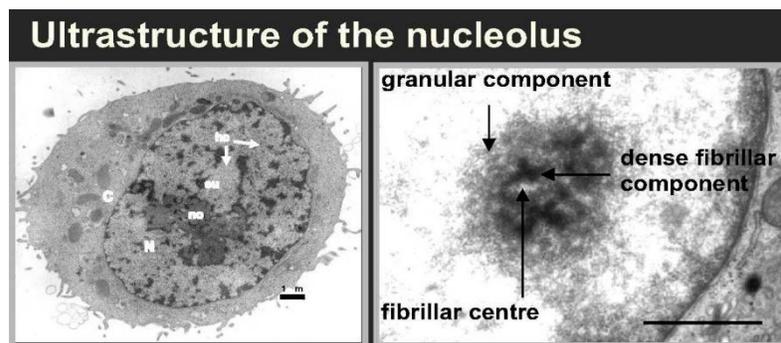
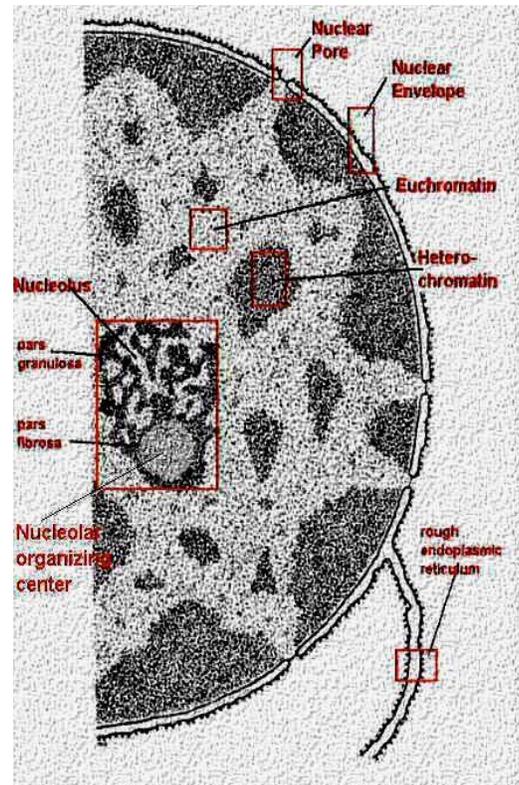
- The nucleolus (plural nucleoli) is a non-membrane bound structure composed of proteins and nucleic acids found within the nucleus
- It is the most dense (prominent) structure of the cell, and frequently is located in central area of nucleus

Function:

- Site of rRNA synthesis, initial ribosomal assembly.

Structure:

- fibrillar centers, filaments of chromatin
- pars fibrosa, newly transcribed rRNA
- pars granulosa, rRNA bound to ribosomal proteins that are beginning to assemble into ribosomes.
- **Nucleolus is usually located in the middle of the nucleus unless there is a defect it migrates to the periphery, a known point of focus on pathology of diseases.**



D. Nucleoplasm= nucleus sap= karyoplasm:

- Analogy with cytoplasm, that part of the nuclear contents other than the nucleolus.
- Highly viscous liquid (**proteins, DNA and RNA are dissolved in it**) that surrounds the chromosomes and nucleolus
- Many substances such as nucleotides and enzymes are dissolved in the nucleoplasm
- A network of fibers known as the nuclear matrix can also found in the nucleoplasm

	Cell membrane	Nuclear membrane
Number of Units	Single lipid bilayer membrane that surrounds the cytoplasm of the cell.	Two lipid bilayer membrane which surrounds the genetic material and nucleolus of the eukaryotic cell.
Membrane Pores	a continuous membrane without any pores.	a discontinuous membrane with complex pores.
Persistence	persists during the lifetime of the cell.	disappears during the cell division in prometaphase and reforms again in telophase.
Permeability and Transportation	semi-permeable membrane and regulates the flow of substances like ions, organic molecules between protoplasm and external environment	is permeable only to small non-polar molecules (mRNA and proteins) and regulates the flow of these molecules between nucleoplasm and cytoplasm.
Endoplasmic Reticulum (ER)	The endoplasmic reticulum is not found attached to the cell membrane.	The endoplasmic reticulum is normally found attached to the nuclear membrane.
Prokaryotic and Eukaryotic	found in both prokaryotic and eukaryotic organisms.	found only in eukaryotic organisms.

أنا ديك بكل ذرة في كياني
ألا تتخلى عني مهما بدر مني ..
فأنا عبدك الضعيف
- د. سلمان العودة.