Presentation Overview

- Introduction
- Types of cell
- Components of Nucleus
  - The Nuclear Envelope
  - The Nucleoplasm
  - The Nucleolus
  - Chromatin/Molecular structure of chromosome
- Function of nucleus
- Reference

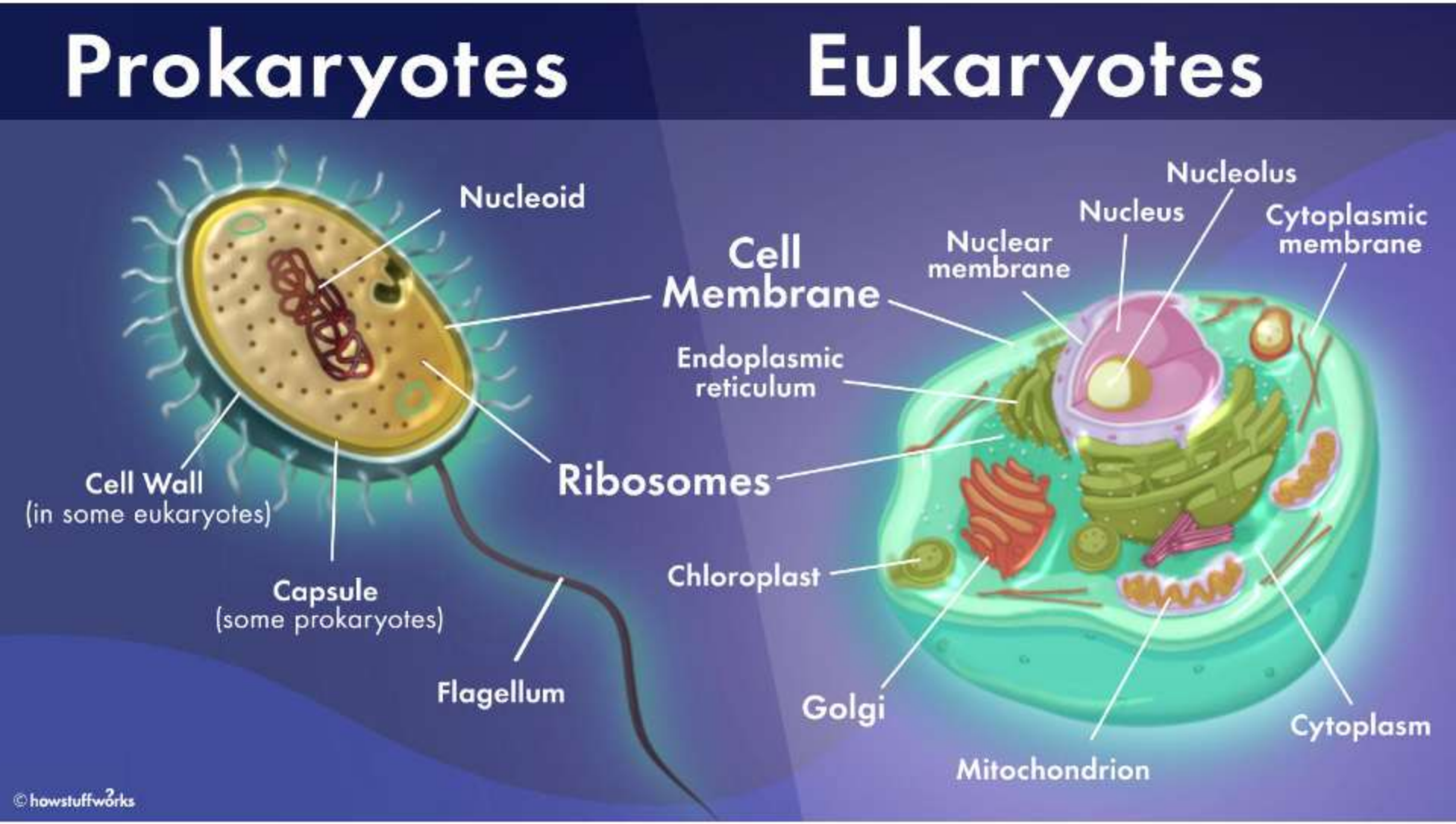
Introduction

- Prominent & Characteristic features
- 'Eukaryon' means 'true nucleus'
- Very essence of eukaryote – membrane bounded nucleus
- Imp functions;
  - Physically separates DNA from the cytoplasm's complex metabolic machinery
  - Nuclear membrane serve as boundary

Discovery of Nucleus

Robert Brown

Answer : Robert Brown discovered the nucleus in the cell in the year 1831. The nucleus is located in the eukaryotic cells. It is a double membrane that mainly covers the protoplasmic body, consisting of heredity information. Robert Brown proved that the nucleus is mainly the storehouse of heredity information.


Prokaryotes
Eukaryotes
Nucleoid
Cell Membrane
Cell Wall
(in some eukaryotes)
Ribosomes
Capsule
(some prokaryotes)
Flagellum
Nucleolus
Nucleus
Cytoplasmic membrane
Nuclear membrane
Endoplasmic reticulum
Chloroplast
Golgi
Cytoplasm
Mitochondrion
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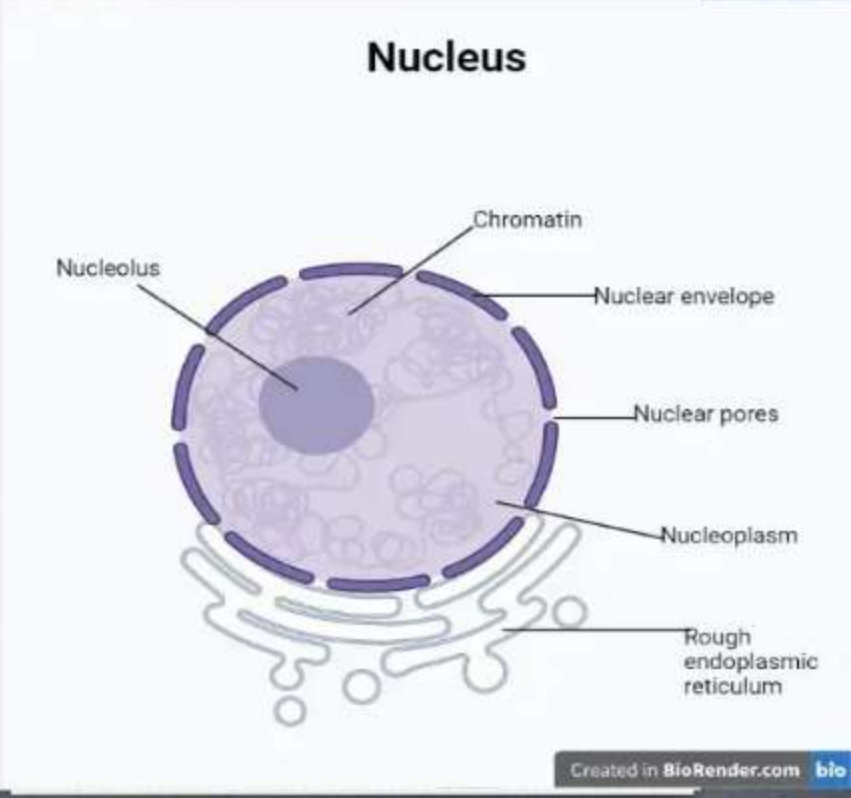
General Definition

- The nucleus is the genetic control center of a eukaryotic cell.
- In most cells, there is only one nucleus. It is spherical, and the most prominent part of the cell, making up 10% of the cell's volume.
- It has a unique structure and function that is essential the cell.

Components of Nucleus

Average diameter of nucleus is 6 um, which occupies around 10% of cell volume.

1. Nuclear Envelope – pore riddled
2. Nucleoplasm – Fluid interior portion
3. Nucleolus – Dense cluster of RNA & Proteins – ribosomes
4. Chromatin – all DNA + Proteins



Ultrastructure Of Nucleus

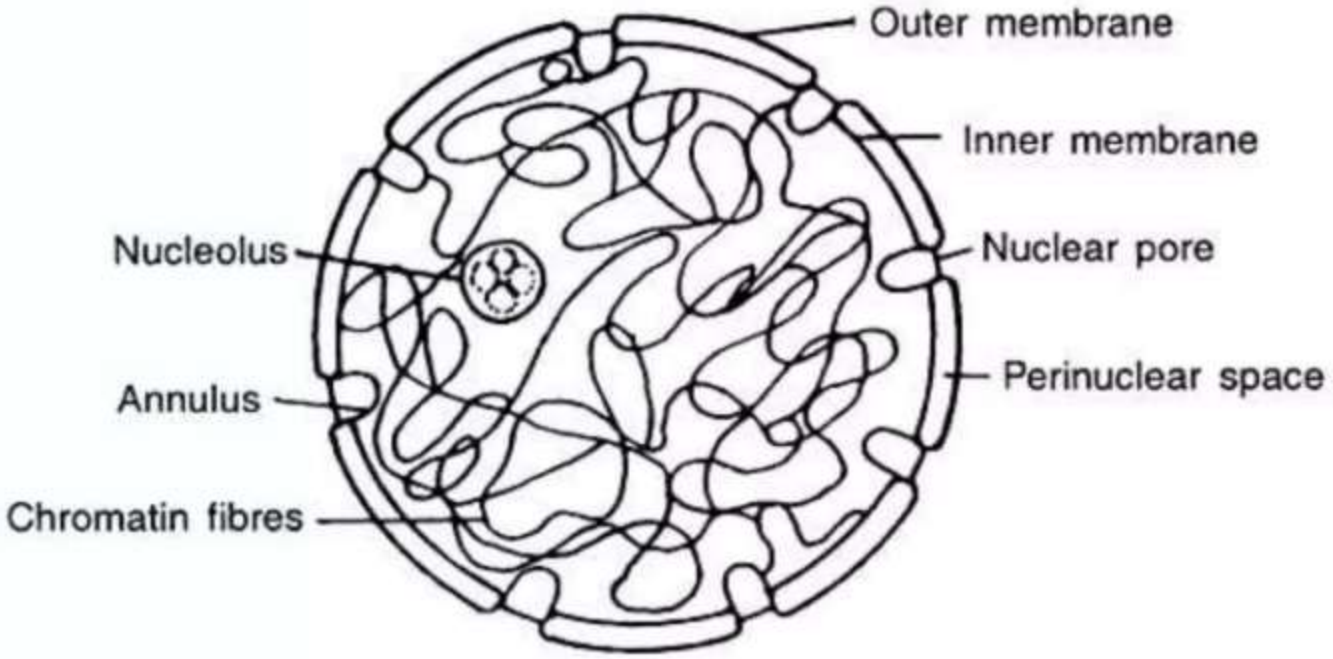
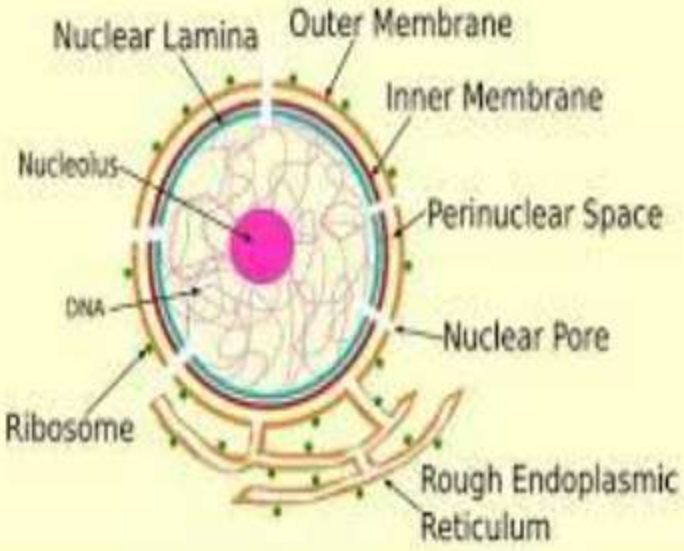


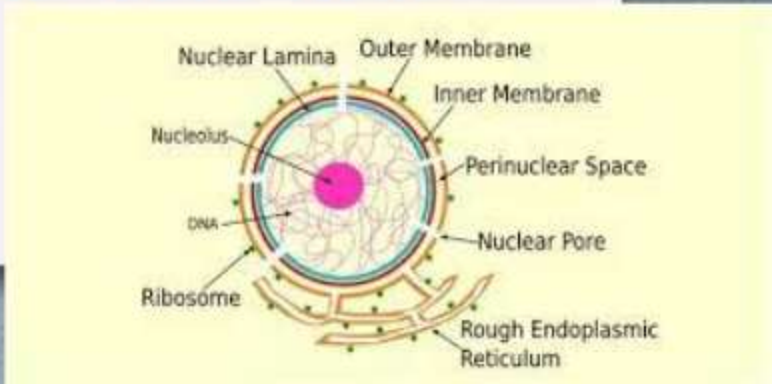
Fig. 2.1. Ultrastructure of Nucleus.

Nuclear Membrane

- Also known as nuclear envelope or nucleolemma
- Separates the nuclear material from cytoplasm
- Consists of two lipid bilayers
- Outer membrane
- Inner membrane



- The nuclear envelope is a double-layered membrane perforated with pores, which control the flow of material going in and out of the nucleus.
- The outer layer is connected to the endoplasmic reticulum, communicating with the cytoplasm of the cell. The exchange of the large molecules (protein and RNA) between the nucleus and cytoplasm happens here.



Function Of Nuclear Membrane

- Shape And Stability: Helps The Nucleus From Collapsing
- Compartmentalizing: Separates The Nuclear Material From Cellular Material
- Regulation Of Substances: Allow The Exchange Of Materials
- Communication: Develops A Chemical Connection Between Nucleus And Cell

The Nuclear Pore

- Most distinctive feature of NE
- Small cylindrical channels –direct contact b/w cytosol & Nucleoplasm
- Readily visible – freeze fracture microscopy
- Mammalian nucleus – 3000 to 4000 pores
- Inner & outer membranes fused
- Structural complexity – control transport of key molecules

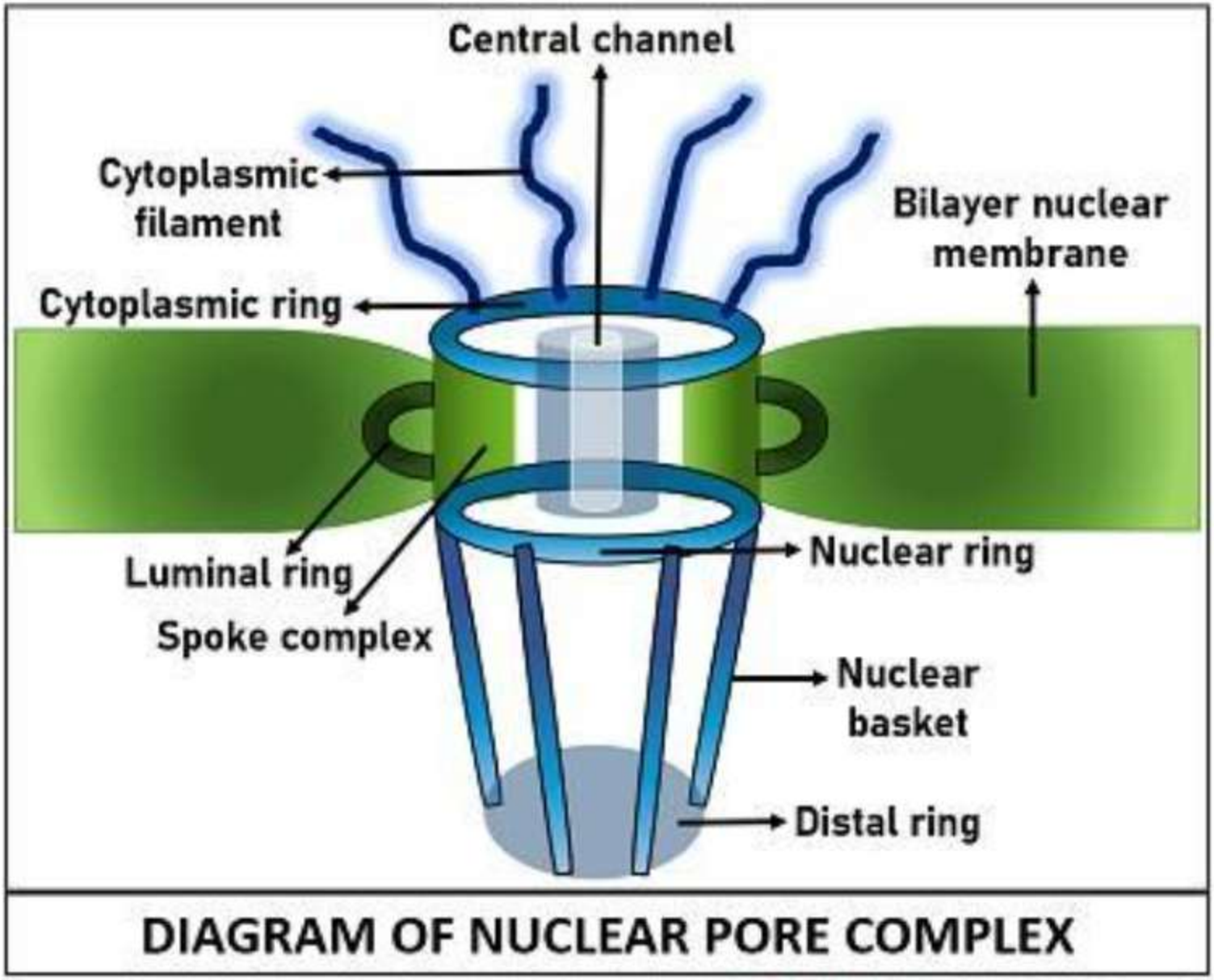


DIAGRAM OF NUCLEAR PORE COMPLEX

BIOLOGY READER

Basic Structure of the Nuclear Pore Complex:

1. Cytoplasmic Ring (Cytoplasmic Filaments)

- Faces the **cytoplasm**
- Extends filaments into the cytoplasm to capture import cargo

2. Cytoplasmic Ring

- Anchors the filaments and connects to the scaffold

3. Inner Ring (Central Framework)

- Core structural component
- Forms the channel through which molecules pass
- Includes FG-nucleoporins (rich in **phenylalanine-glycine** repeats) that create a selective barrier

4. Nuclear Ring

- Similar to the cytoplasmic ring, but on the **nuclear** side

5. Nuclear Basket

- Extends from the nuclear ring into the **nucleoplasm**
- Involved in export and regulatory functions

6. Membrane Ring (Transmembrane Nucleoporins)

- Anchors the complex to the nuclear envelope (interacts with the lipid bilayer)

Function Of Nuclear Pores

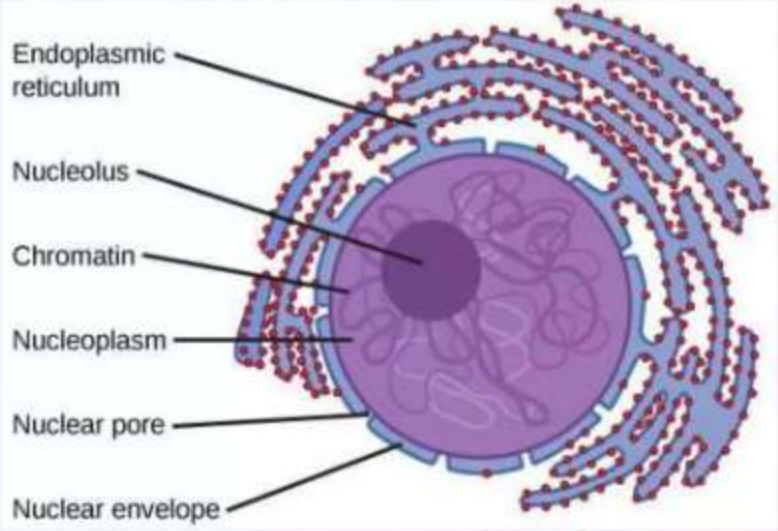
- Exchange of materials between nucleus and cytoplasm
- Passive diffusion of low molecular weight solutes
- Efficient passage through the complex requires several proteins factors

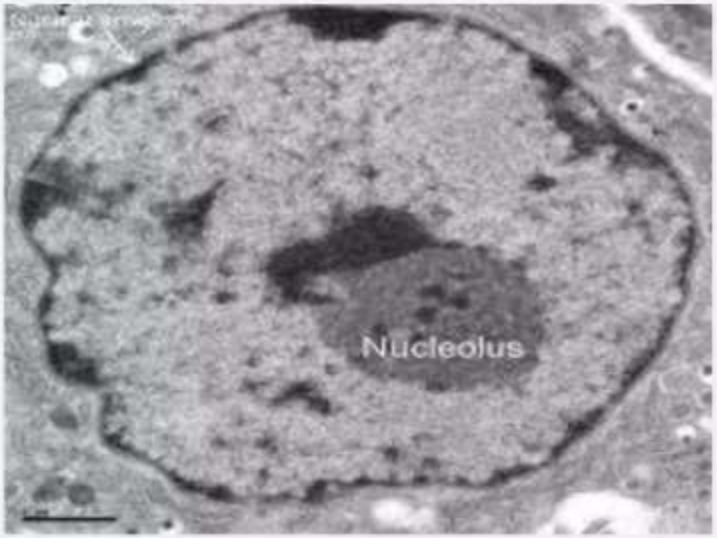
Nucleoplasm

- A jelly-like (made mostly of water) matrix within the nucleus
- Just like the cytoplasm found inside a cell, the nucleus contains **nucleoplasm**, also known as karyoplasm.
- All the other materials "float" inside
- Helps the nucleus keep its shape and serves as the median for the transportation of important molecules within the nucleus
- The **nucleoplasm** is a type of protoplasm that is made up mostly of water, a mixture of various molecules, and dissolved ions.
- It is completely enclosed within the nuclear membrane or nuclear envelope

The Nucleolus

- Ribosome factory
- Large, prominent structures
- Doesn't have membrane
- Most cells have 2 or more
- Directs synthesis of RNA
- The **nucleolus** takes up around 25% of the volume of the nucleus.
- This structure is made up of proteins and ribonucleic acids (rna). Its main **function** is to rewrite ribosomal RNA (rrna) and combine it with proteins.
- This results in the formation of incomplete ribosomes.


Endoplasmic reticulum
Nucleolus
Chromatin
Nucleoplasm
Nuclear pore
Nuclear envelope

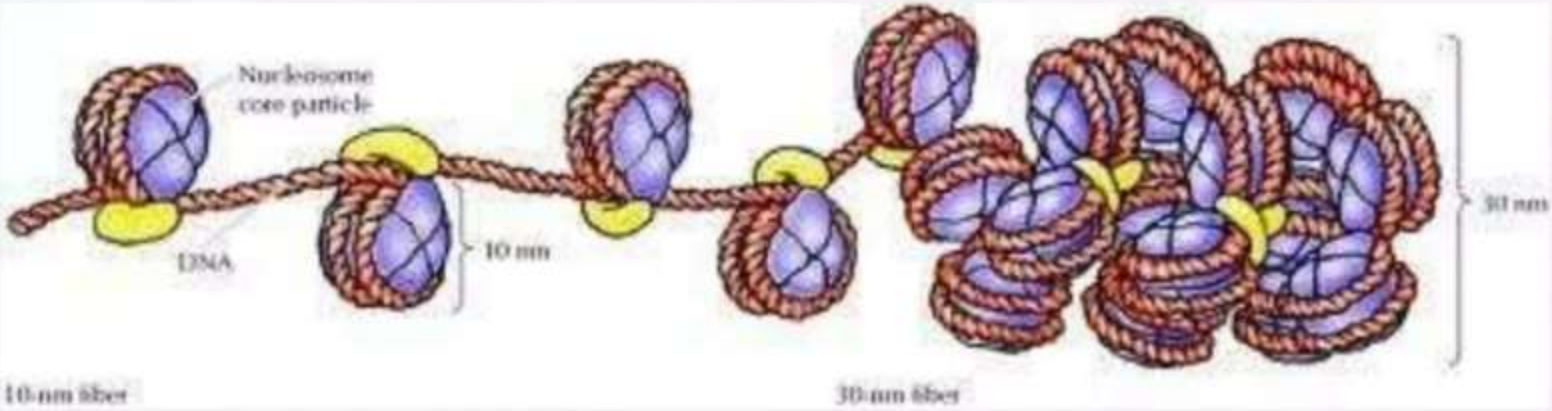

Nucleolus

Chromatin/ Molecular Structure Of Chromosomes

- Chromosomes contain DNA in a condensed form attached to a histone protein.
- Eukaryotic chromosomes – two broad components.

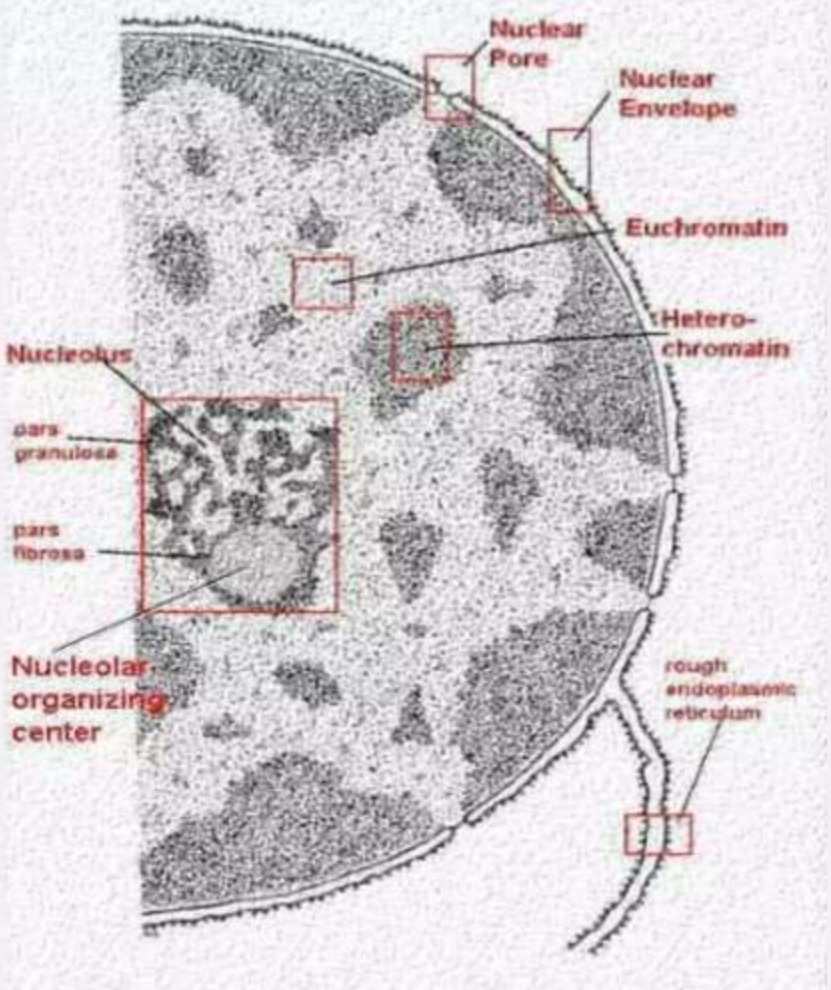
1. Nucleic acids:
   - DNA (primary nucleic acid)
   + small amt of RNA (transit to the cytoplasm)
2. Proteins:
   i. Histones (basic pH) – core histones (H2A, H2B, H3 & H4), Linker histone (H1)
   ii. Non Histone proteins

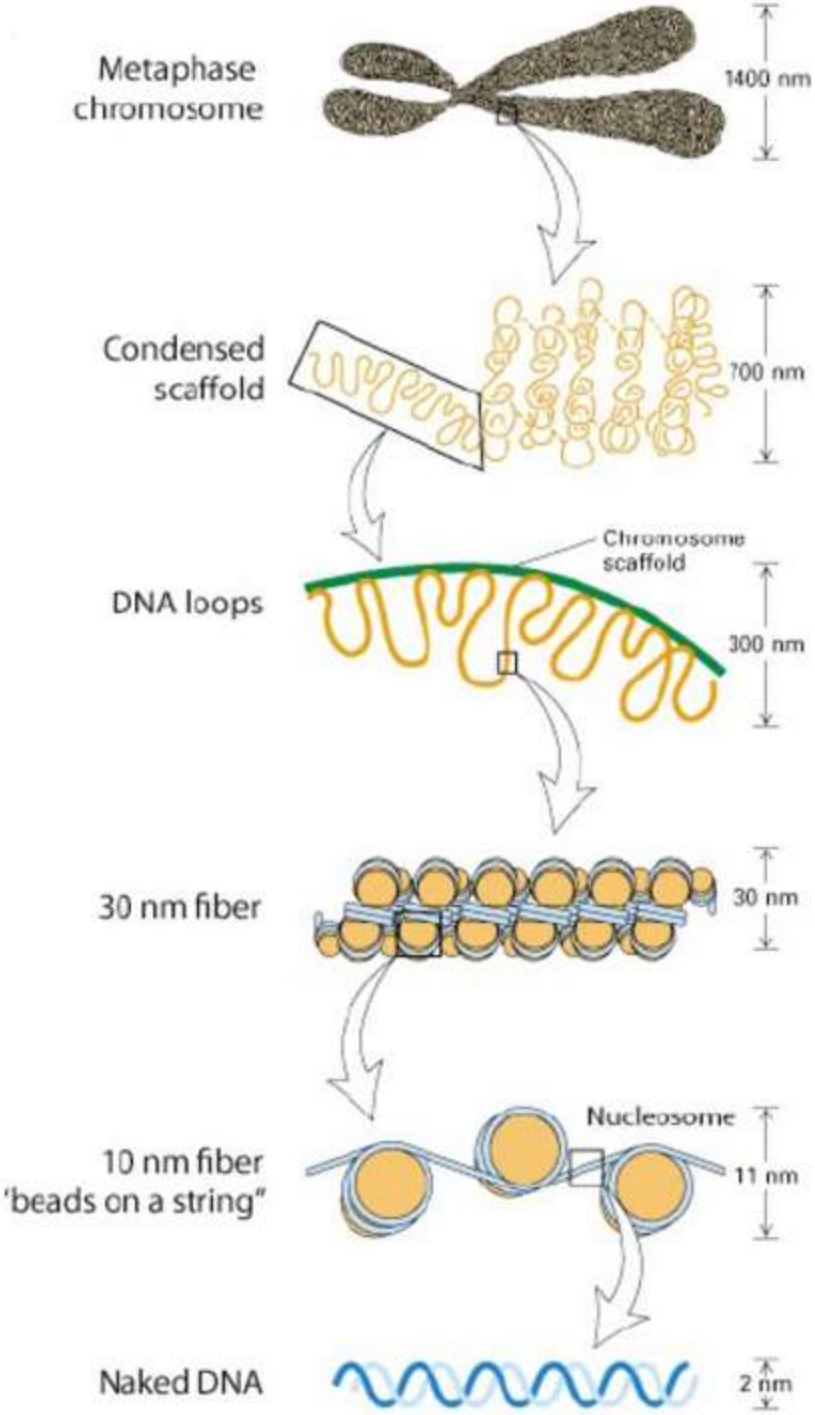
- Histones bind to **–vely** charged DNA – stability to the DNA
- Mixture of DNA & proteins – basic structural unit of chromosomes - chromatin fiber
- E/M examination of intephase chromatin – ellipsoidal beads
- joined by linker DNA known as Nucleosomes.



- Chromatin can be differentiated into two regions (during interphase & early prophase)

1. Euchromatin – lightly staining
2. Heterochromatin – densely staining

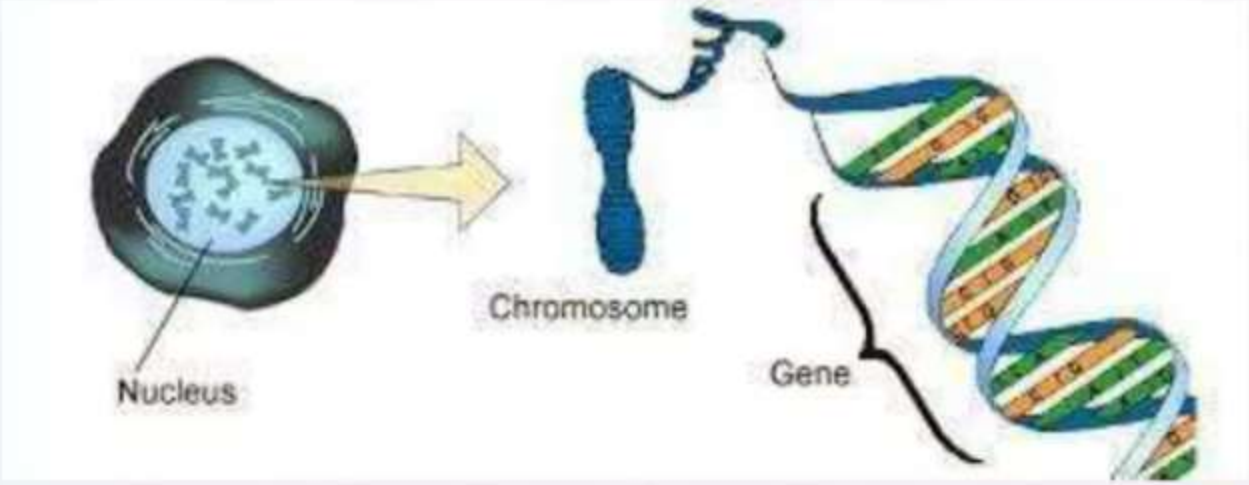



Metaphase chromosome
1400 nm
Condensed scaffold
700 nm
Chromosome scaffold
DNA loops
300 nm
30 nm fiber
30 nm
Nucleosome
10 nm fiber
'beads on a string"
11 nm
Naked DNA
2 nm

Euchromatin	Heterochromatin
Lightly staining regions	Darkly staining
Less tightly packed chromatin fibers therefore non condensed	Tightly packed chromatin fibers therefore condensed
Not visible – light microscope, undergo regular changes in morphology with cell division	Visible, remain highly condensed in all stages
Genetically active regions	Genetically inactive regions – either they lack genes/ contain genes that are not expressed
Replicates earlier during S phase	Replicates later during S phase
GC rich	AT rich

Function of chromosome

- It controls the activities of cell
- Information in the form of genes is located on chromosomes
- Control inheritance and metabolism



Functions of Nucleus

- **The nucleus serves as the cell's control center, housing the genetic material (DNA) and regulating various cellular processes like protein synthesis, cell division, and growth. It also stores DNA, replicates it, and transcribes it into RNA.**

1. Storage and Protection of DNA:

- The nucleus stores the cell's genetic information in the form of DNA, which is organized into chromosomes.
- It provides a protective environment for the DNA, separating it from the other cellular components.

2. Gene Expression and Regulation:

- The nucleus is the site where DNA replication and transcription occur.
- It regulates gene expression, determining which genes are active and which are not.
- The nucleus also plays a role in RNA processing and splicing.

3. Protein Synthesis:

- The nucleus is involved in the production of ribosomes, which are essential for protein synthesis.
- It regulates the synthesis of enzymes and other proteins needed by the cell.

4. Cell Growth and Division:

- The nucleus controls cell growth and division by regulating the cell cycle.
- It ensures that DNA is accurately replicated and distributed to daughter cells during cell division.

5. Regulation of Cellular Activities:

- The nucleus acts as the command center for various cellular activities, including metabolism and response to external stimuli.
- It regulates the activities of other organelles and cell components.