



NUCLEUS

THE BOSS

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A microscopic image of cells, likely from a tissue section, showing numerous cells with bright yellow cytoplasm and blue-stained nuclei. The cells are arranged in a somewhat regular pattern, typical of epithelial tissue.

THE **WWW** OF NUCLEUS

WHAT?

WHERE?

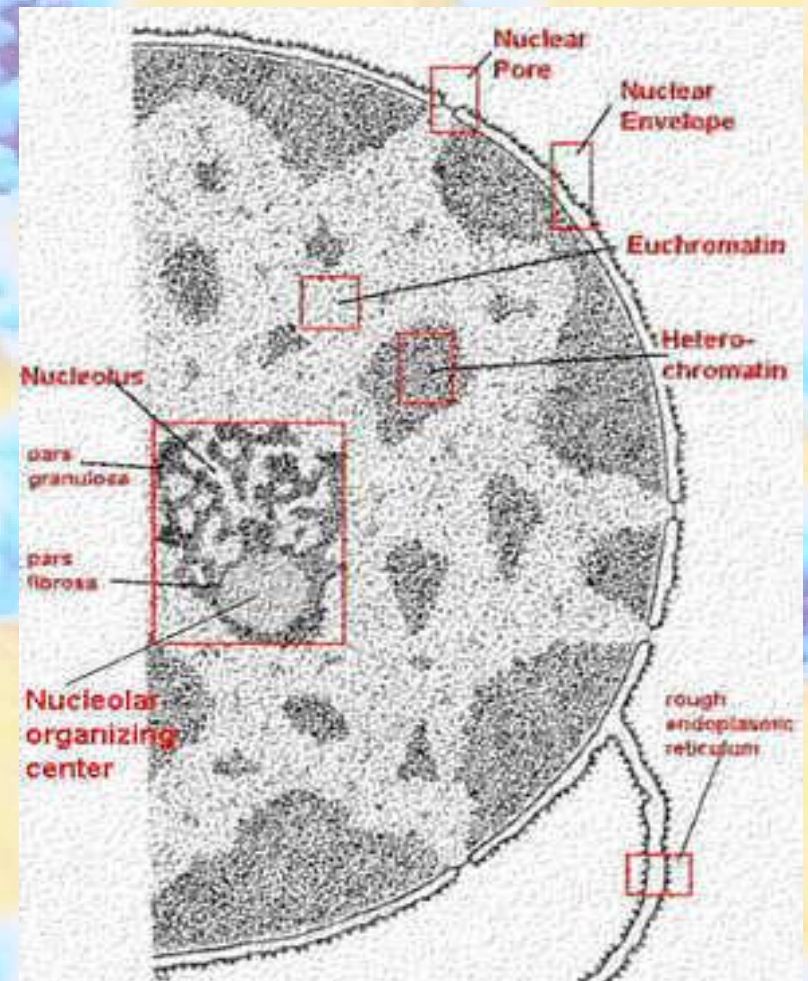
WHY?

NUCLEUS

- The nucleus is often the most prominent cell organelle.
- It contains the genome, the cell's database, which is encoded in molecules of the nucleic acid, DNA.
- The nucleus is bounded by a nuclear envelope composed of two membranes separated by an inter-membrane space.
- The inner membrane of the nuclear envelope is lined by a meshwork of proteins

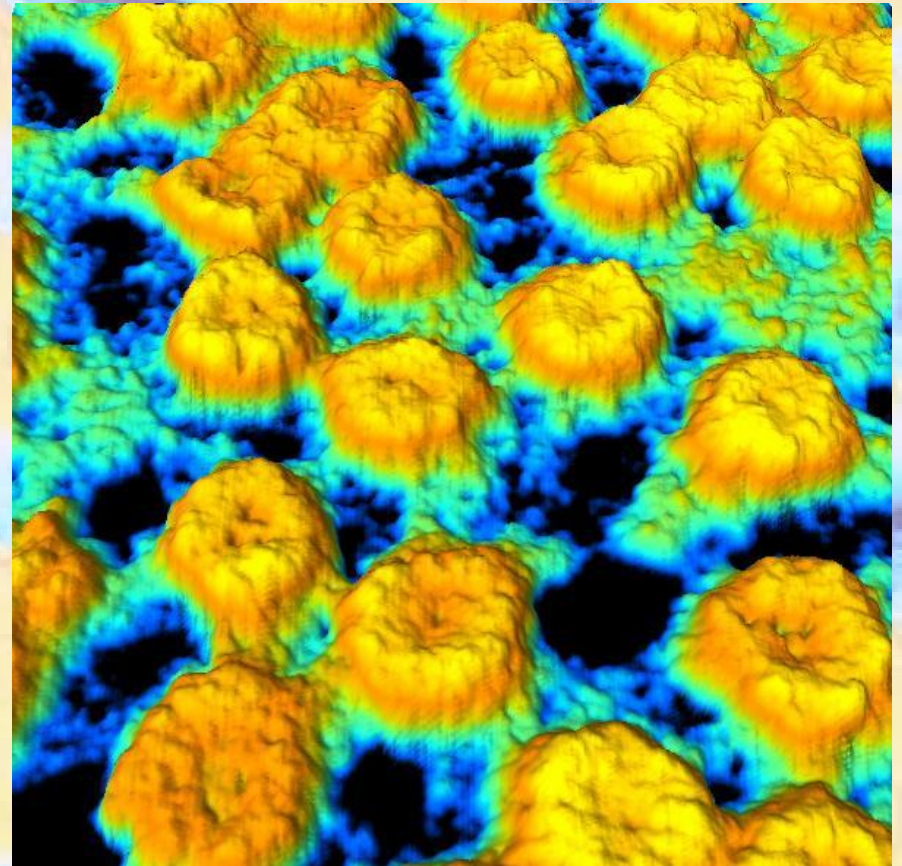
NUCLEUS

- **Includes**
 - Nuclear envelope
 - Nucleolus
 - Nucleoplasm
 - Chromatin.
- **Contains the genetic material encoded in the DNA of chromosomes.**



NUCLEAR ENVELOPE

- Surrounds the nuclear material.
- Consists of two parallel membranes, separated from each other by a narrow perinuclear cisterns.
- These membranes fuse at intervals, forming openings in the nuclear envelope called nuclear pores.



OUTER MEMBRANE

- The outer membrane 6 nm thick.
- It faces the cytoplasm and is continuous at certain sites with the rough endoplasmic reticulum.
- A loosely arranged mesh of intermediate filaments (vimentin) surrounds the outer nuclear membrane on its cytoplasmic aspect.
- Ribosomes stud the cytoplasmic surface of the outer nuclear membrane.
- These ribosomes synthesize proteins that enter the perinuclear cisterna.

INNER MEMBRANE

- 6 nm thick.
- Faces the nuclear material.
- Separated from it and supported on its inner surface by the nuclear lamina, a fibrous lamina that is 80-300 nm thick.
- Composed primarily of lamins A, B, and C.
- These intermediate filament proteins help organize the nuclear envelope and perinuclear chromatin.
- Additionally they are essential during the mitotic events, when they are responsible for the disassembly and reassembly of the nuclear envelope.
- Phosphorylation of lamins leads to disassembly, and dephosphorylation results in reassembly of the nuclear envelope.

PERINUCLEAR CISTERNAE

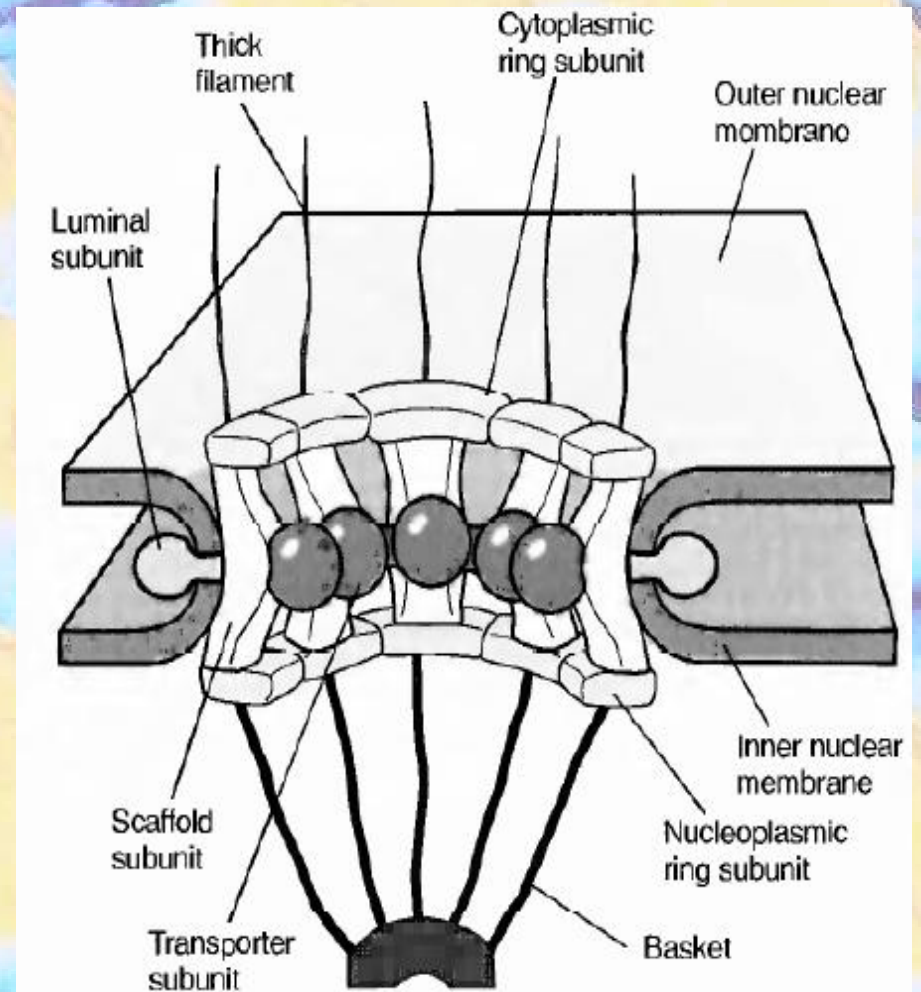
- Located between the inner and outer nuclear membranes and is 20-40 nm wide.
- Continuous with the cisternae of the RER.
- It is perforated by nuclear pores at various locations.

NUCLEAR PORES

- Average 80 nm in diameter.
- Number from dozens to thousands depending upon the metabolic activity; they are associated with.

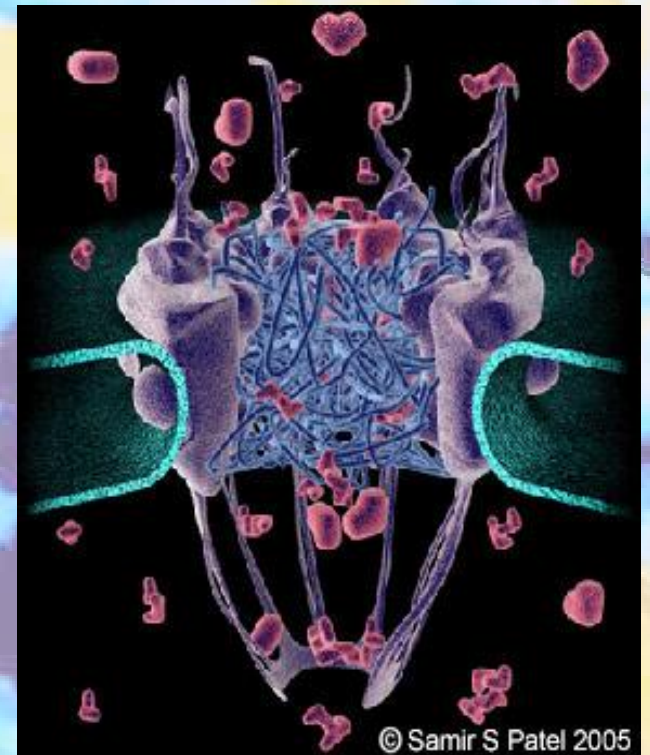
The nuclear pore complex (NPC).

- Formed by fusion of the inner and outer nuclear membranes.
- Permit passage of *certain* molecules in either direction between the nucleus and cytoplasm via a 9-nm channel opening.



NUCLEAR PORE COMPLEX

- The NPC is composed of nearly 100 proteins, some of which are arranged in eight-fold symmetry around the margin of the pore.
- It consists of cytoplasmic ring, nucleoplasmic ring and the middle ring.
- The nucleoplasmic side of the pore exhibits a nuclear basket, whereas the cytoplasmic side displays fibers extending into the cytoplasm.
- A transporter protein is located in the central core and is believed to be responsible for transporting proteins into and out of the nucleus via receptor-mediated transport.

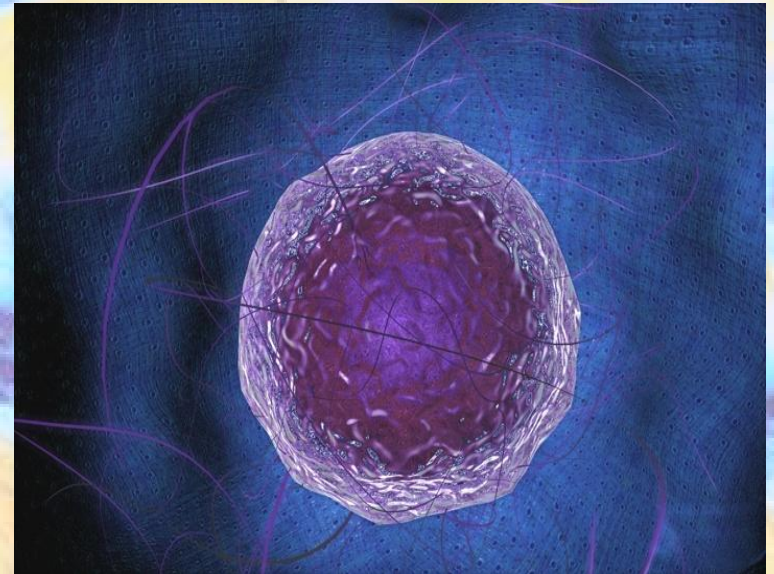


NPC - FUNCTIONS

- **The NPC permits passive movement across the nuclear envelope via a 9- to 11-nm open channel fiber simple diffusion.**
- **Most proteins, regardless of size, pass in either direction only by receptor-mediated transport.**
- **These proteins have clusters of certain amino acids known as nuclear localization segments (NLS) that act as signals for transport.**

NUCLEOLUS

- Nuclear inclusion that is not surrounded by a membrane.
- It is present in cells that are actively synthesizing proteins;
- More than one nucleolus can be present in the nucleus.
- It is generally detectable only when the cell is in interphase.
- Contains mostly rRNA and protein as well as a modest amount of DNA.
- It possesses nucleolar organizer regions (NORs), portions of those chromosomes (in humans, chromosomes 13,14,15,21, and 22) where rRNA genes are located; these regions are involved in reconstituting the nucleolus during the G1 phase of the cell cycle.



NUCLEOLUS

- **The nucleolus contains four distinct regions.**
 - **Fibrilla centers** are composed of inactive DNA where DNA is not being transcribed. NORs are also located here.
 - **Pars fibrosa** are composed of 5-nm fibrils surrounding the fibrillar centers and contain transcriptionally active DNA and the rRNA precursors that are being transcribed.
 - **Pars granulosa** are composed of 15-nm maturing ribosomal precursor particles.
 - **Nucleolar matrix** is a fiber network participating in the organization of the nucleolus.

NUCLEOLUS - FUNCTIONS

- **Synthesis of rRNA and its assembly into ribosome precursors.**
- **Sequesters certain nucleolar proteins that function as cell-cycle checkpoint signaling proteins.**
- **Three such cell-cycle regulator proteins have been identified within the nucleolus, where they remain sequestered until their release is required for targets in the nucleus and/or cytoplasm.**

NUCLEOPLASM

- Nucleoplasm is the protoplasm within the nuclear envelope.
- It consists of a nuclear matrix and various types of particles.

NUCLEAR MATRIX

- **Nuclear matrix** acts as a scaffold that aids in organizing the nucleoplasm.
- It contains other components:
 - **Structural components** include **fibrillar** elements, nuclear pore, nuclear lamina complex, residual nucleoli, and a residual ribonucleoprotein (RNP) network.
 - **Functional components** are involved in the transcription and processing of mRNA and **rRNA**, steroid receptor-binding sites, carcinogen binding sites, heat-shock proteins, DNA viruses, and viral proteins ('I' antigen).
- It may have many more functions which are currently not known.

NUCLEAR PARTICLES

- **Heterchromatin granules** are clusters of irregularly distributed particles
- (20-25 nm in diameter) that contain **RNP** and various enzymes.

- **Perichromatin granules** are single dense granules (30-50 nm in diameter) surrounded by a less dense **halo**.
- Located at the periphery of heterochromatin and exhibit a substructure of 3-nm packed fibrils.
- Contain **4.7s RNA** and two peptides **similar** to those found in heterogeneous nuclear RNPs (hnRNPs).
- They may represent **messenger RNPs (mRNPs)**.
- The number of granules increases in liver **cells** exposed to carcinogens or temperatures above **37°C**.

NUCLEAR PARTICLES

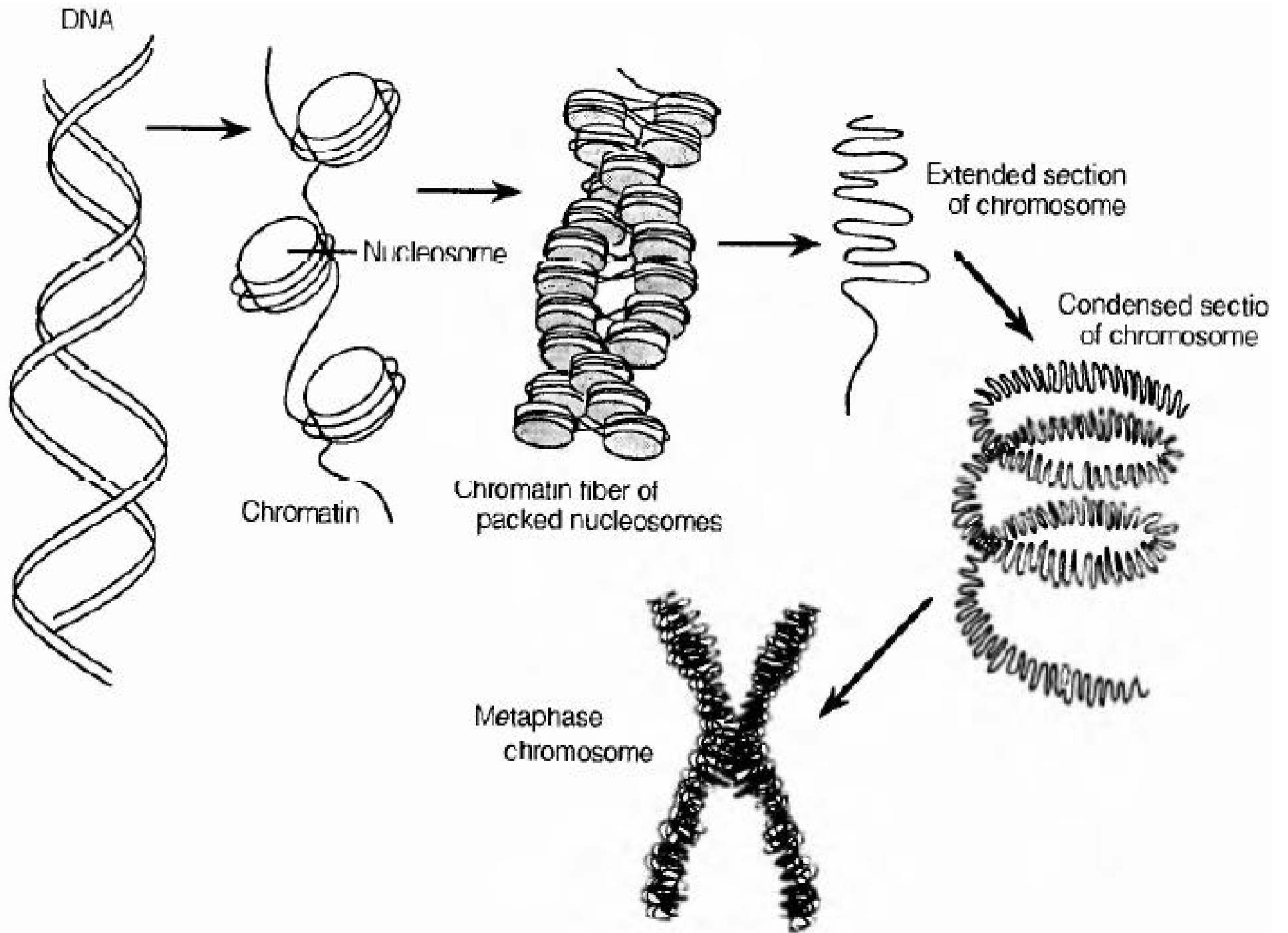
- The hnRNP particles are complexes of precursor mRNA (pre-mRNA) and proteins and are involved in processing of pre-mRNA.
- Small nuclear RNPs (snRNPs) are complexes of proteins and small RNAs and are involved in hnRNP splicing or in cleavage reactions.

CHROMATIN

- Chromatin consists of double-stranded DNA complexed with **histones** and **acidic proteins**.
- It resides **within** the nucleus as heterochromatin and euchromatin.
- The **euchromatin-heterochromatin** ratio is higher in malignant cells than in normal cells.

CHROMATIN

- **Heterochromatin** is the condensed inactive chromatin, is concentrated at the periphery of the nucleus and around the nucleolus, as well as scattered throughout the nucleoplasm.
- **Euchromatin** is the transcriptionally active form of chromatin that appears in the LM as a lightly stained region of the nucleus.
- The main function of chromatin is the synthesis of RNA and cell division.



OTHER COMPONENTS OF THE NUCLEUS

- Some of the components which also form a part of the nucleus include the
 - DNA.
 - Different classes of RNA (m-RNA, r-RNA and t-RNA).
- These are important for cell survival, cell division, and protein synthesis.

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WAKE UP FOLKS!!!!

ITS QUESTION TIME

REFERENCES

- Cell – A Molecular Approach 3rd Ed – Cooper
- Board Review Series – Cell Biology and Histology 4th Ed. - Gartner

