Faculty of Medicine

Histology Department

Nucleus

Block 102PMS

Prepared by

Dr/ *Ola Abd El Tawab*

Histology Department

Faculty of Medicine

Assiut University

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Nucleus

Learning objectives (3nd *week/Lecture*)

After the lecture, students should be able to:

- **List the components of the nucleus.**
- **Identify the structure & function of nuclear envelope.**
- **Recognize the structure & types of chromatin.**
- **Discriminate the structure & function of the nucleolus**

Nuclear function

1-Store house for genetic information

2-Cell division(nucleus regulates the processes of cell division

3-Controlling all cellular function

4-Produces ribosomal subunits in nucleolus and exports them into cytoplasm for assembly into ribosome

Nuclear Morphology

1-Nuclear size: small,medium,large

2-Number per cell: one nuclus,two nuclei (liver cells,superficial cells of transitional epithelium)&many nuclei (osteoclast cells of bone&skeletal muscle cells

3-shape : round,oval,flattened,rod-shaped,kidney shape,segmented

Nuclear location:basal,central or eccentric

Appearance of the nucleus: may be deeply stained nucleus or vesicular (open face) nucleus

There is a constant ratio (nucleo – cytoplsmic ratio) between the size of the nucleus and the size of the cytoplasm. This ratio is characteristic for each cell kind. If this ratio is disturbed by the increase in the size of the cytoplasm, the cell usually divides.

Structures of nucleus

1-*Nuclear envelope*

DeF: Forms a selectively permeable barrier between the nuclear and cytoplasmic compartments

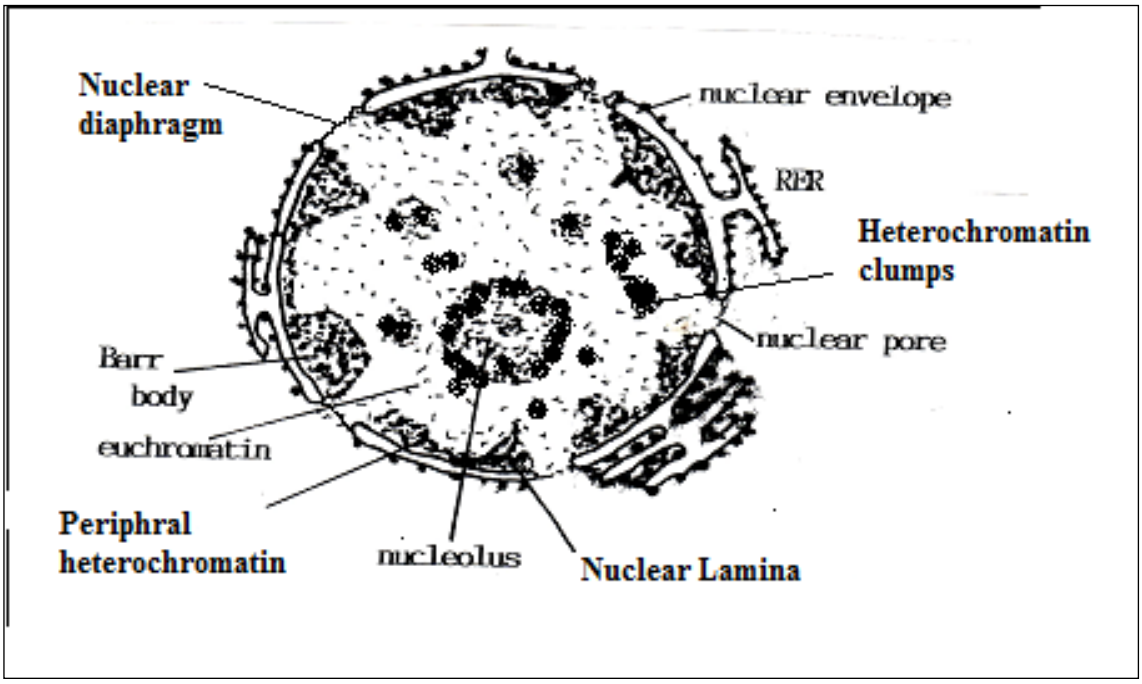
L.M.Dark basophilic membrane which surrounds the nucleus

E.M.: reveals that the envelope has two concentric membranes separated by a narrow (30-50 nm) **perinuclear space**. This space and the outer nuclear membrane are continuous with the extensive cytoplasmic network of the rough endoplasmic reticulum (RER).

Closely associated with the inner nuclear membrane is a highly organized meshwork of proteins called the **nuclear lamina** which stabilizes the nuclear envelope. Major components of this layer are the class of intermediate filament proteins called **lamins**

Circular pores are present in the nuclear envelope and they are guarded by a **pore complex**, these pores allow for the exchange of special substances between the nucleus and the cytoplasm. At the pore, the outer

and the inner membranes fuse to form a complex structure known as the **pore complex**. **Nuclear pore complexes** contain more than 30 core proteins (nucleoporins), span both membranes of the nuclear envelope, . Although ions and small solutes pass through the channels by simple diffusion, the pore complexes regulate movement of macromolecules between the nucleus and cytoplasm. A growing cell has 3000-4000 such channels, each providing passage for up to 1000 macromolecules per second.



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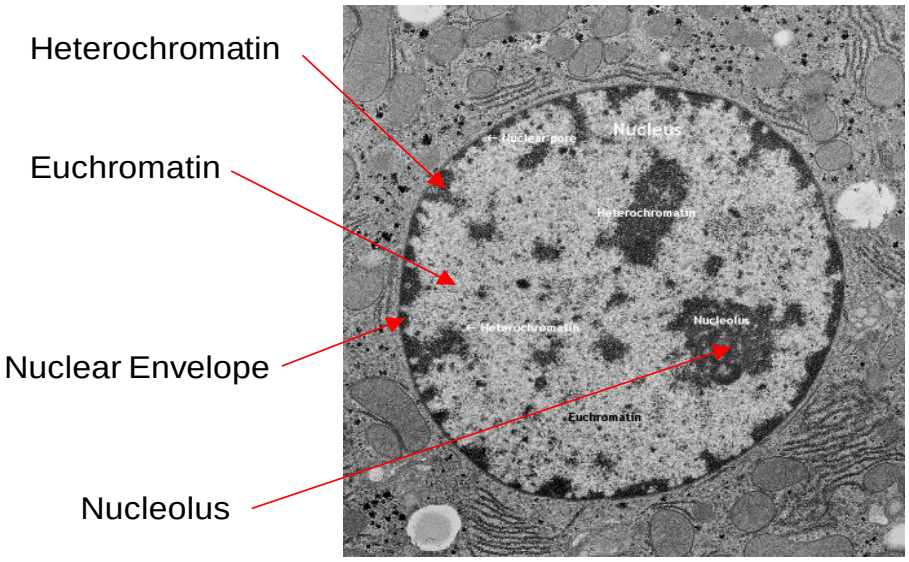
Chromatin is the substance of chromosomes

- **Structures: are formed mainly of nucleoprotein which is formed of DNA bound to basic protein called histones**
- **Stain:basophilic due to presence of DNA**

Interphase Nucleus



Nucleolus:

site of ribosomal assembly and rRNA transcription

surrounding the nucleus. Contains nulear pores throughout.

There are two type of chromatin:

1. **Finely granulated** chromatin called euchromatin or dispersed chromatin representing uncoiled active parts of chromosomes

2. Clumps of chromatin called heterochromatin or condensed chromatin, which represent the inactive coiled parts of chromosomes. It is found in the following areas in the nucleus:

a) **Chromatin associated with the nuclear envelope (peripheral chromatin)** is actually the cause of its staining property. It is the coiled regions of the chromosomes which is always associated with the nuclear membrane.

b) **Chromatin associated with the nucleolus** forms a shell around it. It represents the coiled part of particular chromosomes and responsible

for the organization of the nucleolus. These chromosomes are known as nucleolar organizers.

c) Sex chromatin attached to the nuclear envelope of the nucleus and is called Barr body. This body is present much more frequently in female nuclei and represents one of the "x" chromosomes which is the coiled one.

d)**Clumps of heterochromatin scattered in nucleoplasm.**

MEDICAL APPLICATION

Barr bodies or gender chromatin permit gender to be determined microscopically in patients whose external sex organs do not permit that determination, Sex chromatin analysis also helps reveal other anomalies involving the sex chromosomes, such as the presence of XXY chromosomes (Klinefelter syndrome), which causes testicular abnormalities and azoospermia (absence of sperm. Also (Turner syndrome) which is X0 chromosomes.

Nucleolus

The nucleolus is a generally spherical, highly basophilic subdomain of nuclei in cells actively engaged in protein synthesis. The intense basophilia of nucleoli is due not to heterochromatin but to the presence of densely concentrated ribosomal RNA (rRNA) that is transcribed, processed,and assembled into ribosomal subunits.

With the EM, the nucleolus is formed of two definite areas:

1. A central fibrous area (pars fibrosa) containing the chromatin filaments of the nuclear organizer chromosomes as well as filamentous RNA.

2. The outer portion (pars granulose) is granular and is composed of RNA particles quite similar to ribosomal subunits .

Molecules of rRNA are processed in the nucleolus and very quickly associate with the ribosomal proteins imported from the cytoplasm via nuclear pores. The newly organized small and large ribosomal subunits are then exported back to the cytoplasm through those same nuclear pores.

Nuclear Sap

It is a colloidal clear solution, it is formed of nucleoproteins,enzymes,phosphors,potassium&calcium

Function of nuclear sap

Provide a medium in which ribonucleic acid

(ribosomal,messenger and transfer **RNA)** move towards the nuclear pores.

Self-Assessment

1-The inactive portions of chromosomes are heterochromatin

2-A layer of protein is present closely associated with the nuclear side of the inner membrane. It is called nuclear Lamins

3-Which of the following parts of the nucleus makes ribosomes and RNA?

a)NuclearEnvelope (b)Nucleolus (c)Nucleoplasm (d)Chromatin Pores

Sources

-ELSEVIER'S INTEGRATED HISTOLOGY(Text and atlas)

-Junqueira's Basic Histology: Text and Atlas 14th Edition.

-Wheater's Functional Histology A Text and Colour Atlas 6th Edition.