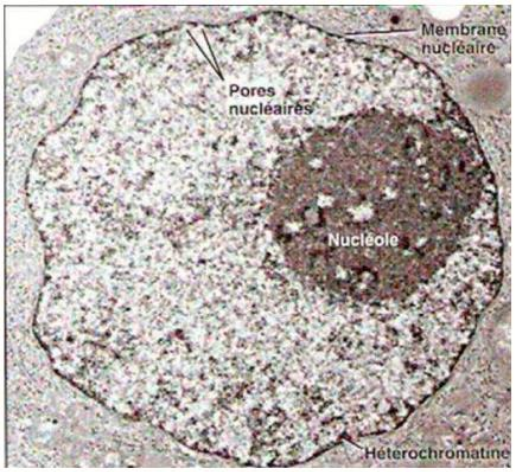
Chromatin, Chromosomes and the Nucleus

Introduction

• The nucleus is the **hallmark** of eukaryotic cells.
• It contains most of the genetic material (DNA).
• DNA is organized as chromatin during interphase, and as chromosomes during division.
• The nucleus controls:
- Gene expression
- DNA replication
- Cell division



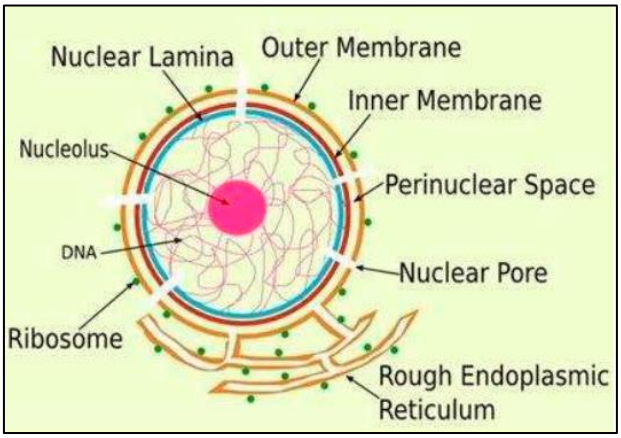
Structure of the Nucleus

• Usually spherical or oval, 5–10 µm in diameter.
• Main components:

1. Nuclear envelope
2. Nucleoplasm
3. Nucleolus
4. Chromatin

Visible under light microscope as a dark spherical structure.

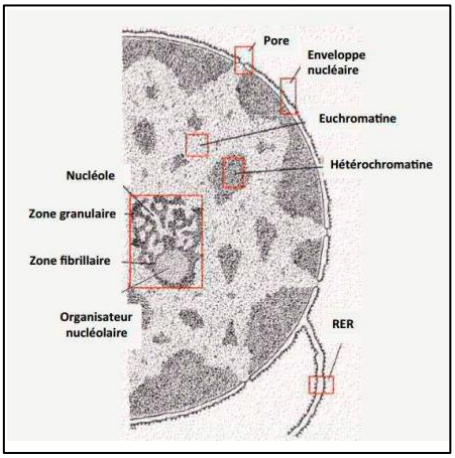
1. The Nuclear Envelope



• Double membrane surrounding the nucleus.
• Outer membrane continuous with the rough ER.
• Inner membrane faces the nucleoplasm.
• Perinuclear space between them.
• Nuclear pores regulate transport of RNA, proteins, and ions.

2. The Nucleoplasm and the Nucleolus

Nucleoplasm: Fluid matrix containing enzymes, nucleotides, ions, and chromatin.
Nucleolus:
- Non-membranous, spherical body.
- Synthesizes rRNA and assembles ribosomal subunits.
- Contains DNA, rRNA, and ribosomal proteins.

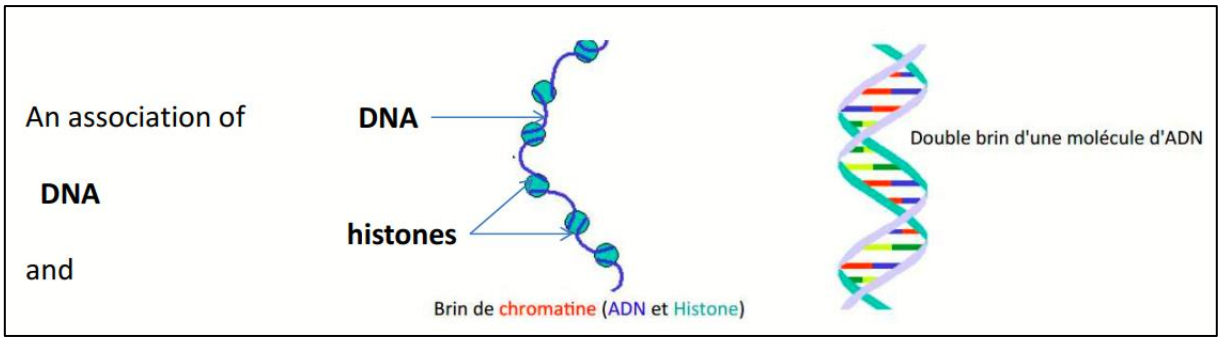


3. Chromatin: Definition

• Chromatin = DNA + proteins (histones + non-histones).
• Located in the nucleoplasm.
• Two states:
- *Euchromatin*: loosely packed, active genes.
- *Heterochromatin*: tightly packed, inactive regions.

Chemical Composition

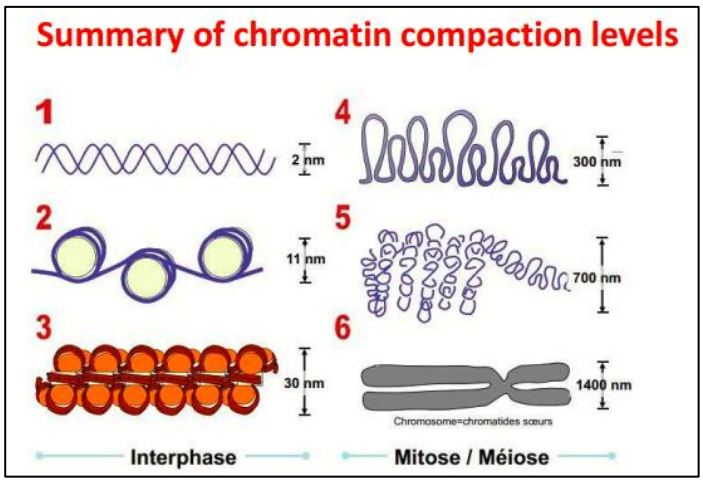
• DNA: genetic information.
• Histones: basic proteins (H2A, H2B, H3, H4).
• Non-histone proteins: regulatory enzymes, transcription factors.
• RNA: messenger and ribosomal.



The Nucleosome

• DNA wraps around a histone octamer.
• 1 nucleosome = 146 base pairs of DNA.
• Appears as "beads-on-a-string".
• Levels of compaction:

1. 10 nm fiber
2. 30 nm solenoid
3. Looped domains
4. Condensed chromosome



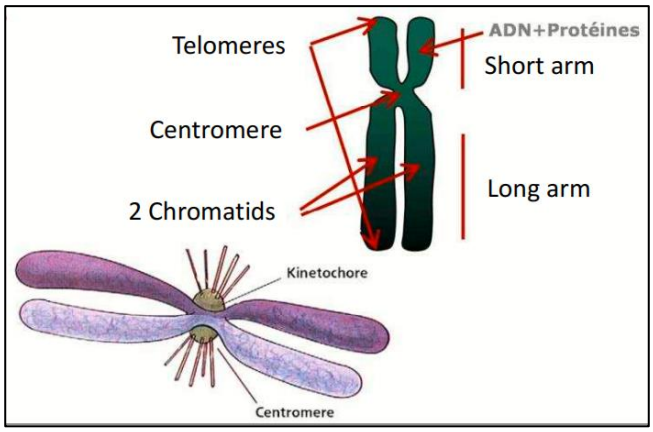
Types of Chromatin

Type	Features	Function
Euchromatin	Lightly stained, less condensed / Faiblement colorée, peu condensée	Active transcription / Transcription active
Heterochromatin	Darkly stained, condensed / Fortement colorée, condensée	Inactive DNA / ADN inactif
→ Constitutive	Always condensed / Toujours condensée	Centromères, télomères
→ Facultative	Condenses/decondenses / Variable	Chromosome X chez la femelle

Chromosomes

• Highly condensed chromatin during mitosis/meiosis.
• One DNA molecule + proteins.
• Function: accurate genetic distribution.

Structure of a Metaphase Chromosome



- Two sister chromatids joined by a centromere.
- Arms: short (p) and long (q).
- Telomeres protect chromosome ends.
- Kinetochore: spindle attachment site.

The Karyotype

- Set of chromosomes in a somatic cell.
- Humans: 2n = 46 chromosomes (22 pairs + XX/XY).
- Used to detect anomalies (Trisomy 21, Turner syndrome).

Functions

Structure	Functions
Nucleus	Stores DNA, controls transcription, cell cycle
Chromatin & Chromosomes	Regulate gene expression, ensure heredity

Microscopic Observation

Structure	Microscope	Stain	Observation
Nucleus	Light	Hématoxyline-éosine	Corps rond sombre
Chromatin	Electron	Acétate d'uranile	Filamenteuse ou dense
Chromosomes	Light (mitosis)	Giemsa	Forme en X

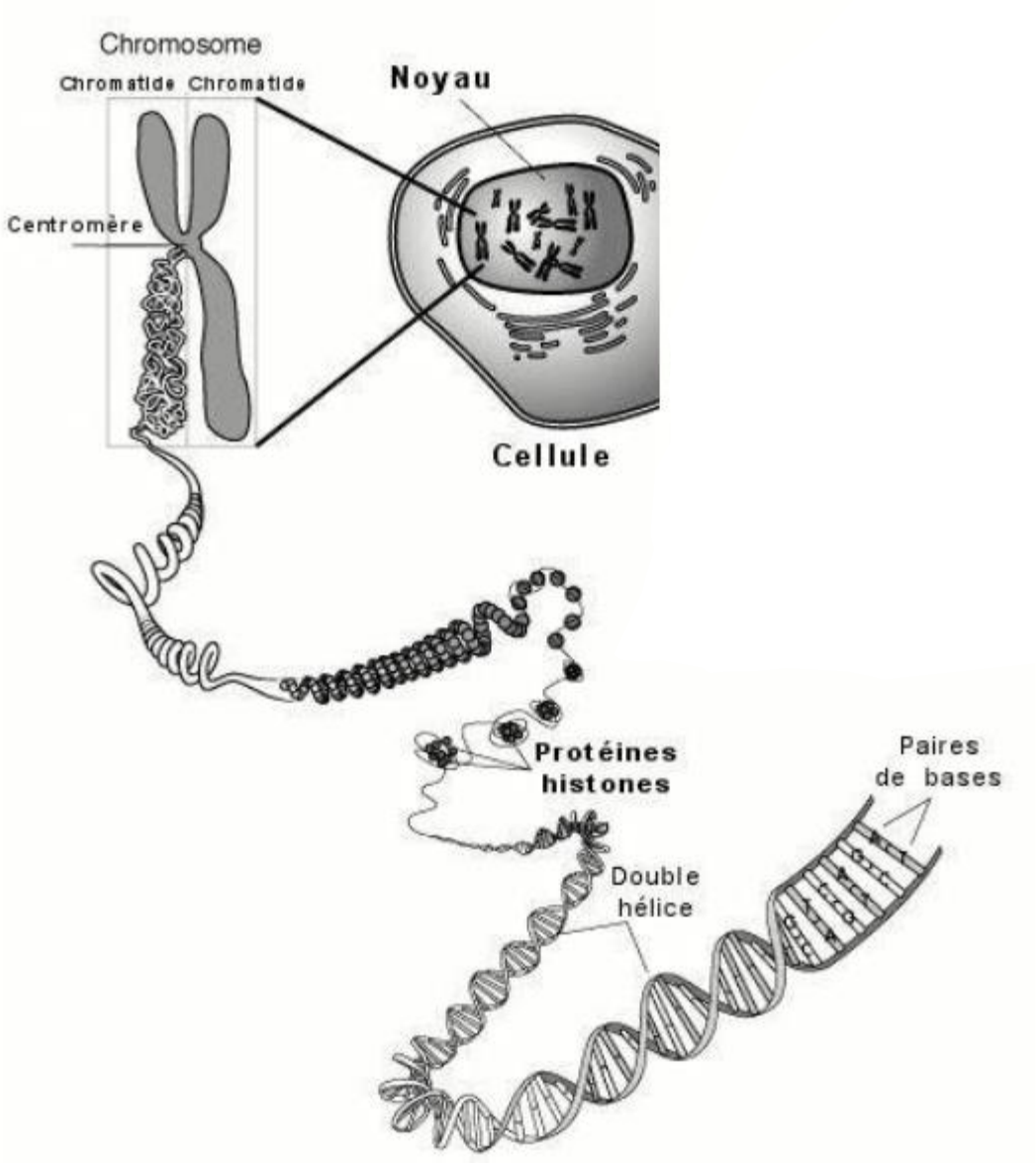
Summary Diagram

DNA → Chromatin → Chromosome
- *Interphase*: DNA active as chromatin.
- *Division*: DNA condensed into chromosomes.

Conclusion

- The nucleus houses and protects genetic material.
- Chromatin allows gene activity.
- Chromosomes ensure equal DNA distribution.

➡ Together, they form the basis of heredity and cell regulation.


Chromosome
Chromatide
Chromatide
Centromère
Noyau
Cellule
Protéines
histones
Paires
de bases
Double
hélice