Chromosomes and DNA Condensation

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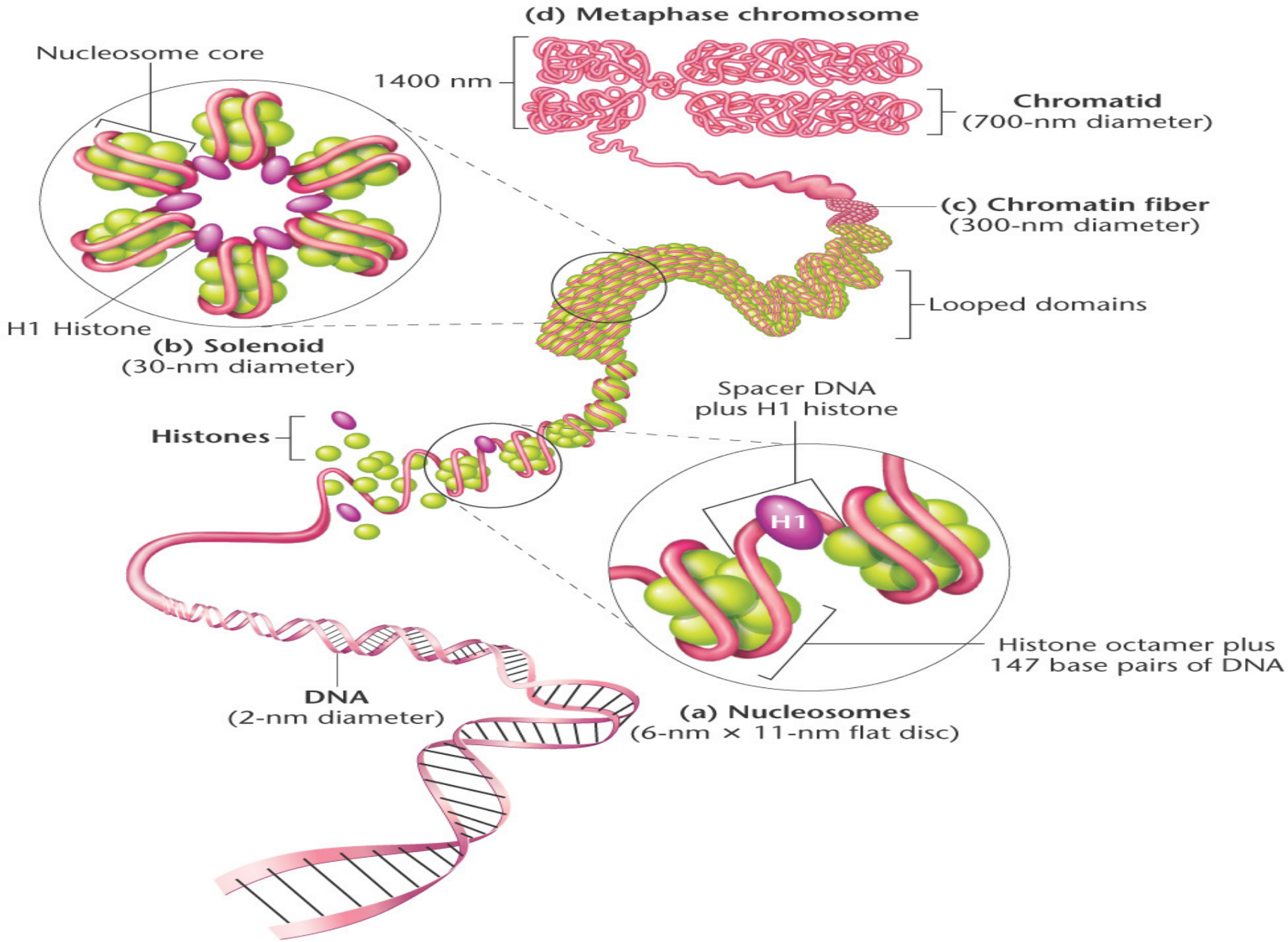
Surat



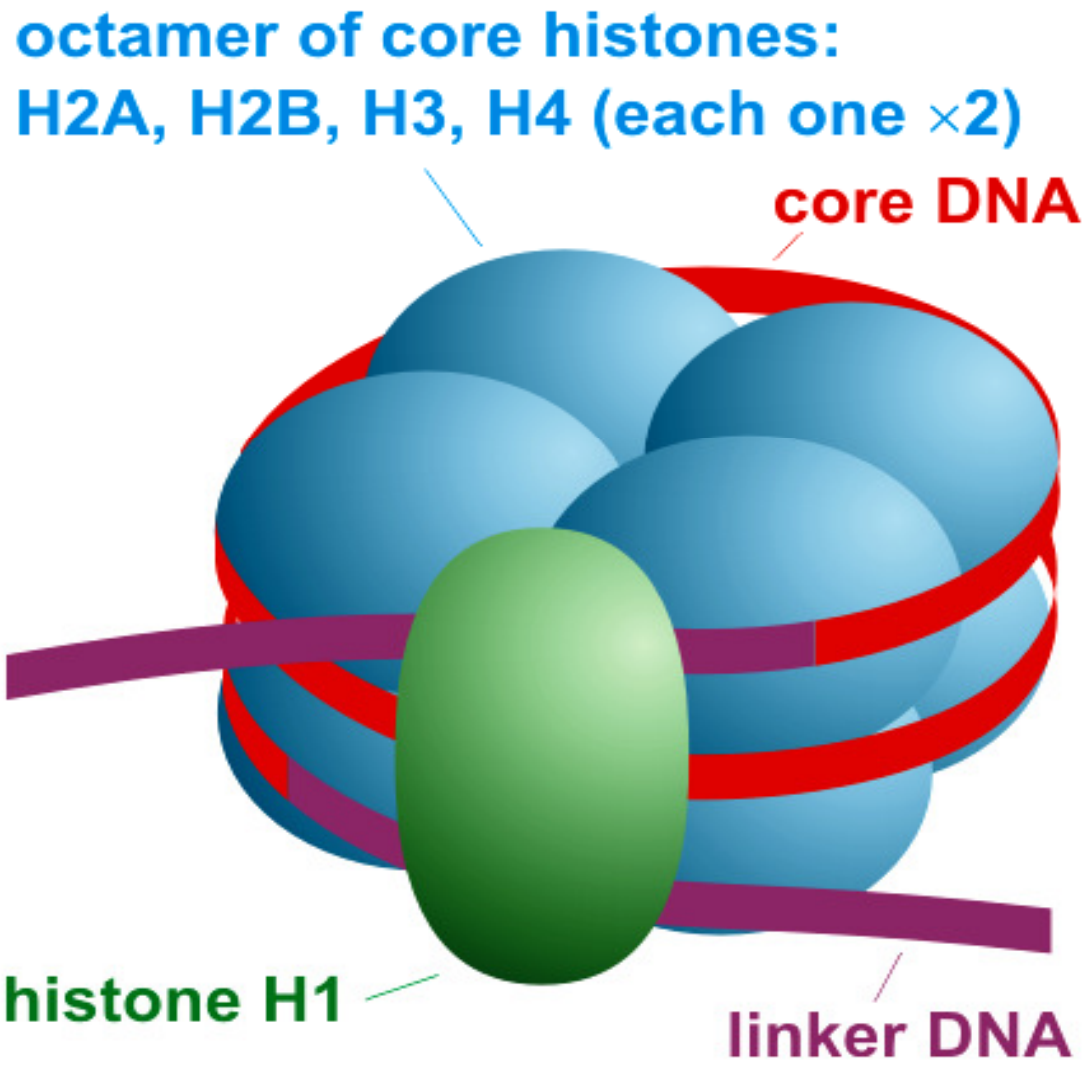
Mathematic behind Condensation

- Human genome (in diploid cells) = 6 x 10^9 bp
- 6 x 10^9 bp X 0.34 nm/bp = 2.04 x 10^9 nm = 2 m/cell
- Very thin (2.0 nm), Extremely fragile
- Diameter of nucleus = 5-10 mm
- DNA must be packaged to protect it,
- But it must still be accessible to allow gene expression and cellular responsiveness

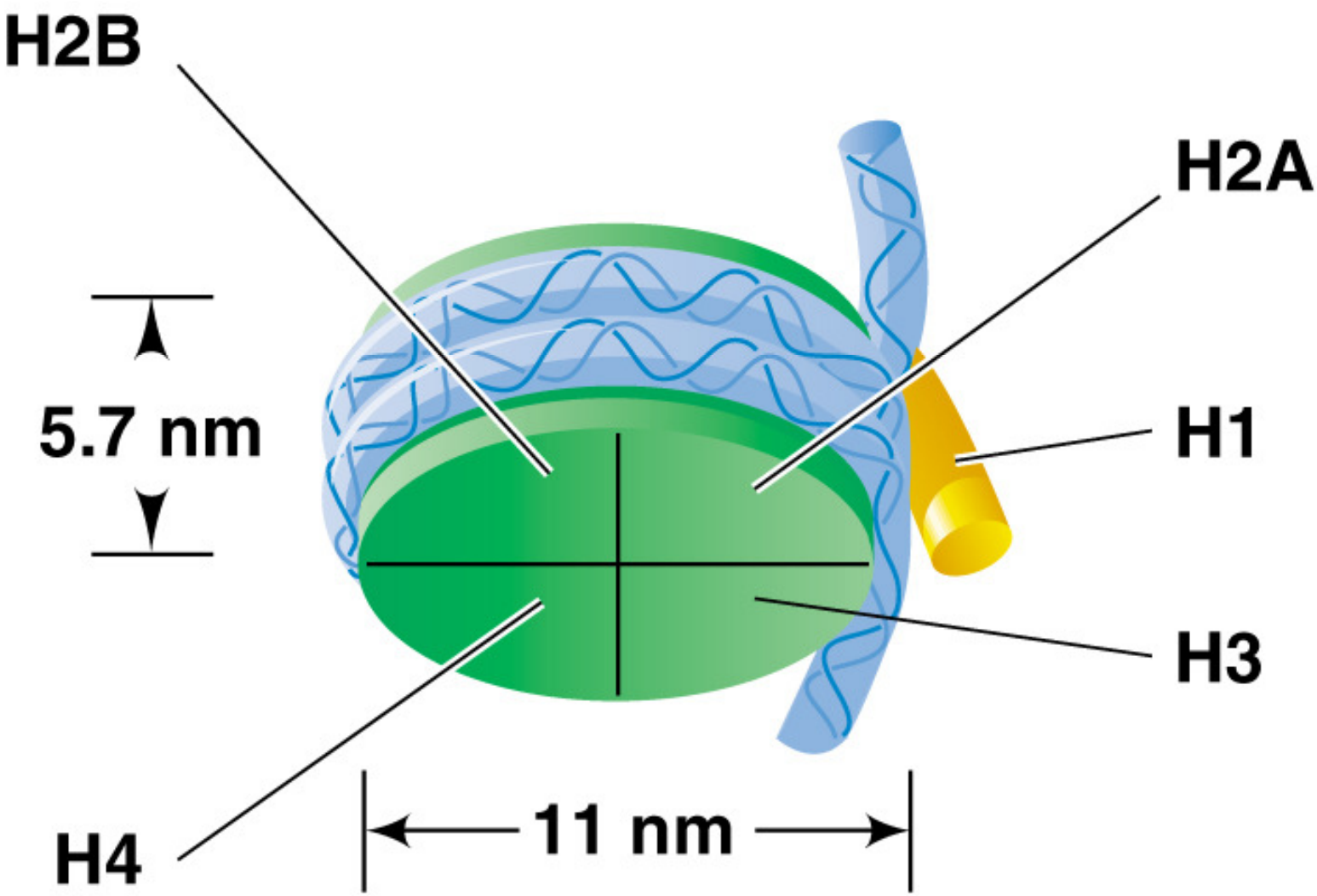
HISTONES

- Main packaging proteins
- 5 classes: H1, H2A, H2B, H3, H4.
- Rich in Lysine and Arginine
- DNA wraps around it 1 3⁄4 times for a 7-fold condensation factor.

Nucleosome

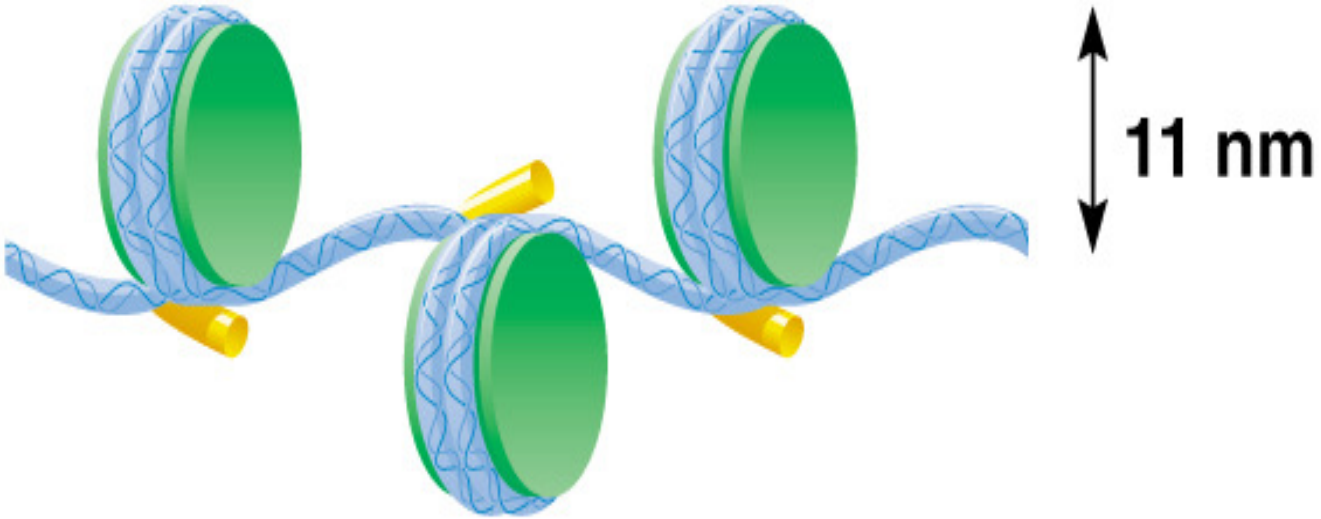

octamer of core histones:
H2A, H2B, H3, H4 (each one ×2)
core DNA
histone H1
linker DNA

Nucleosome

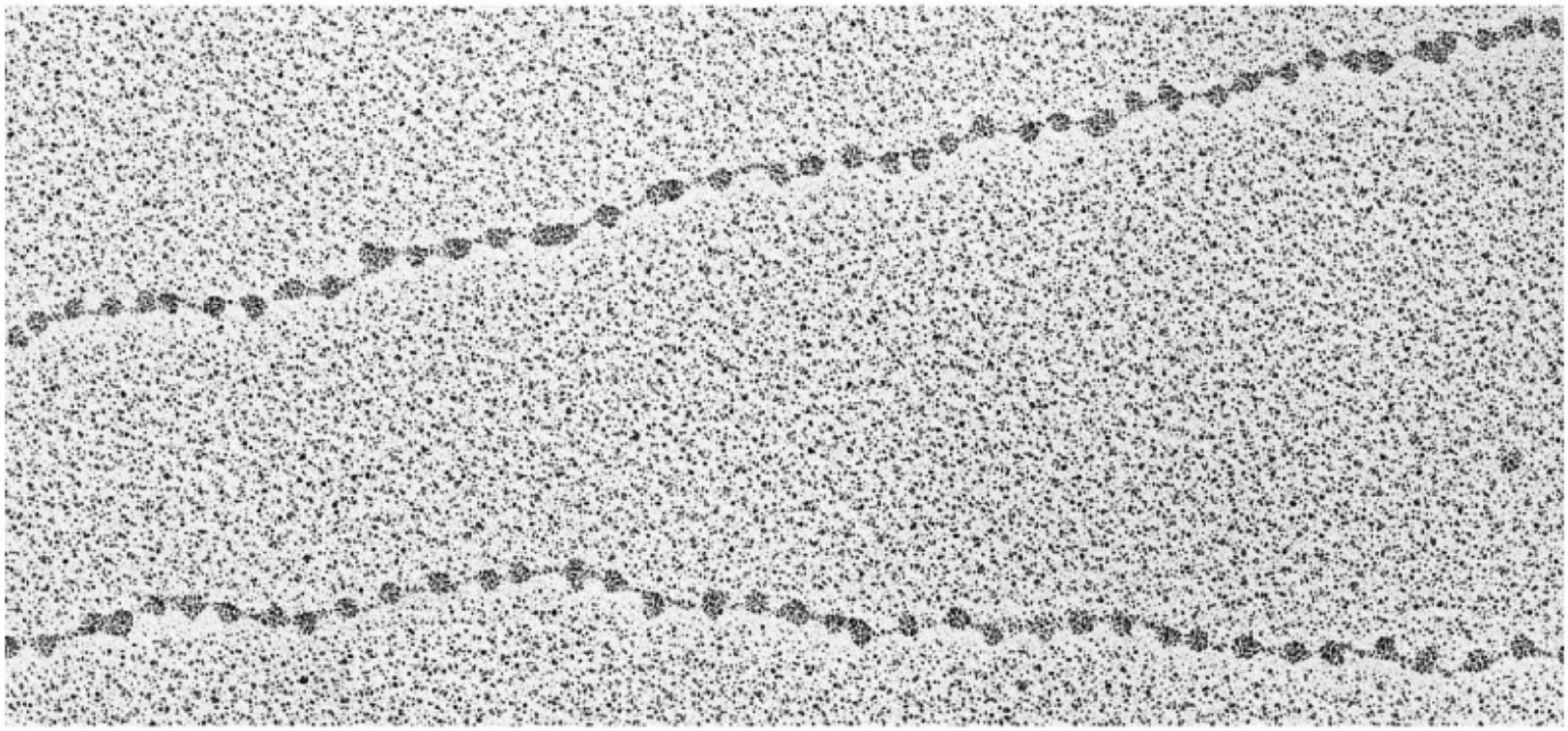


Chromatin fibril

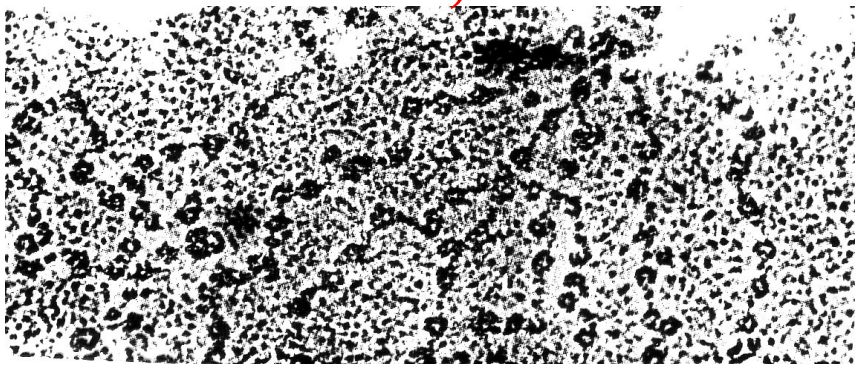
Beads-on-a-string form of chromatin



Beads on a String—10 nm Fiber

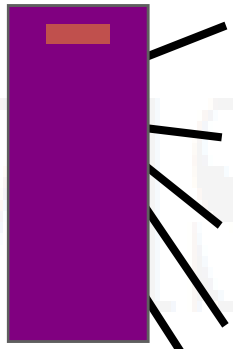


10 nm filament; nucleosomes



protein purification

histones
(= 1g per g DNA)

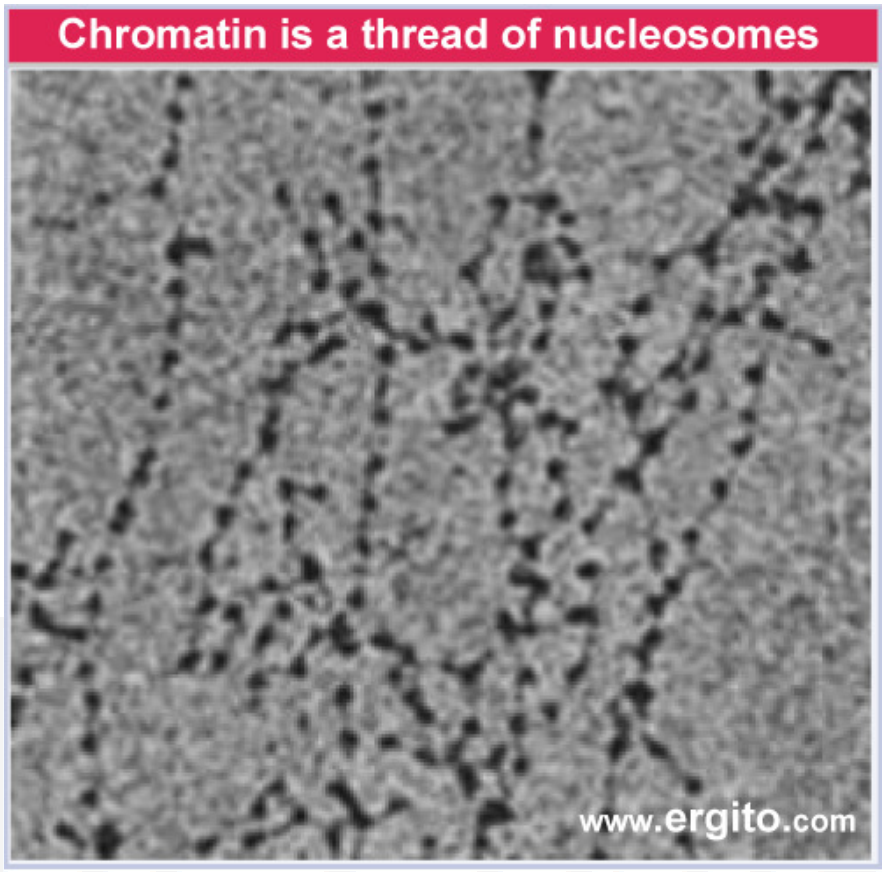


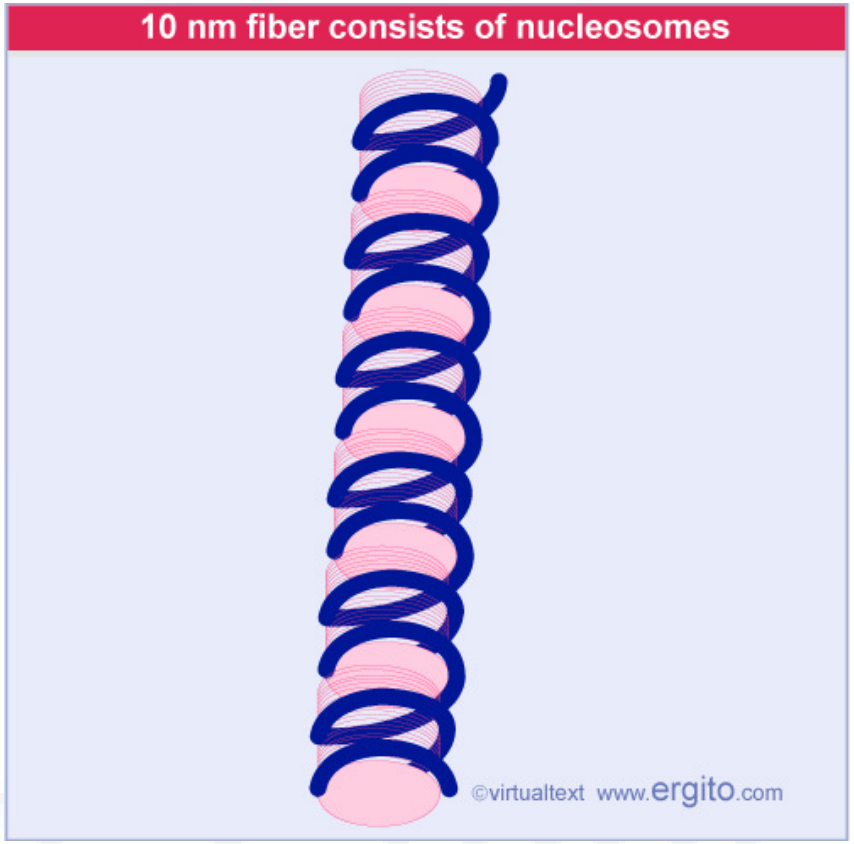
H1
H3
H2A
H2B
H4

- **Basic (arg, lys);**
- **+ charges bind to - phosphates on DNA**

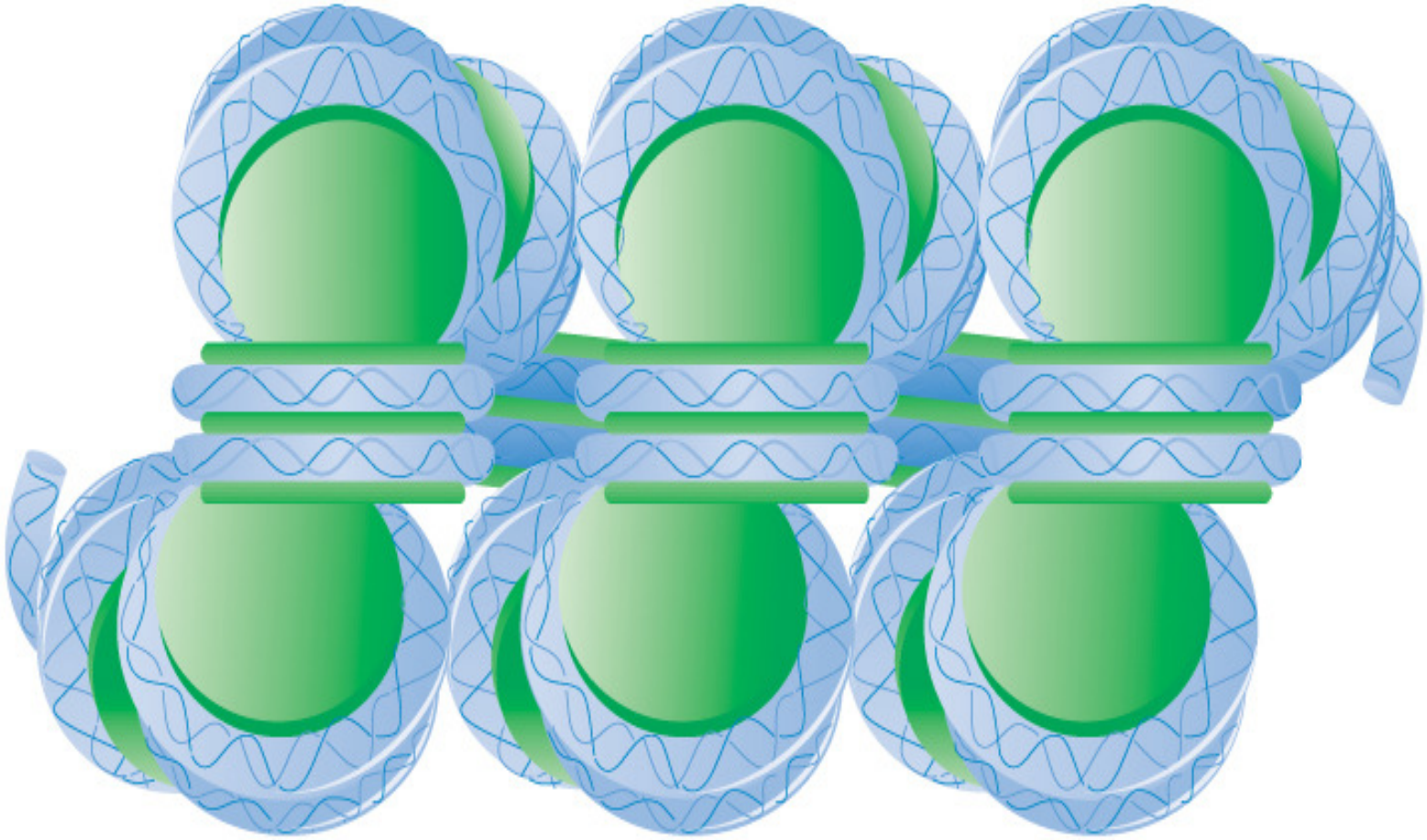
DNA

10 nm Fiber



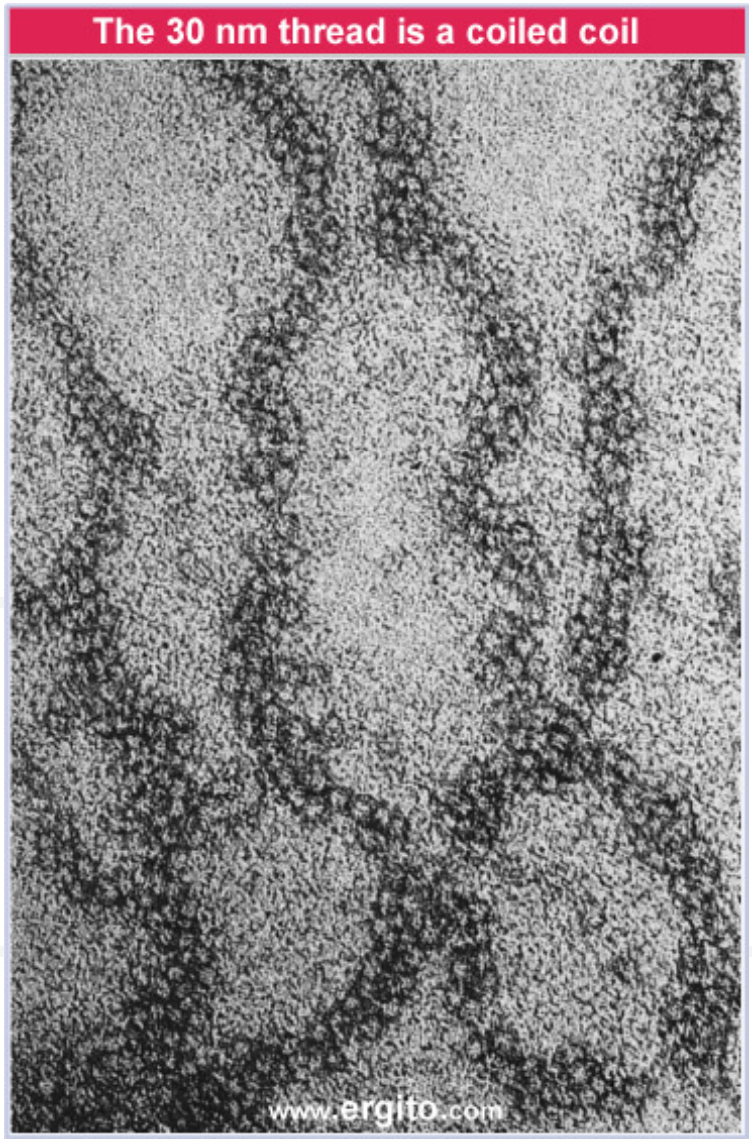


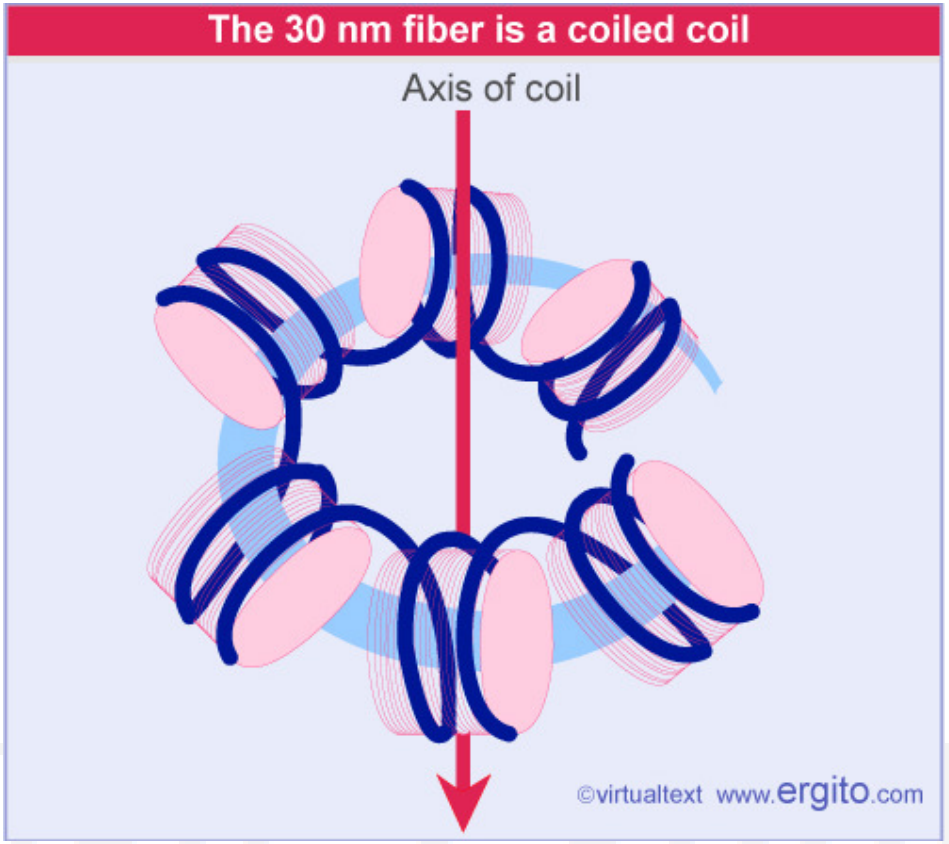
- A string of nucleosomes is seen under EM as a 10 nm fiber



b)

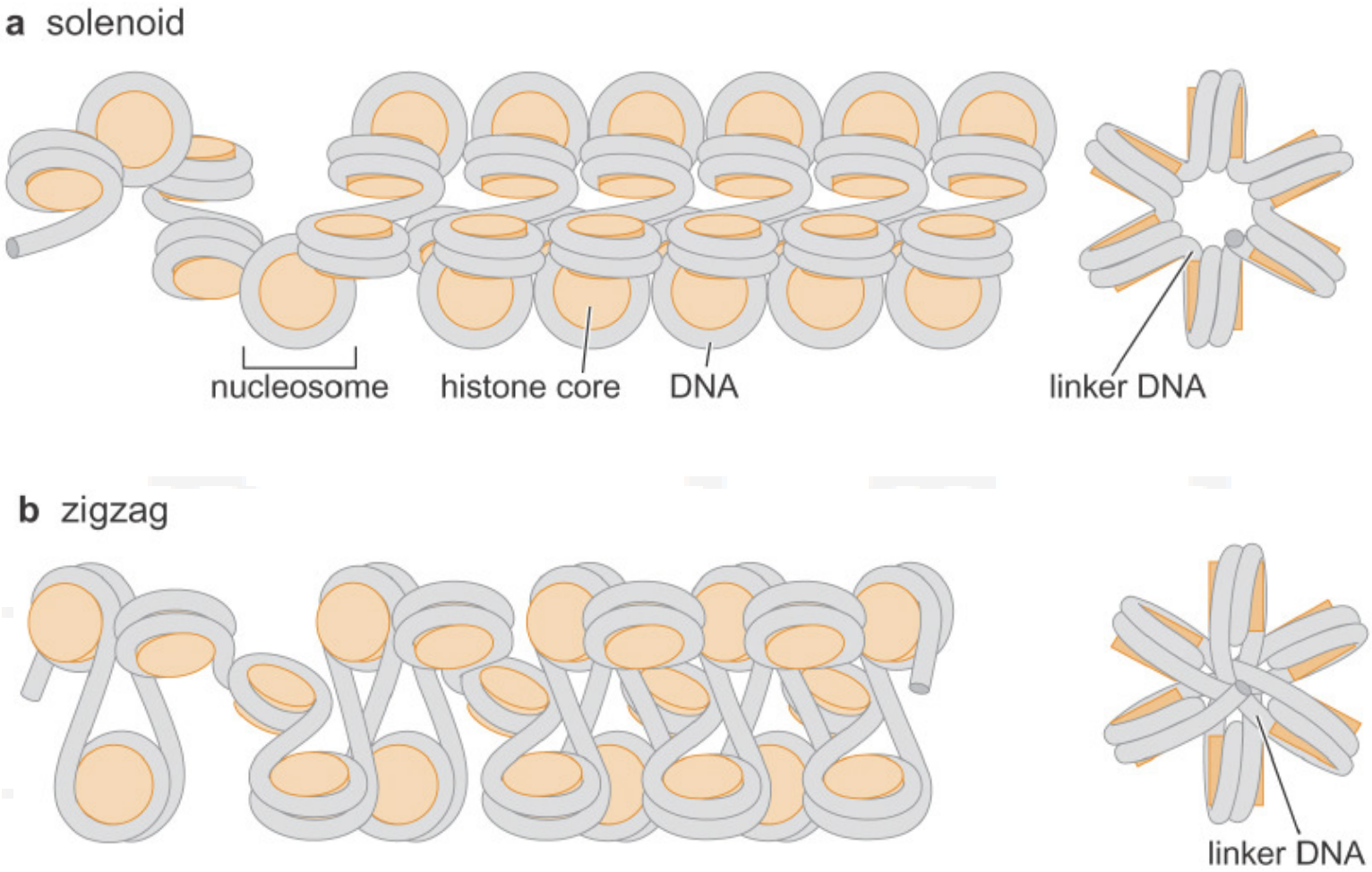
30 nm Chromatin Fibril





- 30 nm fiber is coil of nucleosomes with 6/turn

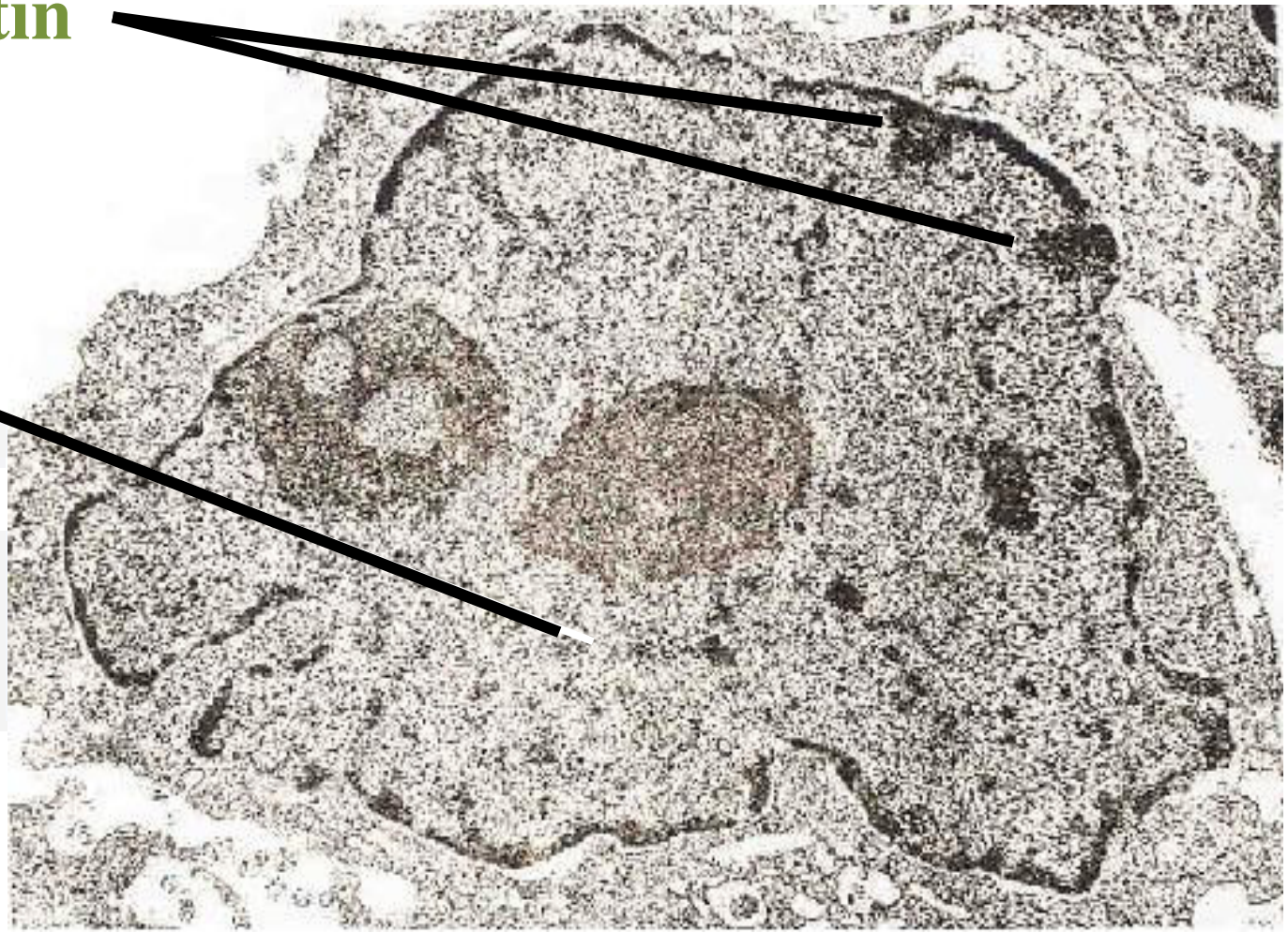
The 30 nm Fiber
(Compacts DNA 7X more)



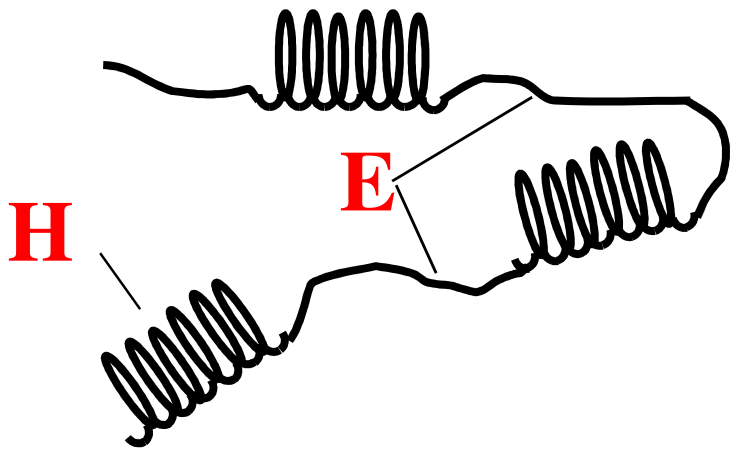
Different forms of chromatin show differential gene activity

Heterochromatin

Euchromatin

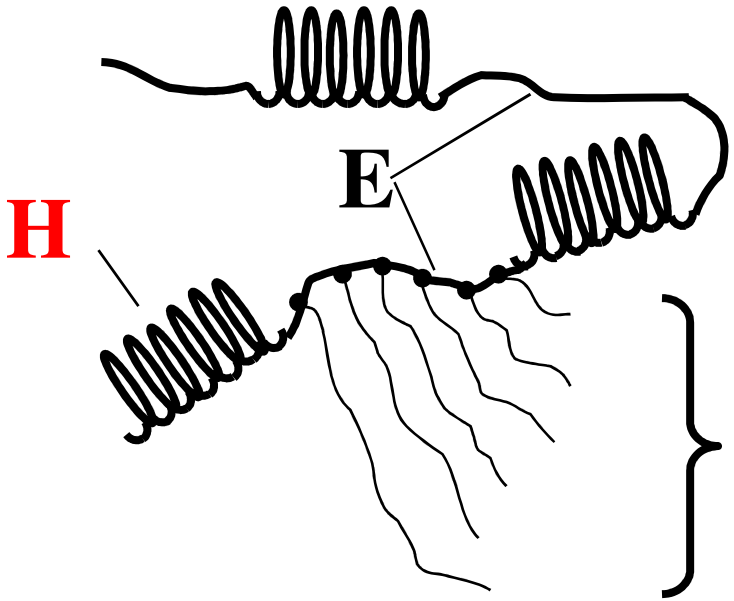


Euchromatin (E) *vs* Heterochromatin (H)



DNase

Heterochromatin = More condensed
=(tightly packed)
= Resistant to DNase digestion.



Transcriptionally active DNA (an active gene) is in *euchromatin*.

Variations In Histones

- How can cells introduce changes in protein structure and thus protein function?
  - Mutations
  - Post transcriptional modifications—ex alternate splicing
  - Post translational modifications
    - Acetylation
    - Methylation
    - Ser-Thr O-phosphorylation
    - His N-phosphorylation
  - NOTE: These processes are dynamic. They give the cell another means to regulate gene expression