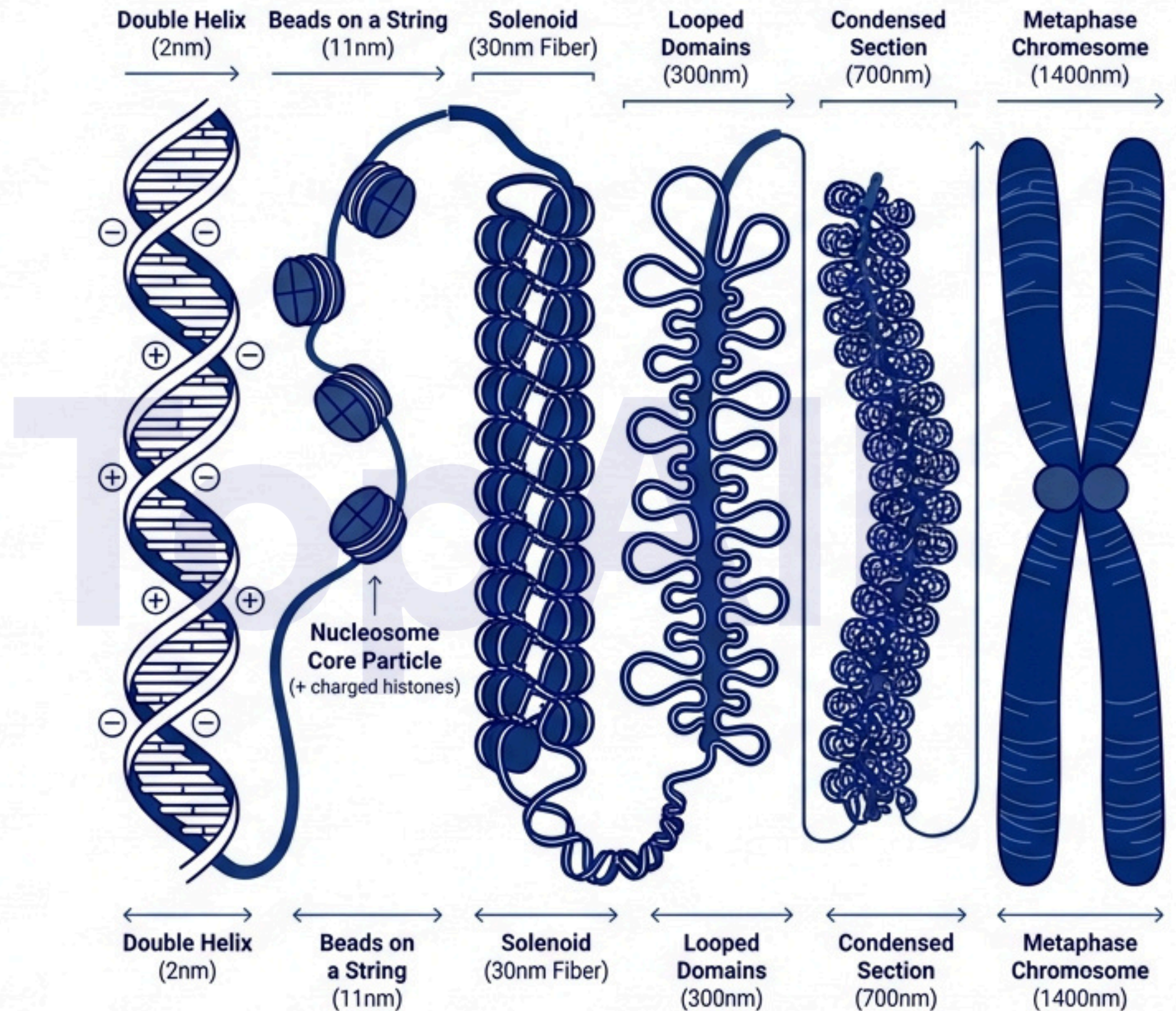


DNA Packaging

The spatial paradox of fitting a 2.2-meter blueprint into a microscopic vault.



The 2.2 Meter Paradox

The Calculation

Total Base Pairs
(Mammalian Cell):

$$6.6 \times 10^9 \text{ bp}$$

Distance between
consecutive bp:

$$0.34 \times 10^{-9} \text{ m}$$

$$(6.6 \times 10^9) \times (0.34 \times 10^{-9}) \approx 2.2 \text{ meters}$$

The Spatial Problem

2.2 meters

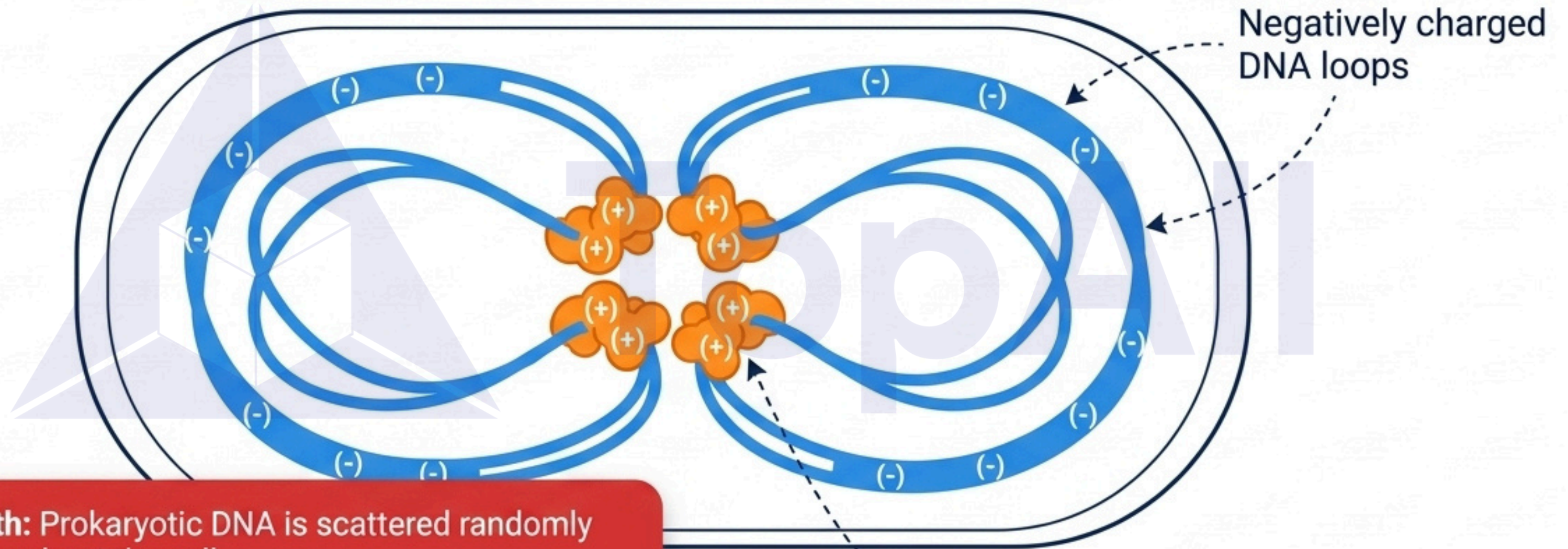


Nucleus Dimension:
 10^{-6} meters

A length far greater than the dimension of a typical nucleus. How is such a long polymer packaged?

The Prokaryotic Baseline: The Nucleoid

E. coli DNA
length = 1.36 mm



Myth: Prokaryotic DNA is scattered randomly throughout the cell.

Fact: It is highly organized into a distinct region called the Nucleoid, held together by charge-based protein interactions.

Positively charged
holding proteins



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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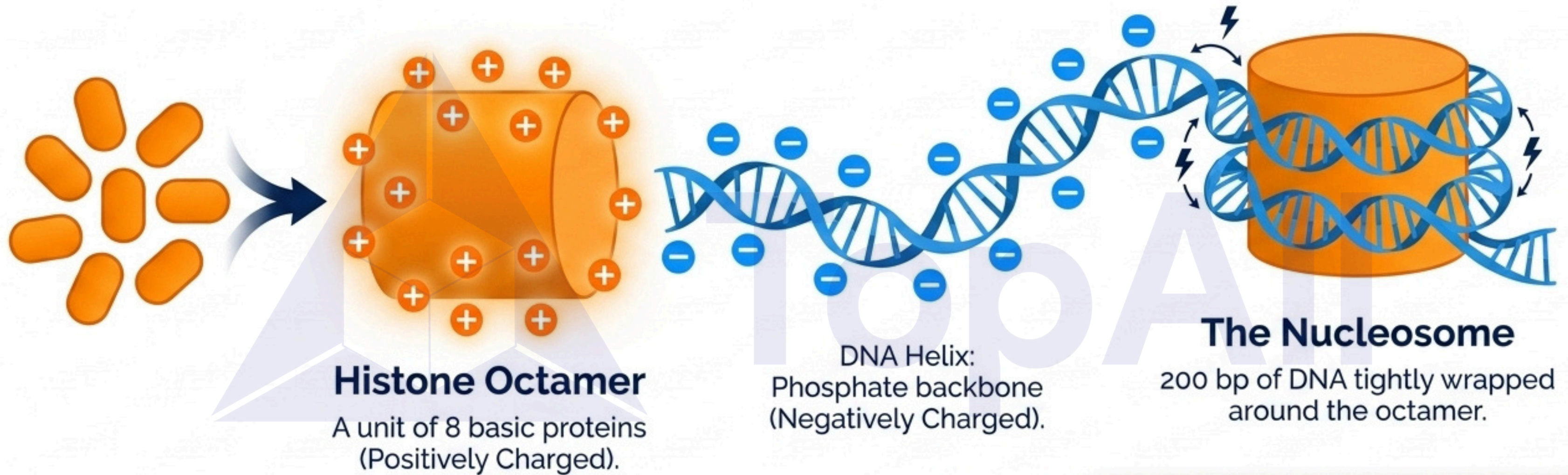
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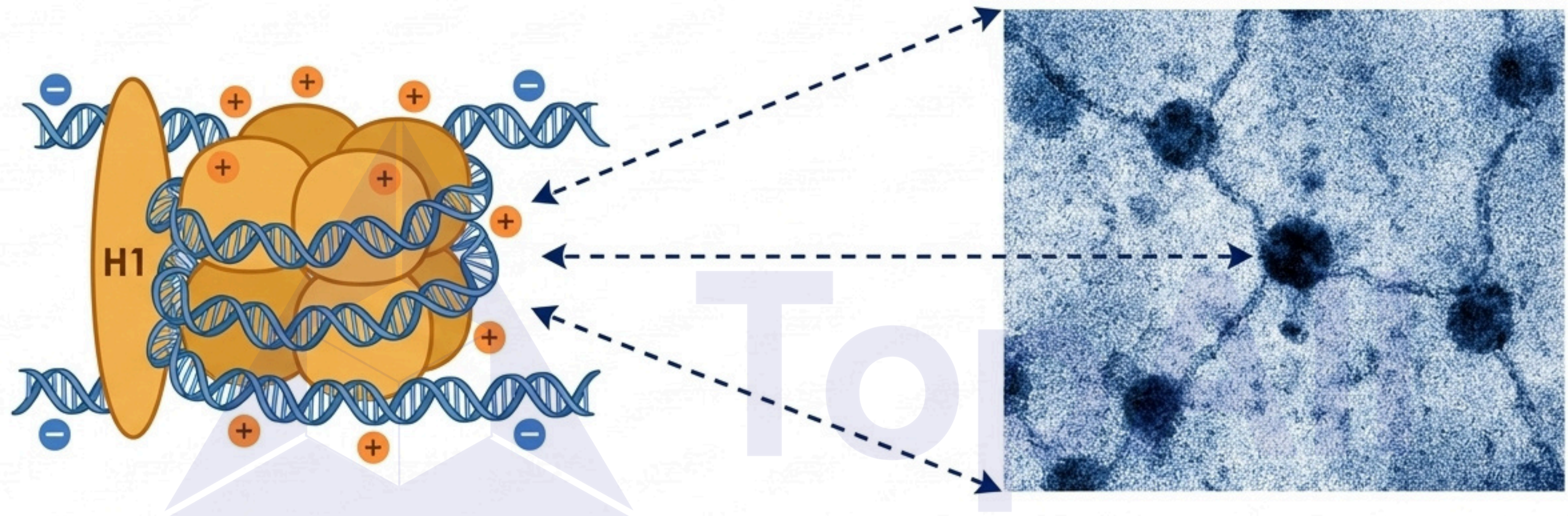
Eukaryotic Masterclass: The Nucleosome



Quick Tip:

Why are histones positive?
They are exceptionally rich in basic amino acid residues Lysine and Arginine, which carry positive charges in their side chains.

From Schematic to Microscopic Reality



Schematic Model

(Nucleosome Core + H1 Histone)

Electron Microscope View

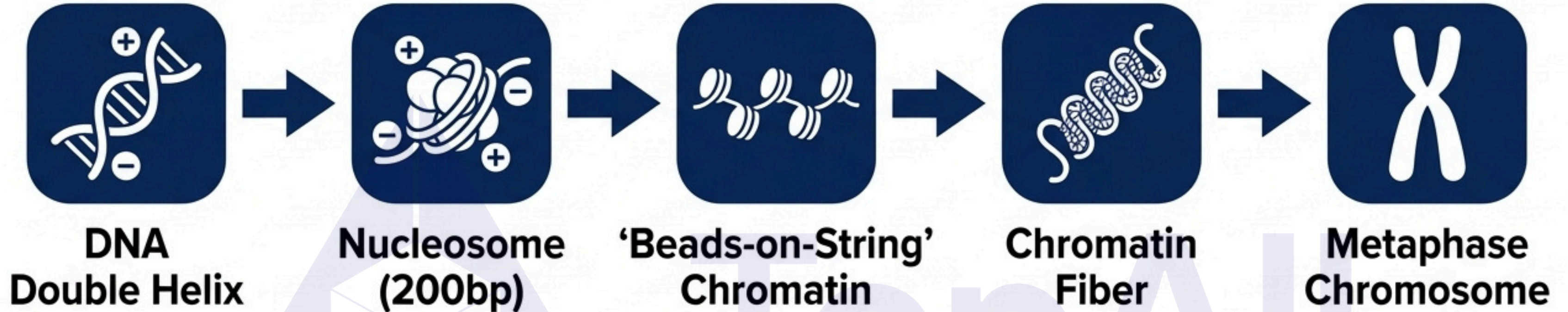
("Beads-on-String" Chromatin)

Higher-level packaging of these chromatin fibers into metaphase chromosomes requires an additional set of **Non-histone Chromosomal (NHC) proteins**.

Structure Dictates Function: Chromatin Types

	Packing Density	Staining Color	Transcriptional Activity
Euchromatin	Loosely packed  Loosely packed	Light  Light	Active (Genes can be read) 
Heterochromatin	Densely packed 	Dark 	Inactive  (Genes are locked away)

The Hierarchy of DNA Packaging



Key Takeaway:

The physical packaging of DNA is driven by elegant electrostatic interactions. In eukaryotes, negatively charged DNA wraps around positively charged histone octamers to solve a massive spatial paradox, while simultaneously regulating which genes are active or silent.





You've Learned the Theory.

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