THE ORGANIZATION AND CONTROL OF EUKARYOTIC GENOMES

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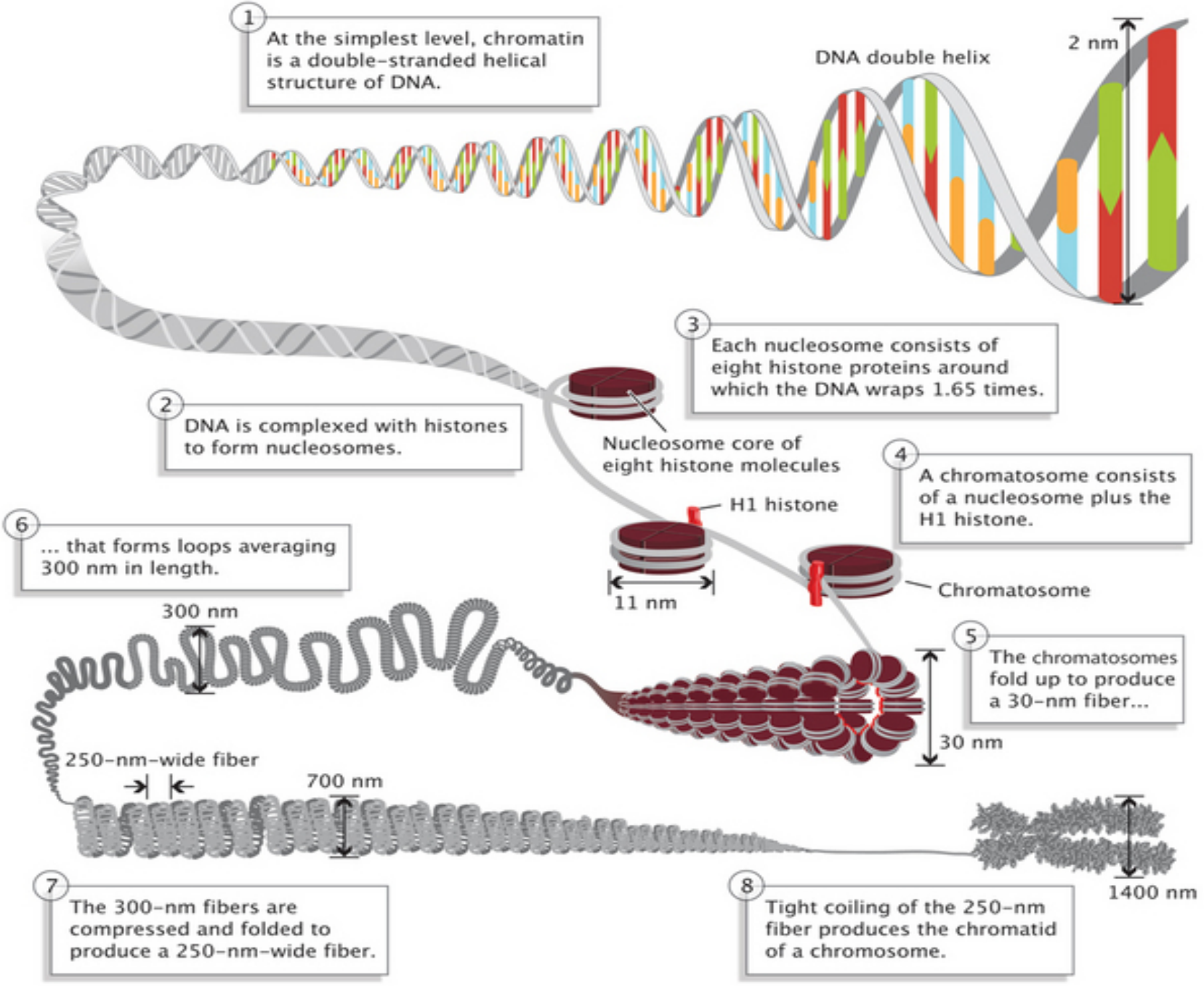

1
At the simplest level, chromatin is a double-stranded helical structure of DNA.
DNA double helix
2 nm
3
Each nucleosome consists of eight histone proteins around which the DNA wraps 1.65 times.
2
DNA is complexed with histones to form nucleosomes.
Nucleosome core of eight histone molecules
4
A chromatosome consists of a nucleosome plus the H1 histone.
H1 histone
11 nm
Chromatosome
6
... that forms loops averaging 300 nm in length.
300 nm
5
The chromatosomes fold up to produce a 30-nm fiber...
30 nm
250-nm-wide fiber
700 nm
1400 nm
7
The 300-nm fibers are compressed and folded to produce a 250-nm-wide fiber.
8
Tight coiling of the 250-nm fiber produces the chromatid of a chromosome.

Genome includes

- Double stranded DNA
- Histone proteins
- Nucleosomes
- Chromatosomes
- Chromatids
- Chromosomes

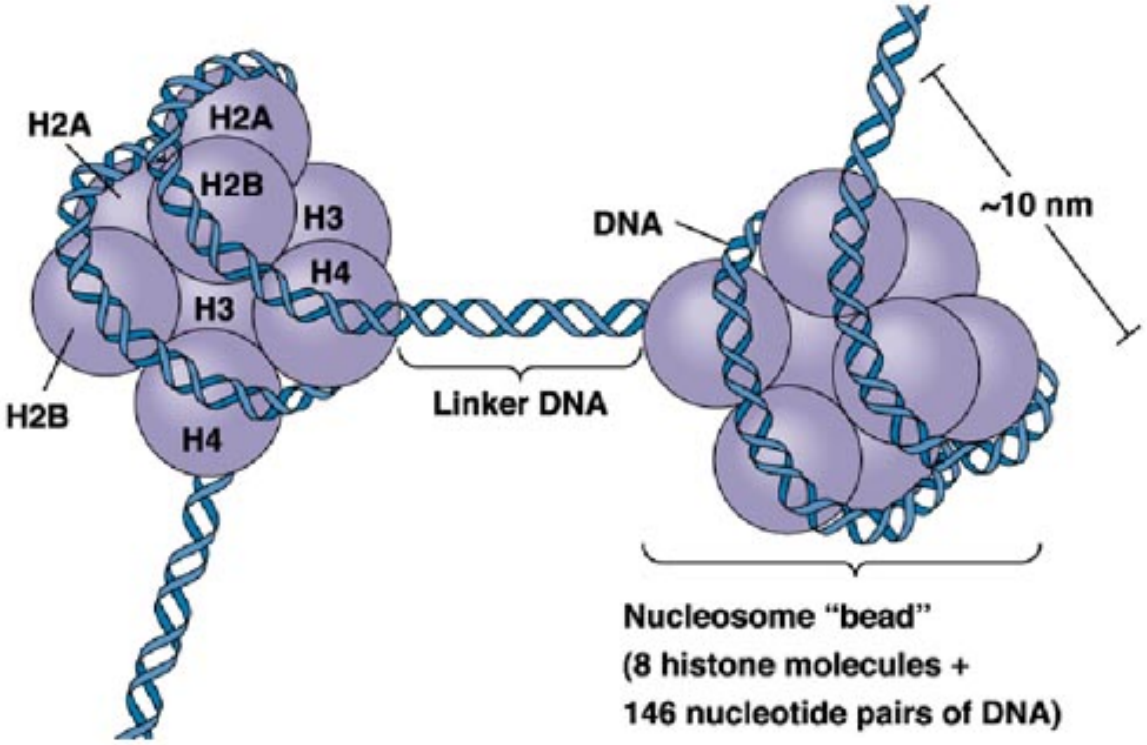
Chromatin structure

- Eukaryotic DNA is precisely combined with large amounts of protein.
- During interphase, chromatin fibers are highly extended.
- If extended, each DNA molecule would be about 6 cm long

DNA packing

- **First level - Histone** proteins
- Their positively charged amino acids bind tightly to negatively charged DNA.
- The five types of histones are very similar from one eukaryote to another .
- Unfolded chromatin has the appearance of beads on a string, a **nucleosome**, in which DNA winds around a core of histone proteins.

Nucleosomes



DNA packing

- The beaded string seems to remain essentially intact throughout the cell cycle.
- Histones leave the DNA only transiently during DNA replication.
- They stay with the DNA during transcription
- By changing shape and position, nucleosomes allow RNA-synthesizing polymerases to move along the DNA.

DNA packing

- **Level two** - As chromosomes enter mitosis the beaded string coils to form the 30-*nm chromatin fiber*.
- **Level three** - This fiber forms *looped domains* attached to a scaffold of non histone proteins.
- **Level four** - the looped domains coil and fold to produce the characteristic metaphase chromosome.

DNA packing

- Interphase chromatin is generally much less condensed than the chromatin of mitosis with the 30-nm fibers and looped domains remaining intact.
- The chromatin of each chromosome occupies a restricted area within the interphase nucleus.
- Interphase chromosomes have areas that remain highly condensed, **heterochromatin**, and less compacted areas, **euchromatin**.

Assignment

- Differentiate between heterochromatin and euchromatin.

Genome Organization at the DNA Level

- In eukaryotes, most of the DNA (about 97% in humans) does *not* code for protein or RNA.
    1. noncoding regions are regulatory sequences.
    2. introns.
    3. **Repetitive DNA, present in many copies in the genome. (Three Types)**

Types of Repeated DNA Sequences

1. **Long terminal repeats (LTRs)**

- Are identical sequences of DNA that repeat hundreds or thousands of times found at either end of retrotransposons or proviral DNA formed by reverse transcription of retroviral RNA.
- They are used by viruses to insert their genetic material into the host genomes.

Types of Repeated DNA Sequences

2. **Tandem repeats**

occur in DNA when a pattern of one or more nucleotides is repeated and the repetitions are directly adjacent to each other.

- Satellite DNA - typically found in centromeres and heterochromatin
- Minisatellite - repeat units from about 10 to 60 base pairs, found in many places in the genome, including the centromeres
- Microsatellite - repeat units of less than 10 base pairs; this includes telomeres, which typically have 6 to 8 base pair repeat units

Types of Repeated DNA Sequences

3. **Interspersed repeat**

- These sequences propagate themselves by RNA mediated transposition, they have been called retrotransposons.
- Some types of interspersed repetitive DNA elements allow new genes to evolve by uncoupling similar DNA sequences from gene conversion during meiosis.
- Types : Transposable elements, DNA transposons, retrotransposons