

CHROMATIN AND HISTONES STRUCTURE

Chromatin

- Chromatin is a term designating the structure in which DNA exists within cells. The structure of chromatin is determined and stabilized through the interaction of the DNA with DNA-binding proteins. There are 2 classes of DNA-binding proteins. The histones are the major class of DNA-binding proteins involved in maintaining the compacted structure of chromatin. There are 5 different histone proteins identified as H1, H2A, H2B, H3 and H4. The other class of DNA-binding proteins is a diverse group of proteins called simply, non-histone proteins. This class of proteins includes the various transcription factors, polymerases, hormone receptors and other nuclear enzymes. In any given cell there are greater than 1000 different types of non-histone proteins bound to the DNA.
- Chromatin is the complex combination of DNA and proteins that makes up chromosomes. It is found inside the nuclei of eukaryotic cells. It is divided between heterochromatin (condensed) and euchromatin (extended) forms. The major components of chromatin are DNA and histone proteins. The functions of chromatin are to package DNA into a smaller volume to fit in the cell, to strengthen the DNA to allow mitosis and meiosis, and to serve as a mechanism to control expression and DNA replication. Chromatin contains genetic material-instructions to direct cell functions. Changes in chromatin structure are affected by chemical modifications of histone proteins such as methylation (DNA and proteins) and acetylation (proteins), and by non-histone, DNA-binding proteins.

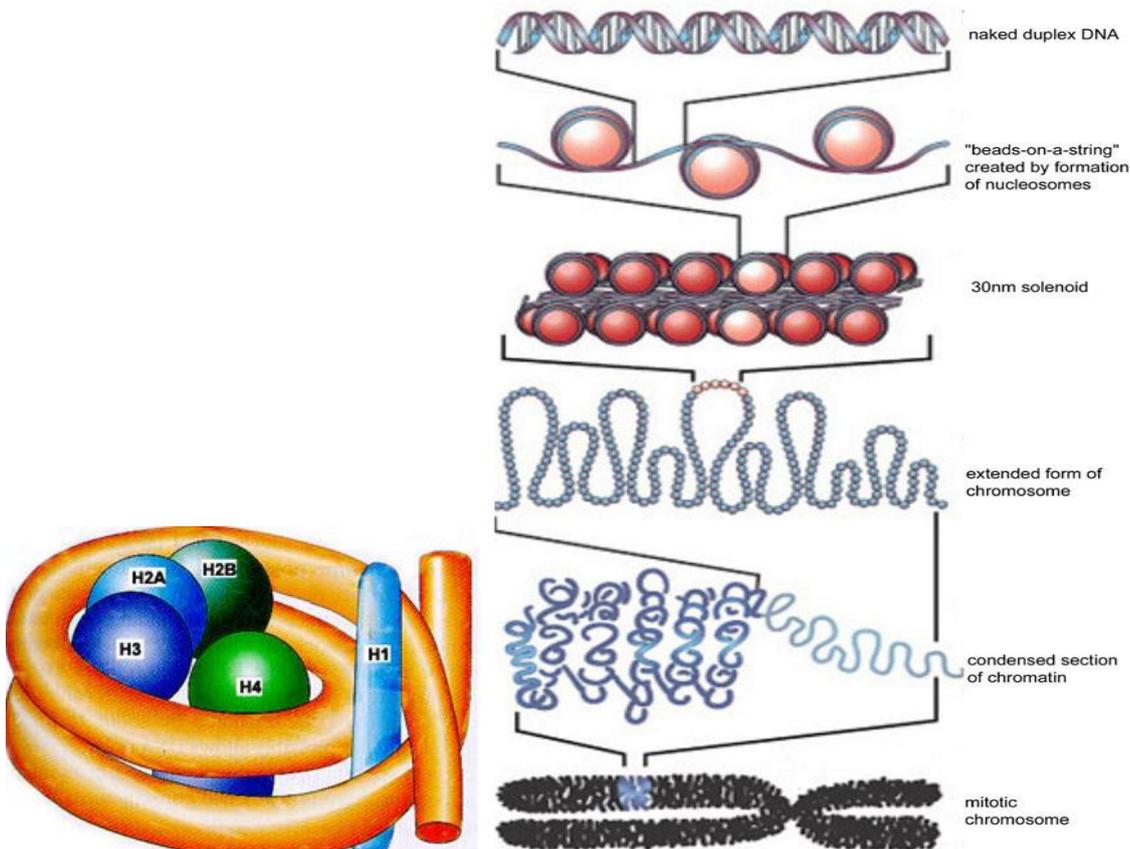


Figure: schematic representation of Nucleosomes (histone and DNA) and hierarchical arrangement of Chromatin

Nucleosome

- The binding of DNA by the histones generates a structure called the nucleosome. The nucleosome core contains an octamer protein structure consisting of 2 subunits each of H2A, H2B, H3 and H4. Histone H1 occupies the internucleosomal DNA and is identified as the linker histone. The nucleosome core contains approximately 150 bp of DNA. The linker DNA between each nucleosome can vary from 20 to more than 200 bp. These nucleosomal core structures would appear as "beads-on-a-string" if the DNA were pulled into a linear structure and observed under an electron microscope.
- The nucleosome cores themselves coil into a solenoid shape which itself coils to further compact the DNA. These final coils are compacted further into the characteristic chromatin seen in a metaphase. The protein-DNA structure of chromatin is stabilized by attachment to a non-histone protein scaffold called the nuclear matrix
- There are two types of chromatin. Euchromatin is the less compact DNA form, and contains genes that are frequently expressed by the cell. The other type, heterochromatin, is the more compact form, and contains DNA that is infrequently transcribed. This structure is further categorized into facultative heterochromatin, consisting of genes that are organized as heterochromatin only in certain cell types or at certain stages of development, and constitutive heterochromatin that consists of chromosome structural components such as telomeres and centromeres.

a. Heterochromatin

- Heterochromatin is a tightly packed form of DNA. Its major characteristic is that transcription is limited. As such, it is a means to control gene expression, through regulation of the transcription initiation. Heterochromatin is believed to serve several functions, from gene regulation to the protection of the integrity of chromosomes; all of these roles can be attributed to the dense packing of DNA, which makes it less accessible to protein factors that bind DNA or its associated factors

b. Euchromatin

- Euchromatin is a lightly packed form of chromatin that is rich in gene concentration, and is often (but not always) under active transcription. Unlike heterochromatin, it is found in both eukaryotes and prokaryotes. The structure of euchromatin is reminiscent of an unfolded set of beads along a string, where those beads represent nucleosomes..