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Euchromatin,Heterochromatin &Nucleosome

When the non-dividing cells of the nucleus were observed under the light microscope, it exhibited the two regions, on the ground of concentration or intensity of staining. The **dark stained** areas are said as **heterochromatin** and **light stained** areas are said as **euchromatin**.

Around **90%** of the total human genome is **euchromatin**. They are the parts of chromatin and participate in the protection of DNA in the genome present inside the nucleus.

Emil Heitz in the year 1928, coined the term **Heterochromatin** and **Euchromatin**. By focussing on the few more points, we will be able to understand the difference between both types of chromatin. Given below is the comparison chart along with the brief description of them.

Definition of Heterochromatin:

The area of the chromosomes which are **intensely stained** with DNA-specific strains and are relatively condensed is known as heterochromatin. They are the tightly packed form of DNA in the nucleus. The organization of **heterochromatin** is so highly compact in the way that these are inaccessible to the protein which is engaged in gene expression. Even the chromosomal crossing over is not possible due to the above reason. Resulting them to be transcriptionally as well as genetically inactive.

Heterochromatin is of two types:

Facultative heterochromatin and **constitutive heterochromatin**. The genes which get silenced through the process of **Histone methylation or siRNA through RNAi** are called as **facultative heterochromatin**. Hence they contain inactive genes and is not a permanent character of every nucleus of the cells.

While the **repetitive and structurally functional genes** like telomeres or centromeres are called as **Constitutive heterochromatin**. These are the continuing nature of the cell's nucleus and contains no gene in the genome. This structure is retainable during the interphase of the cell.

The **main function** of the heterochromatin is to protect the DNA from the endonuclease damage; it is due to its compact nature. It also prevents the DNA regions

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to get accessed to proteins during gene expression.

Definition of Euchromatin:

That part of chromosomes, which are **rich in gene** concentrations and are loosely packed form of chromatin is called as **euchromatin.**

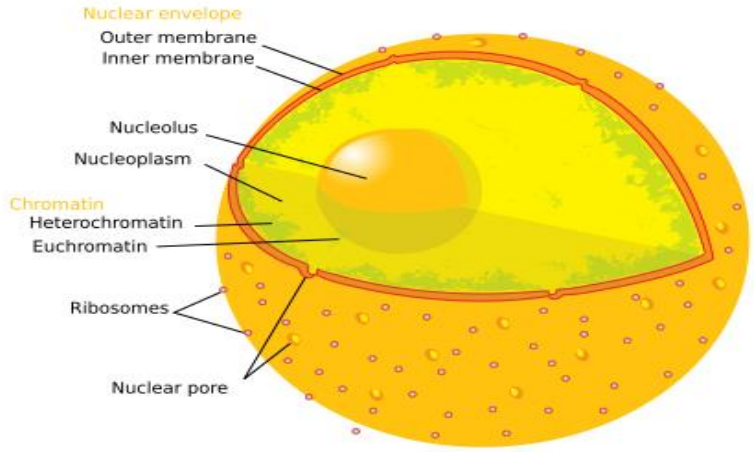
They are active during transcription. **Euchromatin** covers the maximum part of the dynamic genome to the inner of the nucleus and is said that **euchromatin** contains about **90% of the entire human genome**.

To allow the transcription, some parts of the genome containing active genes are loosely packed. The wrapping of DNA is so loose that DNA can become readily available.

The structure of **euchromatin** resembles the **nucleosomes**, which consist of histones proteins having around **147 base pairs** of DNA wrapped around them. Euchromatin actively participates in transcription from DNA to RNA.

The gene **regulating mechanism** is the process of transforming euchromatin into heterochromatin or vice versa. The active genes present in euchromati

The active genes present in euchromatin gets transcribed to make mRNA whereby further encoding the functional proteins is the main function of euchromatin. Hence they are considered as genetically and transcriptionally active. Housekeeping genes are one of the forms of euchromatin.



The nucleus of a human cell showing the location of heterochromatin

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Heterochromatin:

is defined as the area of the chromosome which is darkly stained with a DNA-specific stain and is in comparatively condensed form.

The regions of the chromosome that appear relatively condensed and stained deeply with DNA specific strains.

• It is tightly packed form of DNA.

• Transcriptionally inactive.

• **Facultative heterochromatin** is the result of genes that are silenced through a mechanism such as Histone methylation or siRNA through RNAi.

• **Constitutive heterochromatin** is usually repetitive and forms structural functions such as centromeres or telomeres.

Euchromatin:

is defined as the area of the chromosome which is rich in genes that actively participate in the transcription process.

Euchromatin is the lightly packed form of chromatin that is rich in gene concentration.

• It is often under active transcription.

• Euchromatin comprises the most active portion of the genome within the nucleus, 90% of the human genome is euchromatic.

• The structure of Euchromatin is reminiscent of an unfolded set of beads represent Nucleosomes, Nucleosomes consist of eight proteins known as Histones, with approximately 147 base pairs of DNA wound around them.

• In Euchromatin the wrapping is loose so that the raw DNA may be accessed.

• The basic structure of Euchromatin is an elongated, open 10nm micro fibril, as

noted by electron microscopy.

• Euchromatin participates in the active transcription of DNA to mRNA products.

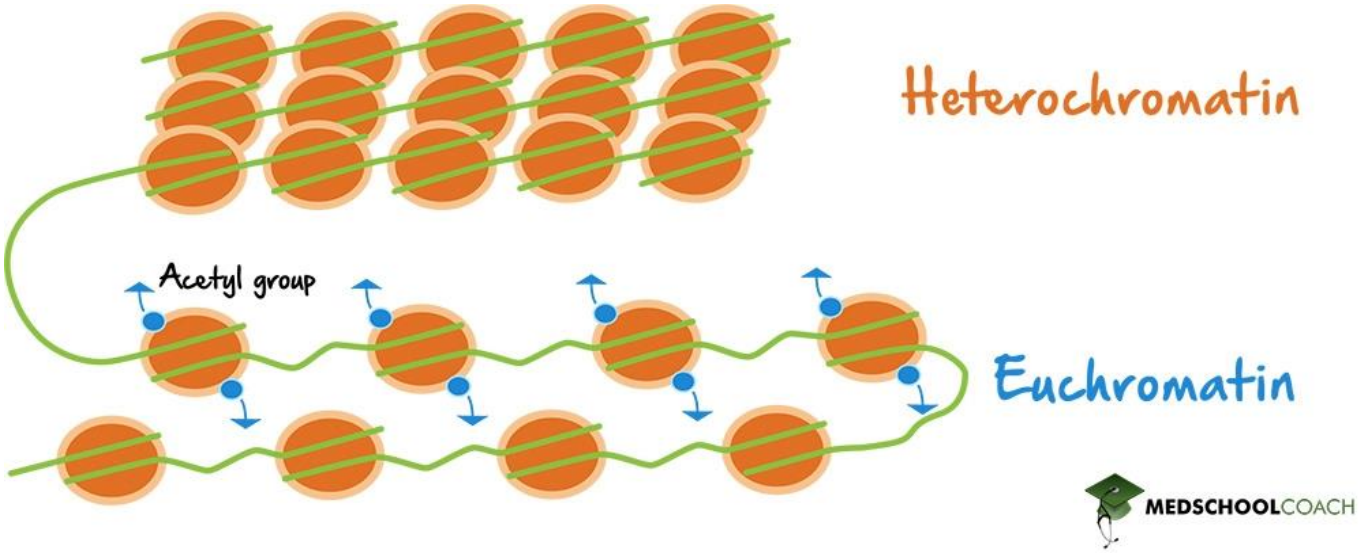


Fig 2. Heterochromatin vs. Euchromatin

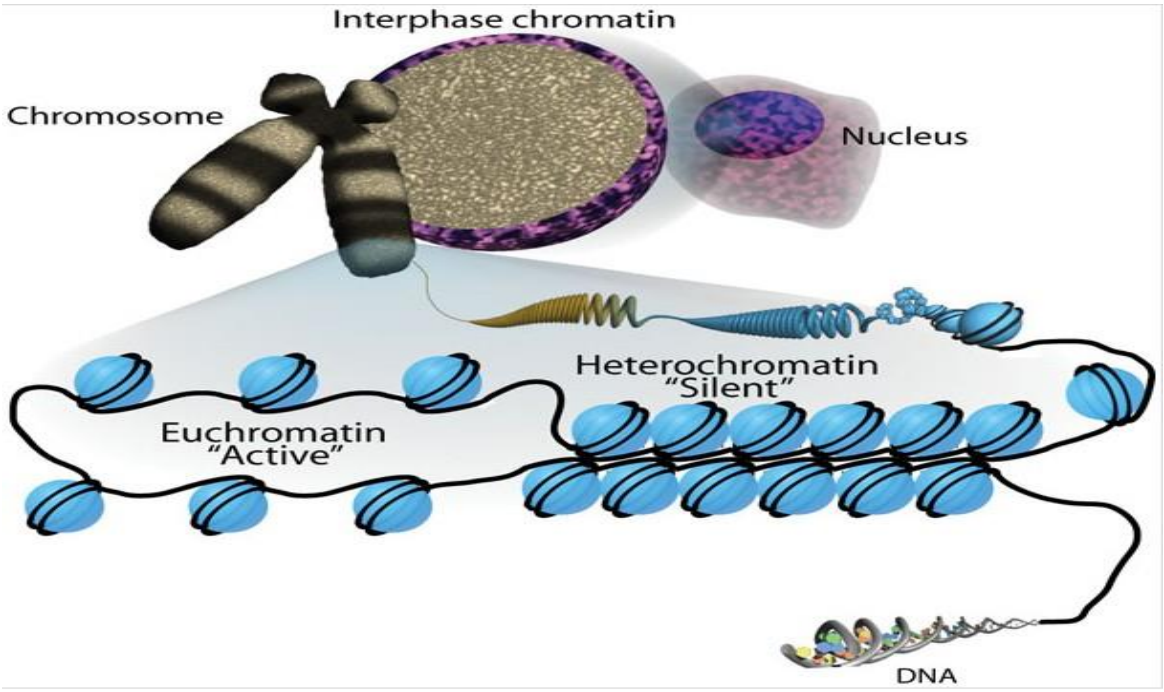


Fig3-Heterochromatin&Euchromatin

A nucleosome:

is the structural unit of DNA packaging in eukaryotes. A nucleosome is basically DNA segments surrounded by histone protein octamers resembling a thread coiled around a spool. A nucleosome is the fundamental unit of chromatin.

The nucleosome is further folded into compact structures such that it can form chromosomes. The DNA has to be wrapped into a nucleosome so that it can fit inside the nucleus. A human cell contains almost 30 million nucleosomes each.

Nucleosomes were first observed by Don and Ada Olins in 1974 in an electron microscope as a particle. The structure was, however, later illustrated by Robert Kornberg. A nucleosome structure is made up of nucleosome core particles that are connected by a stretch of linker DNA.

Nucleosome Structure:

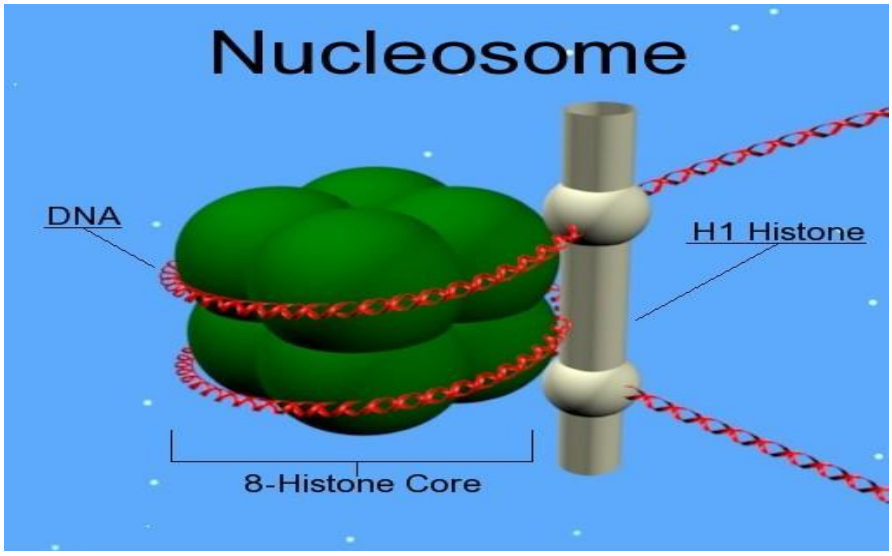
The nucleosome structure consists of DNA and a histone protein complex. One strand of DNA is coiled around one core histone octamer to create a histone nucleosome. Each core histone octamer is comprised of two copies of four core histone proteins for a total of 8 proteins in all:

Two H2A proteins

Two H2B proteins

Two H3 proteins

Two H4 proteins



The histone complex is also made up of one additional linker protein called H1. This protein secures the nucleosome structure. H1 has been largely ignored since its discovery, but recent studies show that it also plays a critical role in fine-tuning transcription

- Unlike most prokaryotic DNA which is referred to as ‘naked’, **eukaryotic nuclear DNA** is associated with proteins called **histones** (to form **chromatin**)

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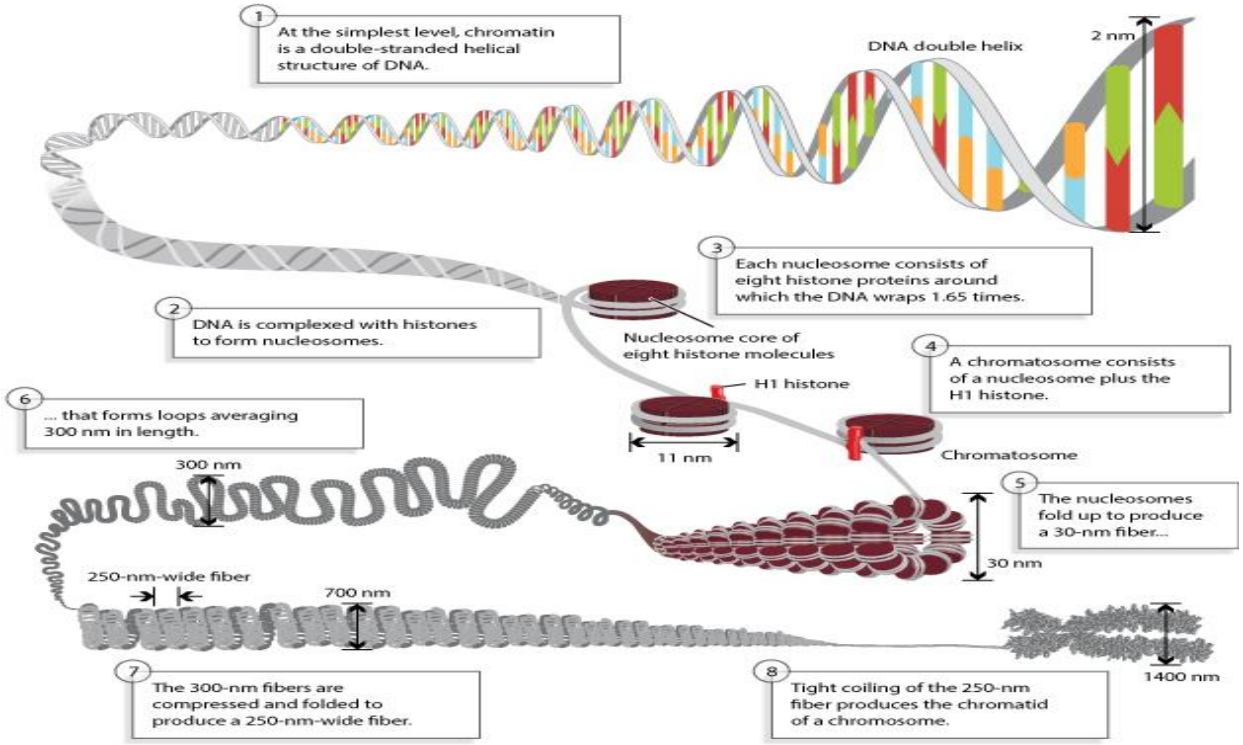
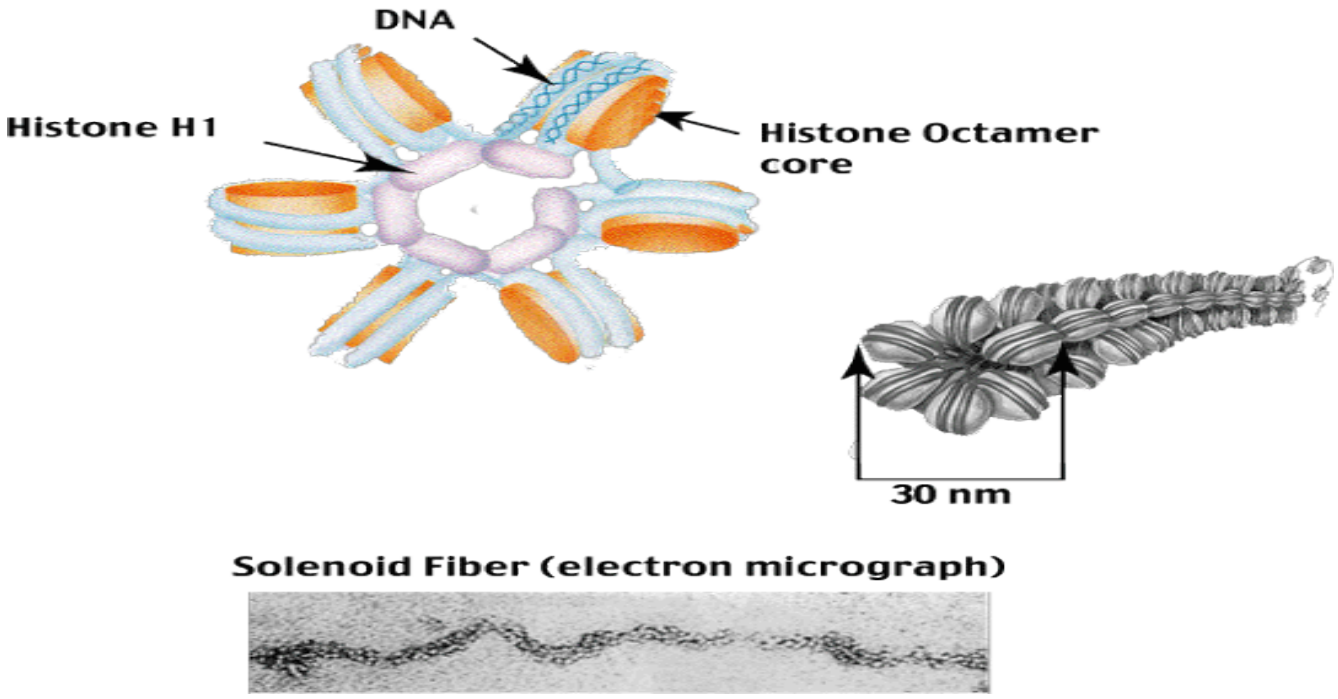
- Histones package the DNA into structures called **nucleosomes**
    - The nucleosome consists of a strand of DNA coiled around a core of **eight histone proteins** (octamer) to form a bead-like structure
    - DNA takes **two turns** around the histone core and is held in place by an additional histone protein which is attached to linker DNA
    - The DNA molecule continues to be wound around a series of nucleosomes to form what looks like a '**string of beads**'
- Nucleosomes help to **supercoil the DNA**, resulting in a compact structure which saves space within the nucleus
    - Nucleosomes also help to **protect DNA** and **facilitate movement of chromosomes** during cell division
    - An analogy for supercoiling is **twisting an elastic band** repeatedly until it forms additional coils
- Nucleosomes can be **tagged with proteins** to promote or suppress transcription



Chromosomes are composed of DNA tightly-wound around histones.



Fig_Solenoid Fiber