Difference Between Heterochromatin and Euchromatin | Compare the Difference Between Similar Terms

The key difference between heterochromatin and euchromatin is that heterochromatin is the highly packed form of chromatin which is generally inactive while euchromatin is the loosely packed form of chromatin which is generally active.

Chromatin is the structure that holds the DNA strand of a chromosome. Heterochromatin and euchromatin are the two main types of chromatin that are present in the cells. There is a difference between heterochromatin and euchromatin in terms of structure and function. In addition, they differ from the transcription and replication properties as well.

CONTENTS

What is Heterochromatin?

Heterochromatin is the tightly packed form of chromatin present in the cells of eukaryotes. It is usually present at the periphery of the nucleus. Due to its highly packed nature, it is visible during the staining of DNA of a cell. Also, this intensely stained DNA has two types; they are the constitutive and facultative heterochromatin. Constitutive heterochromatin is basically responsible for forming the centromere or the telomere while attracting signals for both gene expression and repression. Facultative heterochromatin becomes repetitive under special signals or environments; otherwise, it stays quiet with a highly condensed structure. The basic function of heterochromatin is to shelter the DNA strand. In addition, chromatin helps in gene regulation. When there is a DNA strand without heterochromatin, there is a possibility of endonucleases unnecessarily digesting that fragment.

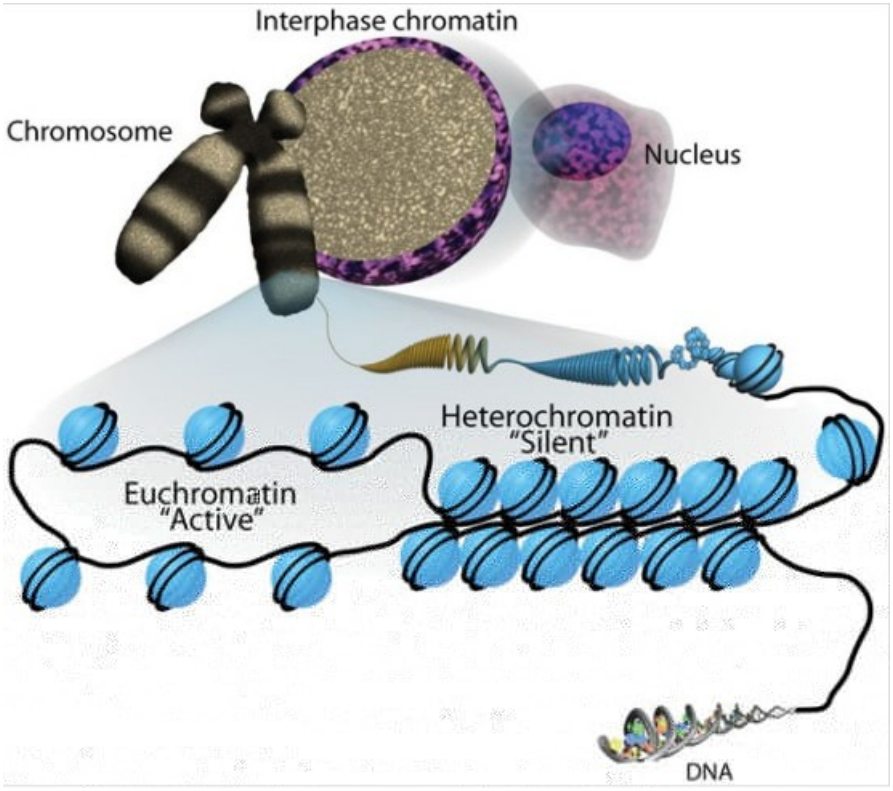

Figure 01: Heterochromatin

Inheritance ensures the presence of heterochromatin in the next generation. Usually, the condensed structure of heterochromatin prevents unwanted gene expression until a specific signal arrives and informs to uncondense DNA in order to expose DNA strands for transcription. Usually, the replication of DNA in heterochromatin takes place in the latter stages. Its compact structure determines most of the functions in gene expression; in fact, it is sometimes called the gene silencing.

What is Euchromatin?

Euchromatin is the loosely-packed DNA sheltering structures in the cells. Usually, they are present towards the inner core of the nucleus. Euchromatin is present in both prokaryotes and eukaryotes. In fact, euchromatin is the only type of chromatin present in the prokaryotic genetic material. Moreover, its loosely packed structure causes less visibility during the DNA staining, unlike heterochromatin.

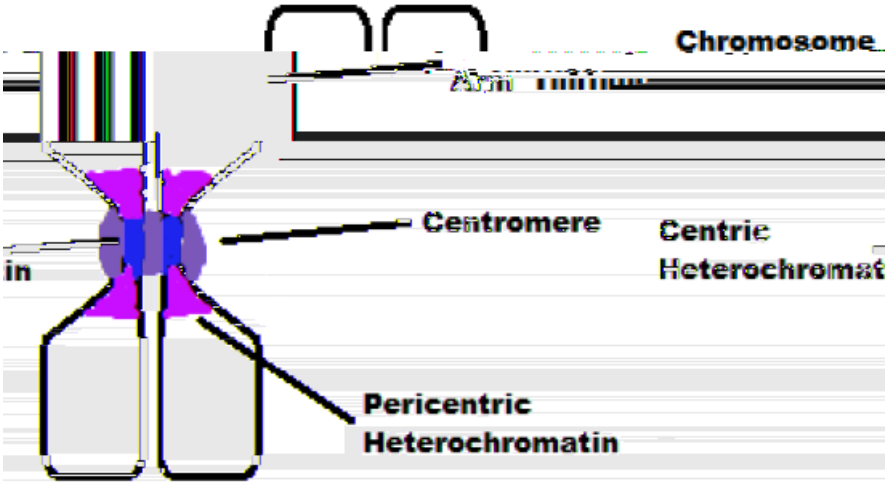

Figure 02: Euchromatin

The uncondensed nature of euchromatin is mainly due to the loose wrapping of histone proteins around the DNA strand. Therefore, the access of DNA is easy to initiate the DNA transcription. Moreover, euchromatin contains the most active genes of an organism. It is because euchromatin participates actively in the transcription of DNA into mRNA. Some euchromatins are not always transcribed but transformed into heterochromatin after the basic function to silence the genes. However, there are some ever active euchromatins to maintain the stability of the basic and essential processes for the survival of the cell.

What are the Similarities Between Heterochromatin and Euchromatin?

- Heterochromatin and euchromatin are two types of chromatin present in the eukaryotic cells.
- Both forms of chromatin are present in the nucleus.
- Moreover, they are complexes of DNA and proteins.
- And, both participate in DNA transcription.
- Also, they both are associated with histone proteins.

Heterochromatin and euchromatin are two varieties of chromatin present in living organisms. The key difference between heterochromatin and euchromatin is that the heterochromatin is the highly packed form of chromatin in the nucleus while euchromatin is the loosely packed form of chromatin in the nucleus. Generally, heterochromatin is inactive while euchromatin is active. Consequently, heterochromatin contains more DNA, while euchromatin contains less DNA. So, this is another significant difference between heterochromatin and euchromatin.

Furthermore, an important difference between heterochromatin and euchromatin is that heterochromatin is less abundant. But, around 90% of the total human genome is euchromatin. Besides, a further difference between heterochromatin and euchromatin is that heterochromatin is only present in eukaryotes, but, euchromatin is present in both prokaryotes and eukaryotes.

Summary – Heterochromatin vs Euchromatin

Heterochromatin and euchromatin are two types of chromatin. The key difference between heterochromatin and euchromatin is the packaging. Heterochromatin is the highly packed form of chromatin while euchromatin is the loosely packed form of chromatin. Hence, heterochromatin contains more DNA while euchromatin contains less DNA. But, heterochromatin is generally inactive while euchromatin is generally active. Thus, this is a summary of the difference between heterochromatin and euchromatin.

Reference:

1. "chromatin." Nature News, Nature Publishing Group, Available here.

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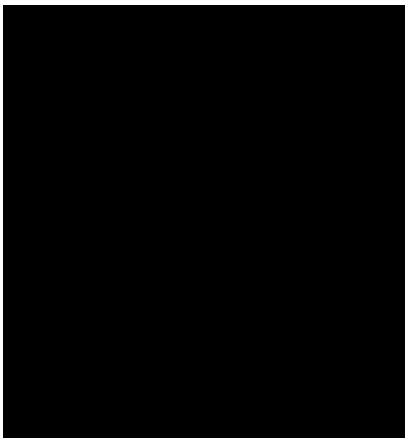
Difference Between Heterochromatin and Euchromatin (with Comparison Chart) - Bio Differences



The major difference between heterochromatin and euchromatin is that heterochromatin is such part of the chromosomes, which is a firmly packed form and are genetically inactive, while euchromatin is an uncoiled (loosely) packed form of chromatin and are genetically active.

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.

Content: Heterochromatin Vs Euchromatin

Comparison Chart

Basis for comparisonHeterochromatinEuchromatin MeaningThe tightly packed form of DNA in the chromosome is called as heterochromatin.The loosely packed form of DNA in the chromosome is called as euchromatin. DNA densityHigh DNA density.Low DNA density. Kind of stainStained dark.Lightly stained. Where they are presentThese are found at the periphery of the nucleus in eukaryotic cells only.These are found in the inner body of the nucleus of prokaryotic as well as in eukaryotic cells. Transcriptional activityThey show little or no transcriptional activity.They actively participate in the process of transcription. Other featuresThey are compactly coiled.They are loosely coiled. They are late replicative.They are early replicative. Regions of heterochromatin are sticky.Regions of euchromatin are non-sticky. Genetically inactive.Genetically active. Phenotype remains unchanged of an organism.Variation may be seen, due to the affect in DNA during the genetic process. It permits the gene expression regulation and also maintains the structural integrity of the cell. It results in genetic variations and permits the genetic transcription.

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 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 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.

Following are the substantial points to differentiate among heterochromatin and euchromatin:

1. The tightly packed form of DNA in the chromosome is called as heterochromatin, while the loosely packed form of DNA in the chromosome is called as euchromatin.
2. In heterochromatin, the density of DNA is high and are stained dark, whereas in euchromatin the density of DNA is little and are lightly stained.
3. Heterochromatin is found at the periphery of the nucleus in eukaryotic cells only, and Euchromatin is located in the inner body of the nucleus of prokaryotic as well as in eukaryotic cells.
4. Heterochromatin shows little or no transcriptional activity as well they are genetically inactive, on the other hand, Euchromatin actively participates in the process of transcription and are genetically active also.
5. Heterochromatin is compactly coiled and is late replicative, whereas Euchromatin is loosely coiled and early replicative.
6. Regions of heterochromatin are sticky, but the areas of Euchromatin are non-sticky.
7. In Heterochromatin part, the phenotype remains unchanged of an organism, though variation may be seen, due to the effect in DNA during the genetic process in the Euchromatin.
8. Heterochromatin permits the gene expression regulation and also maintains the structural integrity of the cell though Euchromatin results in genetic variations, and allows the genetic transcription.

Conclusion

From the above information regarding chromatin – their structure and types. We can say that only Euchromatin is vigorously involved in the transcription process although heterochromatin and its types do not play such significant role.

Constitutive heterochromatin contains the satellite DNA, and it surrounds the centromere, and facultative heterochromatin is disbanded. So apparently it can be said that the eukaryotic cells and their inner structure are relatively complex.

Difference Between Heterochromatin and Euchromatin – Bio Differences

The human body is composed of billions of cells. A cell consists of a nucleus which has chromatin. According to biochemist scientists, the chromatin is the combination of DNA, RNA, and protein extracted from eukaryotic lysed interphase nuclei. Chromatin is responsible for packaging DNA into small volumes so that they can fit inside the cell. It also helps in strengthening the DNA for mitosis and miosis to take place. It also prevents DNA damage and controls the gene expression and replication of the DNA. Chromatin is classified into two groups; heterochromatin and euchromatin. Emil Heitz coined these two terms in the year 1928.

The main difference between heterochromatin and euchromatin is that heterochromatin is such part of the chromosomes, which is tightly packed, genetically inactive, and found at the periphery of the nucleus. In contrast, euchromatin is an uncoiled packed form of chromatin, genetically active and found at the inner part of the nucleus.

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

Comparison Chart

Basis for Comparison Heterochromatin Euchromatin Definition Heterochromatin can be defined as the tightly packed form of DNA in the chromosomes Euchromatin can be defined as the loosely packed form of DNA in the chromosomes. Cell Type Eukaryotes Prokaryotes and Eukaryotes DNA density High DNA density Low DNA density Shape Tightly pack form of chromosome Uncoiled form of chromatin Kind of stain Stained dark Lightly stained Location These are present at the periphery of the nucleus in eukaryotes These are present in the inner body of the nucleus of prokaryotes and eukaryotes. Transcriptional Activity Show little or no transcriptional activity Actively participate in the transcriptional activity Genetic Activity Genetically inactive Genetically active Stickness Sticky Non-sticky DNA replication Heterochromatin replicates later Euchromatin replicates early Types Two types:

1. Constitutive heterochromatin
2. Facultative heterochromatin

Uniform euchromatin Function Regulation of structural integrity and gene expression Genetic transcription and genetic variation

What is Heterochromatin?

Heterochromatin is an area of the chromosomes which are intensely stained with DNA specific strains. These are a tightly packed form of the DNA in the nucleus.

The proteins which are engaged in the gene expression are inaccessible by the heterochromatin because of the compacted nature of the heterochromatin. Because of this reason, chromosomal crossing over is also not possible and as a result, heterochromatin is not transcriptionally and genetically active.

Heterochromatin is divided into two groups; facultative heterochromatin and constitutive heterochromatin. The genes which get silenced by the process of Histone methylation or siRNA through RNA I are called facultative heterochromatin. So, they comprise inactive genes and is not a permanent character of every nucleus of the cells.

While the repetitive and structurally functional genes such as telomeres or centromeres are called constitutive heterochromatin, these are the continuing nature of the nucleus of the cell and contain no gene in their genome. This structure is retainable in the interphase of the cell.

The function of the heterochromatin is to protect the DNA from the endonuclease damage because of the compact nature. It also prevents the DNA regions from getting access to proteins during gene expression.

What is Euchromatin?

The which is rich in gene concentrations and is a type of chromatin loosely packed is called euchromatin. They are active during transcription. Euchromatin composes almost 90%of the entire human genome and covers the maximum part of the dynamic genome of the inner nucleus. Under a light microscope, its parts can be observed as loops that seem to have 40 to 100 kb areas of DNA in it. Under a microscope, it appears as light-colored bands. The diameter of the euchromatin fiber is about 30 nm.

To permit the transcription, some parts of the genome containing active genes are loosely packed. The loose wrapping of the DNA makes it available at the time of the process. The structure of euchromatin is similar to nucleosomes, which contains histones proteins having around 147 base pairs of DNAs wrapped around them.

The function of the euchromatin is to participate in the transcription of DNA to RNA. The gene-regulating mechanism is the process of transforming euchromatin into heterochromatin or vice versa. The active genes of euchromatin get transcribed to make mRNA, whereas further encoding the functional proteins is the major function of euchromatin. This is the reason that euchromatin is called genetically and transcriptionally active. Housekeeping genes are one of the types of euchromatin.

Key Differences

1. Heterochromatin is the tightly packed form of DNA, whereas euchromatin is the loosely packed form of DNA in the chromosome.
2. The density of DNA is high in heterochromatin, whereas the density of DNA is low in the euchromatin.
3. Heterochromatin is stained dark under the microscope, whereas euchromatin is lightly stained under the microscope.
4. Heterochromatin is located at the periphery of the nucleus in the eukaryotic cells. In contrast, euchromatin is located in the inner body of the nucleus in both prokaryotic cells and eukaryotic cells.
5. Heterochromatin is genetically inactive, whereas euchromatin is genetically active.
6. Heterochromatin has sticky regions, whereas euchromatin has non-sticky parts.
7. Heterochromatin is tightly coiled and shows late replication, whereas euchromatin is loosely coiled and shows early replication.
8. In heterochromatin, the phenotype remains unchanged whereas, in euchromatin, the phenotype shows variations.
9. Heterochromatin allows the gene expression regulation and maintains the structural integrity of the cell, whereas euchromatin shows genetic variations and permits the genetic transcription.

Conclusion

In conclusion, both heterochromatin and euchromatin are a type of DNA in the chromosomes. The main difference is that heterochromatin is the densely packed form of DNA, whereas euchromatin is the loosely packed DNA in the chromosomes.

Difference Between Euchromatin and Heterochromatin

Around 3 billion base pairs of nucleotides are available in the human genome. There is a linear sequential arrangement of these nucleotides along DNA. This encodes every Protein and genetic trait in the human body. DNA sequencing or genetic sequencing is important for normal cell function and is highlighted when the anomalies go undetected by intrinsic genetic repair mechanisms and thus resulting in dysfunctional Proteins and various disease states.

The DNA sequence is maintained through a series of processes and is condensed into 46 Chromosomes in Humans. The number of Chromosomes varies for every species. These Chromosomes undergo further condensation through two ways called mitosis or meiosis. On the other hand, interphase Chromosomes also undergo a series of events like DNA folding, wrapping, and bending which are facilitated by Histones. The combination of DNA and Histone Proteins in the nuclear matter is termed as Chromatin.

Chromatin consists of 1147 base pairs of DNA wrapped around the Protein core histone. The histone is made of 2 units of H2A, H2B, H3, and H4 forming an octamer.

The chromatin in the interphase is generally classified into two parts:

- Euchromatin
- Heterochromatin

Euchromatin

A region in which DNA is accessible and is present in an open confrontation because of the relaxed state of Nucleosome arrangements is referred to as Euchromatin.

Euchromatin is associated with the presence of high levels of proteins in the chromatin. In other words, Euchromatin is made up of histones and protamines. Histones are a group of DNA binding proteins. They play a vital role in regulating the process of gene transcription and thus play an

important role in the maintenance of chromosomal organization and cellular function. Histone also maintains the condensation of the chromatin fiber in the nucleus. Protamines are a sub-family of the histone proteins and play an important role in regulating the transition of the chromatin into the Euchromatin.

Euchromatin and Heterochromatin are two structural units that help in maintaining the condensation of the chromatin. There are also other structural units called facultative Heterochromatin and constitutive Heterochromatin.

Structure of Euchromatin

Euchromatin majorly has unmethylated first gene exons. They exist in decondensed form and are present in the distal arms of the Chromosome. Euchromatin is spread all around the nucleus and is replicated during the whole S Phase. It is generally known as the transcriptionally active form of chromatin. Euchromatin has less compact structure and is usually referred to as 11 nm fiber with the presence of beads on a string. The beads represent nucleosomes and string refers to DNA.

Functions of Euchromatin

The chromatin which is involved in the active transcription of DNA into mRNA is Euchromatin. As Euchromatin is more open in order to allow the recruitment of RNA polymerase complexes and gene regulatory Proteins, transcription can be initiated.

Heterochromatin

A functionally different genomic compartment which has relatively low gene density along with a highly compact chromatin structure is referred to as Heterochromatin.

There are two kinds of Heterochromatin: 'Constitutive Heterochromatin' is virtually present in all stages of an organism's life cycle. 'Facultative Heterochromatin' occurs in one of a pair of homologs. Heterochromatin can epigenetically administer the expression of nearby genes resulting in varied phenotypes in genetically identical cells.

Biochemical and genetic approaches show that the RNAi machinery plays an important role in the formation of Heterochromatin.

Heterochromatin is the opposite of Euchromatin. Euchromatin and Heterochromatin are structural units. It is associated with the presence of DNA or histone protein.

Heterochromatin is a part of the chromatin. It is associated with the presence of histone H3 and Heterochromatin proteins. These Heterochromatin proteins consist of proteins of the family of HP1, PH1, and HIRA. The Heterochromatin proteins are associated with the repressive histone marks. These proteins are enriched in the Heterochromatin regions.

The organization of the genetic material into distinct compartments, or domains, within the nucleus is called chromatin structure.

The DNA in a Euchromatin region is loosely packaged and is relatively accessible. In this form, the DNA is in a transcriptionally active state. A key process that contributes to this accessibility is DNA replication. In this process, the genetic material in Euchromatin is replicated and distributed in multiple replication sites, or replication forks, along the length of a Chromosome.

The DNA in Heterochromatin is tightly packaged. These tightly packaged regions have no or very few replication sites. Therefore, the DNA in Heterochromatin is in a transcriptionally repressed state. Transcriptional activity is also repressed in Heterochromatin. This is due in large part to the presence of methyl groups on the DNA in Heterochromatin. Methylation of the DNA prevents transcriptional activity. This process is called transcriptional silencing.

Structure of Heterochromatin

The structure of Heterochromatin is tightly packed and condensed. The changes in Heterochromatin occurs due to the modifications to histones and spreading of silencing complexes causing the changes in structure of chromatin. Due to its repressive structure, Heterochromatin does not completely express the genes within it.

Heterochromatin usually folds into higher order structures and this induces an increase in negative supercoiling of DNA. The structure of Heterochromatin is stable and is also dynamic and changes with the cell cycle. The formation of chromatin is promoted due to the DNA elements called barriers which promote the formation of active chromatin and remove the nucleosomes. This allows the Heterochromatin to spread.

The structure of Heterochromatin is easily explained by analyzing the 'Constitutive Heterochromatin' and 'Facultative Heterochromatin'. Constitutive Heterochromatin is the stable form which consists of repeated sequences of DNA called Satellite DNA. The structural functions are regulated by this form of Heterochromatin and are found in centromeres and telomeres.

Facultative Heterochromatin is known to change its structure according to the cell cycle. This consists of repeated DNA sequences termed as 'LINE Sequences'. This can be seen to change its structure in the inactivated X-Chromosome of females. The structure of Heterochromatin can also be determined by the density gradient data in which the Heterochromatin appears as a regular structure and Euchromatin has an irregular structure.

Functions of Heterochromatin

The functional aspects of Heterochromatin are determined by the modifications of chromatin. The Heterochromatin core histones present in yeast are hypoacetylated which makes the lysine residues to become more positively charged, allowing an increase in the interaction between the histone and DNA, making the nucleosome more closed in structure.

The closed chromatin structure of Heterochromatin is due to the low acetylation of Histone H4-K16 in Heterochromatin, further promoting the folding of Chromatin to high structure orders. The active transcriptional activity is due to the Hypomethylation of Heterochromatin at H3-K4 and K79.

Difference Between Euchromatin and Heterochromatin

Euchromatin

Heterochromatin

Appear as a loose packed form of DNA

Appear as tight packed form of DNA

Heteropycnosis is not shown

Exhibits Heteropycnosis

DNA density is low

High density of DNA is present

Present in prokaryotes and Eukaryotes

Available in Eukaryotes only

In appears in active state

It appears in inactive state

This replicates early

The replication happens late

This is present in the inner body of nucleus

This is present at the periphery of nucleus

There is low transcriptional activity

This participates in the transcriptional activity

Chromosomes have different segments called Euchromatin and Heterochromatin. Chromatin plays an important role in the structure of a nucleus. It carries DNA. DNA is a part of the genetic material present in every cell of our body. Chromatin also consists of proteins and nucleic acids. It controls the process of cell division. Chromatin is the combination of DNA, histone, and other proteins. They are called epigenetic marks, which play a crucial role in the gene expression process.

In this section, we will be discussing in detail about the difference between Euchromatin and Heterochromatin.

Let us talk about the difference between Euchromatin and Heterochromatin in detail. Here we will discuss the differences between Euchromatin and Heterochromatin with examples.

Constitutive Heterochromatin

The DNA in the Euchromatin is made up of two nucleotides: adednine and thymine. They are called the AT-rich region. The AT-rich regions are associated with histone H1 proteins. Heterochromatin is made up of large regions in the genome, which are AT-rich, and are usually associated with the presence of histone H3. This particular region does not have any Euchromatin or Heterochromatin units. This is called a Heterochromatin block. The Heterochromatin block is usually enriched with genes and does not have any genes.

Heterochromatin is considered as a type of transcriptionally inactive region. Homologous and repetitive sequences are associated with Heterochromatin. Homologous sequences are not repeated more than two times. The repetitive sequences are repeated more than twice. In contrast to homologous sequences, repetitive sequences are associated with Heterochromatin. The repetitive sequences are associated with gene silencing and genomic instability. There are few known genes that are exclusively associated with Heterochromatin.

Repetitive sequences are associated with Heterochromatin. Repetitive sequences have a very important function in the genome. Some examples are listed below:

Insulators. The insulator elements prevent the DNA replication and gene expression from one region to another. Insulators block gene expression. Repetitive sequences form the telomere in Euchromatin. Telomeres are the specialized structures formed at the ends of each Chromosome. It prevents DNA degradation and protects the Chromosome ends. Repetitive sequences are associated with gene silencing. Differentially expressed genes in Heterochromatin and Euchromatin. Repetitive sequences are associated with genomic instability. Tandem repeats or minisatellites are associated with the Heterochromatin. The minisatellites are formed by the sequences that contain tandem repeats. Heterochromatin is associated with the high histone H3 methylation. Euchromatin is associated with low levels of H3 methylation. Repetitive sequences are associated with the repressive histone marks.