Difference Between DNA and Histone Methylation

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Key Difference – DNA vs Histone Methylation

Methylation is biological process by which a methyl group (CH_3) is added to a molecule and modified to enhance or repress its activity. In the context of genetics, methylation can occur at two levels: DNA methylation and histone methylation. Both processes directly affect the transcription process of genes and control the expression of genes. **In DNA methylation, a methyl group is added either to cytosine or adenine nucleotide of the DNA molecule, which modifies the two nucleotide residues to repress the function of gene transcription and prevent the expression of genes. In histone methylation, a methyl group is added to the amino acids of the histone protein**. This is the key difference between DNA and histone methylation.

What is DNA Methylation?

The epigenetic process by which methyl groups are added to a DNA molecule in order to control the expression of genes is known as DNA methylation. DNA methylation doesn't alter the sequence of the DNA but affects the activity of DNA. This process is necessary for the normal development of an organism and is linked to many important processes of the body which include preservation of chromosome stability, embryonic development, carcinogenesis, ageing, x-chromosome inactivation and repression of transposable elements. When methylation process occurs at a promoter region of a gene, it is involved in the repression of gene transcription. A DNA molecule consists of a combination of four (04) nucleotides: adenine, guanine, thymine and cytosine. Out of the four bases of DNA, adenine and cytosine can be methylated. During DNA methylation, a methyl group is added to the 5^{th} carbon of the cytosine ring to convert the cytosine base to 5-methylcytosine. This cytosine residue modification process is catalyzed by an enzyme known as DNA methyltransferase. A modified cytosine base is present next to a guanine base. Therefore, in the double helical structure of DNA, modified cytosine bases are present diagonally to each other on opposite DNA strands.

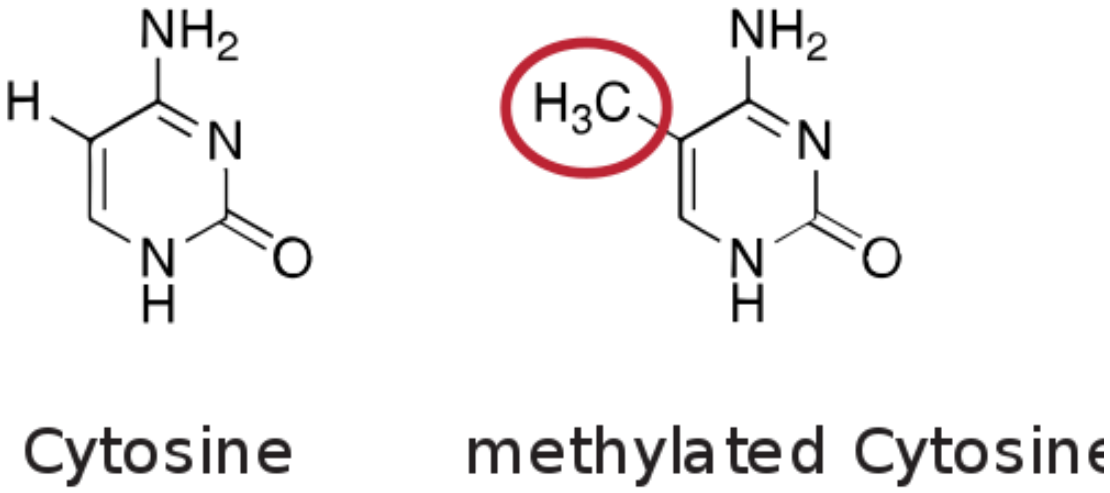

Figure 01: DNA methylation

Adenine methylation is process found in plants, bacteria and mammals. DNA methylation of plants and other organisms is found in three different sequence contexts. They are CG, CHH and CHG, where H refers to either Adenine, Thymine or Cytosine.

What is Histone Methylation?

Histone is a protein that makes up the nucleosome, which is the structural unit of the eukaryotic chromosome. The nucleosome wraps around the DNA double helix which results in the formation of chromosomes. Histone methylation is a process that transfers methyl groups to the amino acids of the histone protein. The DNA is wound around two sets of identical histone proteins referred to as a protein octamer. The four types of histone proteins (two copies each) involved in this formation are H2A, H2b, H3 and H4. These four types of histone proteins consist of a tail extension. These tail extensions act as the targets of nucleosome modification by methylation. The activation and inactivation of DNA depend greatly on the tail residue that is methylated and its capacity of methylation.

Methylation of histones directly affects the transcription of genes. It has the ability to either increase or decrease the process, which depends on the type of the amino acids in the histone protein that is to be methylated and on the number of methyl groups attached. Transcription process is enhanced due to some methylation reactions that weakens the bonds present between histone tails and DNA. This occurs due to enabling of the uncoiling process of DNA from the nucleosome which facilitates the interaction between the transcription factors, polymerases and DNA. This process is a critical step in the regulation of gene expression and results in the expression of different genes by different cells. Methylation of histone proteins occurs on tail residues, most commonly

on lysine (K) residues of histone tails of H3 and H4 and also on arginine (R) as well. Lysine and arginine are amino acids. Histone methyltransferase is an enzyme that is utilized to transfer methyl groups to lysine and arginine, the tail residues of H3 and H4 histone proteins.

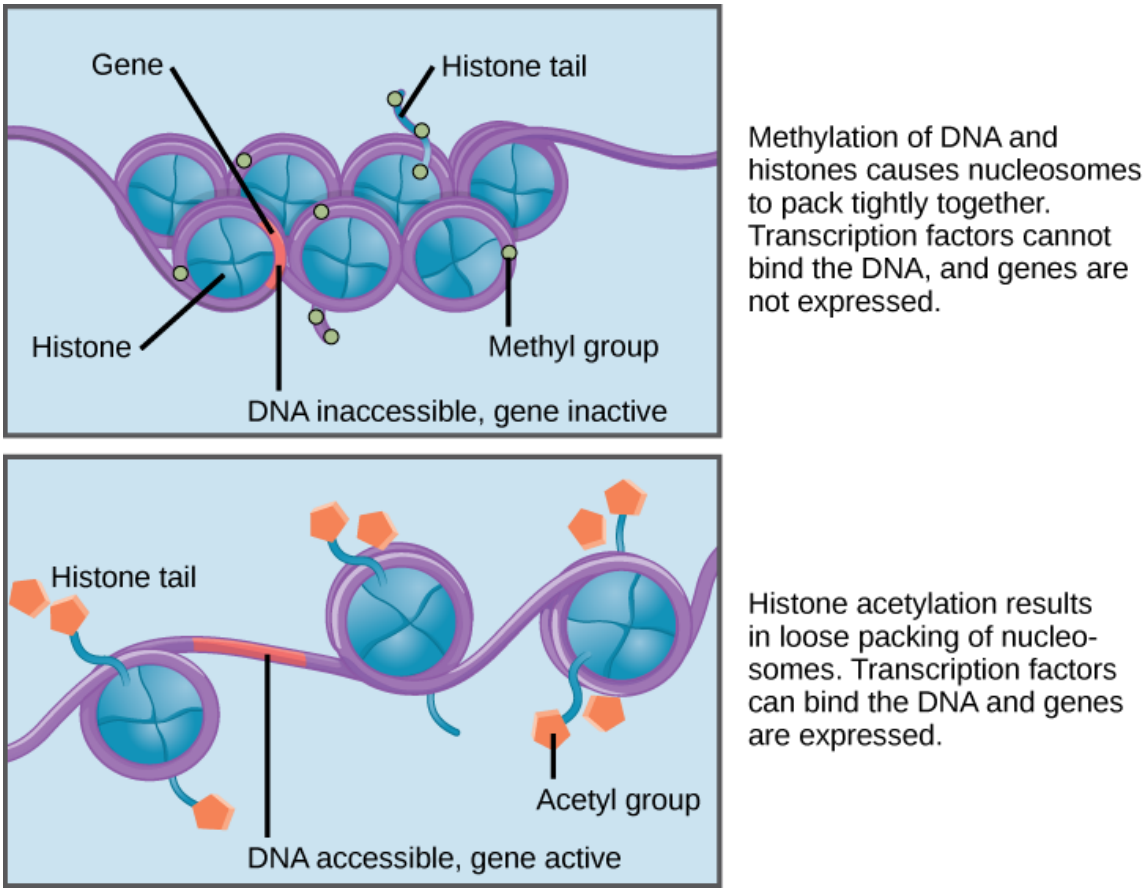

Figure 02: Histone Methylation

What are the similarities between DNA and Histone Methylation?

- In both processes, methyl groups are added.

What is the difference between DNA and Histone Methylation?

DNA vs Histone Methylation	
Addition of a methyl group to cytosine or adenine nucleotides of a DNA molecule is known as DNA methylation.	Transfer of methyl groups to the amino acids of the histone proteins is known as histone methylation.

Catalyst	
The addition of methyl group to the cytosine residue is catalyzed by DNA methyltransferase.	The reaction which transfers methyl groups to the amino acid of histone protein is catalyzed by histone methyltransferase.
Function	
If DNA methylation occurs in the promoter region of a gene, it suppresses the transcription of genes and prevents gene expression.	If histone methylation occurs, it promotes the uncoiling of DNA from the wrapped nucleosome and facilitates the interaction of transcription factors and polymerases with DNA and enhance the gene transcription process.

Summary – DNA vs Histone Methylation

Methylation is a process by which a methyl group is added to a molecule like DNA or protein. In the context of genetics, DNA methylation and histone methylation directly affect the regulation of transcription of a gene and control the gene expression of cells. The reactions of DNA methylation and histone methylation are catalyzed by DNA and histone methyltransferase, respectively. When a methyl group is added to DNA, it is known as DNA methylation and when a methyl group is added to amino acids of the histone protein, it is known as histone methylation. This is the difference between DNA and histone methylation.

References:

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2. Kondo, Yutaka. "Epigenetic Cross-Talk between DNA Methylation and Histone Modifications in Human Cancers." Yonsei Medical Journal, Yonsei University College of Medicine, 31 Aug. 2009, Available here. Accessed 29 Aug. 2017

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