



The Role of Epigenetics in Disease and Health: Beyond DNA Sequences

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In recent decades, the field of genetics has revolutionized our understanding of biology. In particular, we know about how genetic information encodes the blueprint for life and how variations and mutations in these sequences contribute to disease or health. What is unique is that the genetic trait changes do not always caused by any changes in genetic sequences. Epigenetics refers to the study of how environmental factors and lifestyle choices can affect the gene activity. Changes in the heritable traits of organisms can be caused by modification of gene expression rather than alteration to the underlying DNA sequence. Therefore, this change does not involve any DNA mutation.

DNA methylation is a biological process of adding a methyl group to the DNA molecule. The activity of DNA segments can change without changing the sequence by the process of methylation. This process plays an important role in normal development and aberrant DNA methylation patterns are associated with various diseases. Histones are highly basic proteins around which DNA is wound. The modifications in histone protein plays a fundamental role in most biological processes and can alter the accessibility of the DNA for transcription, as well as influencing gene expression. There are non-coding RNA molecules that do not encode proteins but play vital role in regulating the gene expression by interacting with other molecules and influencing chromatin structure.

Over the past few decades, mechanisms of epigenetics have emerged as a crucial factor in governing every biological process in the human body. Throughout human life, these mechanisms have been impacted various physiological and pathological conditions. For example, cancer is often characterized by epigenetics abnormalities, such as hypermethylation of tumor suppressor genes or hypomethylation of oncogenes. Epigenetic modifications are also implicated in complex diseases like cardiovascular disease, autoimmune conditions and neurodegenerative disorder. Beyond these diseases, epigenetics also offers insights into health and development. Furthermore, understanding the epigenetic mechanisms influence human health, leading to new preventive strategies and treatment of various diseases. Early life experiences, including nutrition and stress, can lead to epigenetic changes that affect long-term health outcomes of the individual.

Advances in this research can pinpoint any epigenetic changes that affect long-term health outcomes. The advances of epigenetic research can lead to early diagnosis and preventive measures. Identifying the epigenetic markers associated with the diseases enable early detection of the diseases and more effective preventative strategies. Some epigenetic therapies like; drugs that modify histone acetylation or DNA methylation, are already in development and provide future treatments for disease. To understand how life style factors, influence epigenetic regulation can lead to personalized lifestyle recommendations that influence the public health strategies.