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A Brand new discipline: Comparative epigenetics

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Abstract

Epigenetics is defined as "the branch of science that examines changes in gene expression which is not based on changes in DNA sequence and can be inherited in mitosis and sometimes meiosis," and, with its rapid development, forces us to reconsider our knowledge in all fields of biology, especially in genetics, embryology, and evolution. Epigenetic mechanisms regulate gene expression at different levels like DNA (DNA methylation), chromatin (histone modifications, chromatin rearrangements, three-dimensional chromatin organization), post-transcriptional (RNA modifications, functions of non-coding RNAs), even post-translational (protein refolding, prions) levels. How the underlying genetic mutations affect phenotype depends on interaction with other genes in the genome and functioning of epigenetic mechanisms. Epigenetic mechanisms form an interface that enables the genome to interact with the environment. Although the concept of epigenetics emerged with works of Conrad H. Waddington in 1940s, studies in this field gained momentum with the development of molecular biology techniques in 1980s, and the completion of genome sequencing studies in 2000s. However, with technological advances, this new branch is already divided into sub-disciplines. Comparative epigenetics is the discipline that studies epigenetic modifications conserved in different animals and tries to uncover epigenetic mechanisms that provide phenotypic plasticity, acclimation, and adaptability. Since there is significant variation among animals in biological traits, including reproduction and sex determination, a wide variation can be expected in epigenetic mechanisms that regulate organisms' interaction with environment. Studying different animals will help elucidate different aspects of epigenetic mechanisms. Whole-genome sequencing studies in species other than humans and model organisms are still scarce but increasing rapidly, and early studies in different species suggest more and different epigenetic mechanisms than previously known. Moreover, information obtained from comparative epigenetic studies will provide significant benefits in fields like agriculture, climate change, environment and wildlife protection, and ecotoxicology.

Keywords: comparative epigenetics, epigenetics, adaptation, plasticity

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