EDITORIAL

Epigenetics

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All cell types of an organism contain the same genetic information, but showcase distinct functions and characteristics (1). Cell phenotypes are determined by mechanisms that regulate which genes are expressed and which are silenced, termed epigenetic mechanisms (2). Epigenetics refer to the study of mechanisms and molecules that can perpetuate alternative gene activity states in the context of unaltered DNA sequence (3). The key factors describing epigenetics are heritability and reversibility (4). The mechanisms underlying epigenetic regulation include DNA methylation, histone modification, chromatin remodeling, non-coding RNA activity and the interplay amongst these (5). The key characteristics of epigenetics have generated immense research interest for possible applications in various biological fields.

The high interest in epigenetic research, in conjunction with the impressive technological leaps over the past decade, has allowed for the high throughput mapping of epigenetic alterations. Specifically, epigenomics allows the study of the effects of epigenetic alterations on the genetic material of a cell, termed the epigenome (6). In humans, epigenetic tests can, in principle, provide information on an individual's disease risk profile, a patient's response to treatment, and exposure to physicochemical and psychosocial disruptors of epigenetic mechanisms (7). Furthermore, such tests can elucidate the complexities characterizing epigenetic regulation.

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Epigenetic irregularities like abnormal DNA methylation, histone modifications, or RNA silencing are observed in several human diseases, while genetic mutations that alter the epigenetic machinery can also cause pathologies (8). A prime example is cancer, where deregulation of epigenetic mechanisms can lead to oncogene activation or tumor suppressor gene inactivation, allowing cells to acquire characteristics that are hallmarks of cancer (9,10). Another example is neurodegenerative diseases. Specifically, since virtually all neurodegenerative diseases are associated with aging, it is hypothesized that epigenetic alterations accumulate through time until repair mechanisms and stress-response pathways are unable to counteract mentioned changes, leading to irreversible neurological damage (11). These are not the only diseases associated with the deregulation of epigenetic mechanisms, with some other examples being autoimmune and inflammatory diseases (12), cardiovascular disease (13), and metabolic disorders (14). The involvement of epigenetic mechanisms in so many diseases lays the foundation for the development of epigenetics-based drugs and biomarkers. Epigenetics-based drugs are highly appealing since epigenetic marks are reversible (15). Currently, a number of drugs targeting epigenetic enzymes and analogues of epigenetic modifications have already been introduced to clinical use, while other epigenetics-based drugs are in the clinical trial phase (16). Also, as mentioned above, epigenetic modulators are very intriguing disease biomarkers. These biomarkers showcase plenty of advantages since they can explain various differences in patient endophenotypes while incorporating information in relation to the effects of the environment and lifestyle on health and disease (17). Therefore, epigenetics could potentially become an essential part of the emerging field of personalized medicine (18).

Apart from medicine, epigenetics has also taken center stage in agricultural sciences. Regarding plants, studies conducted under laboratory conditions on model organisms have explored how epigenetics influence plant life, while studying non-model organisms in complex environments can produce novel evolutionary and ecological information (19). Epigenetics affect agronomically important plant traits, such as flowering time, fruit development, plant immunity and responses to environmental factors. The elucidation of the mechanisms underlying plant epigenetics can provide tools that can be used for crop improvement and productivity increase with regards to the environmental conditions (20). Moreover, epigenetics could potentially be used to improve livestock management and selection. Specific management and nutritional strategies could promote favorable epigenotypes in the livestock population, leading to better quality products and higher productivity (21).

Additionally, the advancement of epigenetics seems also to influence social sciences. Scientists may find in epigenetics a causal link between social adversities and health discrepancies (22). The establishment of such associations could lead to the reorganization of political and clinical fields in order to accompany developments in epigenetics (23). Moreover, epigenetics could become the basis for novel economic theories (24), which in turn may influence essential economic policies. Lastly, epigenetics may influence the field of psychology, especially since they showcase the influence of behavior and environment in human development, which could provide novel information on the development of mental disorders as well as therapeutic approaches (25).

All in all, epigenetics seems to be a case of paradigm shift influencing the basic assumptions driving various scientific fields.

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The authors declare that they have no competing interests.

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