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skin | genomics and visible aging

scientific breakthroughs

UNRAVELING THE MYSTERY OF THE human genome, the sum of an individual organism's genes that represent its full genetic information, was a 13-year project that was completed in 2003 in a coordinated effort by the U.S. Department of Energy and National Institutes of Health. The outcome was the identification of the 20,000-25,000 genes in human DNA and determining the sequence of the three billion chemical base pairs that make up human DNA. This unprecedented Human Genome Project was the catalyst for the growth of the United States biotech industry. Understanding human DNA provides us with better comprehension of the human body. Although we have gained many insights from this research, the way genomics affects skin function has garnered much attention.

GENOMICS IS THE STUDY OF ALL THE GENES OF THE CELL AND HOW THEY ARE REGULATED IN RESPONSE TO INTERNAL AND EXTERNAL STIMULI.

What is the study of genomics?

Genomics is the study of all the genes of the cell and how they are regulated in response to internal and external stimuli. As it relates to the skin, genomics can help us understand its underlying biology. Why does skin maintain its youthful appearance? Why does it age (intrinsically or extrinsically)? How and why does pigment develop? The molecular events that occur as the skin adapts to its environment—for example, how different layers and cell types in the skin communicate with one another—provides chemists with greater opportunities to identify new sites for intervention with the biological processes that lead to negative skin outcomes. Genomics also help us confirm the efficacy of currently used ingredients and formulations, enabling us to develop new, optimized skin care ingredients.

Through a series of complex cell signaling mechanisms, external environmental signals are transmitted to a cell's nucleus. It responds by the upregulation and downregulation (turning on and off) of gene expression. This leads to changes and accumulation of mRNA, or messenger ribonucleic acid. This is a molecule that only exists briefly. It is formed by transcription, the process by which DNA makes RNA. RNA is responsible for encoding a chemical design for proteins within the body. Therefore, the upregulation and downregulation of genes, which are affected by environmental stimuli, will ultimately lead to changes in protein production. Proteins play many roles within the skin, but fundamentally they are molecules that carry on physical and chemical reactions that represent skin's adaptation response.

The microarray and biomarkers

One of the most important tools in genomics is the gene chip, also known as a microarray. This was developed from the Southern blotting method invented by British biologist Edwin Southern. The technology allows us to identify which genes are turned on/up/off/down in response to different biological stimuli (conditions). This method enables scientists to perform the parallel analysis of tens of thousands of genes in a single experiment.

Biomarkers serve as an important clue in the grasp of how genome behavior affects skin function. These chemical substances are indicators of the biological state of the cell. They are also referred to as gene expression signatures. Proteins, lipids and mRNA are all considered gene expression signatures.

Specific biomarkers increase and decrease with age. Understanding these helps us unravel the causes and outcomes of intrinsic and extrinsic age on the skin.

continues

CERTAIN PEPTIDES INCREASE THE EXPRESSION OF SOME SKIN BIOMARKERS, LEADING TO AN ANTI-AGING EFFECT.

Some biomarkers that decrease as skin ages are collagen types I, III and IV, as well as epidermal hyaluronic acid. The synthesis of important lipids like cholesterol and fatty acids also decreases. Additionally, the critical process of epidermal differentiation that is responsible for the establishment and maintenance of a healthy barrier function can be disturbed. The epidermal differentiation complex (EDC) is a cluster of genes that encode important epidermal proteins. This disruption has been identified as playing a role in atopic dermatitis, psoriasis and ichthiosis vulgaris.

Conversely, other biomarkers increase as skin ages. Some examples of these are inflammatory responses, cytokine activity, protease activity, immune responses that lead to photoaging, extracellular matrix breakdown, elastin degradation, increased creation of endogenous free radicals and an impairment of skin repair processes.

Using genomics

While genomics can assist with the complete comprehension of the biological processes that lead to negative skin outcomes, it can also be utilized to monitor the levels of protection provided by sunscreens. One gene, the p53 gene, suppresses the formation of tumors. If a person inherits only one copy of the p53 gene from their parents, they are predisposed to cancers. In-depth research is being conducted to substantiate that the higher the level of p53, the less the skin has been protected from UV radiation and the higher the stress is from exposure.

The undesirable changes in the skin's physical characteristics, such as the development of fine lines, wrinkles, age spots and an overall dull complexion, are all brought on by changes in the biological and physiological processes mentioned above.

What works

Having a deeper understanding of the instigators and processes by which skin develops challenging conditions or degrades with visible aging will continue to fuel research and the discovery of topical agents to address this. Certain peptides increase the expression of some skin biomarkers, leading to an anti-aging effect. For example, the remodeling of collagen types I, III and VI, Matrix metalloproteinases (MMPs, tissue inhibitors of metalloproteinases (TIMPs) and laminins I and IV.

Additional substances that have been tested are niacinamide, a variety of topical antioxidants and retinoids. One identified mechanism of retinoid action includes the receptor-mediated stimulation of epidermal proliferation and collagen synthesis.

Effective skin care regimens that are consistent with the findings of skin genomics focus on the improvement of barrier function, promotion of normal desquamation, exfoliation and skin turnover, antioxidant control, UV protection, the maintenance of consistent synthesis and the replacement of extracellular matrix components.

As science delves deeper into the understanding of complex biological processes that guide the human body, chemists will have exciting opportunities to harness this new knowledge to provide effective topical formulations. It is an exciting time in skin health science. Many more beneficial discoveries are surely on the horizon. ■

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