Protecting the human epigenome with nutritional epigenetics intervention programs

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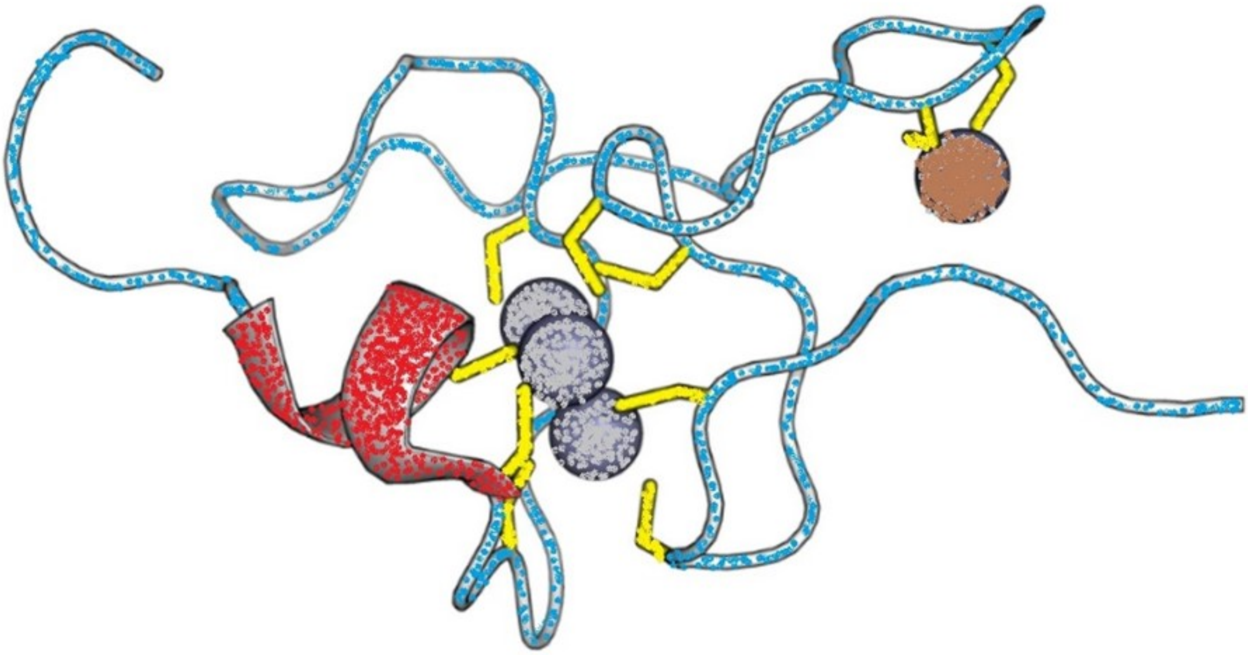
22 July 2024



Dr Renee J. Dufault, Executive Director at the Food Ingredient and Health Research Institute, explains the significance of nutritional epigenetics in understanding the impact of nutrients and dietary chemicals on gene expression patterns, as well as their role in the development of conditions such as autism and ADHD

Rising rates of autism, attention-deficit/ hyperactivity disorder, and type-2 diabetes are occurring worldwide and can be explained by changes in the human epigenome. Nutrients and dietary chemicals can alter or modify the expression of genes and impact their behavior patterns across generations. [(1)] Nutritional epigenetics is the field of research where scientists study the effects of nutrients and dietary chemicals on gene expression. [(2), (3)] The inheritable and reversible patterns of gene expression result from changes in DNA chromatin structure, which occur most commonly through mechanisms of methylation. [(2)] Genes may be methylated (silenced) or demethylated (turned on) at distinct locations in the human genome, which contains all of the genes. Inheritable DNA methylation patterns are reversible depending on prenatal dietary exposures to nutrients and dietary chemicals. [(3), (4)]

Dietary chemical exposures

Dietary chemical exposures may vary depending on food manufacturing and agricultural practices. Dietary chemicals enter the food supply directly as food ingredients and allowable residues or indirectly as contaminants. Food quality depends on food ingredients and pesticide safety regulations, which vary by country and, in some cases, by geographic region. In the United States, for example, the Food and Drug Administration regulates petroleum-based food colors by certifying each batch to ensure the heavy metal impurities do not exceed the allowable levels. [5], [6] For example, each batch of yellow #5 (E-102) and yellow #6 (E-110) may contain up to 10ppm lead (Pb), 3ppm arsenic (As), and 1ppm mercury (Hg). [6] In the European Union and the United Kingdom, any product containing these two petroleum-based food color ingredients must be labeled with the warning 'May have an adverse effect on activity and attention in children.' [7]

Dietary chemical exposures from consuming ultra-processed foods impact gene behavior Yellow #5, Yellow #6, and high fructose corn syrup are examples of ingredients in ultra-processed food products that may contain specific heavy metal residues and lead to harmful zinc losses in the body. [6], [8], [9], [10] Consumption of any dietary chemical or ingredient known to cause zinc loss or deficiency can impact metallothionein (MT) gene behavior and lead to the bioaccumulation of heavy metals in blood and other tissues. [10], [11], [12] The MT gene provides the instructions for building metallothionein proteins, which are made up, in part, of zinc and copper atoms bound to cysteine molecules. [13] MTs serve as metal transporter proteins in the body and play a key role in heavy metal detoxification and elimination. [13]

Children with autism and ADHD are frequently zinc deficient and, therefore, have difficulty eliminating heavy metals due to MT gene disruption. [10], [12], [13] Consequently, they tend to bioaccumulate Cd, Pb, and/or Hg, and the severity of their symptoms correlates directly with the heavy metal levels found in their blood. [14], [15], [16]

Changes in epigenome caused by co-exposures to dietary chemicals

Co-exposures to dietary and other chemicals from the consumption of ultra-processed foods may impact child development and gene methylation patterns across generations. In one recent study, researchers found prenatal co-exposures to organophosphate (OP) pesticide and Pb residues, along with an unhealthy ultra-processed food diet, resulted in a significantly higher risk of ADHD in the human offspring. [17] In another recent study, researchers found that a family history of an unhealthy diet affects DNA methylation patterns in tissues, which creates conditions for the development of insulin resistance in offspring and predisposes them to type 2 diabetes. [18] An unhealthy maternal diet high in ultra-processed foods results in poor prenatal nutrition and creates changes in the human epigenome. [18], [19] Preventing unhealthy diets in pre- and post-pregnancy can, therefore, reduce autism and ADHD prevalence in children. Nutritional epigenetics education intervention programs can now be used to protect the human epigenome from further harm and promote healing.

Nutritional epigenetics education interventions

Dr Dufault and her collaborators at the non-profit Food Ingredient and Health Research Institute were the first in the world to develop nutritional epigenetics models to explain autism and ADHD. [1], [10], [16] They created a curriculum for differentiated nutritional epigenetics instruction that was used successfully during a clinical trial to reduce parental ultra-processed food intake significantly. [20] Parents who participated in the clinical trial also significantly increased their intake of whole, unprocessed foods. [20] When parents understand gene expression behavior patterns from a nutritional epigenetics point of view, they are better equipped to prevent disorders of development in their children.

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