jem
journal für ernährungsmedizin

Epigenetics and Human Health

Journal für Ernährungsmedizin 2010; 12 (1), 26-27

Erschaffen Sie sich Ihre ertragreiche grüne Oase in Ihrem Zuhause oder in Ihrer Praxis

Mehr als nur eine Dekoration:

- Sie wollen das Besondere?
- Sie möchten Ihre eigenen Salate, Kräuter und auch Ihr Gemüse ernten?
- Frisch, reif, ungespritzt und voller Geschmack?
- Ohne Vorkenntnisse und ganz ohne grünen Daumen?

Dann sind Sie hier richtig

Book: Epigenetics and human Health

LINKING HEREDITARY, ENVIRONMENTAL AND NUTRITIONAL ASPECTS

Evidences gather that epigenetics is a central mechanism in the interaction between environment, nutrition, gene responses and health.

Carolin Berner, Stefanie Engle, Alexander G. Haslberger

The term epigenetics describes mechanisms inducing changes in gene expression or phenotype not caused by alterations in the underlying DNA sequence. Compared to the genome, which is almost identical in different cell types and consistent throughout life, the epigenome is varying between different cell types as well as over the course of a lifetime (1). Twin studies demonstrated, that identical twin pairs, being epigenetically indistinguishable at early life exhibit striking differences in epigenetic patterns, as over time they accumulated significant differences in global levels of epigenetic marks (2).

It is becoming increasingly evident that distinct nutritional stimuli are able to alter the DNA configuration at critical ontogenic stages as well as that these alternations persist in gene expression. Occurring in the gametes these changes may be heritable and they are affected from the moment testes and ovaries develop during foetal growth (3-5). A meanwhile famous study of how maternal nutrition affects the epigenetic state of the unborn addresses the Dutch hunger winter 1944-45. The methylation of the IGF2, which plays a crucial role in growth and development, was investigated in individuals exposed to the famine periconceptionally. All CpG sites except one were significantly less methylated than unexposed controls (6).

Disregulation of epigenetic processes is involved in the initiation and progression of several diseases. Compared to genetic alternations epigenetic aberrations are potentially reversible and therefore are exciting targets for potential chemoprevention strategies and therapies (7, 8). Next to numerous synthetic epigenetic chemotherapeutics a multitude of biologically active food compounds have been described to impact epigenetic pattern directly by enzyme activity interference and indirectly by metabolic processes associated with energy metabolism (9).

> ... a multitude of biologically active food compounds have been described to impact epigenetic pattern directly and indirectly

Food components, participating in the one-carbon metabolism, including vitamine B12, vitamine B6, folate, choline and methionine provide methyl groups for the biochemical pathway of methylation processes. Epidemiological data reveal diminished dietary folate induced inhibition of DNA methylation to be associated with increased cancer susceptibility and low folate status is linked to higher risk in developing colorectal cancer (10, 11). Several more bioactive food components have also been suggested to alter cancer susceptibility. Genistein, e.g. was associated with cancer chemoprevention and decreased DNA methyltransferases expression (12). Interestingly most dietary HDAC inhibitors identified so far have been strongly linked to cancer chemoprevention. There is also evidence that oxidative stress can inhibit HDAC activity and enhance inflammatory gene expression, leading to a chronic inflammatory response (13). Furthermore, the histone deacetylase SIRT1 mediates the effects of dietary restriction. Resveratrol, a dietary polyphenol, appears to be a dietary mimetic of some effects of dietary restriction by activating SIRT1 (14).
Due to the central role epigenetics plays in mediating environmental and nutritional effects on hereditary disposed genes as well as transgenerational and evolutionary aspects, the book assembles work from these different areas.

The first articles in the book emphasize on the interactions between concepts of genetic diversity, epigenetics, environmental health, molecular epidemiology, nutrition and evolution theory. Paolo Vineis describes epigenetics as a new paradigm for research: "It refers not to structural but to functional changes in DNA (gene regulation). We are observing continuous quantitative changes, i.e. nature seems to work in degrees, not according to leaps like mutations: the ratio between hypo- and hyper-methylation, for example, seems to be very relevant to cancer. Epigenetic changes are reversible: animal experiments have been conducted with dietary supplements that were able to reverse methylation patterns. Epigenetic patterns seem to be heritable (though this may be the weakest part, since the evidence is not entirely persuasive). Epigenetic changes fill the gap between genes and the environment: the mysterious relationships between (spontaneous) heritable mutations and selection in neodarwinian theory may be overcome by a more sophisticated paradigm that resembles Lamarck's research program ".

Ibrahim Elmadfa highlights the role of nutrition on gene regulation and its correlation with carcinogenesis, the prevalence of overweight and related metabolic diseases. Fritz Schiemer, coming from ecology, identifies epigenetics as a main research priority for an improved understanding of the interactions between human societies and their environment. The working group of Alexander Haslberger focused on the interaction of hereditary and epigenetic mechanisms in the regulation of gene expression on the molecular level. They explain epigenetic mechanisms and what consequences environmental influences like diet and toxins can have on the immune system and aging.

Part II emphasizes on hereditary aspects: Stefania Boccia illustrates some key concepts of genetic association studies with the core area of meta-analysis. She reports on a systematic review of the published meta-analyses of the effect of methylenetetrahydrofolatereductase gene polymorphisms on cancer risk. The group of Kurt Zatloukal discusses the challenges faced by biobanks and for investigation of gene-environment interactions with the example of non-alcoholic fatty liver disease. Gunnar Kaati summarizes case studies on epigenetic inheritance and asks for transgenerational effects because of nutritional constraints during key fetal organ development and other critical phases of the life cycle.
Chemical compounds can modify the rate of carcinogenesis by affecting mutation frequency, growth rate, or expression of phenotypic deviations. Wilfried Bursch highlights the importance of chemicals to induce epigenetic effects in safety evaluation with the example of hepatocarcinogenesis. The gropup of Sigfried Knasmüller summarizes groups of food carcinogen as a basis for epigenetic evaluation. They discuss occurrence, modes of action and modulation of human risks by genetic factors and dietary constitutents.

Part IV extends on nutritional aspects. Guy Vergères describes technologies used in nutrigenomics, nutrigenetics and nutri-epigenetics along the –omics cascade and illustrates the research strategies with examples. Stefanska and Fabianowska-Majewska give a short overview of the mechanisms of DNA methylation inhibition by the selected bioactive food components and their potential use in cancer prevention and epigenetic therapy. Petra Rust finishes this chapter by discussing the need for personalized nutrition. She highlights the challenges for personal dietary advice when identifying individual risk factors considering the genetic diversity of populations, the complexity of foods, cultures and lifestyles, and the variety of metabolic processes.

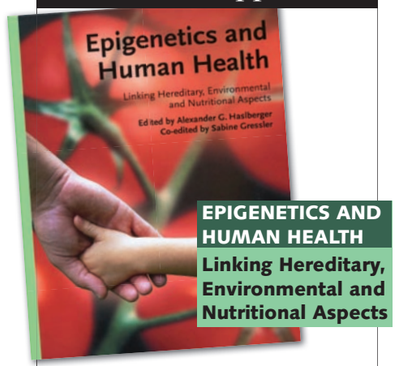
> Epigenetic changes are reversible: animal experiments have been conducted with dietary supplements that were able to reverse methylation patterns.
>
> Paolo Vineis

In Part V the new understanding of epigenetics and environmental health interactions is detailed in case studies of fields such as gynecology, oncology, infectious diseases, asthma, or neurodegenerative diseases by the groups of Johannes Huber, Heidrun Karlic, Despina Komninou, Lucia Migliore, Robert Mader, Borut Beterlin, Rachel Miller. The last Part explores concepts to translate the new understanding into public health policies and strategies including principal ethical aspects. Tobias Schulte in den Bäumen and Angela Brand discuss the problems public health experts and health policy makers have to face with the emerging fields in genomic research. They introduce the field of Public Health Genomics as a translational research and the Public Health Genomics European Network (PHGEN) as a successful platform for researchers, policy makers and their institutions in organizing this process. Astrid Gescheh argues for an integrated, ethically sound policy framework in public health from which to deal with emerging social, ethical and legal issues in the expanding area of epigenetics.

> ...asks for transgenerational effects because of nutritional constraints during fetal organ development and other critical phases in life cycle.

Berner C., Engle S., Haslberger A.G,
Dep. for Nutritional Sciences, University of Vienna,
alexander.haslberger@univie.ac.at

Buchtipp



Haslberger, Alexander / Greßler, Sabine (Hrsg.)
Wiley-VHC, 2009

REFERENCES:

1. Szyf M. DNA methylation and demethylation as targets for anticancer therapy. Biochemistry (Mosc). 2005 May;70:533-49.
2. Fraga MF, Ballestar E, Paz MF, Ropero S, Setien F, Ballestar ML, Heine-Suner D, Cigudosa JC, Urioste M, et al. Epigenetic differences arise during the lifetime of monozygotic twins. Proc Natl Acad Sci U S A. 2005 Jul 26;102:10604-9.
3. Dolinoy DC, Das R, Weidman JR, Jirtle RL. Metastable epialleles, imprinting, and the fetal origins of adult diseases. Pediatric research. 2007 May;61:30R-7R.
4. Jirtle RL, Skinner MK. Environmental epigenomics and disease susceptibility. Nature reviewsGenetics. 2007 Apr;8:253-62.
5. Dolinoy DC, Jirtle RL. Environmental epigenomics in human health and disease. Environ Mol Mutagen. 2008 Jan;49:4-8.
6. Heijmans BT, Tobi EW, Stein AD, Putter H, Blauw GJ, Susser ES, Slagboom PE, Lumey LH. Persistent epigenetic differences associated with prenatal exposure to famine in humans. Proc Natl Acad Sci U S A. 2008 Nov 4;105:17046-9.
7. Dashwood RH, Myzak MC, Ho E. Dietary HDAC inhibitors: time to rethink weak ligands in cancer chemoprevention? Carcinogenesis. 2006 Feb;27:344-9.
8. Myzak MC, Dashwood RH. Histone deacetylases as targets for dietary cancer preventive agents: lessons learned with butyrate, diallyl disulfide, and sulforaphane. Curr Drug Targets. 2006 Apr;7:443-52.
9. Johnson IT, Belshaw NJ. Environment, diet and CpG island methylation: epigenetic signals in gastrointestinal neoplasia. Food Chem Toxicol. 2008 Apr;46:1346-59.
10. Rowling MJ, McMullen MH, Chipman DC, Schalinske KL. Hepatic glycine N-methyltransferase is up-regulated by excess dietary methionine in rats. J Nutr. 2002 Sep;132:2545-50.
11. Rowling MJ, McMullen MH, Schalinske KL. Vitamin A and its derivatives induce hepatic glycine N-methyltransferase and hypomethylation of DNA in rats. J Nutr. 2002 Mar;132:365-9.
12. Li Y, Liu L, Andrews LG, Tollefsbol TO. Genistein depletes telomerase activity through cross-talk between genetic and epigenetic mechanisms. Int J Cancer. 2009 Jul 15;125:286-96.
13. Dashwood RH, Ho E. Dietary agents as histone deacetylase inhibitors: sulforaphane and structurally related isothiocyanates. Nutr Rev. 2008 Aug;66 Suppl 1:S36-8.
14. Wakeling LA, Ions LJ, Ford D. Could Sirt1-mediated epigenetic effects contribute to the longevity response to dietary restriction and be mimicked by other dietary interventions? Age (Dordr). 2009 Jul 1.