Epigenetics, Genomics and Nutrigenomics: A Nutrition Perspective

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## Faculty Disclosure

<table>
<thead>
<tr>
<th>Commercial Interest</th>
<th>Nature of Relevant Financial Relationship (Include all those that apply)</th>
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<td>• Genova Diagnostics</td>
<td>• Honoraria</td>
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Presentation Learning Objectives

After participating in this presentation, learners should be better able to:

• Understand the scientific concepts that define nutrigenomics

• Identify how these concepts may be applied in clinical practice
Overview

• Nutrition in the 21st Century
• The Science of Nutrigenomics
• Epigenomics
• Foodomics
• Dietary Recommendations Based on Nutrigenomics
• Clinical Applications of Nutrigenomics
Overview

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Nutrition is complex with many variables

- 200 decisions every day about food/eating
- We eat ~1.5 kg food & drink ~2 L liquid/day;
- About 40 essential nutrients are known;
- 10,000+ phytonutrients
- Thousands of unknown/known compounds in foods without known biological functions;
- About $10^{13}$ cells in the body & about $10^{14}$ bacteria in the GI tract;
- Mostly unknown and complicated interplay between diet and the microbiome;
- Many organs & some hundreds of cell types are found in the body;
- About 25,000 genes in human cells;
- Human genome includes 3 billion base pairs;
- Some millions single nucleotide polymorphisms (SNPs);
- A large epigenetic variation between individuals due to environmental factors;
- About 100,000 transcripts (mRNA);
- About 100,000 proteins;
- About 1000 lipids & thousands of water-soluble metabolites.

21st Century Overhauls in Scientific Thinking

Want to Know My Future?

New genetic tests can point to risks—but not always a cure
BY BONNIE ROCHMAN

Eat Butter.
Scientists labeled fat the enemy. Why they were wrong
BY BRYAN WALSH
Forecasting Nutrition Research in 2020

1. Global food security
2. Microbiome/microflora
3. Gene expression
4. Energy metabolism
5. Cancer
6. Inflammation
7. Aging
8. Bioengineering
9. Nutrition education
10. Interdisciplinary and cross-discipline collaboration

Commentary
Forecasting Nutrition Research in 2020

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Keywords: clinical nutrition, obesity, microbiome, gene expression, nutrition education, public health

Advances in nutrition during the past century have helped untold millions of people around the world enjoy healthier and longer lives and be more productive members of society. These advances include the identification of numerous essential nutrients, the identification of common disease states that can arise as a consequence of deficiencies of these essential nutrients, the use of food fortification to correct common deficiencies in the diet, and improvements in agricultural practices and food processing that have resulted in marked advances in food safety and quality. However, many challenges still remain. To a significant extent, these challenges reflect expectations of what constitutes a good diet and what the result of following food guidelines will produce. Moving forward in an era of limited economic resources and aging populations, a critical focus is required to direct attention to the most pressing challenges with the greatest need and opportunity for return on investment. Balancing the desire for quick and effective solutions with the slow, steady, and incremental nature of nutrition research is a struggle confronting academia, industry, and government.

To address these challenges, a group of distinguished nutrition scientists gathered for a panel symposium in celebration of the 10th anniversary of the Konova Distinguished Lecture in Nutrition at the University of California, Davis. Eight of the panels were previous Konova Distinguished Lecturers. The symposium discussion revolved around 2 questions that were posed to the panel members prior to the meeting: (1) What will be the “hottest” areas of nutrition research in 2020 and (2) were we just starting a career in nutrition, what would be a reasonable focus for one’s work? A distillation of the discussion follows, organized from the most global to the most individual topics, with some concluding thoughts on the nature of nutrition research.

WHAT WILL BE THE “HOTTEST” AREAS OF NUTRITION RESEARCH IN 2020?

Global Food Security

Collectively, global food security, food safety, and sustainability are among the most pressing topics in nutrition research in 2020. Global concerns regarding ways to satisfy food needs for more than 8 billion people on Earth by 2050 in the face of global climate change will likely overshadow the microcosms of issues on a local or national level. Even if client food may be available to feed everyone on Earth by 2050, but economic and political issues will likely hinder appropriate distribution. Water is an essential nutrient, and access to clean water is also among the most pressing global health challenges.

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Forecasting Nutrition Research in 2020

Gene Expression

- Human genome
- Microflora microbiome
- Nutrient influences (phytochemicals)
- Transgenerational effects
The Human Disease Network

Systems Biology Network Medicine

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Food Is...

- Medicine
- Connection
- Information
“...we are witnessing food being redefined as “information” that alters cellular function in the post-prandial state...The message is translated to the cell through a complex web of enzymes called kinases, which, through their activation or inhibition, alter genetic expression of a cell and change its function in response to the message.”
Cell Signaling Cascade

Food sends signals to genes

http://www.uic.edu/classes/bios/bios100/mike/spring2003/lect07.htm
Nutrigenomics = Food is Information

- Gene expression or DNA is modified by the action of nutrients and bioactive food components.
- Modification can occur directly or indirectly.
- Chronic disease onset, incidence, progression, and/or severity influenced by diet-regulated genes and their common variants.
The Many Layers of Food and Informational Signals

- SAD vs. Mediterranean Diet
  - Organically grown or conventional?
  - GMO or non-GMO?
  - Combinations of food
  - Eating circumstances
Nutrigenomics allows us to question current dogma

- Food is more than calories.
- A calorie is a calorie.
- Bad foods give you disease unless you have genes to intervene and protect you.
New concepts to ‘digest’

• Food is full of informational signals.
• A calorie is to be judged upon the context it comes from.
• We are continually interacting with dietary signals, in which certain foods enhance a beneficial, neutral or negative effect on genes.
All carbohydrates are not created equal.

- Study with subjects on two different diets of exactly the same number of calories and grams of CHO
- Different types of CHO
  - Rye
  - Oat, wheat and potato
- Needle biopsy of adipose tissue revealed an upregulation of inflammatory and stress genes in the high glycemic (o/w/p group)
- “Dietary carbohydrate modification with rye vs. oat, wheat and potato differentially modulates the gene expression profile in abdominal subcutaneous adipose tissue, even the absence of weight loss.”

The power of non-nutritive phytonutrients

- Acute dietary study
- 2-day standard phytochemical diet
- 2-day low-phytochemical diet
- No significant differences were found between the 3 diets for total energy, protein, carbohydrate, or fat intakes.
- “The results indicate that a varying phytochemical consumption can contribute to differences in urinary metabolic profiles.”

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But, we know that we are more than our genes...
The Gene-Environment Dynamic

Genome-transcriptome-proteome

Environmental perturbations

Inflammation
Thrombosis Hemorrhage
Fibrosis

Intermediate pathophenotypes

Immune response
Cell proliferation
Apoptosis Necrosis

Distinct pathophenotypes: clinical syndromes and diseases
An Essential Nexus for Clinical Nutrigenomics: SNPs

- 30,000 genes in human chromosomes
- 50% of genome – repetitive sequence
- About 1 SNP (“gene variant”) for every 1000 genes
- Influence drug response and disease risk (multi-genetic influence)
- May lead to different nutrient requirements due to the different function and metabolism

SNPs and High-Dose Nutrients

- SNP-regulated enzymes exhibit reduced functionality due to reduced cofactor or coenzyme binding.
- About 30% of the 1000 disease phenotypes related to SNP polymorphisms exhibit reduced enzyme binding.
- At least 50 diseases shown to respond to high-dose nutrient supplements.
- “Our analysis of metabolic disease that affects cofactor binding, particularly as a result of polymorphic mutations, may present a novel rationale for high dose vitamin therapy, perhaps hundreds of times the normal dietary reference intake in some cases.”

Ames et al., AJCN. 2002; 75:616-658
Epigenetics: The Wild Card

• Heritable changes that do not impact gene sequence.
• Modification to gene sites or histone proteins
  – Methylation
  – Phosphorylation
  – Acetylation
  – Ubiquinylation

Nutrition in Clinical Practice 20:75-87, February 2005
General examples of the gene-environment interaction

- Warrior genes in environmental excess
- Pima Indians in the Southwest get type 2 diabetes at eight times the rate of white Americans.
- Individuals have widely varying responses to high- or low-fat diets, wine, salt, even exercise.
- Adverse reactions to drugs and drug/nutrient interactions
- Famine and transgenerational fetal programming
- Stressed signals from foods translating into inflammation
Sodium Restriction & HTN

• Varying degrees of salt sensitivity exist
• Is it universally beneficial?
• Lack of assessments and genotypic analyses
• Population-specific effects
• Specific gene variants identified, clinical application lacking
  – Bradykinin receptor B2 gene
  – Endothelin converting enzyme 1 gene
• Could be influenced by environmental factors such as degree of physical activity
Dietary Cholesterol and Hypercholesterolemia

- Dietary limitation of 300 mg cholesterol daily for Americans
- Current epidemiological evidence does not support the correlation between dietary cholesterol and increased CHD risk
- About ¼ of population is sensitive to dietary cholesterol and responds with increased plasma LDL, but with a compensatory rise in HDL
- Dietary cholesterol may help to reduce small dense LDL particles
- Egg consumption variability between diabetics and non-diabetics

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Foodomics is the comprehensive, high-throughput approach for the exploitation of food science in the light of an improvement of human nutrition.

Foodomics is a new approach to food and nutrition that studies the food domain as a whole with the nutrition domain to reach the main objective, the optimization of human health and well-being.

Food synergy

Reducing dietary recommendations to individual nutrients without considering the whole food and its multitude of constituents, including phytonutrients, may not be accounting for “food synergy”.
Phytoprofiling

The role of phytochemical modulation of cellular physiology and propose phytochemical profiling, or phytoprofiling, to assist in the facilitation of determining phytonutrient requirements with more effective interventions with plant-derived compounds.
Phytoprofiling: The Role of Color

- Associations of colors of fruits and vegetable subgroups and cardiometabolic risk factors
- 3-year changes of cardiometabolic risk factors in adults
- Higher intake of red/purple FV may be related to lower weight and abdominal fat gain
- Yellow, green and white FV may be related to lipid parameters.

Eur J Clin Nutr. 2015 Apr 8. doi: 10.1038/ejcn.2015.49. [Epub ahead of print]
The New Frontier for Nutrigenomics: Phytonutrients to Modulate Cellular Signaling
Targeted Supplemental Nutrients to Overcome Dysfunctional Cell Signaling

Perhaps phyttonutrients are only as good as our gut microbiome.
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Now that we have broken ground on nutrigenomics, where is the clinical translation?
Can we truly tailor food and dietary supplements in a personalized gene and epigenetic approach?
One-size-fits-all eating

USDA and US Department of Health and Human Services lifestyle recommendations:

1. Prevent overweight and obesity
2. Control calorie intake to manage body weight
3. Increase physical activity and reduce time spent in sedentary behaviors

One-size-fits-all eating

1. Reduce **daily sodium intake** to less than 2300 mg; further reduce intake to 1500 mg for those 51 yrs+
2. Consume less than 10% of calories from **saturated fat**, replace with mono- and poly-unsaturated fat
3. Consume less than 300 mg of **dietary cholesterol**
4. Keep **trans fat** as low as possible
5. Reduce intake of calories from **solid fats and added sugars**
6. Limit consumption of foods that contain **refined grains**
7. Consume **alcohol** in moderation – one drink daily for women; two for men.

Similar Dietary Recommendations

(1) American Heart Association for CVD risk reduction
(2) American Cancer Society
(3) American Diabetes Association
“Nutritionism” slowly phasing out and being replaced with personalized, nutrigenomics-based lifestyle approaches to health in the 21st century.
Nutrigenomics + Epigenetics + Phenotype + Environment + Foodomics + Genetics + Taste Preferences + Sociogenomics

Network of associations between dietary intake, adipose gene expression, and phenotypic markers. Green nodes: nutrients; yellow: lipid, fatty acid, and apolipoprotein variables in blood; red: inflammatory and oxidative stress markers in blood; blue: gene expression (enzyme) in adipose tissue. Solid line: positive correlation/covariance; dashed line: negative correlation/covariance.

Diet for your DNA

People are ready, but is technology?

"Nutrigenomics has the potential to be the next big thing in our fight against lifestyle-linked diseases…"

– Dr. Lynn Frewer
The future direction of personalized nutrition: my diet, my phenotype, my genes

Personalized nutrition currently exists at three levels:

- Internet-delivered services
- Personalized dietary advice using phenotypic information to get a “metabotype” (anthropometry, physical activity, clinical parameters, biochemical markers)
- Genomic data - Epigenomic?
Examples of nutrigenomic approaches

- Iron need and iron transport polymorphisms
- Zinc need and polymorphisms
- Vitamin D requirement for diabetics with polymorphisms in the vitamin D receptor
- The influence of polymorphisms on coenzyme Q10 (CoQ10) need for energy production and its role in cerebellar ataxia
- Folate, MTHFR polymorphisms and depression
- B vitamin gene variants and risk to smoking induced lung cancer
- Antioxidants and polymorphisms in glutathione S-transferases (GST)
- Bitter tasting and body composition differences
Food modulates genetic variants that relate to changes in apoA-V and triglyceride concentrations.

Figure 1: Genotype effect of APOA5 -1131 T>C on mean percent changes in fasting apolipoprotein A-V and triglyceride by whole grains and legumes and refined rice groups at 12 weeks. Means ± SE. P-values derived from an independent t-test after adjusting for change in HOMA-IR. HOMA-IR, homeostatic model assessment; TG, triglyceride.
Can including genetic information to personalize a patient's diet (nutrigenetics) improve long-term weight management?

- N=50 patients in genetic group; N=43 patients in control group
- Standard Mediterranean diet, modified for nutrigenetic group
After 300 days of follow-up individuals in the nutrigenetic group were more likely to have maintained some weight loss (73%) than those in the comparison group (32%).
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Personalized Approaches to Nutrition & Dietary Supplements
MTHFR Polymorphisms
Conditions associated with folate metabolism

- Alzheimer’s Disease
- Anxiety
- Cancer
- Cognitive Decline
- Depression
- Heart Disease and Stroke
- Obsessive Compulsive Disorder
- Spina Bifida and NTDs
The Modern Day Genetic Variant

- MTHFR 677 C->T polymorphism
- Homozygous expression of 677 TT (~33%)
  - Small-scale intervention studies to support the hypothesis that these individuals may have higher folate requirements.
  - Risk for vascular and neoplastic diseases, neural tube defects
  - TT could have a protective effect such as in the Physicians Health Study with men showing 55% lower risk for colorectal cancer, but protective effect lost when folate status impaired.
Clinical Practice Experience with MTHFR Polymorphisms and Methylfolate

- 30 patients, 8 physicians
- Patients reported improvements in physical (60%) and mental/behavioral symptoms (36%) following treatment.
- A minority of participants reported side effects, but they occurred in almost every body system and ranged in severity. Doctors relied on trial and error to determine treatment doses, frequency and components.
- However, patients report largely positive experience.
- MTHFR testing results in variable clinical processes in domains related to delivery of diagnosis and prognosis, and therapeutic options.
- Clinicians and patients would benefit from therapeutic algorithms based on rigorous research.

Bitter Taste Receptor Polymorphisms
The Metabolic Benefits of Bitter Bio-Actives

Humans are capable of sensing five basic tastes: sweet, sour, salt, umami and bitter.

Bitter taste is sensed by bitter taste receptors (T2Rs) that belong to the G-protein coupled receptors (GPCRs) superfamily.

Humans have T2Rs that are expressed in the oral cavity, gastrointestinal (GI) neuroendocrine cells and airway cells.

Potential Bitter Compounds to Modulate in Diet & Supplements

- Green tea catechins
- Soy isoflavones
- Hops polyphenols
- Caffeine
- Bitter melon
- Berberine
- Fenugreek

TASTE RECEPTORS
In particular, the frequency of A/A homozygotes increases gradually from 35% in subjects aged 20 to 70 up to 55% in centenarians.
Gut effects of bitter tastants
Bitter tasters have lower BMI

Figure 2: Mean adiposity measures in women classified by PROP phenotype. Nontaster women had significantly higher BMI, body fatness, and triceps skinfold than supertaster women. No group differences were found for WC (see inset). *p < 0.05; **p < 0.01.

Do polymorphisms in chemosensory genes matter for human ingestive behavior?

*TAS2R38* predicts variation in bitterness of synthetic pharmaceuticals (e.g., propylthiouracil) and natural plant compounds (e.g., goitrin), and this variation associates with differential intake of alcohol and vegetables.

Green, leafy vegetables & T2DM


"An increase of 1.15 servings a day was associated with a 14% decrease in incidence."
To soy or not to soy?
Dietary Soy and Cancer

- Population differences
- Type of soy
- Type of tumor
- Polymorphisms

- Epigenetic mechanisms of isoflavones
- Gut microflora conversion to metabolites
Fish oil supplementation
Omega-3 Fatty Acids and APOE

- APOE genotype response to EPA and DHA
- APOE4 carriers may experience an increase in total cholesterol and LDL-C with DHA supplementation

“High dose DHA supplementation is associated with increases in total cholesterol in E4 carriers, which appears to be due to an increase in LDL-C and may in part negate the cardioprotective action of DHA in this population subgroup.”

Detoxification Pathway Polymorphisms
Food Intolerances

- Involvement of immune system
- Possible enzyme deficiency or inadequacy
- Detoxification of colonic bacteria-generated metabolites
- Individual food substances and food classes – histamines, sulfites, nightshades, gluten, phenylethylamine (PEA) in chocolate, casein, lactose, oxalates
Individualized Toxin Exposure

- Air
- Food
- Water
- Drugs
- Radiation
- Internally-generated metabolites
  - Inflammation, lipid peroxidation, oxidative stress, disease states, infections, and microflora
TAILORING FOODS TO EXPOSOMIC PATHWAYS

1. Phase I Cytochrome Systems
2. Phase II Conjugation Enzymes
3. Antioxidant Response Element/Nrf2
4. Metallothionein Response Element

Review Article
Modulation of Metabolic Detoxification Pathways Using Foods and Food-Derived Components: A Scientific Review with Clinical Application

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Research into human biotransformation and elimination systems continues to evolve. Various clinical and in vivo studies have been undertaken to evaluate the effects of foods and food-derived components on the activity of detoxification pathways, including phase I cytochrome P450 enzymes, phase II conjugation enzymes, Nrf2 signaling, and metallothionein. This review summarizes the research in this area to date, highlighting the potential for foods and nutrients to support and/or modulate detoxification functions. Clinical applications to alter detoxification pathway activity and improve patient outcomes are considered, drawing on the growing understanding of the relationship between detoxification functions and different disease states, genetic polymorphisms, and drug-nutrient interactions. Some caution is recommended, however, due to the limitations of current research as well as indications that many nutrients exert biphasic, dose-dependent effects and that genetic polymorphisms may alter outcomes. A whole-foods approach may, therefore, be prudent.

1. Introduction

Food-based nutrients have been and continue to be investigated for their role in the modulation of metabolic pathways involved in detoxification processes. Several publications to date have leveraged cell, animal, and clinical studies to demonstrate that food-derived components and nutrients can modulate processes of conversion and eventual excretion of toxins from the body [1]. In general, the nature of these findings indicates that specific foods may upregulate or favorably balance metabolic pathways to assist with toxic biotransformation and subsequent elimination [2, 3]. Various whole foods such as cruciferous vegetables [2, 4, 5], berries [6], soy [7], garlic [8, 9], and even spices like turmeric [10, 11] have been suggested to be beneficial and commonly prescribed as part of naturopathic-oriented and functional medicine-based therapies [12, 13].

While these foods are important to note, the science in this active area of inquiry continues to evolve to reveal new findings about food-based nutrients and their effect on health. Thus, the purpose of this review article is to summarize the science to date on the influence of whole foods, with a special focus directed toward phytonutrients and other food-based components, on influencing specific metabolic detoxification pathways, including phase I cytochrome enzymes, phase II conjugation enzymes, antioxidant support systems, and metallothionein upregulation for heavy metal metabolism. Based on this current science, the paper will conclude with clinical recommendations that may be applied in a personalized manner for patients via the discretion of a qualified health professional.

2. The Metabolic Pathways of Detoxification

Discussion of physiological pathways for detoxification has been mainly centered around phase I and phase II enzyme systems. This review will cover phase I cytochrome P450...
**In vivo example phytonutrient INDUCERS of CYP1 enzymes**

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<th>Food or Bioactive</th>
<th>Type of Study</th>
<th>Reference</th>
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<td>Resveratrol</td>
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<td>Curcumin</td>
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<td>Garlic oil</td>
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<td>Fish oil</td>
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<td>B-Apo-8’-carotenal</td>
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<td>Cruciferous vegetables</td>
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### In vivo example phytonutrient INHIBITORS of CYP1 enzymes

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<td>Moon et al., 2006</td>
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<tr>
<td></td>
<td>Chamomile and peppermint tea</td>
<td>In vivo</td>
<td>Maliakal &amp; Wanwimolruk, 2001</td>
</tr>
<tr>
<td></td>
<td>Dandelion tea</td>
<td>In vivo</td>
<td>Thapliyal &amp; Maru, 2001</td>
</tr>
<tr>
<td>CYP1B1</td>
<td>Curcumin (implant)</td>
<td>In vivo</td>
<td>Bansal et al., 2014</td>
</tr>
</tbody>
</table>

### In vivo example phytonutrient INDUCERS of Glutathione S-transferases (GSTs)

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Food or Bioactive</th>
<th>Type of Study</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSTs</td>
<td>Crabuniferous vegetables(^1)</td>
<td>Clinical, observational</td>
<td>Navarro et al., 2009; Wark et al., 2004; Lampe et al., 2000</td>
</tr>
<tr>
<td></td>
<td>Allium vegetables(^2)</td>
<td>Clinical</td>
<td>Lampe et al., 2002</td>
</tr>
<tr>
<td></td>
<td>Resveratrol(^3)</td>
<td>Clinical</td>
<td>Chow et al., 2010</td>
</tr>
<tr>
<td></td>
<td>Habitual fruit and vegetable consumption</td>
<td>Observational</td>
<td>Wark et al., 2004</td>
</tr>
<tr>
<td></td>
<td>Citrus</td>
<td>Observational, in vivo</td>
<td>Perez et al., 2010; Wark et al., 2004</td>
</tr>
<tr>
<td></td>
<td>Garlic</td>
<td>In vivo</td>
<td>Chen et al., 2003; Wu et al., 2002; Guyonnet et al., 2001</td>
</tr>
<tr>
<td></td>
<td>Fish oil</td>
<td>In vivo</td>
<td>Chen et al., 2003</td>
</tr>
<tr>
<td></td>
<td>Black soybean</td>
<td>In vivo</td>
<td>Zhang et al., 2013</td>
</tr>
<tr>
<td></td>
<td>Purple sweet potato</td>
<td>In vivo</td>
<td>Hwang et al., 2011</td>
</tr>
<tr>
<td></td>
<td>Curcumin(^4)</td>
<td>In vivo</td>
<td>Iqbal et al., 2003</td>
</tr>
<tr>
<td></td>
<td>Green tea</td>
<td>In vivo</td>
<td>Newsome et al., 2014</td>
</tr>
<tr>
<td></td>
<td>Rooibos tea</td>
<td>In vivo</td>
<td>Marnewick et al., 2003</td>
</tr>
<tr>
<td></td>
<td>Honeybush tea</td>
<td>In vivo</td>
<td>Marnewick et al., 2003</td>
</tr>
<tr>
<td></td>
<td>Ellagic acid(^5)</td>
<td>In vivo</td>
<td>Celik et al., 2013</td>
</tr>
<tr>
<td></td>
<td>Rosemary</td>
<td>In vivo</td>
<td>Lin et al., 2014</td>
</tr>
<tr>
<td></td>
<td>High-CLA ghee</td>
<td>In vivo</td>
<td>Chinnadurai et al., 2013</td>
</tr>
<tr>
<td></td>
<td>Genistein (kidney GSTs)</td>
<td>In vivo</td>
<td>Froyen et al., 2009</td>
</tr>
</tbody>
</table>

Individuals with decreased UGT1A1 activity may be at greater risk for carcinogenesis, but they may modulate their risk through dietary intervention with cruciferous vegetables.
Foods for Personalization of Metabolic Detoxification Pathways

Glucuronidation
- Almond
- Apple
- Broccoli
- Carrot
- Chile pepper
- Cocoa
- Cranberries
- Halibut
- Pumpkin
- Sweet potato
- Turmeric

Sulfation
- Almonds
- Brazil nuts
- Egg
- Leek
- Onion
- Potato
- Scallops
- Spinach

Glutathione
- Apples
- Artichoke hearts
- Asparagus
- Cruciferous vegetables
- Eggs
- Green tea
- Oats
- Pomegranate
- Red peppers
- Sprouted lentils
- Turmeric
- Yogurt

Methylation
- Banana
- Beans
- Beets
- Broccoli
- Brussels sprouts
- Cabbage
- Cauliflower
- Eggs
- Legumes
- Potato
- Soy foods
- Spinach
- Sweet potato

Source: The Detox Prescription, Woodson Merrell, MD, 2013
THE FUTURE OF NUTRITION:

Interface between nutrition with lifestyle, psychology, environment, and physiology/genes
A typical patient’s experience with Personalized Lifestyle Medicine

INITIAL
• Genetic tests run by major labs
• SNP evaluation
• Laboratory biomarkers
• Evaluation of physical symptomatology
• Assessment of lifestyle factors
  – Social networks
  – Stressors

ONGOING
• Tracking using applications
• Virtual coaches
“When comparing patients who received more than one visit with either form of consultation, the TM [telemedicine] group demonstrated substantially more improvement than the FTF [face-to-face] group in improving nutrition (88% versus 65%), increasing activity (76% versus 49%), and decreasing screen time (33% versus 8%).”

## Personalized Lifestyle Medicine Prescription

<table>
<thead>
<tr>
<th>Therapeutic Modality</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| **Food & Supplements**  | • No alcohol, reduced carbohydrate  
                          • Organically-grown foods  
                          • Phytoestrogenic foods  
                          • Foods with aromatase inhibitory qualities  
                          • Phytonutrient-dense foods to reduce inflammation and to protect skin (carotenoids)  
                          • Phytomethylators                                                                                                                                 |
| **Activity**            | Regular moderate exercise                                                                                                                                 |
| **Stress**              | Stress reduction practices (e.g., meditation, yoga)                                                                                                                                 |
| **Environment**         | Low-toxin load; Nutritional detoxification twice annually                                                                                                                                 |
Supplementary Resources

- Frontiers Journal: [http://www.frontiersin.org/Nutrigenomics](http://www.frontiersin.org/Nutrigenomics)
Summary

- There is a lot we now know about genes.
- There is a lot we still don’t know about genes and modulation of the epigenome.
- There is still less we know about nutrigenomic application to clinical medicine.
- Food (and eating) is (are) filled with informational signals delivered to our cells.
- Don’t rely solely on nutrigenetic testing for clinical application.
- See the whole picture of the patient and apply principles of personalized lifestyle medicine.
Presentation Clinical Actions

After participating in this presentation, clinicians should be better able to:

• Discuss the value of genetic testing in clinical practice
• Discuss how foods can be tailored to genes in a personalized way
Thank You!

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deanna@deannaminich.com