IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

The Evolution of Nutrition

Andrew Shao, IADSA Chair Scientific Council

IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

Evolution of the science of nutrition

April 27, 2016

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

Part I: The Early Days

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Part I: The Early Days

James Lind

- Public health challenges
  - Communicable disease, short life-span
  - Overt nutrient deficiency
- Scientific focus
  - Discovery of vitamins and essential minerals, hunger and malnutrition
- Basis for nutrition recommendations
  - Narrow and limited basis due to limited data and understanding

Part I: The Early Days

- Public health challenges
  - Communicable disease, short life-span
  - Overt nutrient deficiency
- Scientific focus
  - Discovery of vitamins and essential minerals, hunger and malnutrition
- Basis for nutrition recommendations
  - Narrow and limited basis due to limited data and understanding

Early nutrition

- Focused on eradicating diseases of nutrient deficiency
- Essential nutrient = substance that must be obtained from the diet; absence produces symptoms of deficiency disease
- Term “vitamins” – Derived from “vital amines”, initially described in 1912 by Casimir Funk

Early nutrition milestone: Discovery of vitamins

Public health challenge/epidemic

Inability to eradicate common challenges, conditions & diseases

"Trial and error" approach

Scientists observe that diets either cure disease or exacerbate conditions

Logic prevails

Eventually scientists identify the specific components in food responsible for the observed effects

Nutrient deficiency diseases

Commonly known nutrient deficiency diseases	Nutrient
Scurvy	Vitamin C
Rickets	Vitamin D
Blindness	Vitamin A
Red blood cell hemolysis	Vitamin E
Bleeding	Vitamin K
Beriberi	Thiamin
Pellegra	Niacin
Iron-deficiency anemia	Iron
Goitre	Iodine

Part I: The Early Days

- Public health challenges
  - Communicable disease, short life-span
  - Overt nutrient deficiency
- Scientific focus
  - Discovery of vitamins and essential minerals, hunger and malnutrition
- Basis for nutrition recommendations
  - Narrow and limited basis due to limited data and understanding

Famous vitamin discoveries

- Early emphasis on discovery, isolation, structure and mechanism of action

Nobel Prize in Physiology or Medicine	
Discovery of Vitamins	
Christiaan Eijkman (1929)	Vitamin B_1
Sir Frederick Gowland Hopkins (1929)	Growth Stimulating Vitamins
George Hoyt Whipple (1934)*	Vitamin B_{12}
George Richards Minot (1934)*	Vitamin B_{12}
William Parry Murphy (1934)*	Vitamin B_{12}
Henrik Carl Peter Dam (1943)	Vitamin K
Isolation of Vitamins	
Adolf Otto Reinhold Windaus (1928)*	Vitamin D
Albert von Szent-Györgyi Nagyrapolt (1937)	Vitamin C
Richard Kuhn (1938)	Vitamin B_2 and B_6
Edward Adelbert Doisy (1943)	Vitamin K
Nobel Prize in Chemistry	
Synthesis of Vitamins	
Walter Norman Haworth (1937)	Vitamin C
Paul Karrer (1937)	Vitamin E
Robert Burns Woodward (1965)*	Vitamin B_{12}
Structure of Vitamins	
Paul Karrer (1937)	Vitamin A and B
Richard Kuhn (1938)	Vitamin B_2
Lord (Alexander R.) Todd (1957)*	Vitamin B_{12}
Dorothy Crowfoot Hodgkin (1964)*	Vitamin B_{12}

Source: www.nobelprize.org

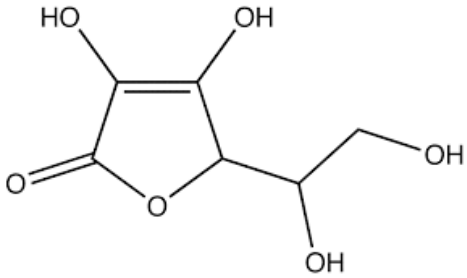
Vitamin C

"Scurvy"

- **Results from prolonged vitamin C deficiency had**
- **Origin of term from 'scorbutus' (Latin), 'scorbut' (French), and 'Skorbut' (German)**

What is it?

- **Common problem observed in sailors in 17th & 18th centuries**
- **Characterized by swollen gums, poor wound healing, joint pain**



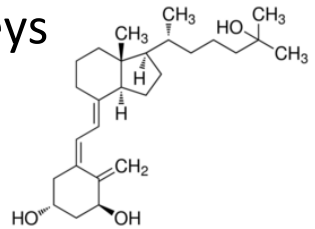
Link to vitamin C?

- **1747, trial conducted by James Lind showed lemons and oranges treat sailors with scurvy**
- **1928, Albert Szent-Györgyi isolated substance from adrenal glands he called 'hexuronic acid'**
- **1932, Charles Glen King isolated vitamin C in his laboratory, concluded that it was 'hexuronic acid'**
- **Norman Haworth deduced the chemical structure of vitamin C in 1933.**

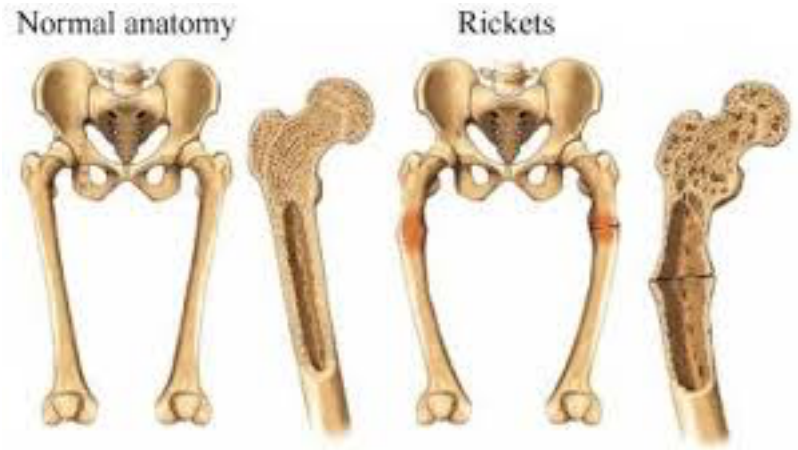
Carpenter, KJ *Ann Nutr Metab*. 2012;61(3):259-64

Vitamin D

- The “sunshine” vitamin
- Discovered by Elmer McCollum in 1922
- Responsible for the cure and prevention of rickets
- “Active” (hormonal) form produced normally via a series of steps involving the skin, liver and kidneys

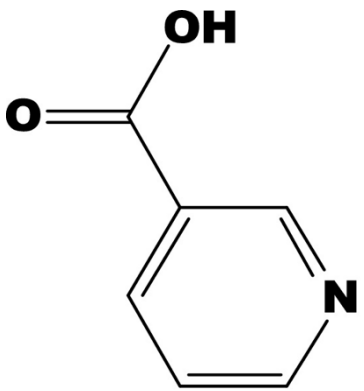


The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

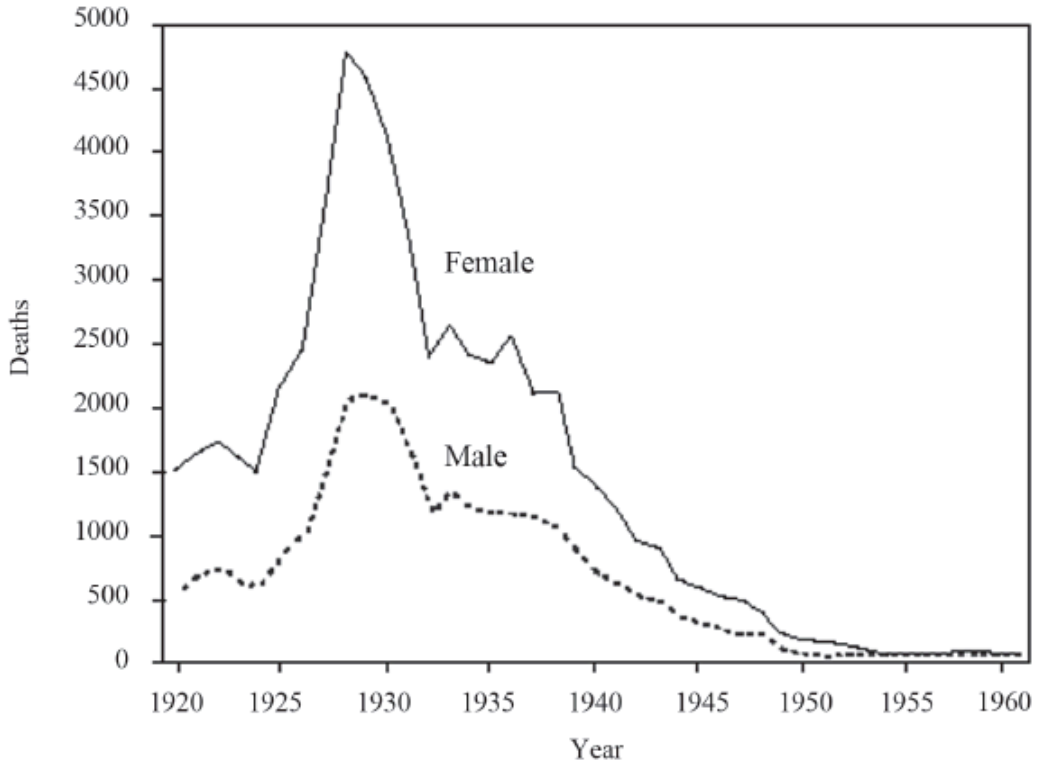


DeLuca, HF *BoneKEy Reports 3*, Article number: 479 (2014)

Niacin



- Epidemic of pellagra in the southern US in the 1920s
- Dermatitis, dementia
- Disappeared after fortification o flour with B vitamins



Tulchinsky, TH *Public Health Reviews*, 2010 Vol. 32, No 1, 243-255

Part I: The Early Days

- Public health challenges
  - Communicable disease, short life-span
  - Overt nutrient deficiency
- Scientific focus
  - Discovery of vitamins and essential minerals, mechanism of action
- Basis for nutrition recommendations
  - Narrow and limited basis due to limited data and understanding

Basis of early recommendations

- First ever “dietary standard” passed in Britain: Merchant Seaman’s Act of 1835 – included a provision for limes or lemon juice in the rations of mercantile service
- 1847: Based on studying the Dutch army Mulder recommended 100 g protein/day for active laborer and 60 g/day for sedentary individuals
- Most recommendations focused on energy (in form of protein and fat) to support manual labor and military
- Shift in mid-1930’s to recommendations for specific foods (meat, milk, leafy vegetables, eggs, organ meats, fish)

Harper, AE *Am J Clin Nutr* 1985: 41; 140 - 148

First Recommended Dietary Allowances

- In US, first recommendations developed during WW II by the US National Academy of Sciences in response to nutritional challenges that might affect national defense
- First official Recommended Dietary Allowances established in 1941 for civilians and military
- RDAs revised every 5 – 10 years since

Dietary allowances for adults[1]

	Stielbing, 1933, 1939	NRC, 1941
Energy, *kcal*	2810	2775
Protein, *g*	68	66
Calcium, *g*	0.9	0.91
Phosphorus, *g*	1.22	—
Iron, *mg*	13–14	12
Vitamin A, *IU*	5800	4696
Vitamin B_1, *IU*[2]	460	516
Vitamin C, *mg*	71	71
Riboflavin, *mg*	1.74	2.3
Nicotinic acid, *mg*	—	15.5
Vitamin D, *IU*	—	210

NRC = National Research Council, Washington, DC

Harper, AE *J. Nutr*. 2003: 133; 3698–3702

First Dietary Guidelines in US

- 1943, USDA introduced a nutrition guide promoting the "Basic 7" food groups to help maintain nutritional standards under wartime food rationing
- Equal emphasis on <u>all food groups</u>

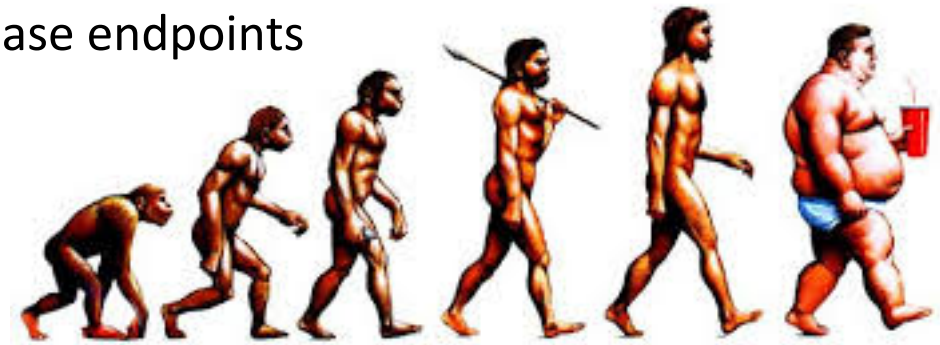
IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

Part II: Present Day Nutrition

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Part II: Present Day Nutrition

- Public health challenges
  - Non-communicable disease, longer life-span
  - Sub-optimal nutrient intake/status and issues of “excess”
  - Limited implementation of dietary guidance
- Scientific focus
  - Substantial advances in the etiology of chronic disease, role of diet, lifestyle, genetic background
  - Beneficial effects of non-essential bioactive food components
- Basis for nutrition recommendations
  - Dietary gaps identified through food intake surveys
  - Systematic reviews, chronic disease endpoints
- Food-based dietary guidance

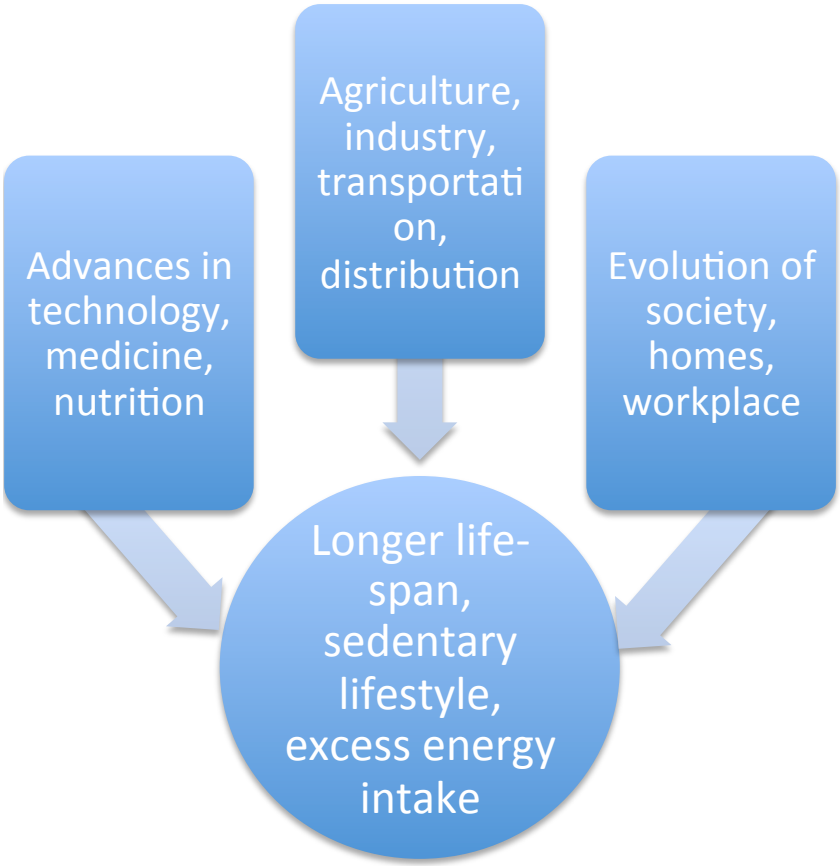


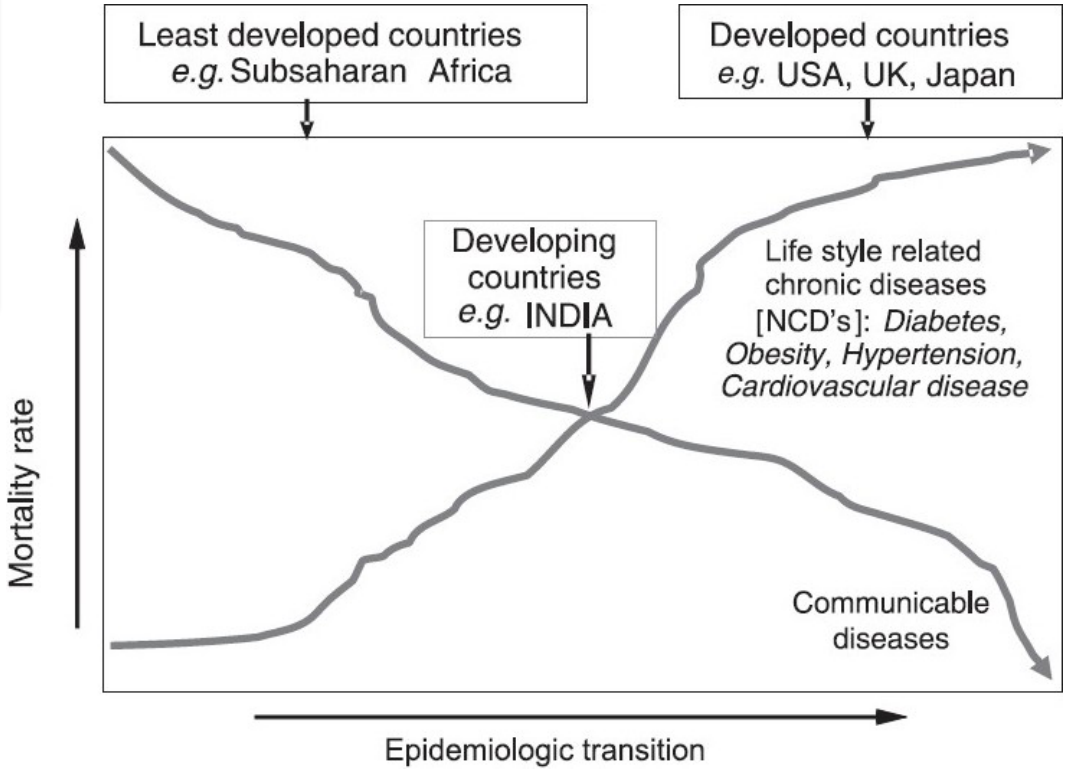
The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Part II: Present Day Nutrition

- Public health challenges
  - Non-communicable disease, longer life-span
  - Sub-optimal nutrient intake/status and issues of “excess”
  - Limited implementation of dietary guidance
- Scientific focus
  - Substantial advances in the etiology of chronic disease, role of diet, lifestyle, genetic background
  - Beneficial effects of non-essential bioactive food components
- Basis for nutrition recommendations
  - Dietary gaps identified through food intake surveys
  - Systematic reviews, chronic disease endpoints
- Food-based dietary guidance

Communicable vs. Non-communicable: A transition

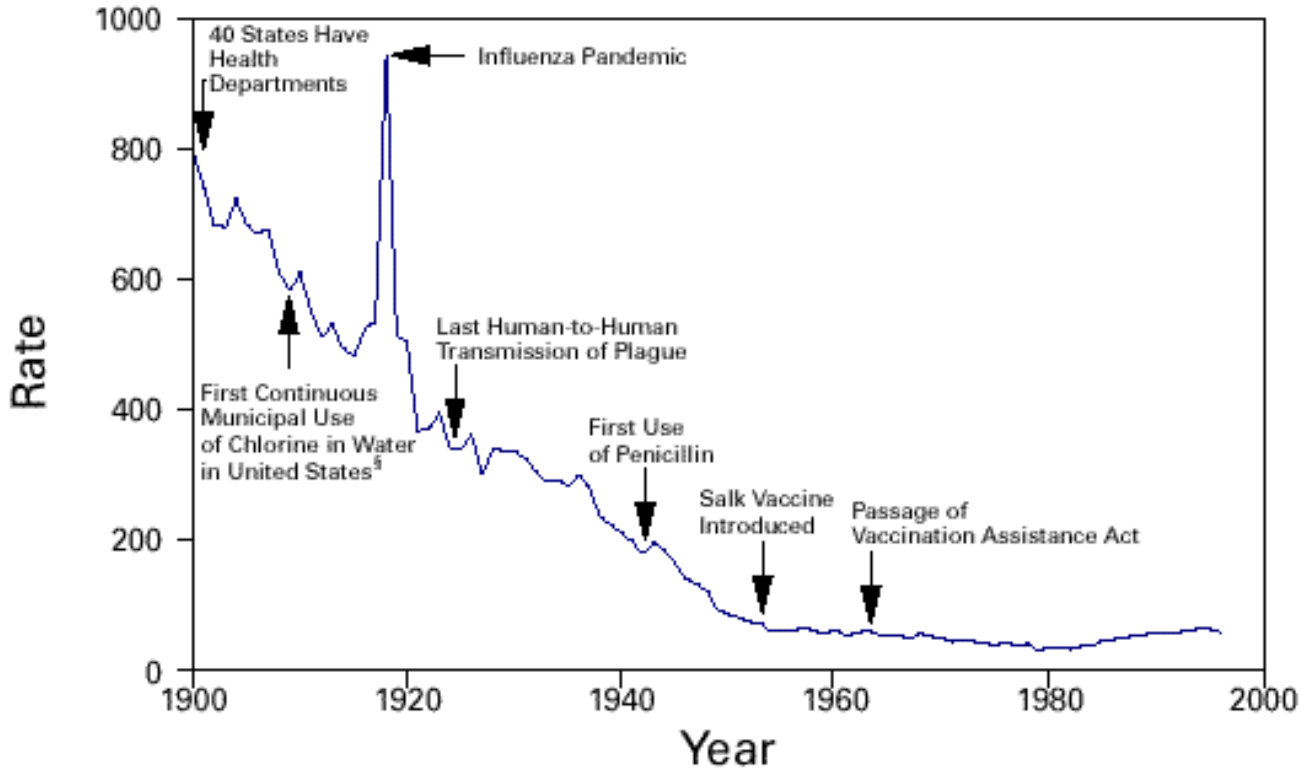




Anjana, RM et al. *Indian J Med Res* 133, April 2011, pp 369-380

Trends in communicable disease

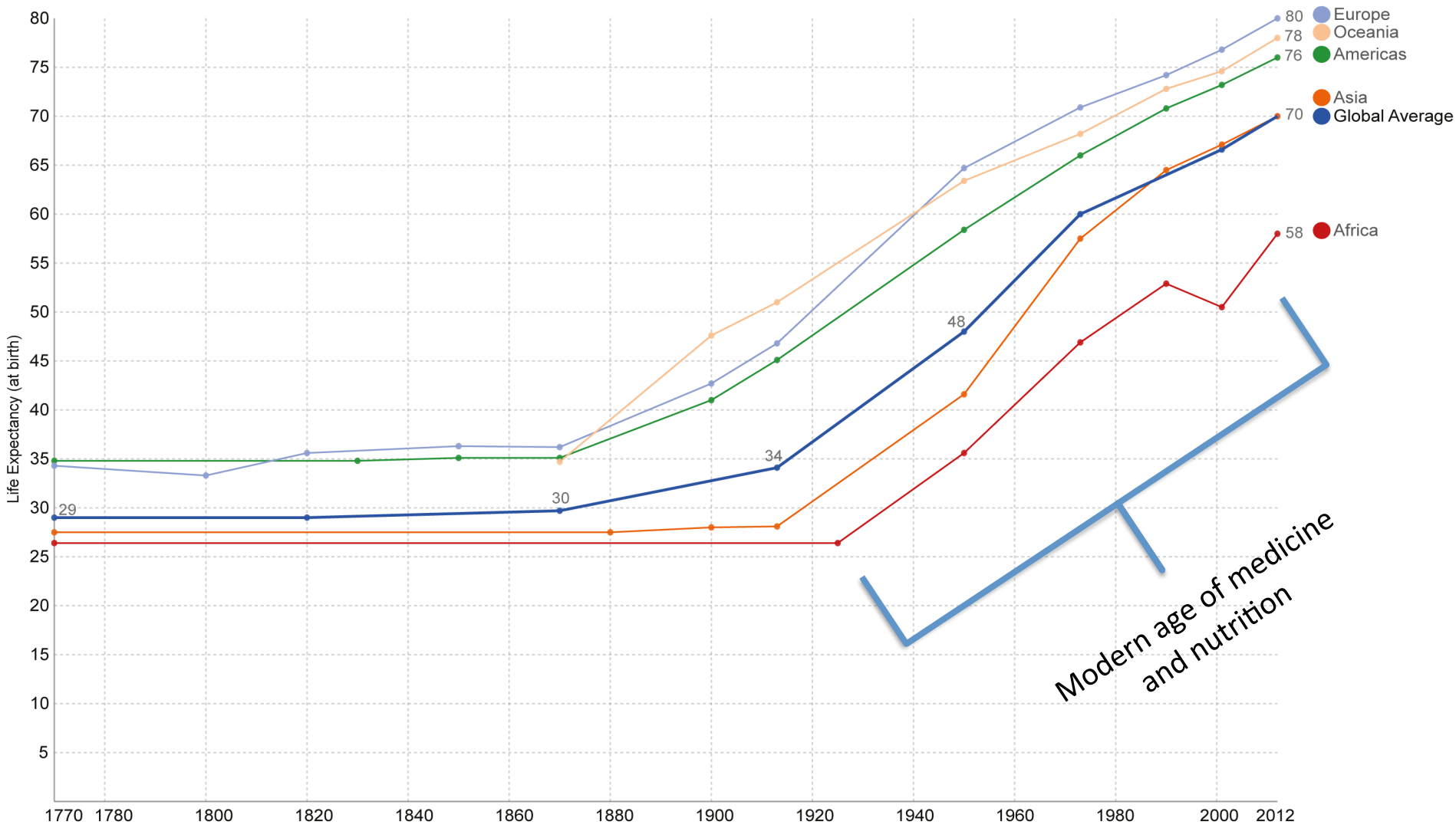
FIGURE 1. Crude death rate* for infectious diseases — United States, 1900–1996†



*Per 100,000 population per year.
†Adapted from Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United States during the 20th century. JAMA 1999:281;61–6.
§American Water Works Association. Water chlorination principles and practices: AWWA manual M20. Denver, Colorado: American Water Works Association, 1973.

IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

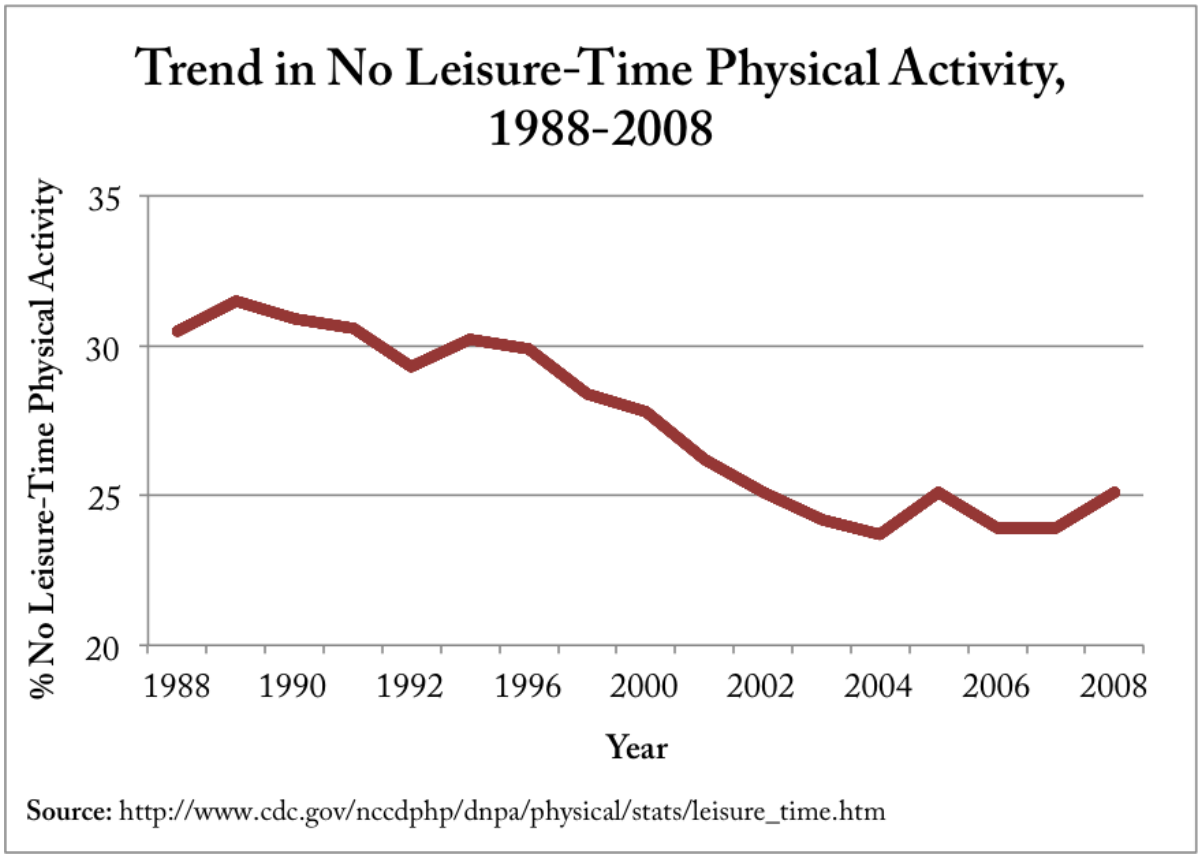
Life expectancy trends



Data sources: 1770-2001 from James C. Riley (2005) – Estimates of Regional and Global Life Expectancy. Population and Development Review; 2012 from WHO.
The interactive data visualisation is available at OurWorldinData.org. There you find the raw data and more visualisations on this topic.

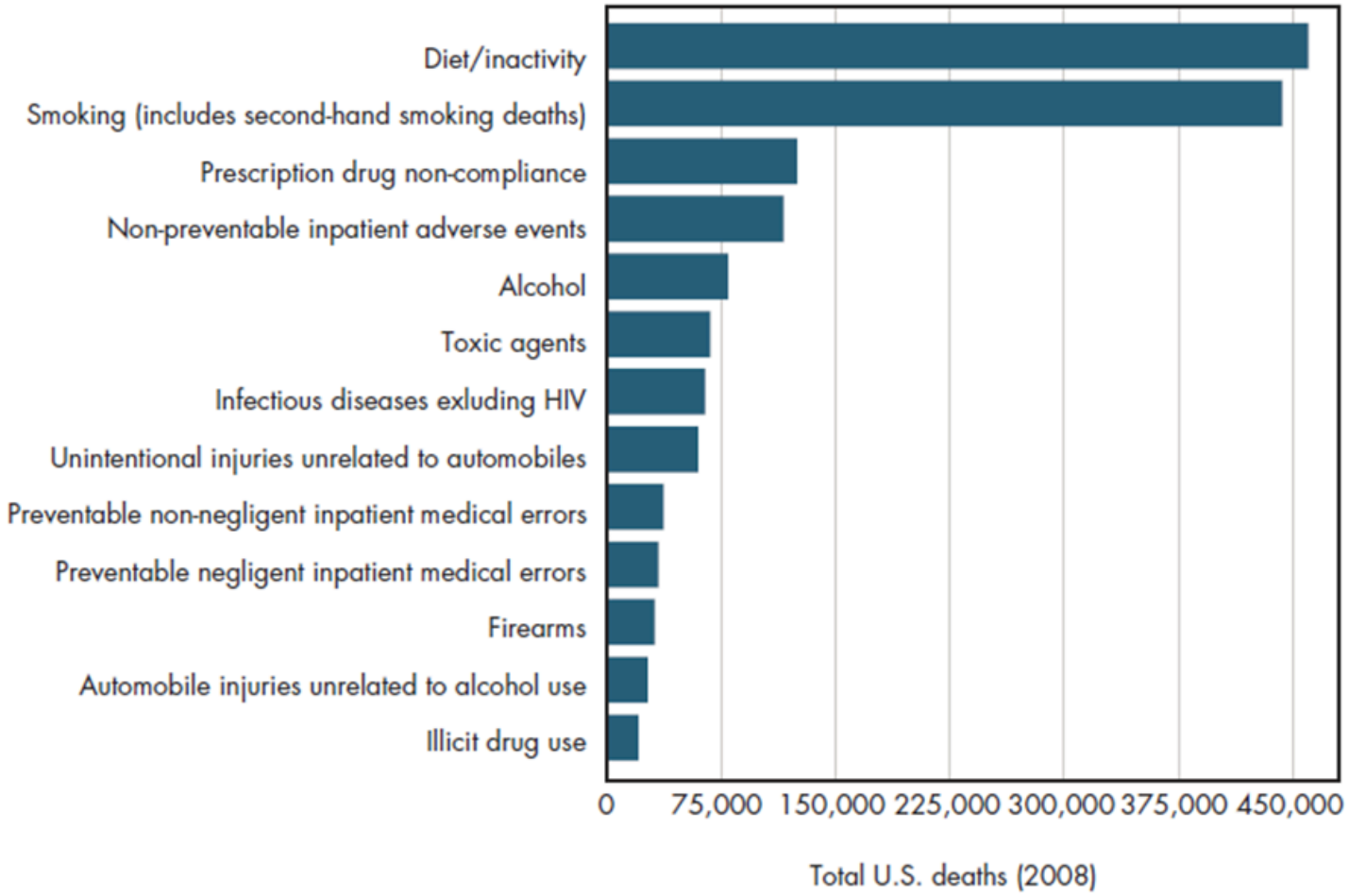
Physical activity trends

- US Centers for Disease Control and Prevention: Decline in leisure physical activity levels



Impact of lifestyle on mortality

- Fundamental shift from communicable disease to lifestyle as the major contributor to death



Source: Conover, CJ *The American Health Economy Illustrated*, 2012

Global diabetes trends

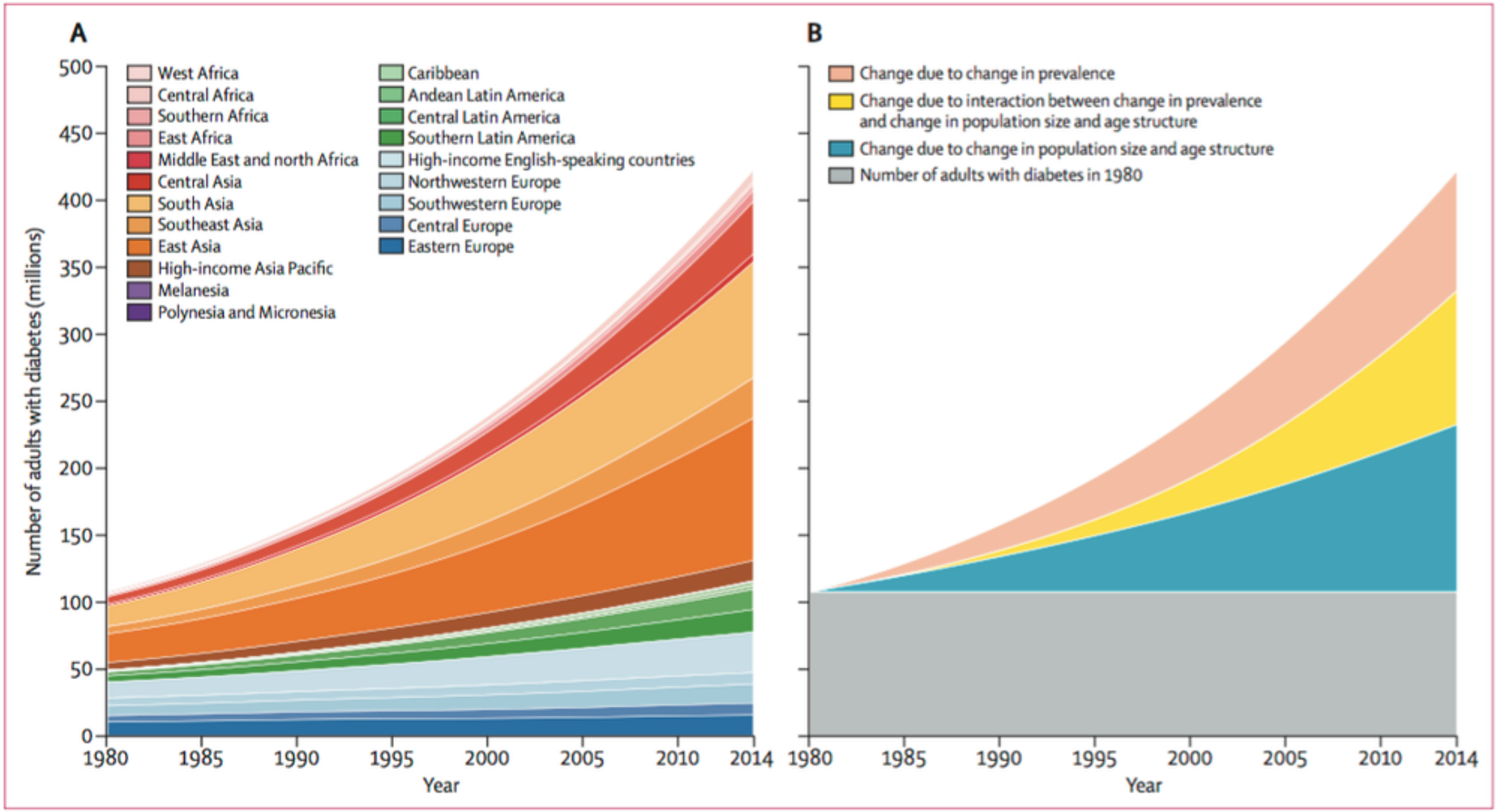


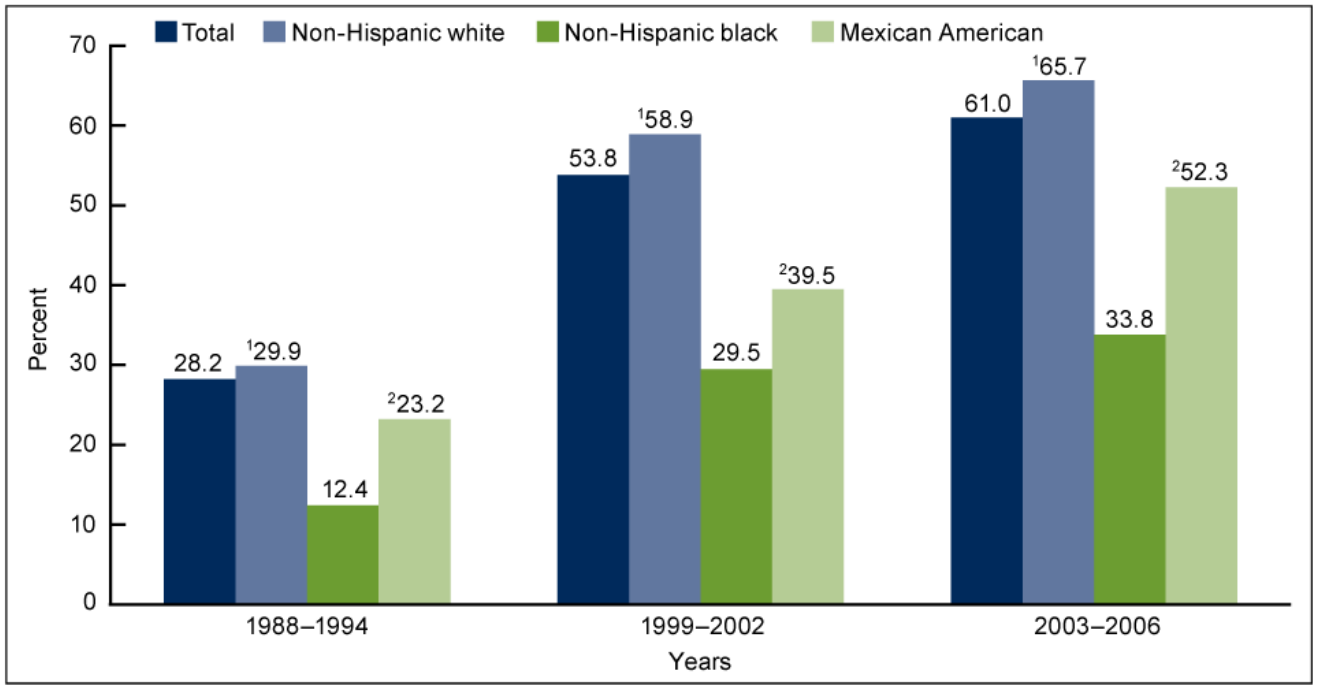
***Figure 7*: Trends in the number of adults with diabetes by region (A) and decomposed into the contributions of population growth and ageing, rise in prevalence, and interaction between the two (B)**
For results by region see appendix pp 101–102.

NCD Risk Factor Collaboration *The Lancet* 2016; 387: 1513–30

Emergence of industry

- Significant contribution to dietary intake and food consumption behavior

Figure 3. Prevalence of supplemental calcium use in women aged 60 and over, by racial and ethnic group: United States, 1988–2006



[1]Significantly different from non-Hispanic black and Mexican-American women.
[2]Significantly different from non-Hispanic black women.
NOTE: 1988–1994 rates significantly different from those of the 1999–2002 and 2003–2006 survey periods.
SOURCE: CDC/NCHS, National Health and Nutrition Examination Surveys.

Source: US Centers for Disease Control and Prevention

Part II: Present Day Nutrition

- Public health challenges
  - Non-communicable disease, longer life-span
  - Sub-optimal nutrient intake/status and issues of “excess”
  - Limited implementation of dietary guidance
- Scientific focus
  - Substantial advances in the etiology of chronic disease, role of diet, lifestyle, genetic background
  - Beneficial effects of non-essential bioactive food components
- Basis for nutrition recommendations
  - Dietary gaps identified through food intake surveys
  - Systematic reviews, chronic disease endpoints
- Food-based dietary guidance

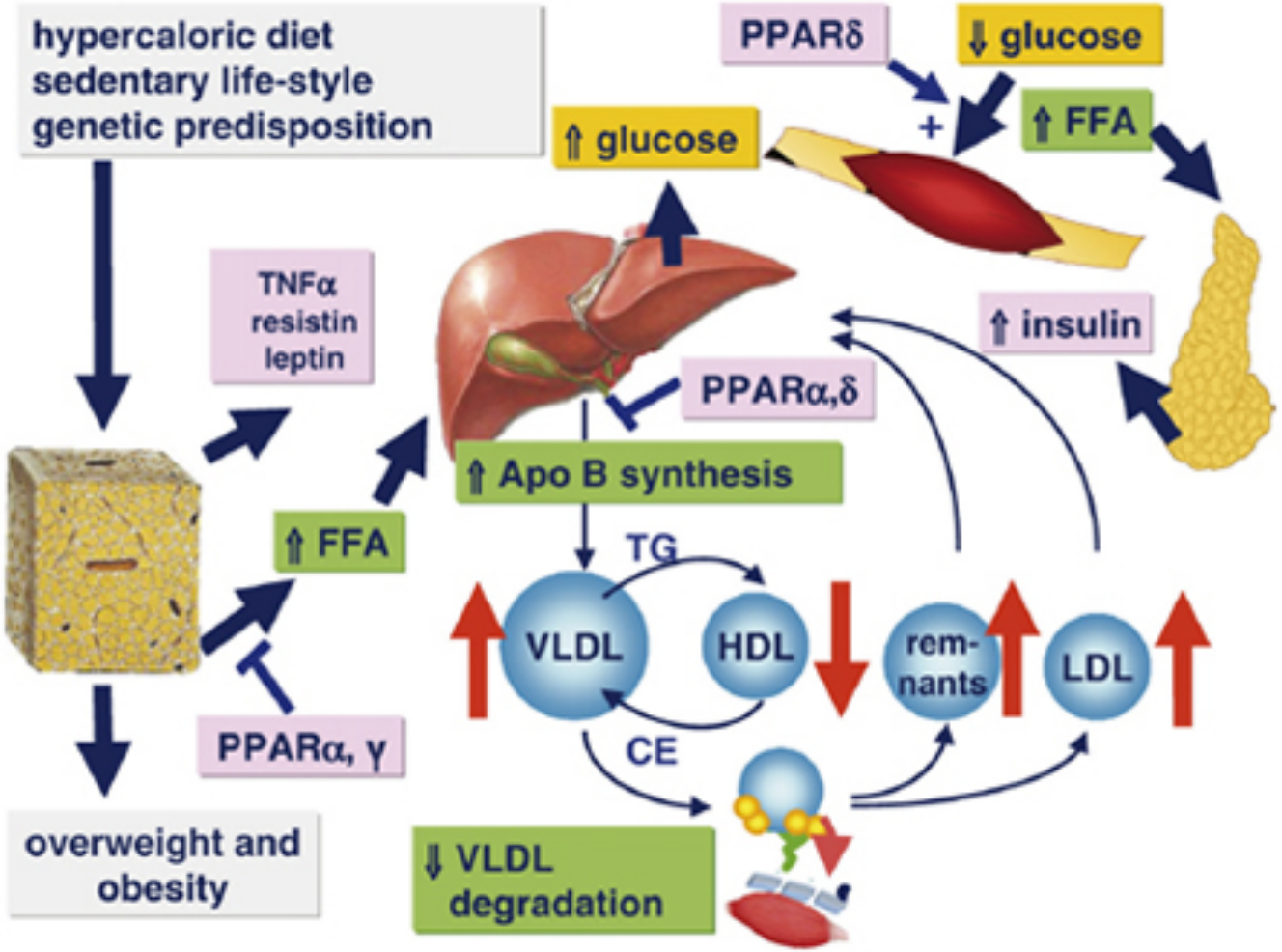
Research trends

- Increased scientific focus on diet and nutrition role in etiology of chronic disease

"Nutrition" OR "Diet" AND "Chronic disease" = 10965 citations

Understanding metabolism

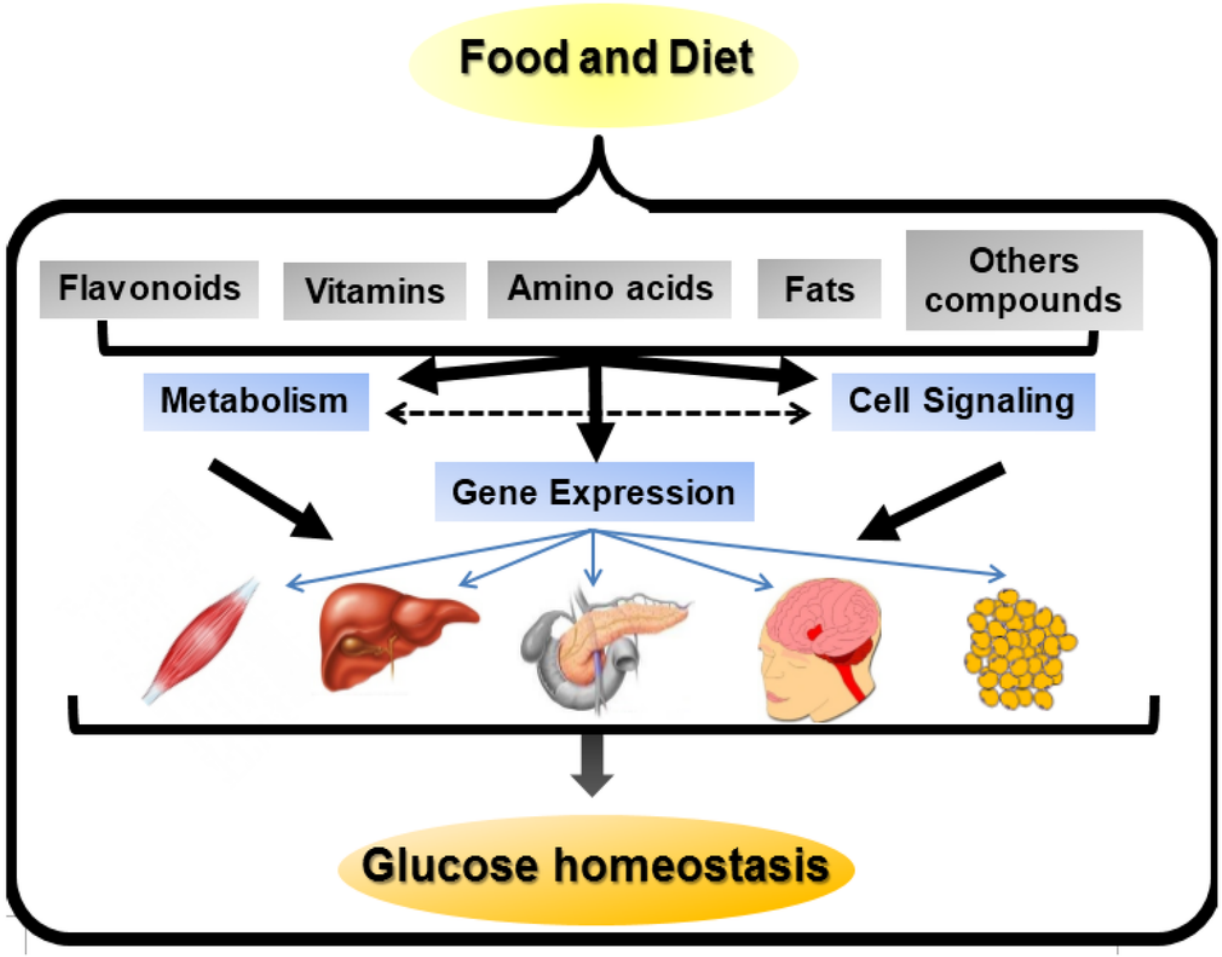
- Advances in cell and molecular biology and biochemistry allow for a better understanding of macro and micronutrient metabolism



Source: Globalhealthwatch.com

Understanding mechanism of action

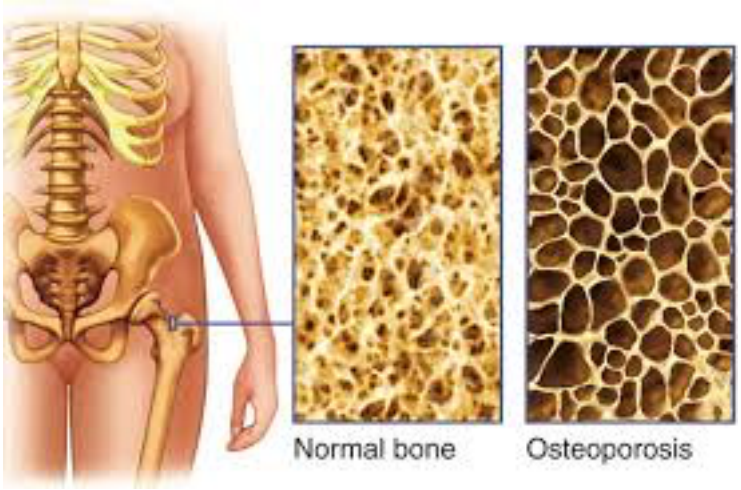
- Advances in technology allow for a better understanding of nutrients' mode of action in the body

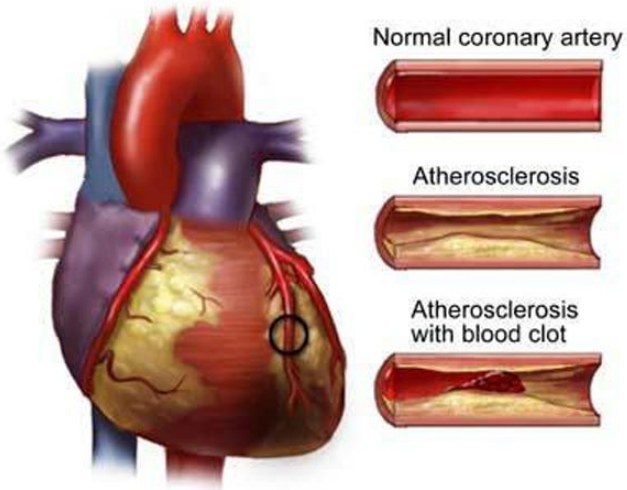


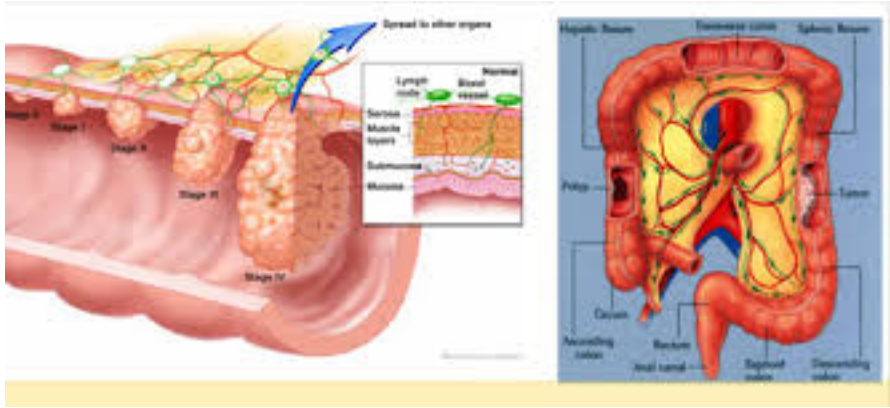
Berná, G et al. *Nutrients* 2014, *6*(11), 5338-5369

Nutrients linked to chronic disease

- Folate
- Calcium
- Vitamin D
- Fiber
- Omega-3



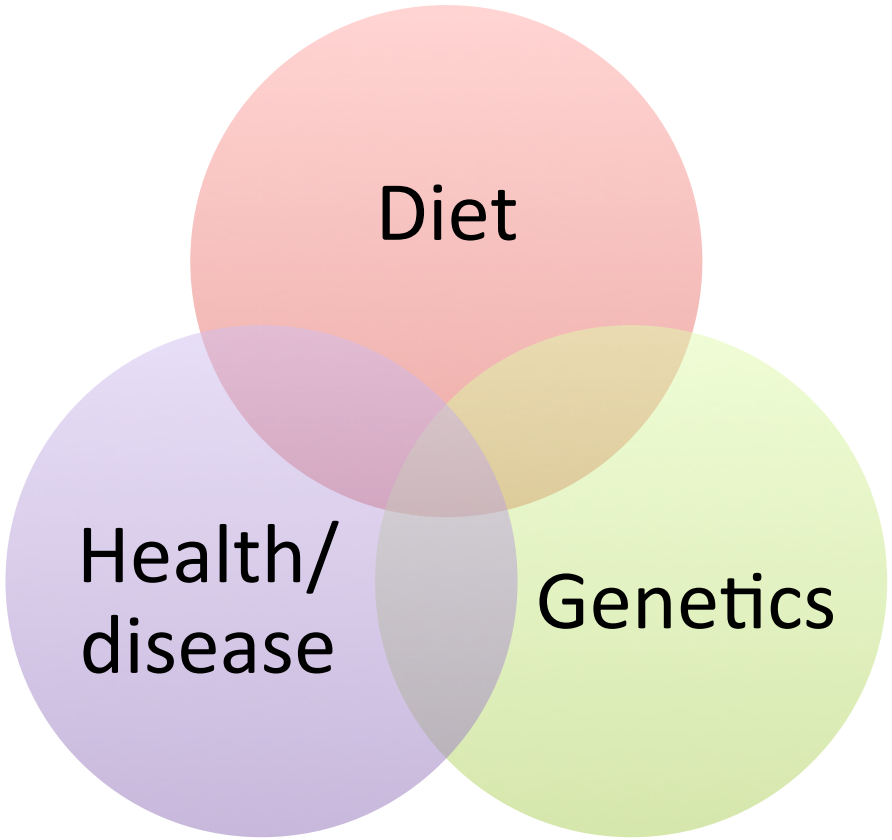




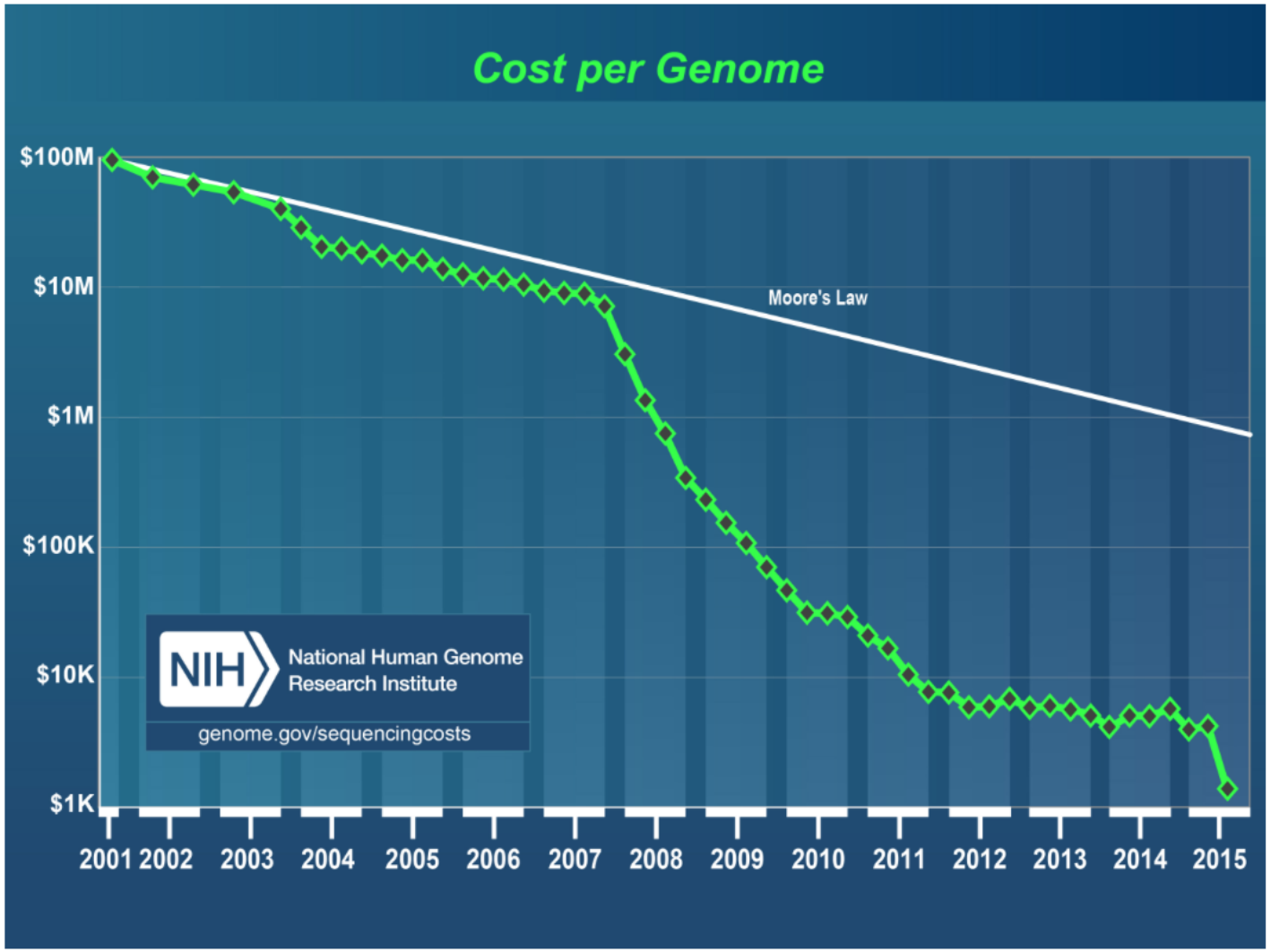
The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Nutrigenomics

- Study of the effects of foods and food constituents on gene expression
- Focused on identifying and understanding molecular-level interaction between nutrients and other dietary bioactives with the genome.

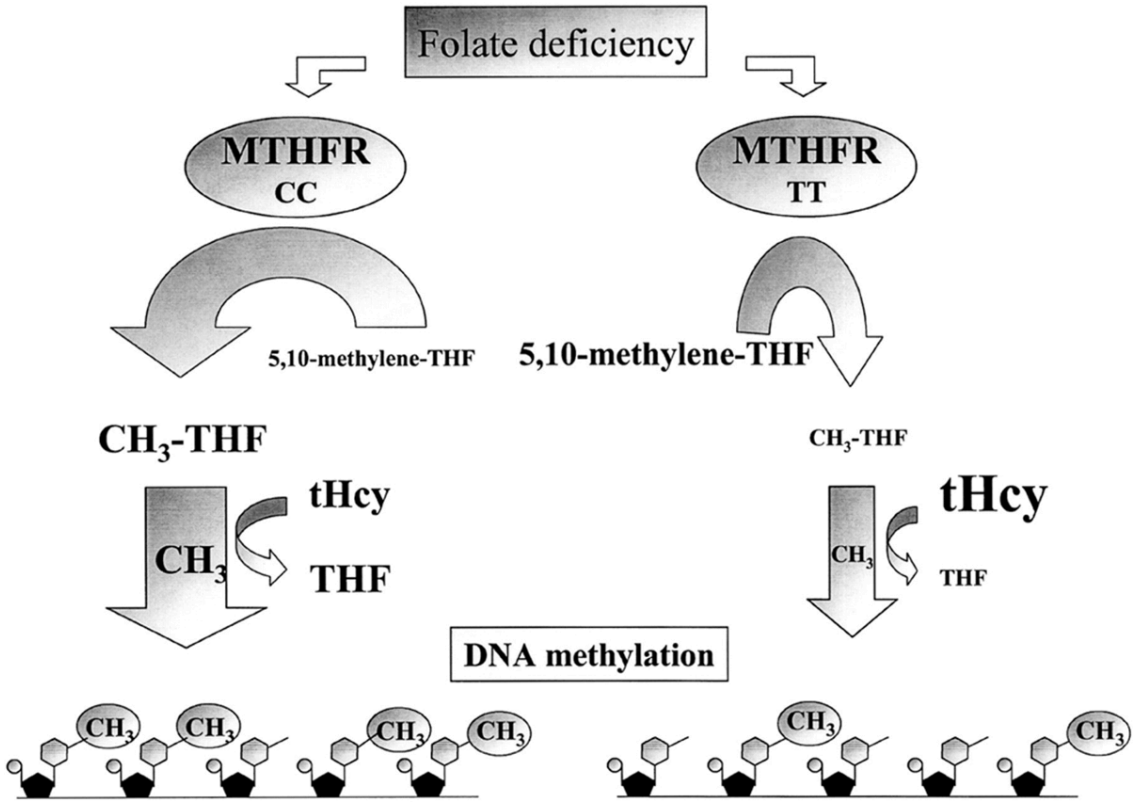


Advances in DNA technology



Gene-nutrient interactions

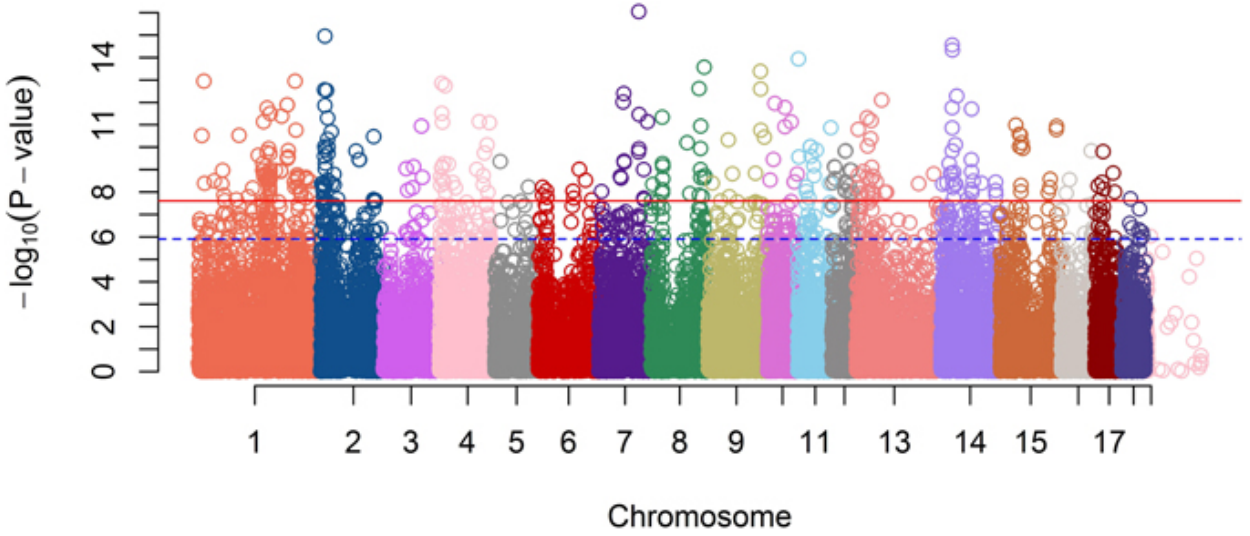
- Genetic polymorphisms determine responsiveness to nutrient interventions
- Folate metabolism and response to folate deficiency varies by allele



Friso, S *J. Nutr.* 132: 2382S–2387S, 2002

"GWAS"

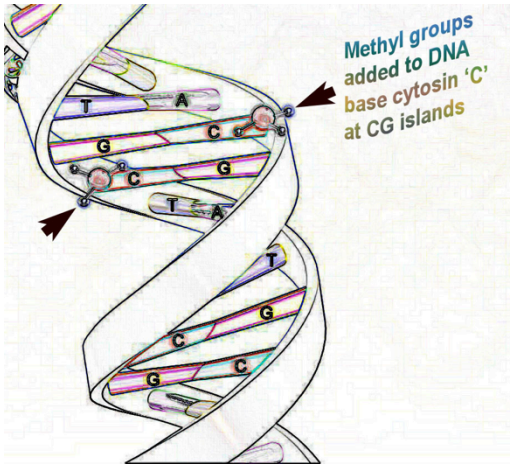
- Genome wide association studies
- Examination of many common genetic variants in different individuals to see if any variant is associated with a trait, such as chronic disease
- Technology advances allows for rapid analysis of millions of genetic variants from single sample using micro-array analysis

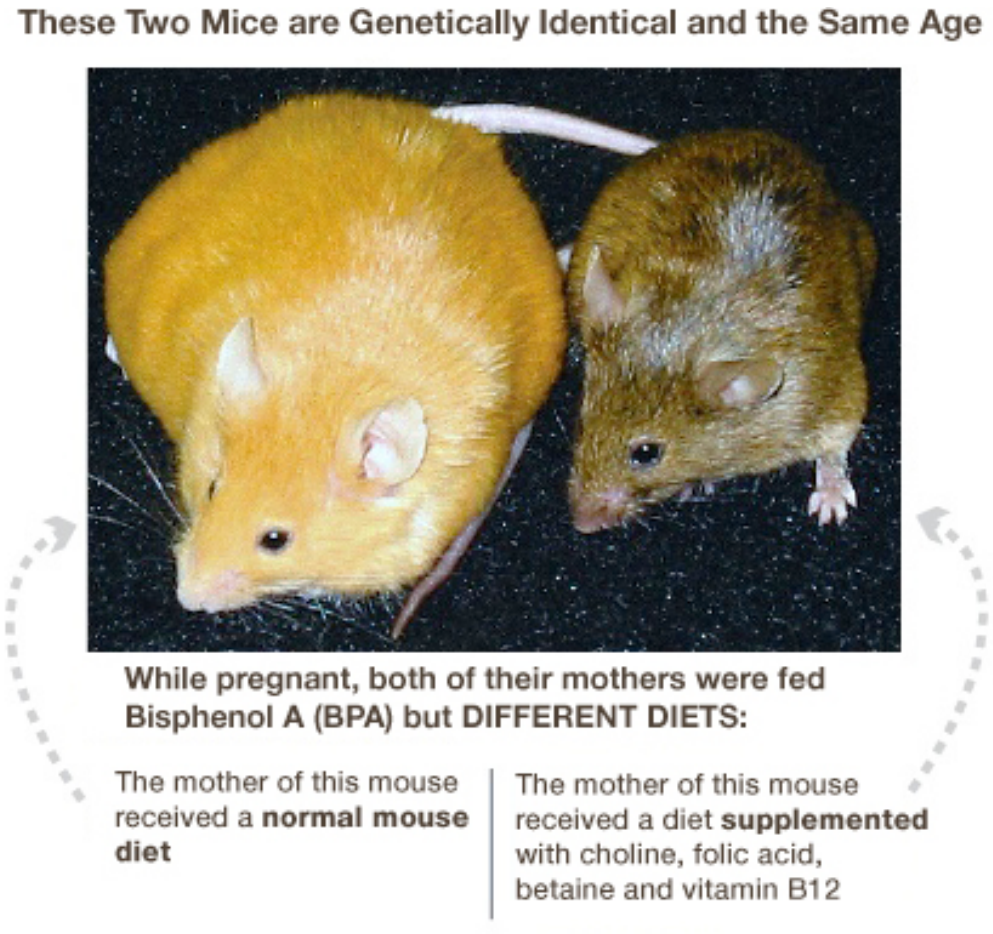


Adopted from Kogelman et al. *Frontiers in Genetics* July 2014; Vol 5 (214)

Epigenetics

- "Epi" = "adjacent to"
- DNA methylation can affect how and to what extent genes are turned "on" or "off"
- Dietary components that are methyl "donors": B vitamins, choline, betaine

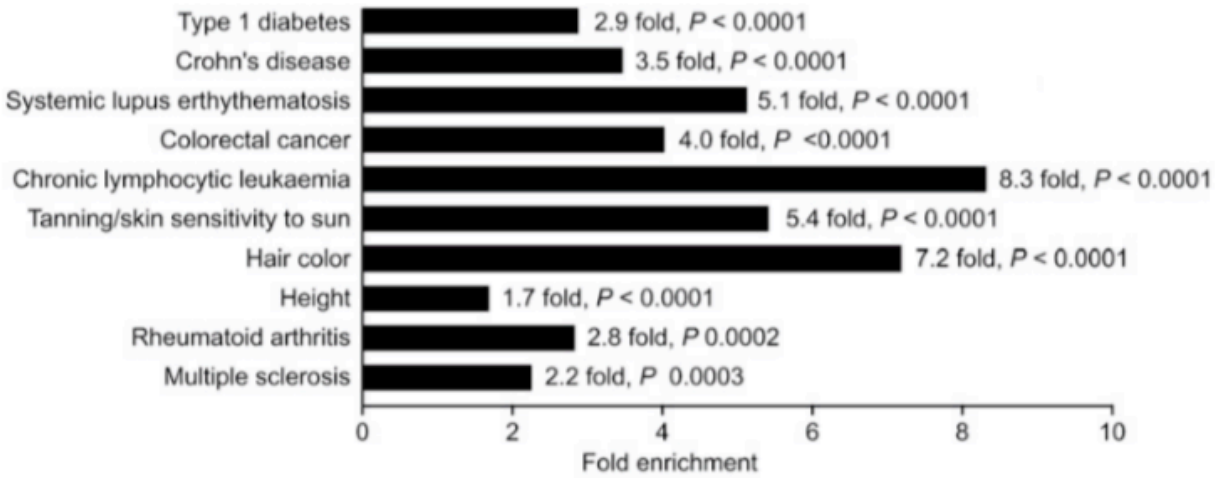




Source: http://learn.genetics.utah.edu/content/epigenetics/nutrition/

Vitamin D: Beyond bone?

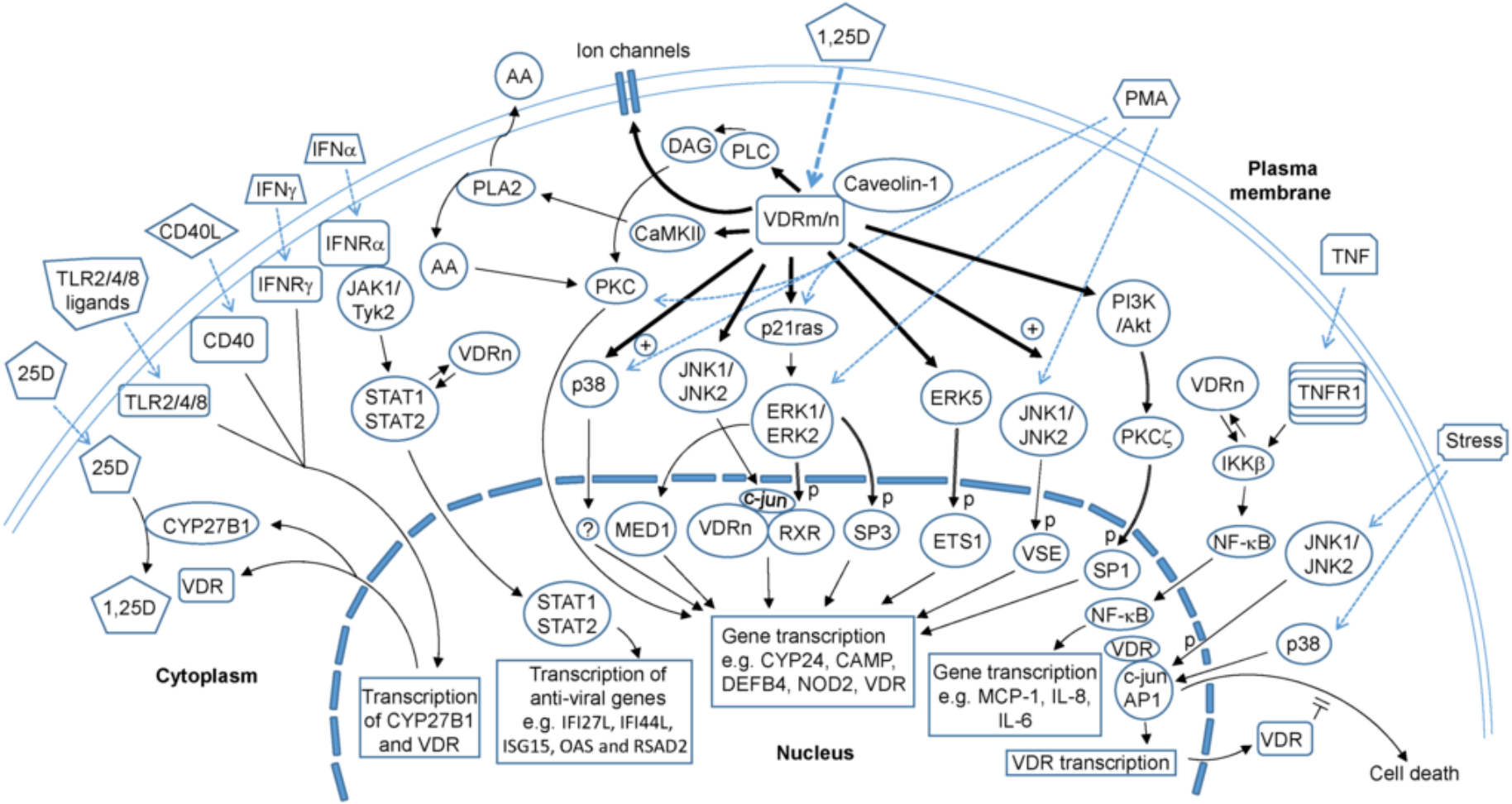
- 1,25(OH)2D3 activates > 200 genes, many linked to cell differentiation and immunomodulation



Ramagopalan, SV et al. *Genome Research* 20:1352–1360 2010

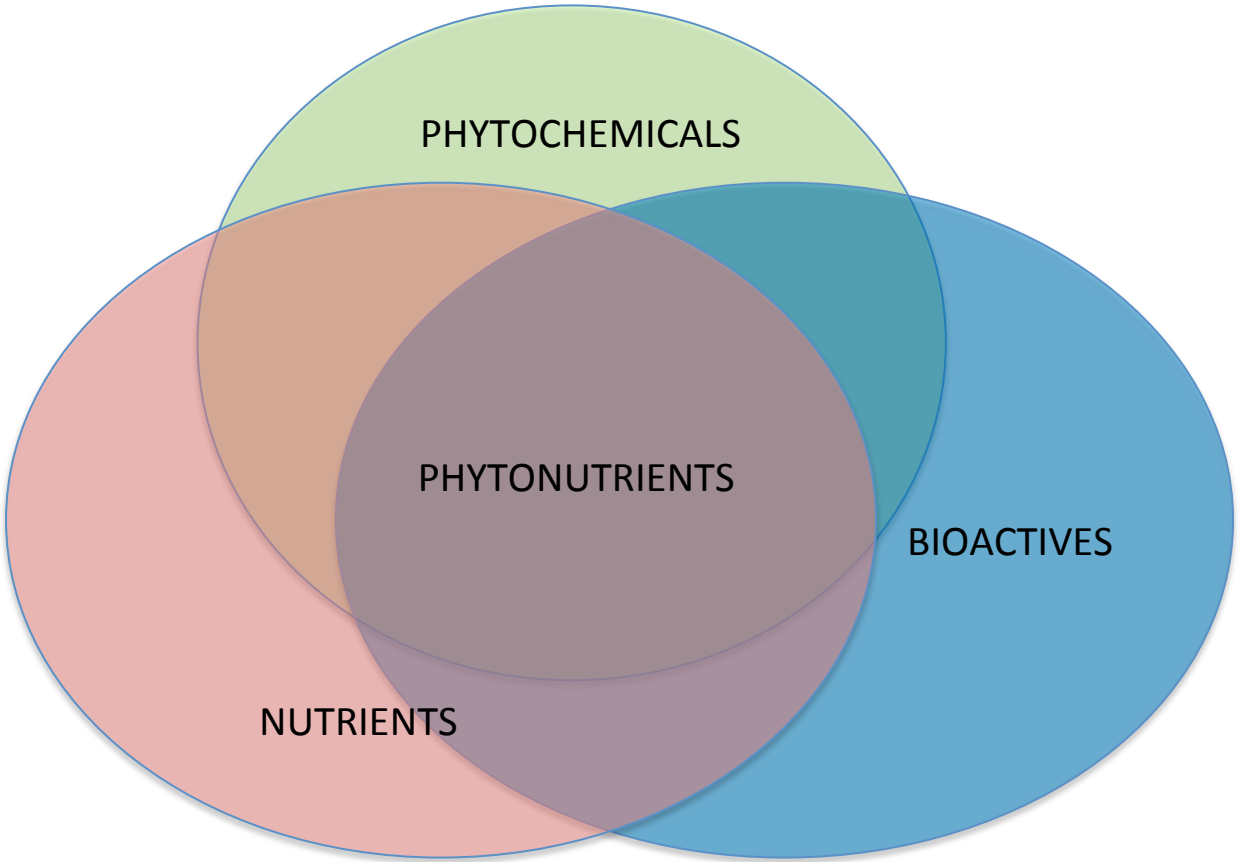
Extraskeletal benefits of vitamin D
Skin cancer
Breast cancer
Colon cancer
Immunity
Diabetes
Asthma
Dementia
Cardiovascular disease
Muscle

Understanding vitamin D



Hii, CS *Nutrients* 2016, *8*(3), 135

Beyond essential nutrients

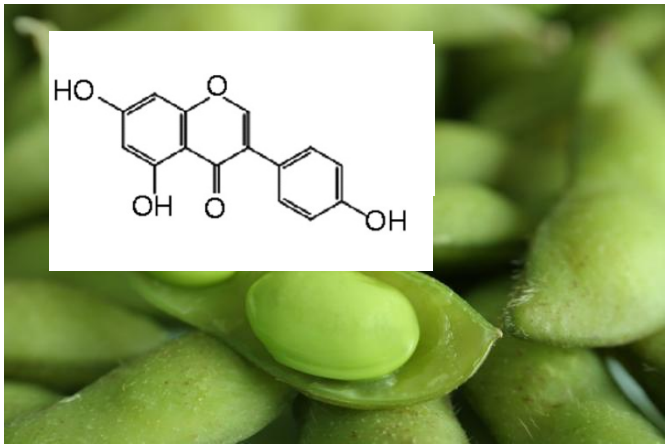


Definitions

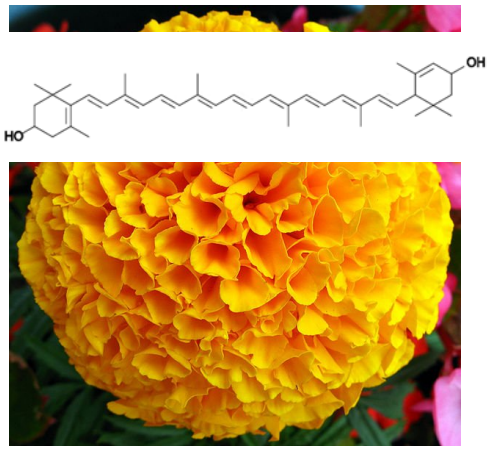
[Fito (greek *phyto*) = plant]

- Phytonutrients: compounds derived from plants (phyto) that promote health (nutrients). (Beecher 1999)
- Phytochemicals: different bioactive nutrients present in fruits, vegetables, grains and other plant foods that have been associated with reduced risk of major chronic diseases. (Liu 2004)
- Bioactives: compounds that are constituents in foods and dietary supplements , other than those needed to meet basic human nutritional needs, which are responsible for changes in health status. (NIH)
- Scientific literature → phytonutrients/phytochemicals/bioactives

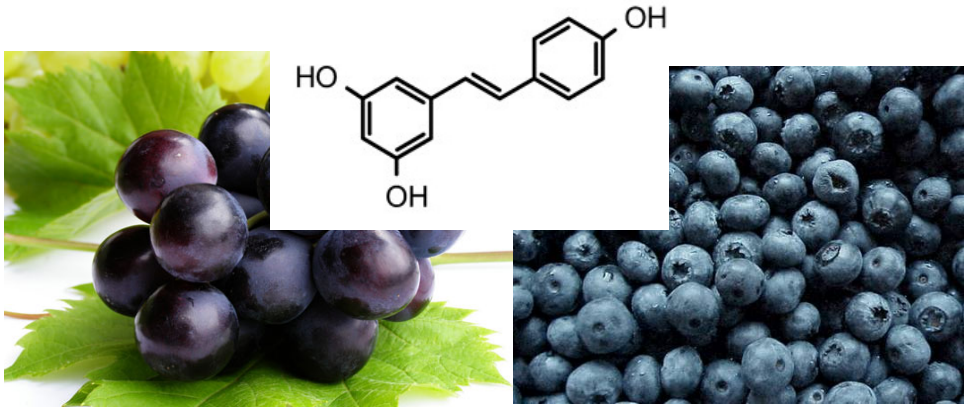
Examples



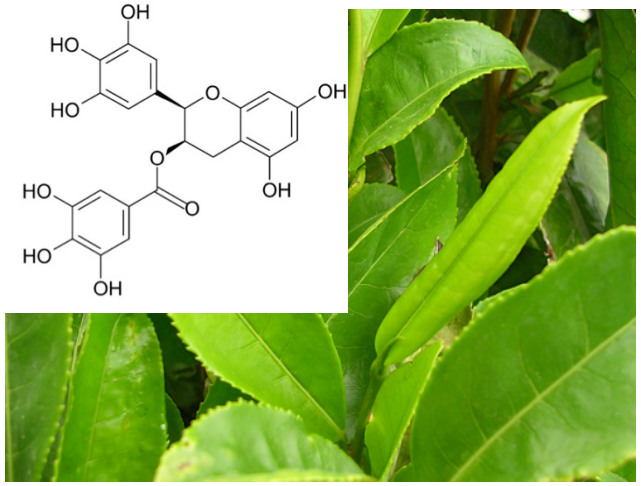
Isoflavones



Carotenoids



Anthocyanins



Catechins

Drugs ≠ Nutrients ≠ Phytonutrients (bioactives)

Parameter	Drugs	Nutrients	Bioactives
Chemically defined and well characterized	Yes, single entities	Yes, single entities	No, complex mixtures
Essentiality	None	Essential	Unclear
Inadequacy results in disease	No	Yes	Unclear
Homeostatically controlled by the body	No	Yes	No
True placebo group	Yes	No	No
Targets	Single organ/tissue	All cells/tissues	Multiple cells/tissues
Systematic function	Isolated	Complex networks	Complex networks
Baseline "status" affects response to intervention	No	Yes	Unclear
Effect size	Large	Small	Small to moderate
Side effects	Large	Small	Small
Nature of effect	Therapeutic	Preventive	Preventative and therapeutic

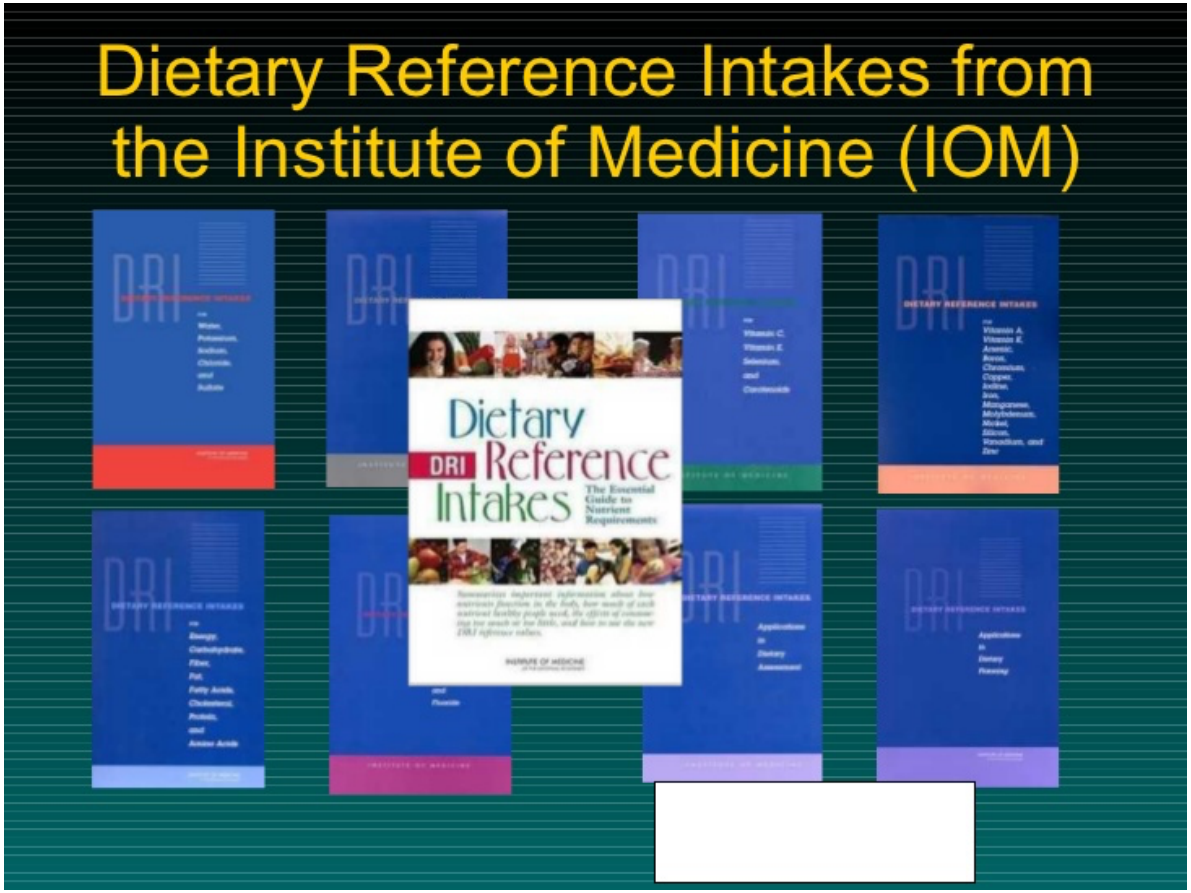
Heber & Shao 2011

Part II: Present Day Nutrition

- Public health challenges
  - Non-communicable disease, longer life-span
  - Sub-optimal nutrient intake/status and issues of “excess”
  - Limited implementation of dietary guidance
- Scientific focus
  - Substantial advances in the etiology of chronic disease, role of diet, lifestyle, genetic background
  - Beneficial effects of non-essential bioactive food components
- Basis for nutrition recommendations
  - Dietary gaps identified through food intake surveys
  - Systematic reviews, chronic disease endpoints
- Food-based dietary guidance

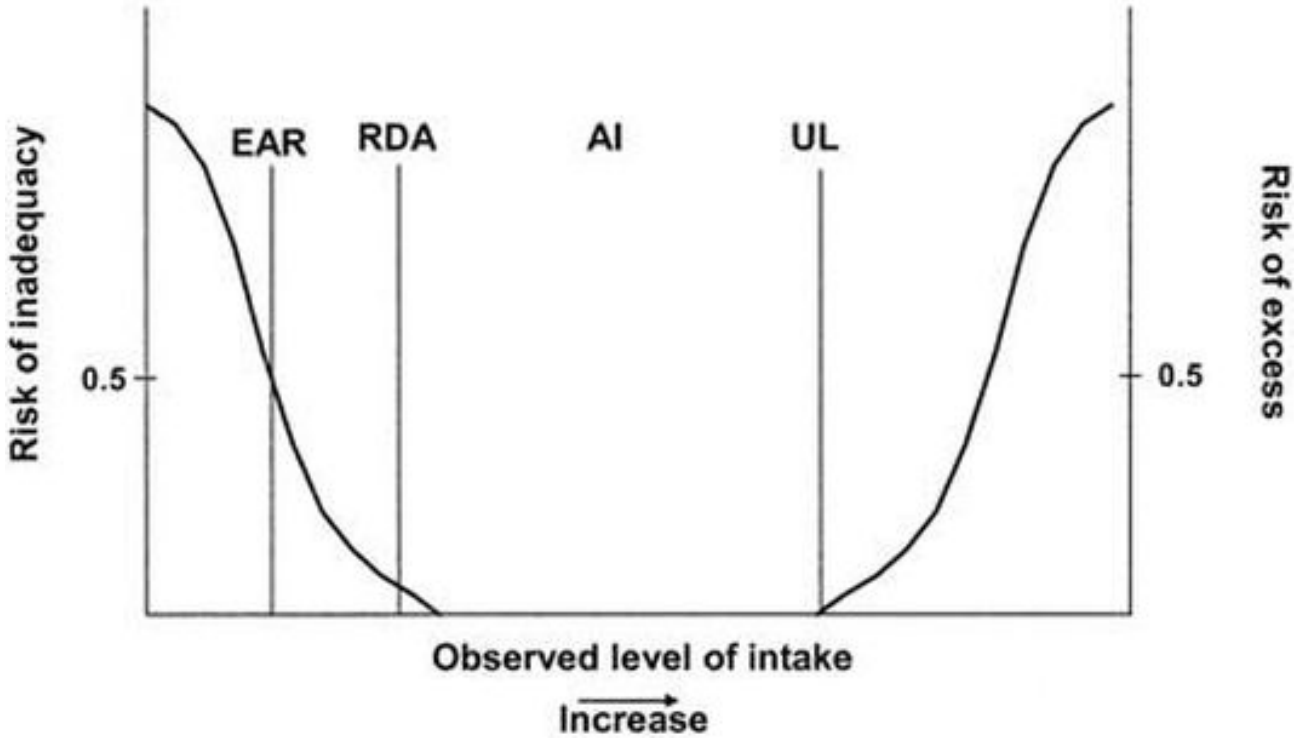
Dietary reference intakes

- 1997 – 2004
- Served as a model for other countries
- Established to:
  - Reduce nutritional inadequacy
  - Promote health
  - Reduce risk of chronic disease
  - Provide basis for assessing and planning diets for the population



What are the DRIs?

- Framework based on dual risk (inadequacy and excess)
- Set of population-based intake values for micro and macronutrients
  - Recommended Dietary Allowance (RDA)
  - Estimated Average Requirement (EAR)
  - Adequate Intake (AI)
- For the first time includes safe upper intake level (UL)



Nutrient intake surveys to assess adequacy of the diet

- Nutrient inadequacy (as opposed to deficiency) documented around the world based on nutrient intake surveys
- US National Health and Nutrition Examination Survey
- European Nutrition and Health Report

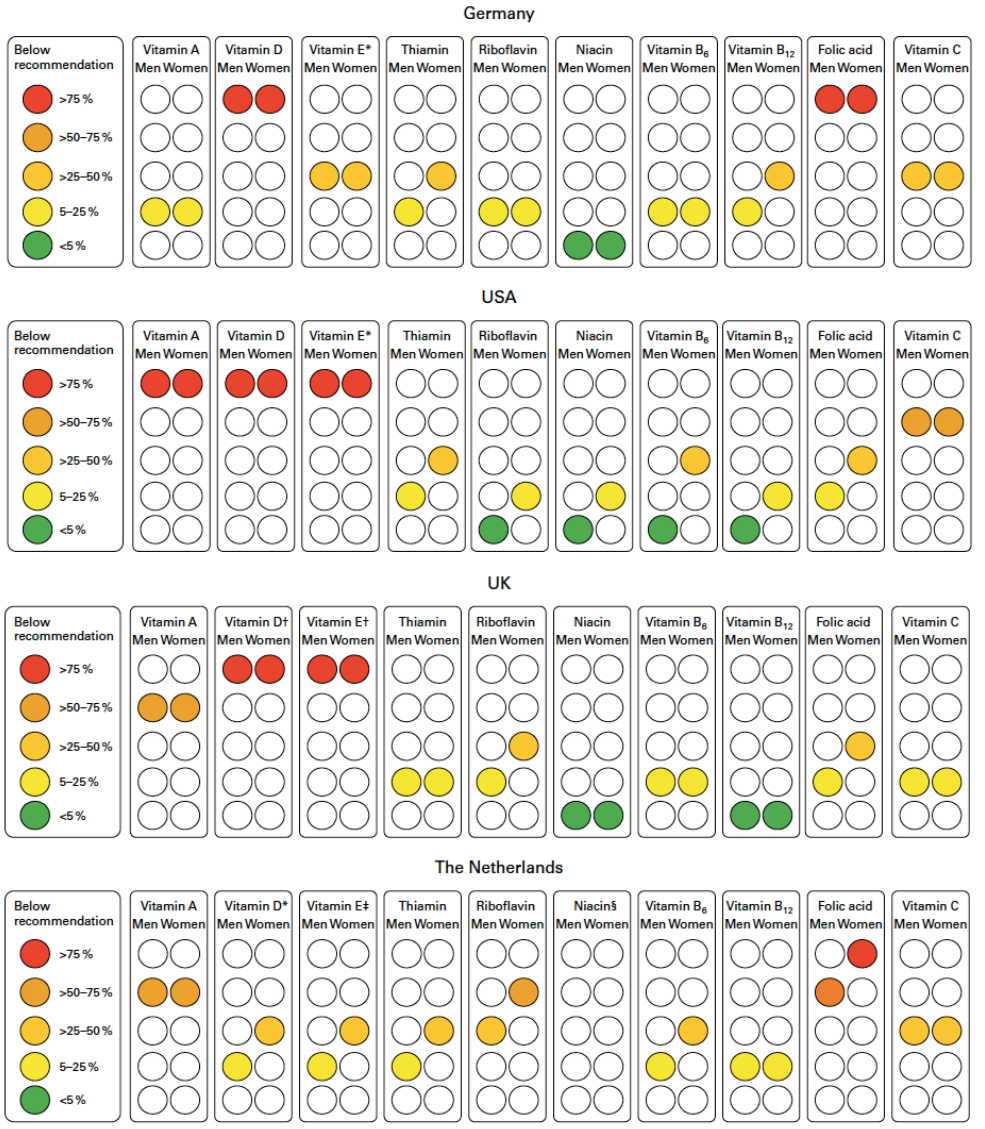
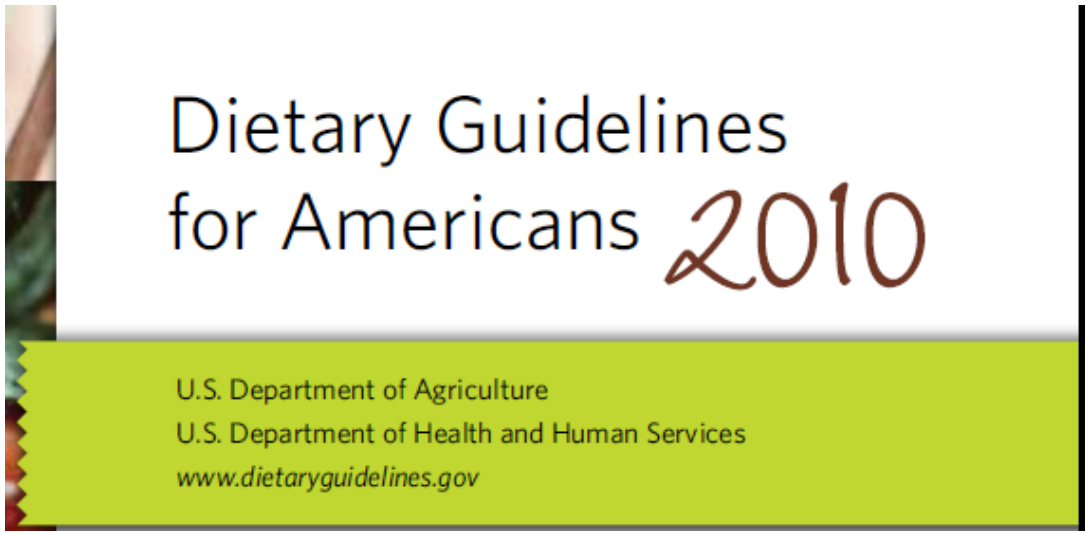


Fig. 1. Population with intakes below the specific recommended reference value for the country[16–26]. The level of recommendation covering the needs of 97·5 % of the population was used where it existed. * Average nutrient requirement/approximation. † No references exist, therefore, the Institute of medicine reference was used. ‡ > 25–50 % for men aged 19–30 years. § Data not available.

Troesch et al. *Brit J of Nutr* (2012), 108, 692–698

Change in the scientific basis for recommendations

- "…shift to a systematic and transparent evidence-based review process…"



Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010
http://www.cnpp.usda.gov/DGAs2010-DGACReport.htm

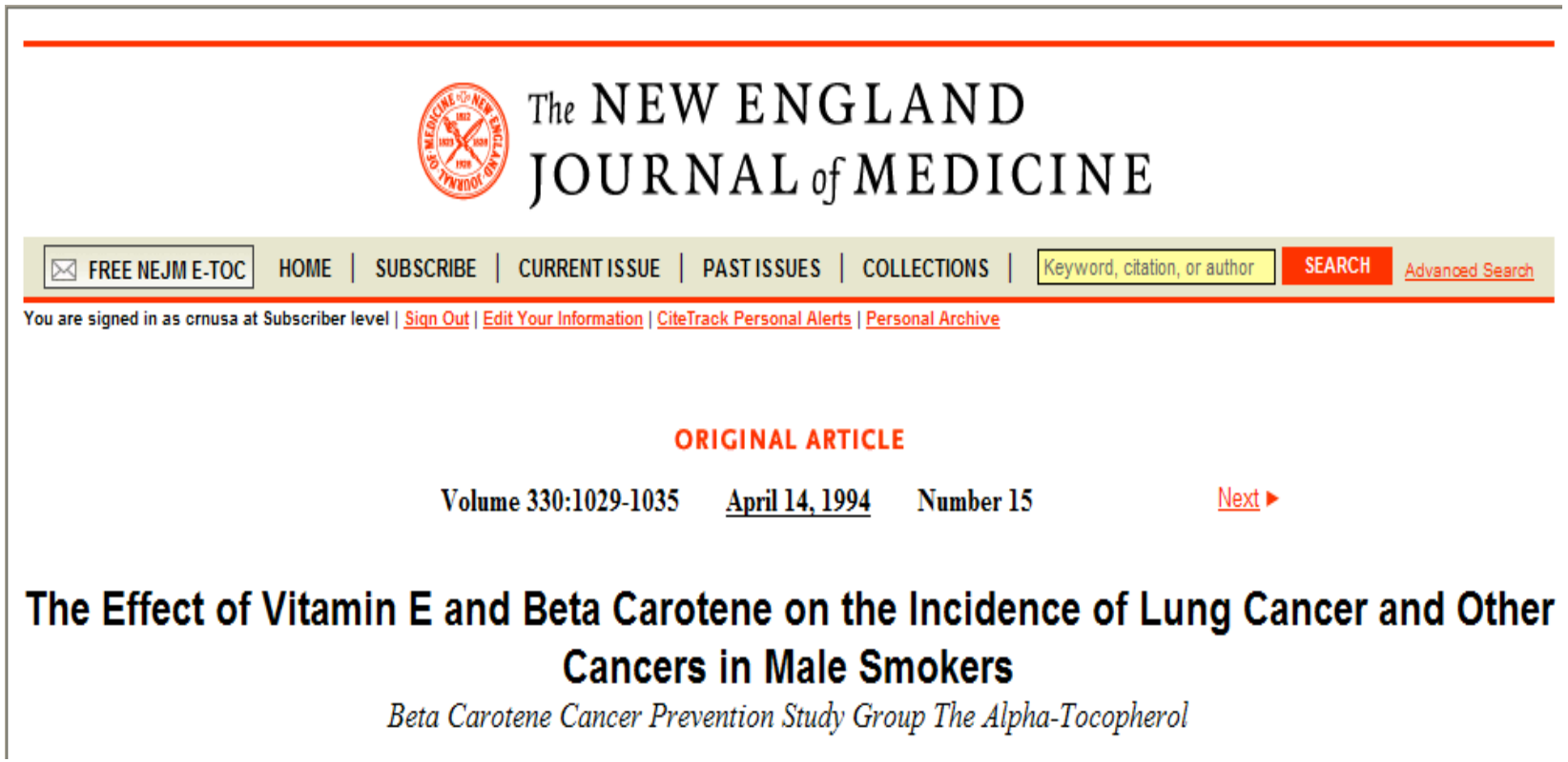
Hierarchy of evidence

Challenges with the hierarchy

- Lack of data
  - Human studies
  - Specific target population (children, pregnant women)
  - Chronic disease endpoints
- Cost, feasibility, latency of collecting data
  - RCTs examining chronic disease endpoints are cost prohibitive
  - Demonstrating prevention, inherently more complex and difficult vs. treatment
  - Ethical issues

Looking for the “magic bullet”

- Can a nutrient reverse the effects of life-long smoking?



The NEW ENGLAND JOURNAL of MEDICINE

FREE NEJM E-TOC | HOME | SUBSCRIBE | CURRENT ISSUE | PAST ISSUES | COLLECTIONS | Keyword, citation, or author | SEARCH | Advanced Search

You are signed in as crnusa at Subscriber level | Sign Out | Edit Your Information | CiteTrack Personal Alerts | Personal Archive

ORIGINAL ARTICLE

Volume 330:1029-1035 April 14, 1994 Number 15 Next ▸

The Effect of Vitamin E and Beta Carotene on the Incidence of Lung Cancer and Other Cancers in Male Smokers

Beta Carotene Cancer Prevention Study Group The Alpha-Tocopherol

EDITORIAL

Editorials represent the opinions of the authors and *JAMA* and not those of the American Medical Association.

JAMA. 2009;301(1):102-103

Randomized Trials of Antioxidant Supplementation for Cancer Prevention

First Bias, Now Chance—Next, Cause

Peter H. Gann, MD, ScD

line serum levels, smoking status, and genetic factors that might have modified response. After that, like Voyager space probes,

"…nonpharmacological dietary prevention of prostate cancer is probably more complex and may involve certain inconvenient truths... If it requires whole foods, extracts, or dietary patterns, *it may be necessary to give up the reductionist need to know which molecule is most responsible* and perhaps give up the notion of placebo controls as well. If it requires starting exposure early in life and sustaining it for decades, it *may mean having to give up the idea of phase 3 trials altogether*. This does not mean that whole food or complex mixture studies cannot be sound and biologically based…it may be time to critically examine the methods used to vet hypotheses for some phase 3 trials…"

Questioning the evidence-based paradigm

The Journal of Nutrition
2008 W. O. Atwater Memorial Lecture

Nutrients, Endpoints, and the Problem of Proof

Robert P. Heaney*

Creighton University, Omaha, NE 68131

- Drug-free state exists that can be contrasted with a drug-added state; not the case with nutrients.
- Nutrients are subject to the body's homeostatic control and have threshold effects, i.e., some physiologic measure improves as intake rises up to a level of sufficiency, above which higher intakes produce no additional benefit.
- Nutrients don't function in isolation and have beneficial effects on multiple tissues and organ systems; a focus on a single or "primary" outcome measure, which is favored by RCTs, is not practical.

Heaney *J. Nutr.* 2008;138 1591-1595

Questioning the reductionist approach?

Evidence-based criteria in the nutritional context

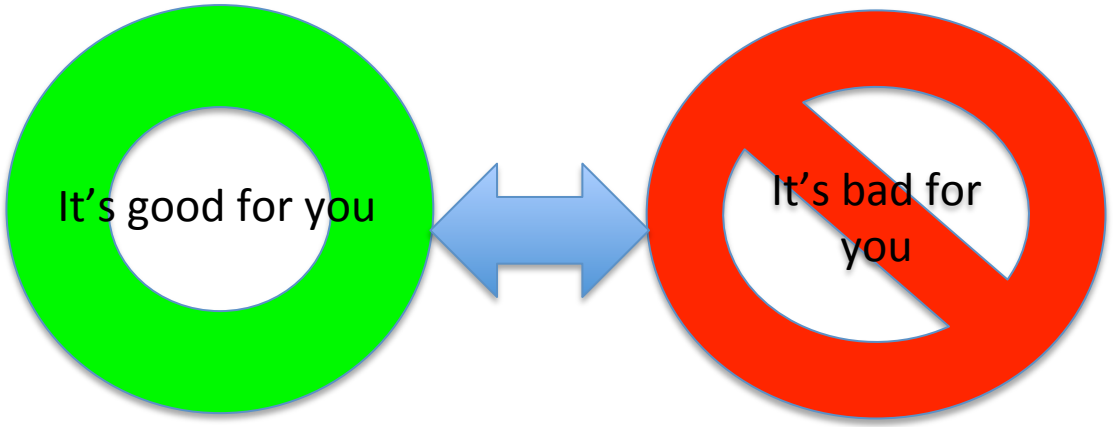
Jeffrey Blumberg, Robert P Heaney, Michael Huncharek, Theresa Scholl, Meir Stampfer, Reinhold Vieth, Connie M Weaver, and Steven H Zeisel

"This may mean action at a level of certainty that is different from what would be needed in the evaluation of drug efficacy. Similarly, it is judged that the level of confidence needed in defining nutrient requirements or dietary recommendations to prevent disease can be different from that needed to make recommendations to treat disease. In brief, advancing evidence-based nutrition will depend upon research approaches that include RCTs but go beyond them."

Nutrition Reviews Vol. 68(8):478–484, 2010

Nutrition contradiction

- Over the past several decades, as nutrition science has evolved, the public's perception of what is "good for you" vs. "bad for you" has "flip-flopped"
- Scientists have spent countless resources satisfying consumers' demand for the nutrition "villain" and "hero"



IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

The nutrition “villain” and “hero”

Antioxidants
Fiber
Protein
Probiotics
Organic
All natural

Saturated fat
Refined carbs
Trans fat
Salt
Sugar
GMO?

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

Part III: The Future

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Part III: The Future

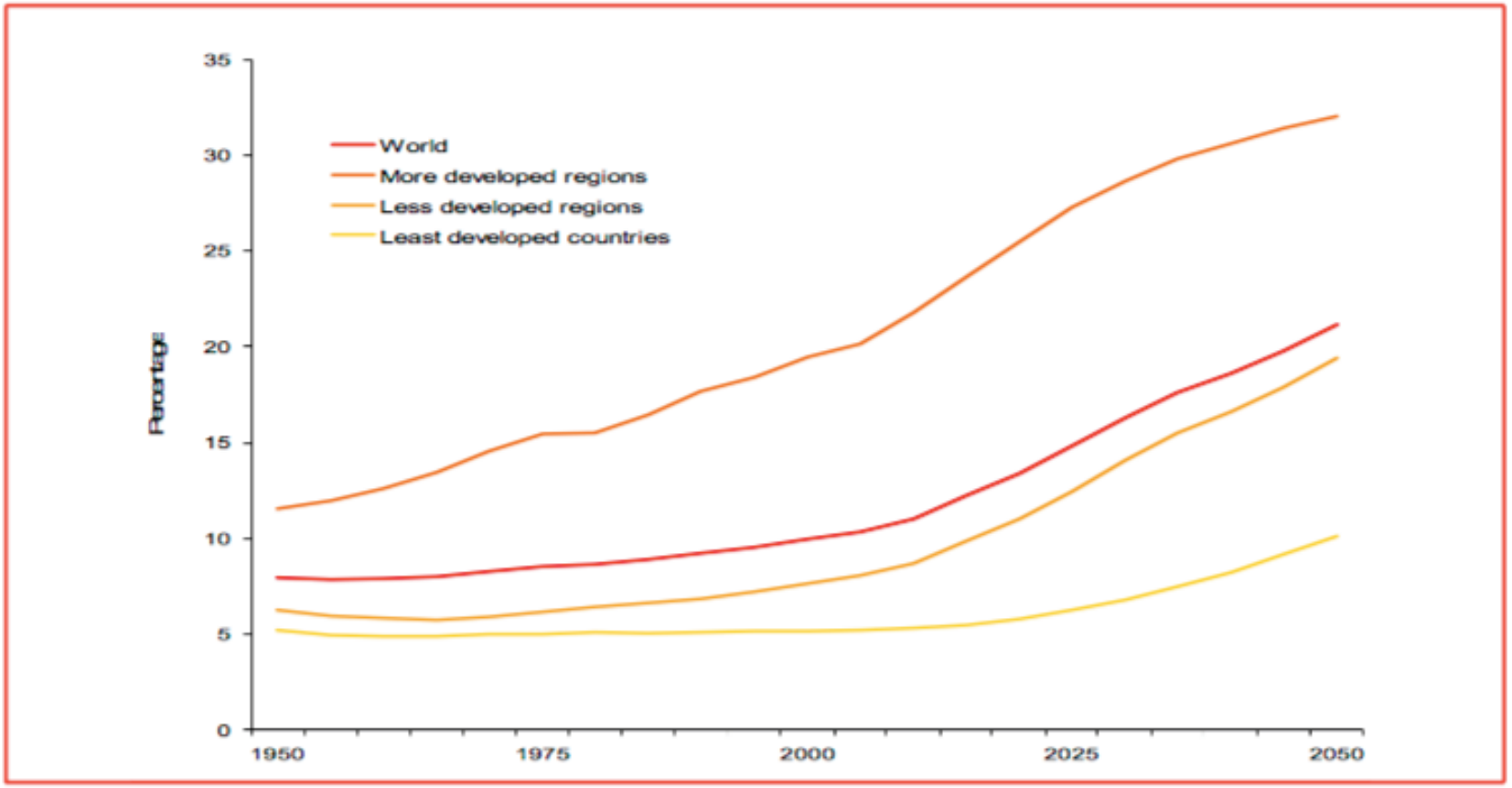
- Public health challenges
  - Rapidly aging population
  - Climate change, sustainability, expanding population
- Scientific focus
  - Social, environmental, cultural influences of behavior and choice
  - Personalized nutrition
  - Impact of the micro biome on health throughout the lifecycle
- Basis of recommendations
  - Dietary gaps identified through nutrient status assessment
  - Less emphasis on individual nutrients and more on overall beneficial dietary patterns and lifestyle; dietary landscape
  - Incorporation of aspects of sustainability and food security

Part III: The Future

- Public health challenges
  - Rapidly aging population
  - Climate change, sustainability, expanding population
- Scientific focus
  - Social, environmental, cultural influences of behavior and choice
  - Personalized nutrition
  - Impact of the micro biome on health throughout the lifecycle
- Basis of recommendations
  - Dietary gaps identified through nutrient status assessment
  - Less emphasis on individual nutrients and more on overall beneficial dietary patterns and lifestyle; dietary landscape
  - Incorporation of aspects of sustainability and food security

The world is rapidly aging

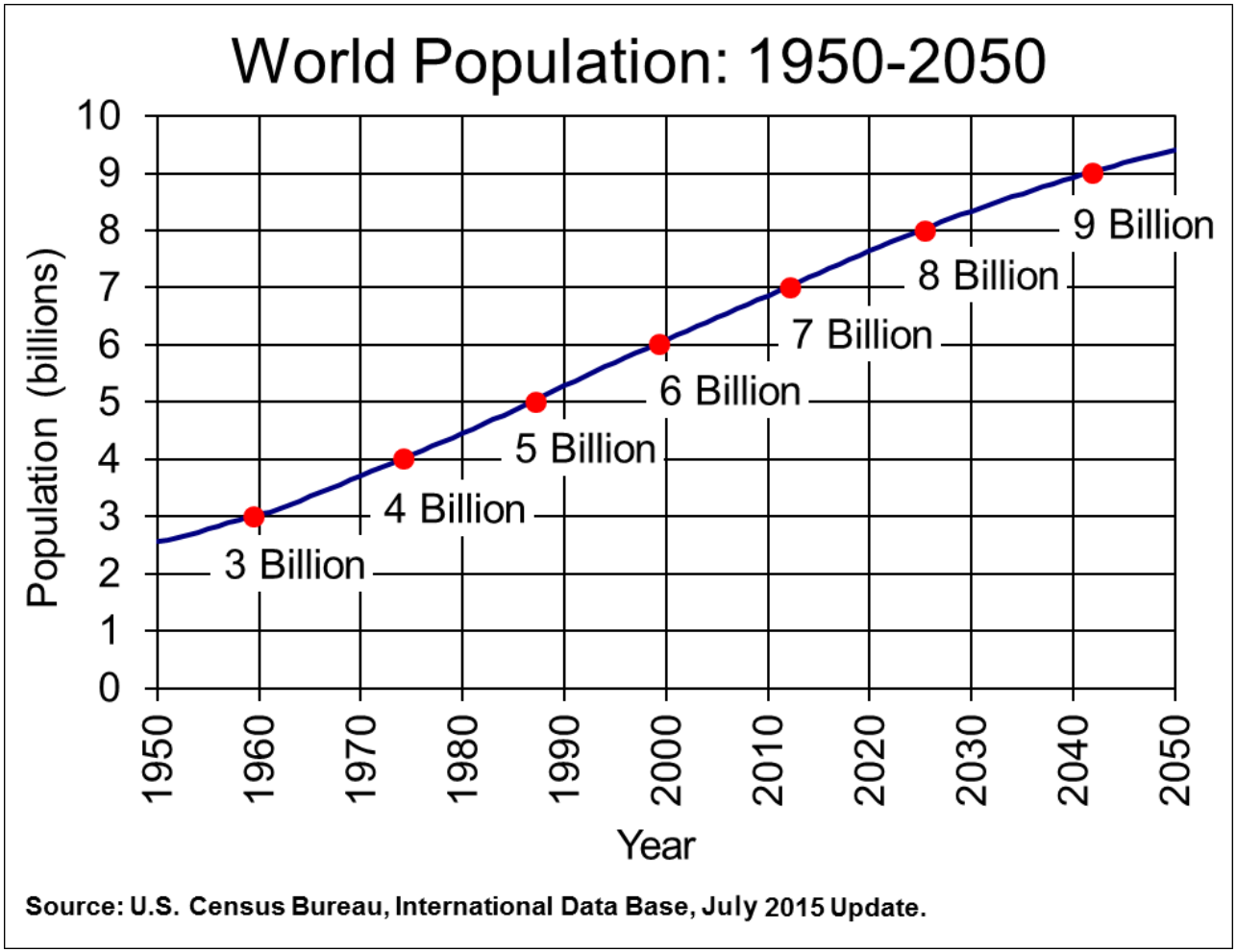
Figure 1.8
Proportion of the population aged 60 years or over: world and development regions 1950-2050



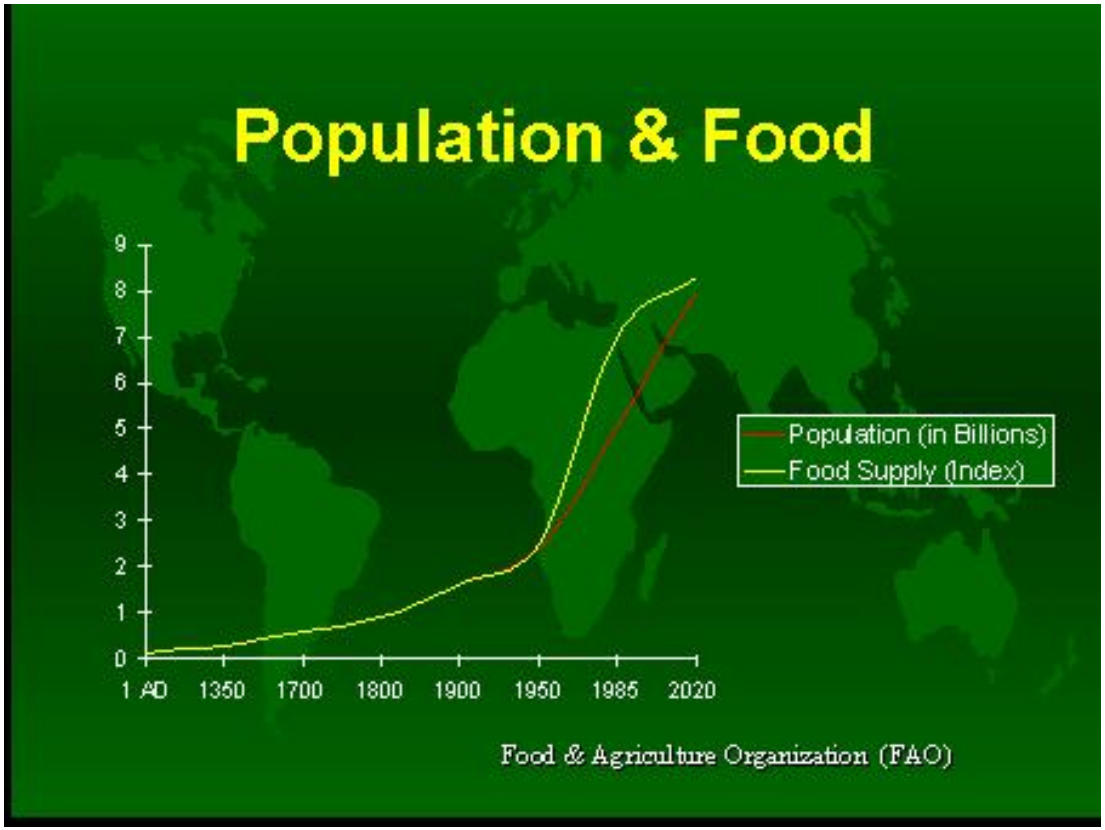
Source: World Population Ageing 2013 report, United Nations

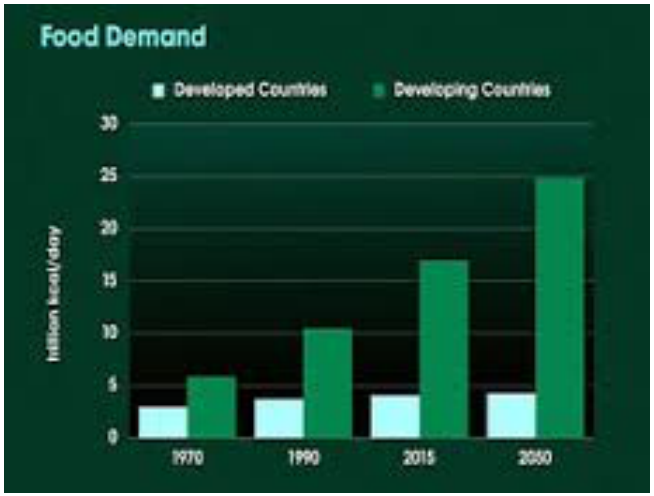
Expanding population

- Population growth fuels concerns over food security and sustainability



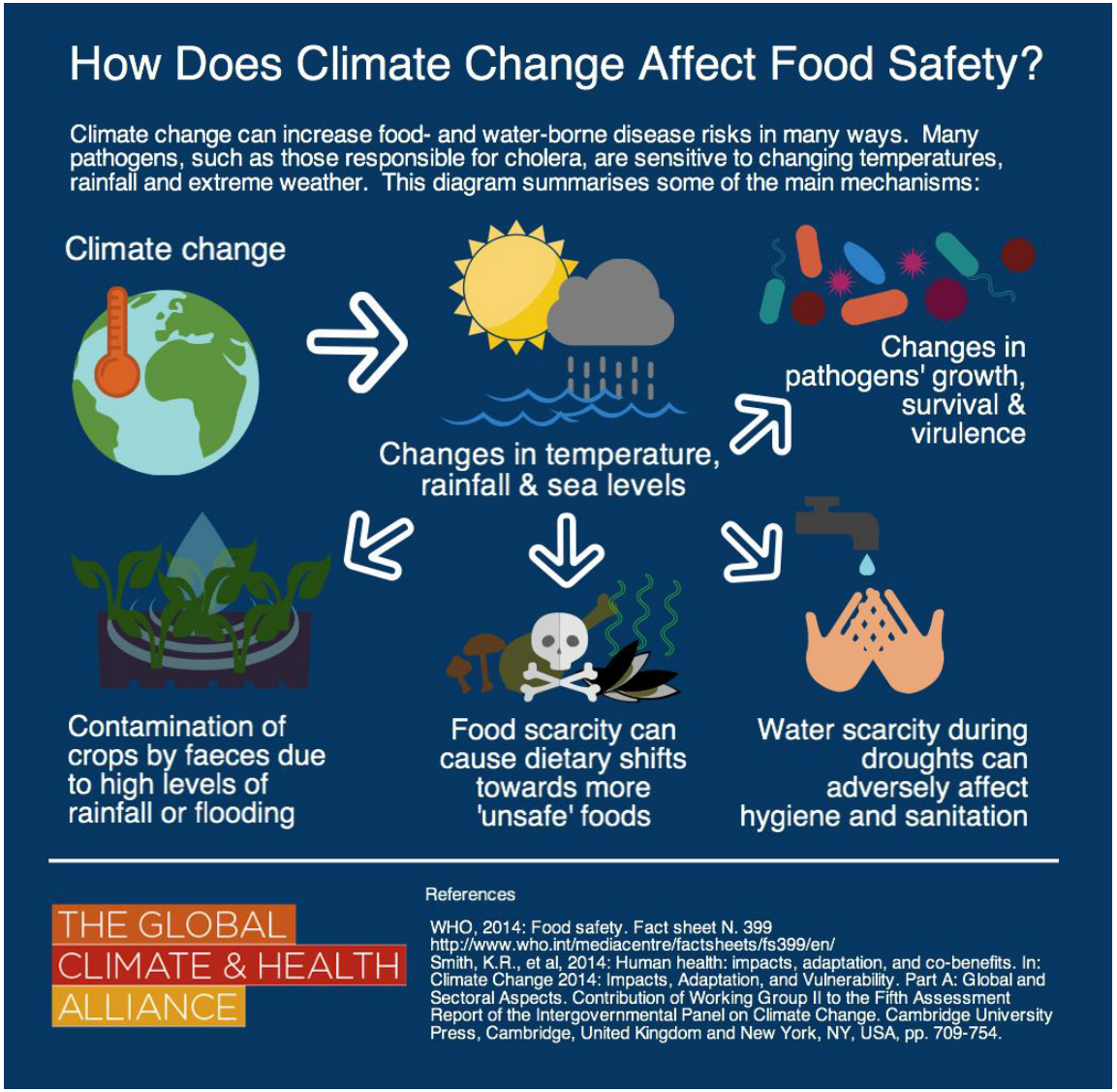
Food supply keeping up with population growth





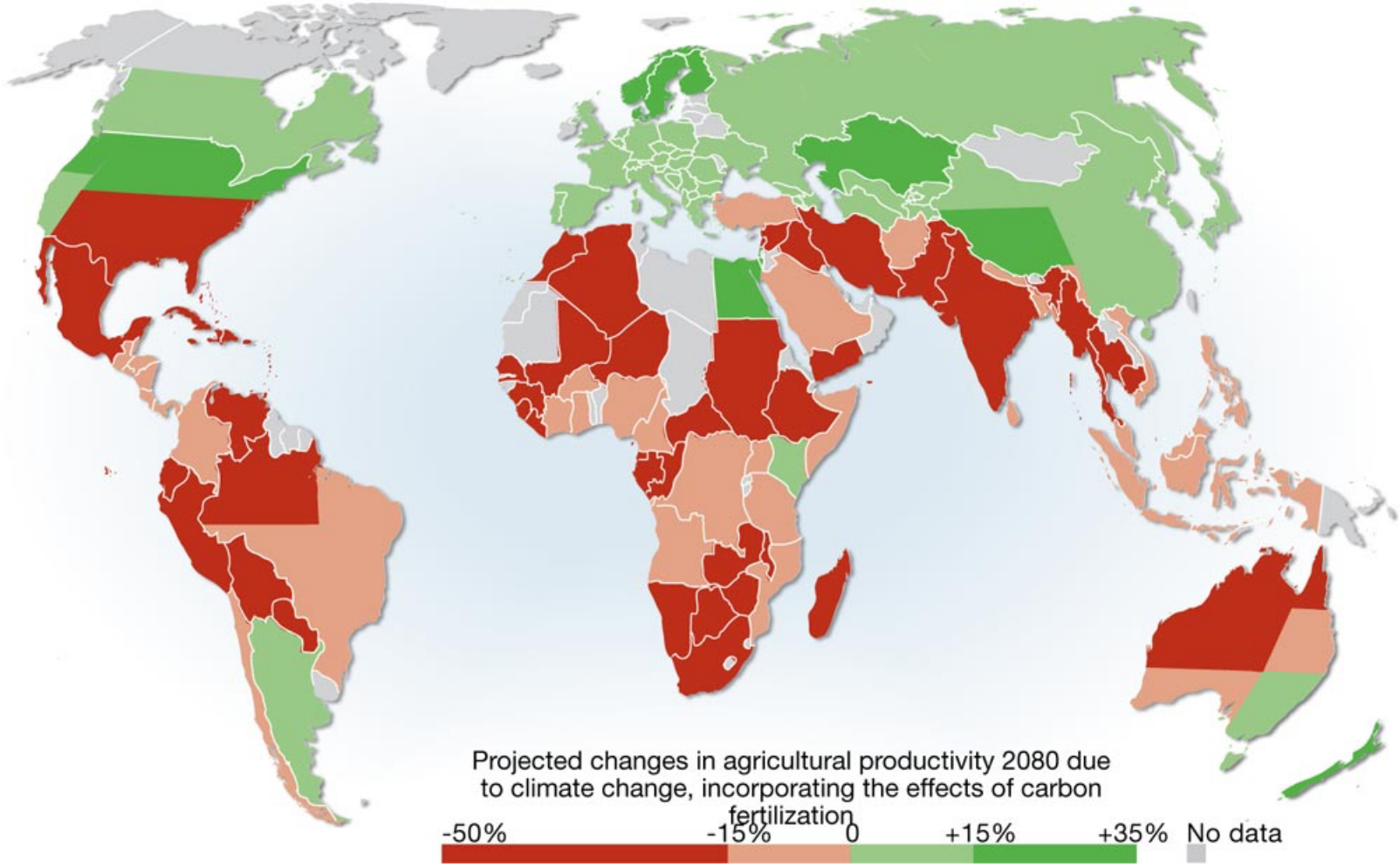
Source: www.FAO.org

Impact of climate change



Source: WHO

Climate change and food security



Cline, W 2007 *Global Warming and Agriculture*

Part III: The Future

- Public health challenges
  - Rapidly aging population
  - Climate change, sustainability, expanding population
- Scientific focus
  - Social, environmental, cultural influences of behavior and choice
  - Personalized nutrition
  - Impact of the micro biome on health throughout the lifecycle
- Basis of recommendations
  - Dietary gaps identified through nutrient status assessment
  - Less emphasis on individual nutrients and more on overall beneficial dietary patterns and lifestyle; dietary landscape
  - Incorporation of aspects of sustainability and food security

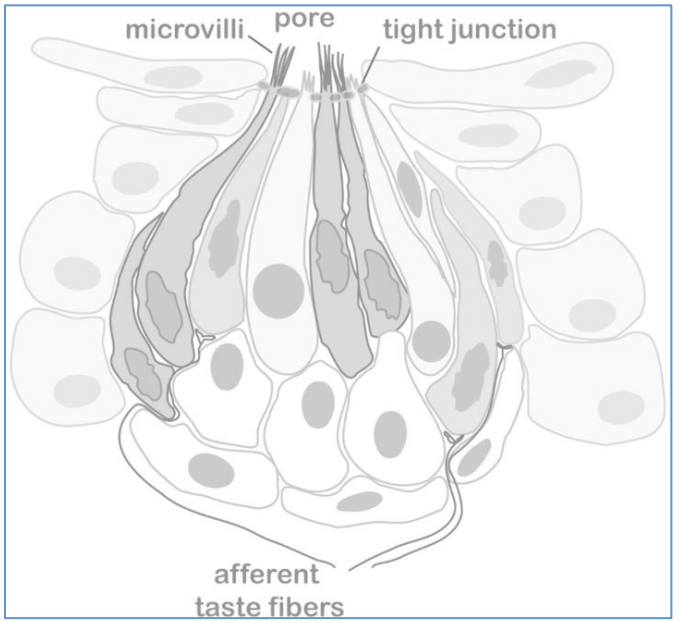
- National Nutrition Research Roadmap 2016–2021: *Advancing Nutrition Research to Improve and Sustain Health*
- Interagency Committee on Human Nutrition Research, 2016

Key Research Priorities for 2016-2021

Question 1: How can we better understand and define eating patterns to improve and sustain health?
Question 1 Topic 1 (Q1T1): How do we enhance our understanding of the role of nutrition in health promotion and disease prevention and treatment?
Question 1 Topic 2 (Q1T2): How do we enhance our understanding of individual differences in nutritional status and variability in response to diet?
Question 1 Topic 3 (Q1T3): How do we enhance population-level food- and nutrition-related health monitoring systems and their integration with other data systems to increase our ability to evaluate change in nutritional and health status, as well as in the food supply, composition, and consumption?
Question 2: What can be done to help people choose healthy eating patterns?
Question 2 Topic 1 (Q2T2): How can we more effectively characterize the interactions among the demographic, behavioral, lifestyle, social, cultural, economic, occupational, and environmental factors that influence eating choices?
Question 2 Topic 2 (Q2T2): How do we develop, enhance and evaluate interventions at multiple levels to improve and sustain healthy eating patterns?
Question 2 Topic 3 (Q2T3): How can simulation modeling that applies systems science in nutrition research be used to advance exploration of the impact of multiple interventions?
Question 2 Topic 4 (Q2T4): How can interdisciplinary research identify effective approaches to enhance the environmental sustainability of healthy eating patterns?
Question 3: How can we develop and engage innovative methods and systems to accelerate discoveries in human nutrition?
Question 3 Topic 1 (Q3T1): How can we enhance innovations in measuring dietary exposure, including use of biomarkers?
Question 3 Topic 2 (Q3T2): How can basic biobehavioral science be applied to better understand eating behaviors?
Question 3 Topic 3 (Q3T3): How can we use behavioral economics theories and other social science innovations to improve eating patterns?
Question 3 Topic 4 (Q3T4): How can we advance nutritional sciences through the use of research innovations involving Big Data?

Understanding what drives food choice

- Unsuccessful implementation of dietary guidance has led to investment in research around what drives food intake behavior



Loper et al. *Nutr Rev*. 2015 Feb; 73(2): 83–91.

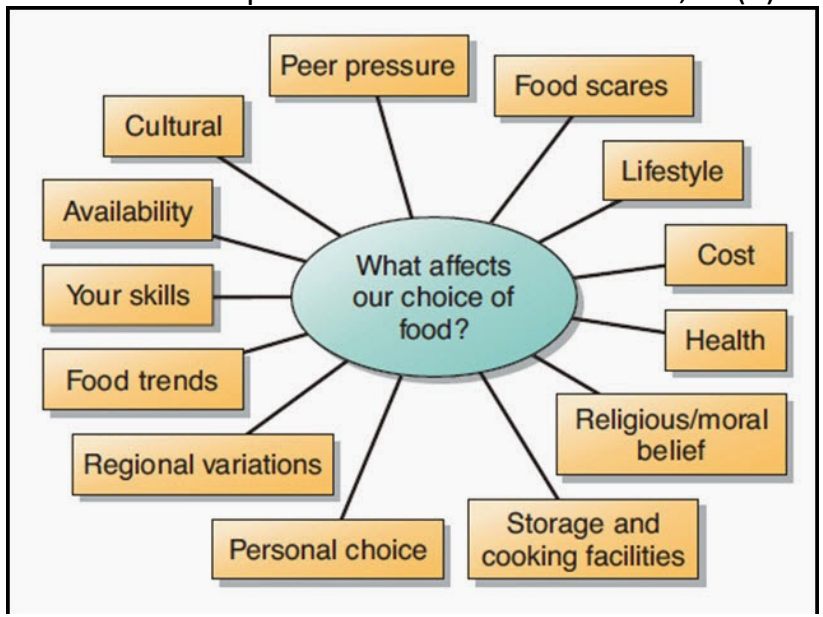
nutrients

Editorial

Food Choice and Nutrition: A Social Psychological Perspective

- Social and environmental influences on food choice
- Psychological influences on eating behavior
- Eating behavior profiling

Hardcastle et al. *Nutrients* 2015, *7*, 8712–8715



The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Personalized approach

Nickler et al. *Respiratory Research* (2015) 16:125

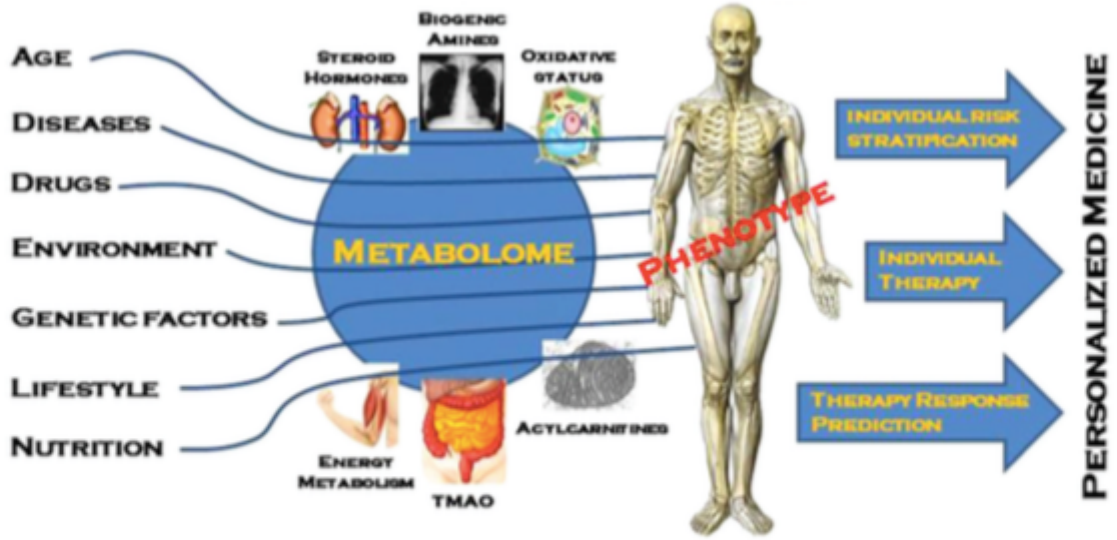


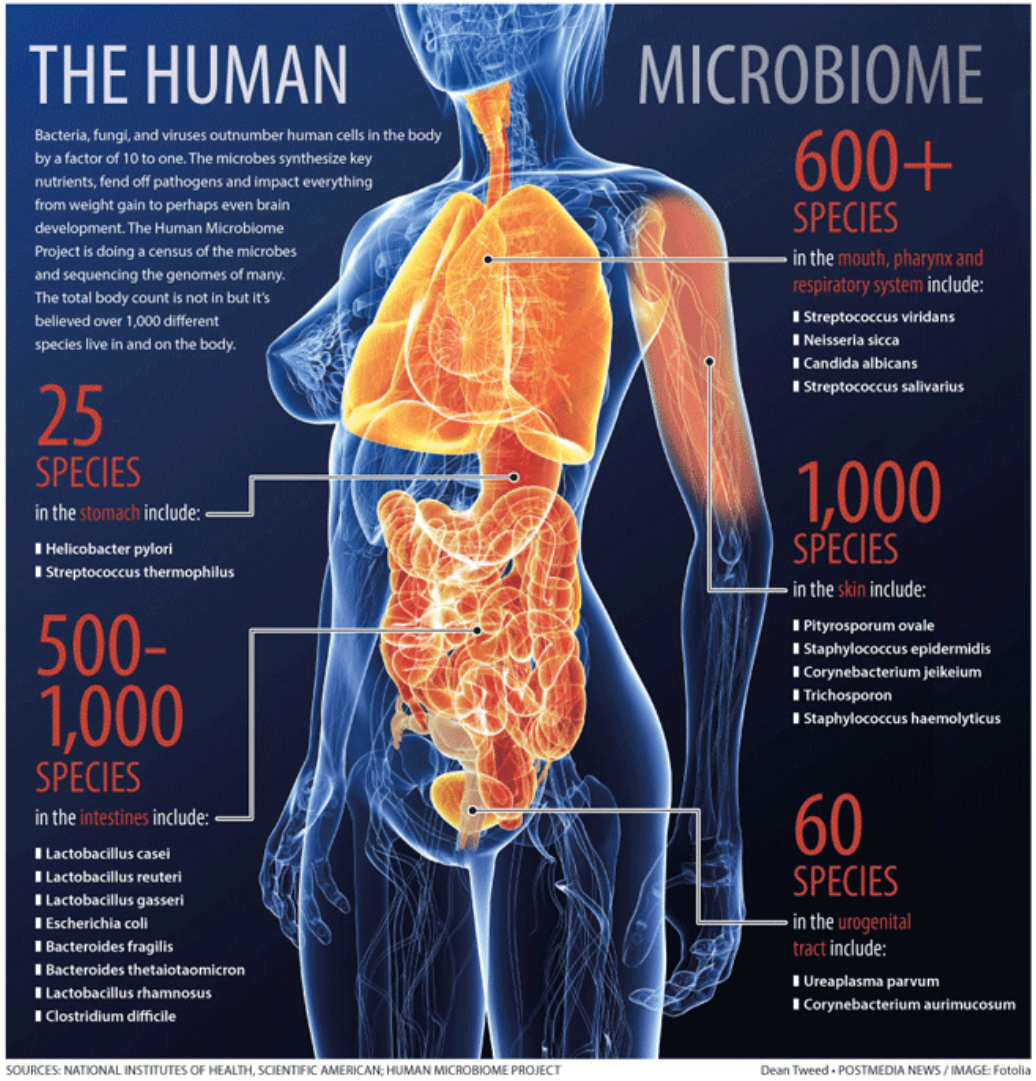
Fig. 2 Metabolomics to improve outcome prediction in LRTI. Figure 2 shows the influence of different factors such as age, diseases, drugs, environment, genetic factors, lifestyle and nutrition on endogenous metabolome which defines the human phenotype. The knowledge of metabolic interactions may provide individual risk stratification, prediction of therapy response as well as new targets for future individual therapy and therefore a form of personalized medicine. (Abbr.: TMAO, trimethylamine-*N*-oxide)

Advances in science and technology, combined with failure of broad recommendations

- Genetics and environmental factors force a more “personalized” approach

The microbiome

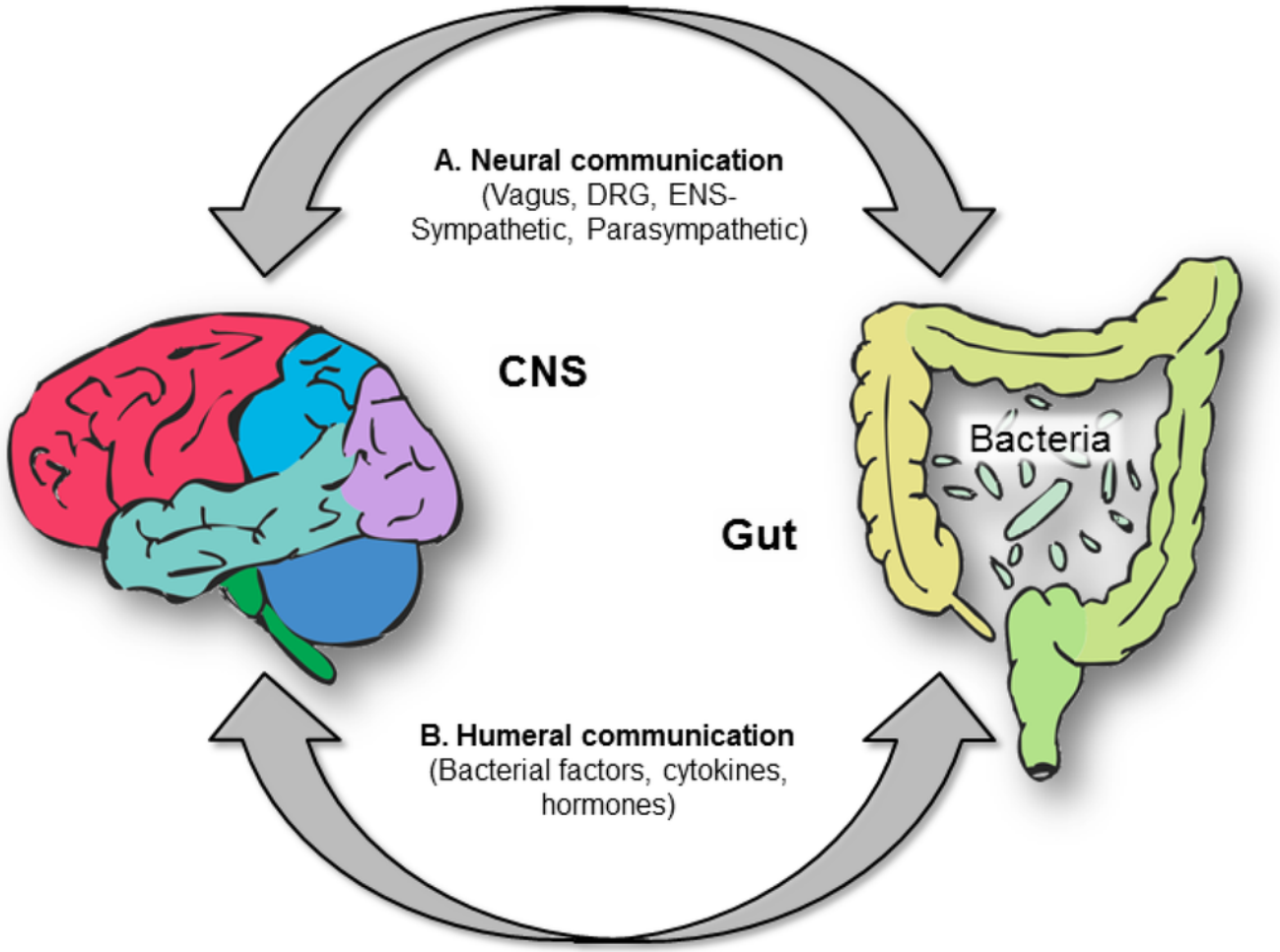
- Number of bacterial cells in (oral, gut) or on (skin) the body exceed our own by 10-fold (100 trillion vs. 10 trillion)
- The composition, nature and metabolism of these cells is influenced by diet and lifestyle and in turn influences health and well being



Source: www.Thefoodmind.com

The gut-brain axis

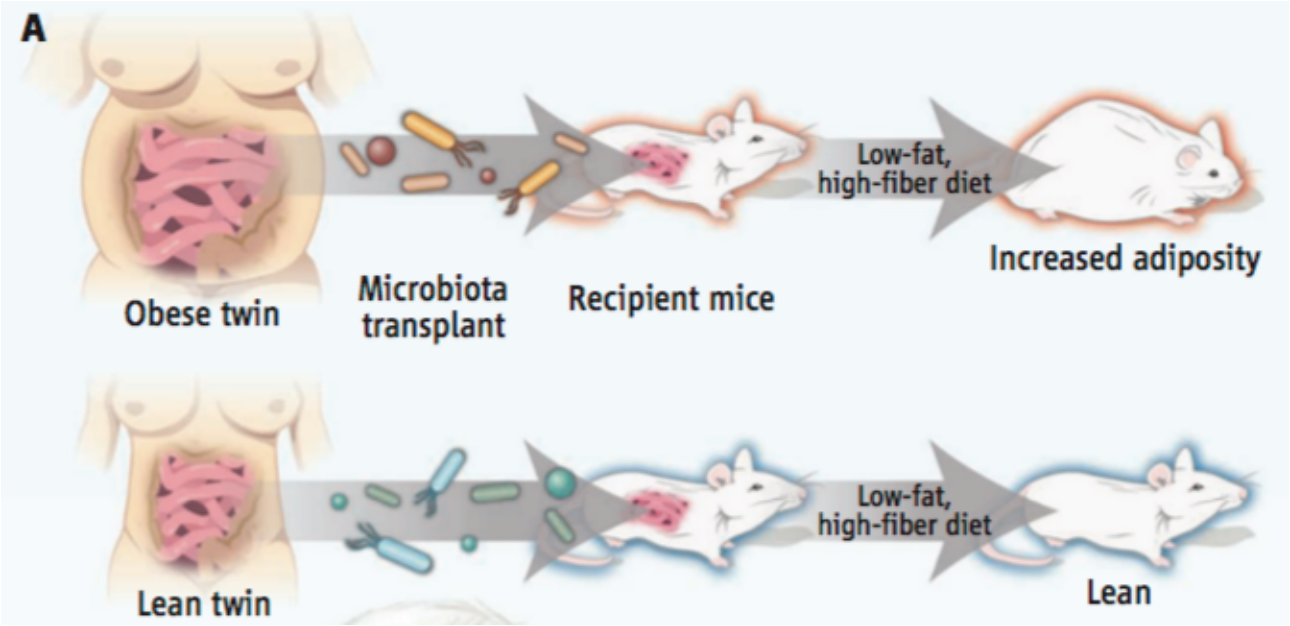
- Gut-brain axis links emotional and cognitive brain centers with peripheral functioning of digestive tract
- Alterations in the gut will become important in the pathophysiology of human central nervous system disorders



Jenkins, TA et al. *Nutrients* 2016, *8*(1), 56

Microbiome link to obesity

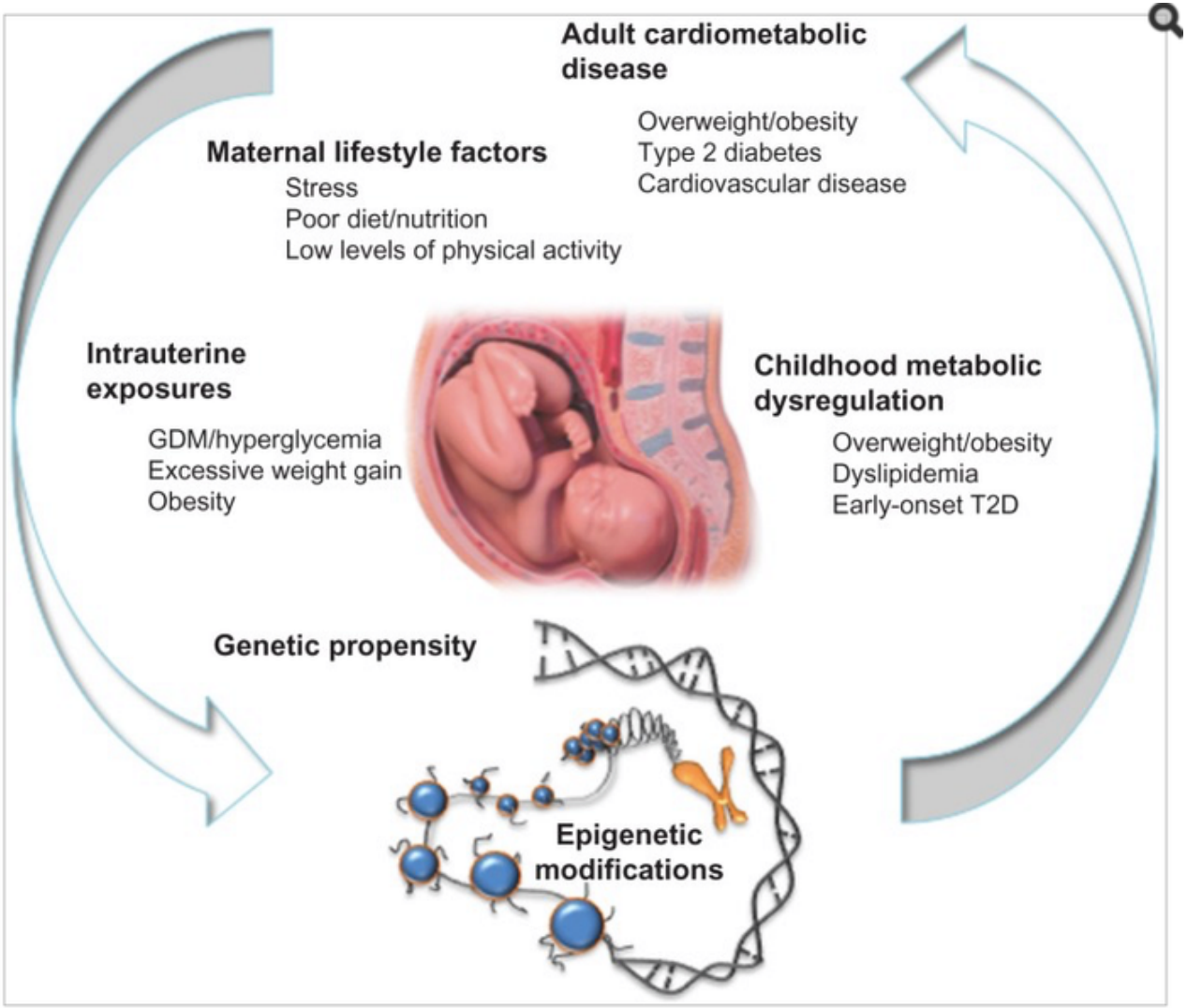
- Germ-free mice inoculated with microbiota from obese or lean human twins take on the microbiota characteristics of the donor
- Those receiving the obese microbiota (red outline) had an increase in adiposity, whereas those receiving the lean microbiota (blue outline) remained lean



Walker, AW *Science* VOL 341, 2013

Impact of maternal nutrition

- Risk of cardiometabolic disease may be shaped by maternal lifestyle factors that influence the intrauterine milieu
- Dysregulation ensues in early childhood progresses toward overt disease outcomes in later adulthood



Part III: The Future

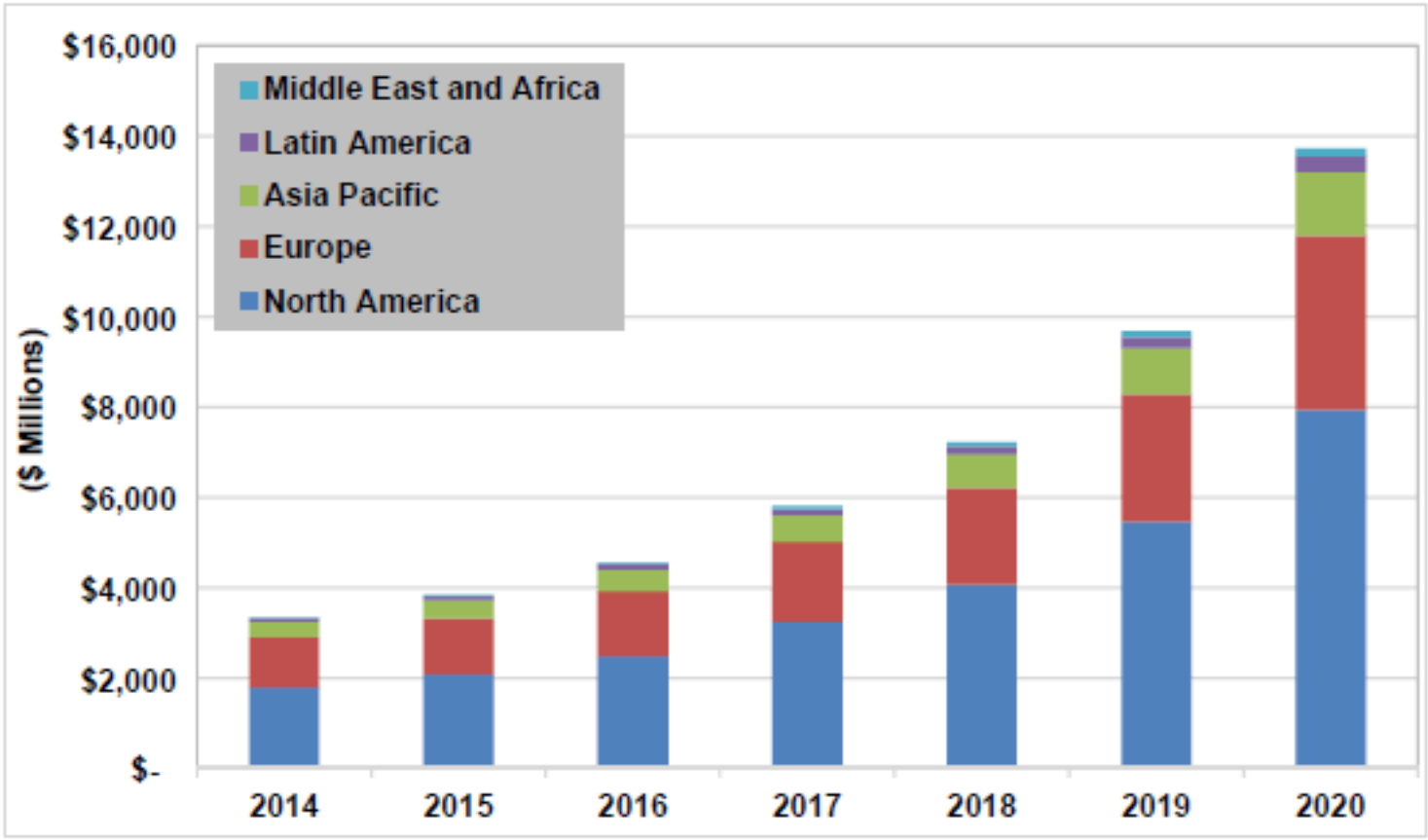
- Public health challenges
  - Rapidly aging population
  - Climate change, sustainability, expanding population
- Scientific focus
  - Social, environmental, cultural influences of behavior and choice
  - Personalized nutrition
  - Impact of the micro biome on health throughout the lifecycle
- Basis of recommendations
  - Dietary gaps identified through nutrient status assessment
  - Less emphasis on individual nutrients and more on overall beneficial dietary patterns and lifestyle; dietary landscape
  - Incorporation of aspects of sustainability and food security

Nutrition status assessment

- Outside clinical setting, current status assessment methods rely mainly on dietary recall approaches
  - Food Frequency Questionnaires
  - 24-hr Recall
- These are notoriously inaccurate severely limiting utility
- "*…dietary exposures are very difficult to measure because all individuals eat foods, even if the amount and the kind of food consumed is various between subjects, and people rarely perceive what they eat and how much they do. Inaccurate dietary assessment may be a serious obstacle of understanding the impact of dietary factors on disease*." Shim, J-S *Epidemiol Health*. 2014; 36
- Objective status assessment methods are needed to properly inform recommended nutrient intakes

Explosion of home health technologies

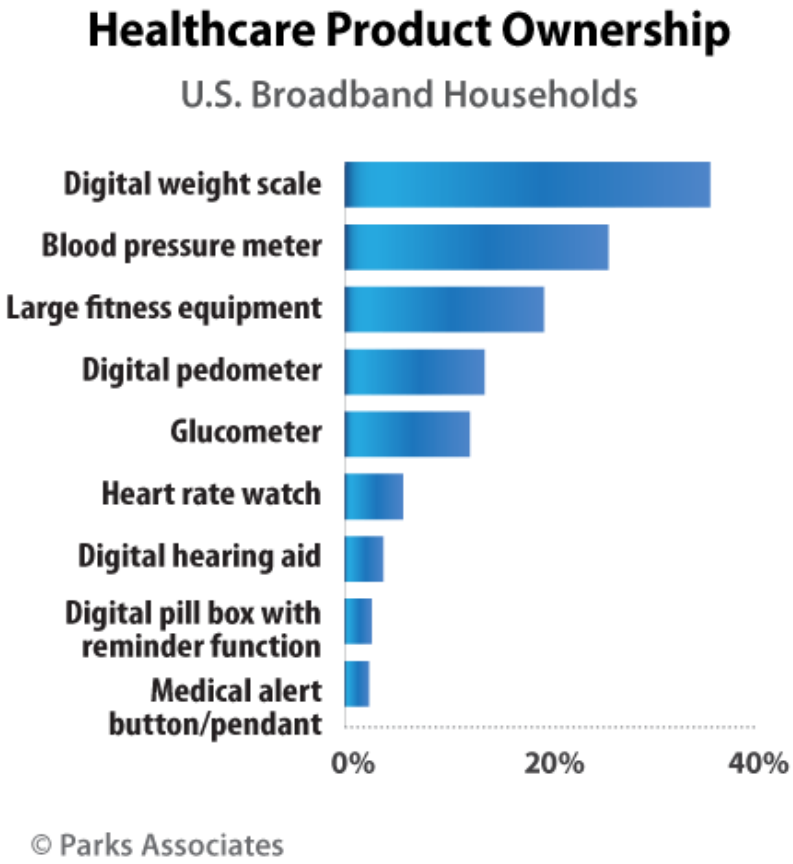
Total Home Health Technologies Revenue by Region



Source: Tractica

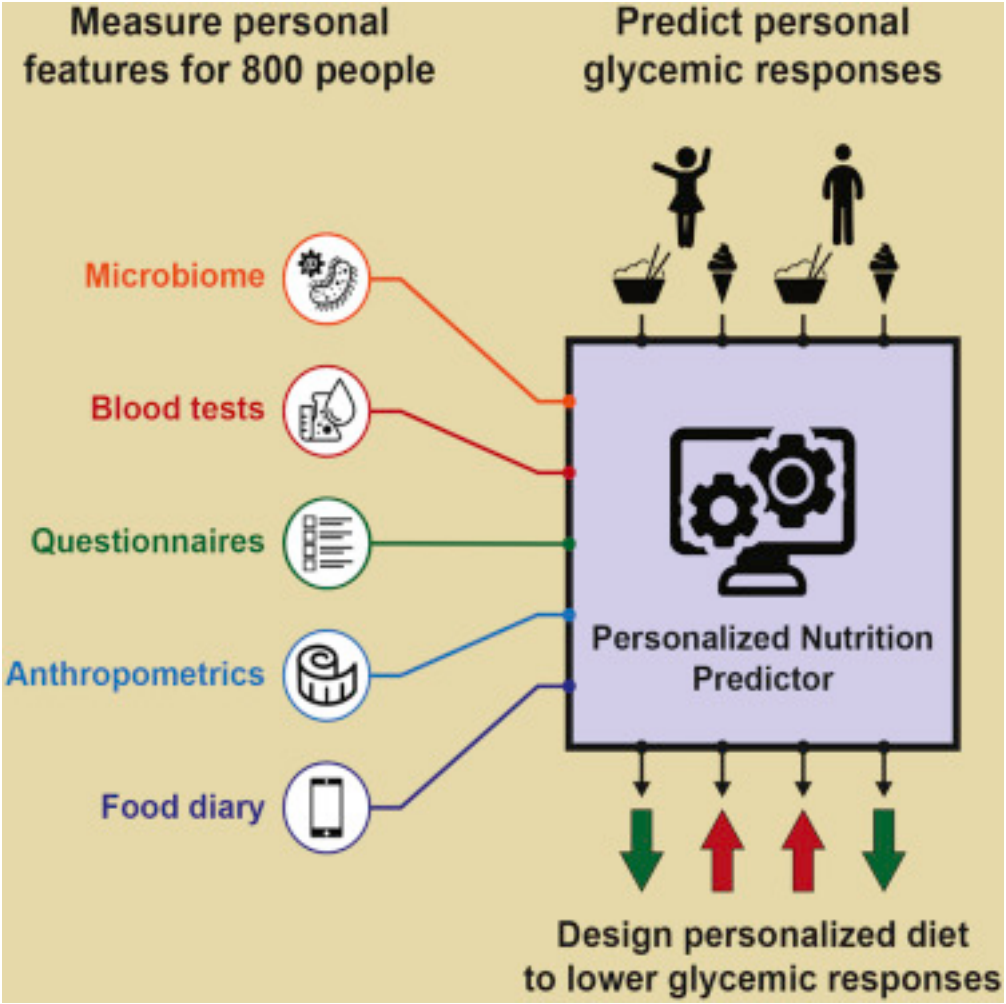
Handheld devices, health and wellness

Source: Consumer Technology Association



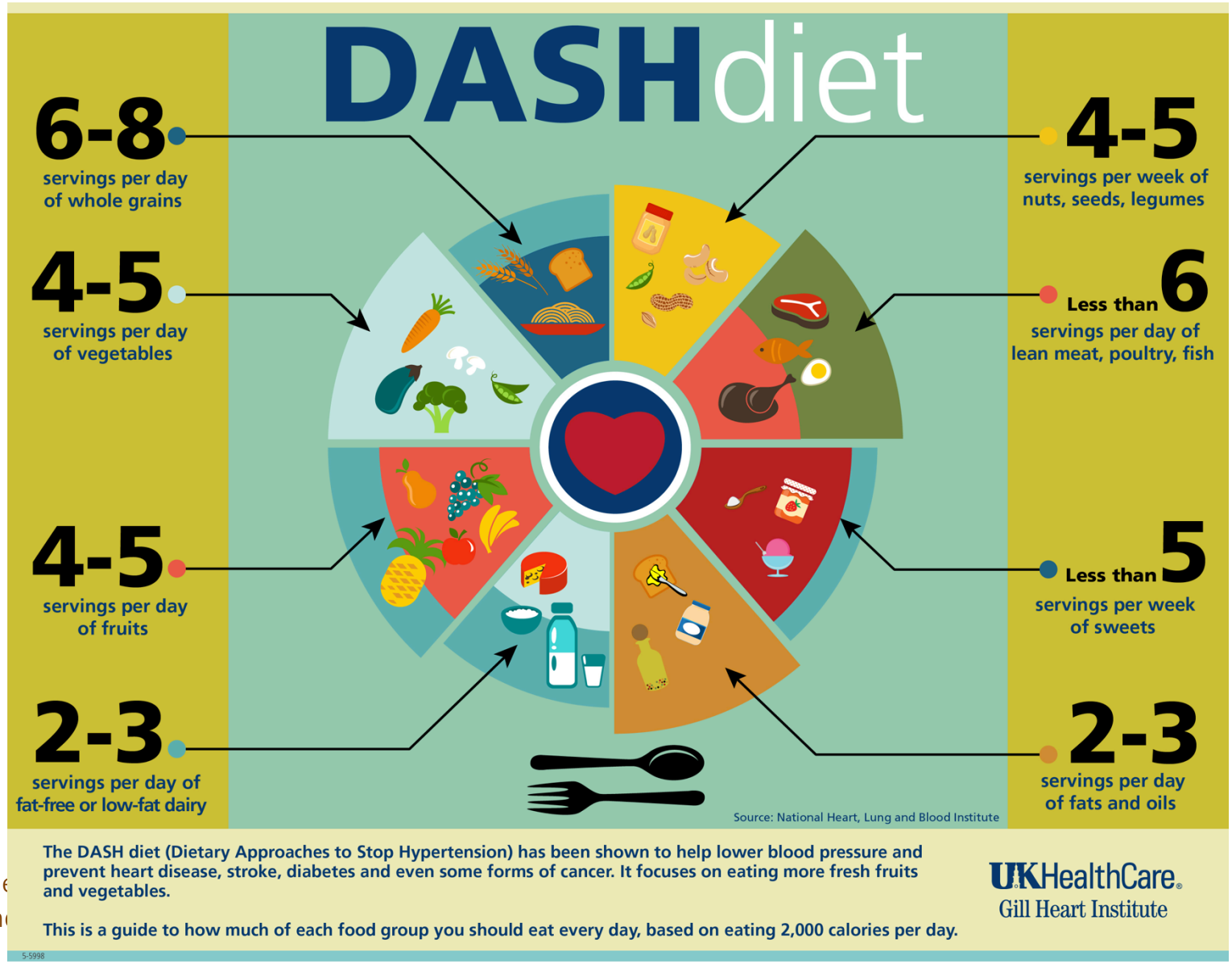
Technology advances

- Technology will allow the use of “small data” capture to drive personalized diets
- Handheld devices will allow consumers to understand their own nutrient status
- Biomarkers of nutrition status replace intake assessment as the basis for identifying dietary gaps



Zeevi, D et al. *Cell* Vol 163 (5), p1079–1094, 2015

Dietary patterns: “DASH” diet



Dietary patterns: Mediterranean diet

Sáez-Almendros et al. *Environ Health* 2013; 12: 118.

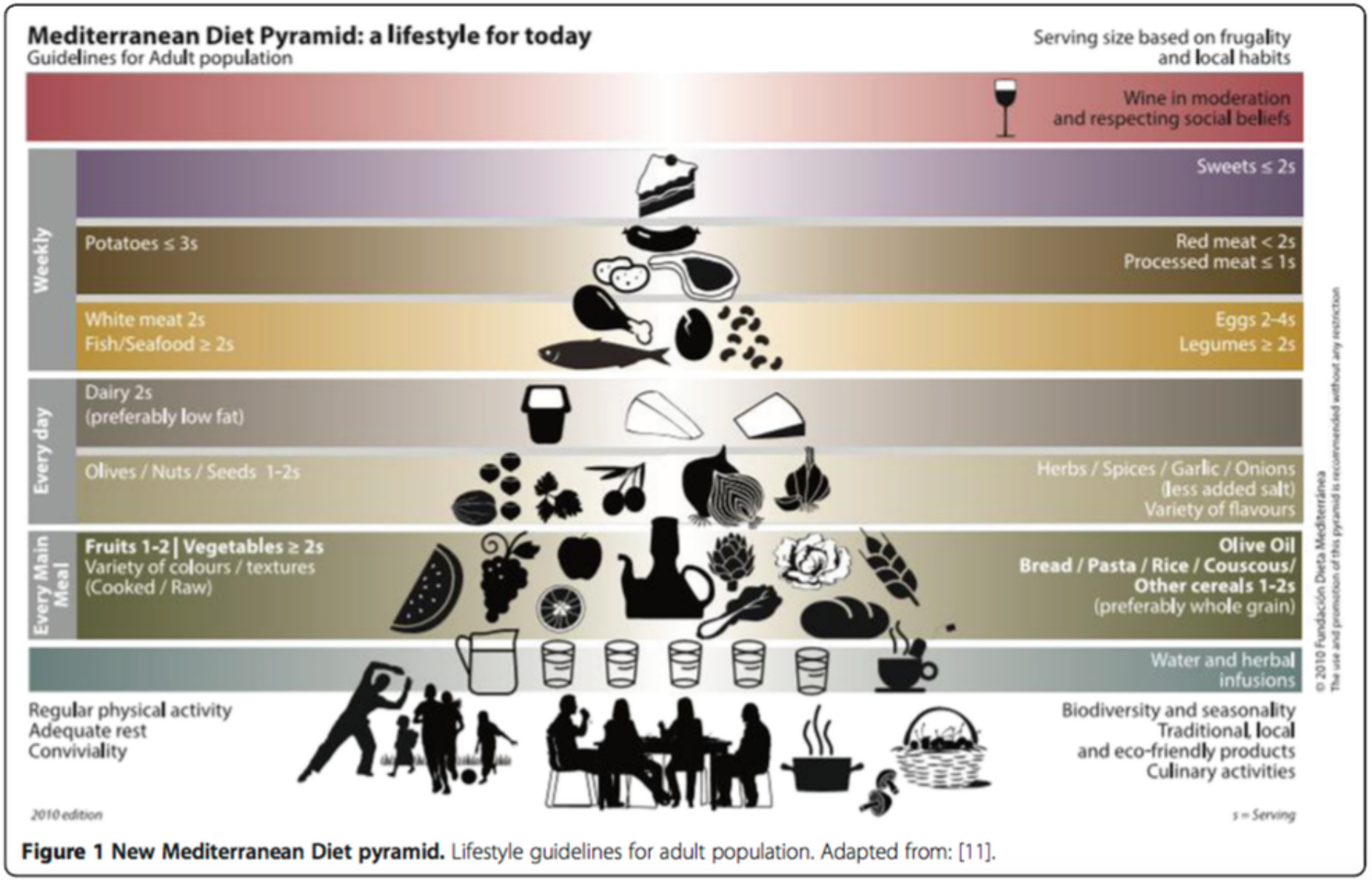
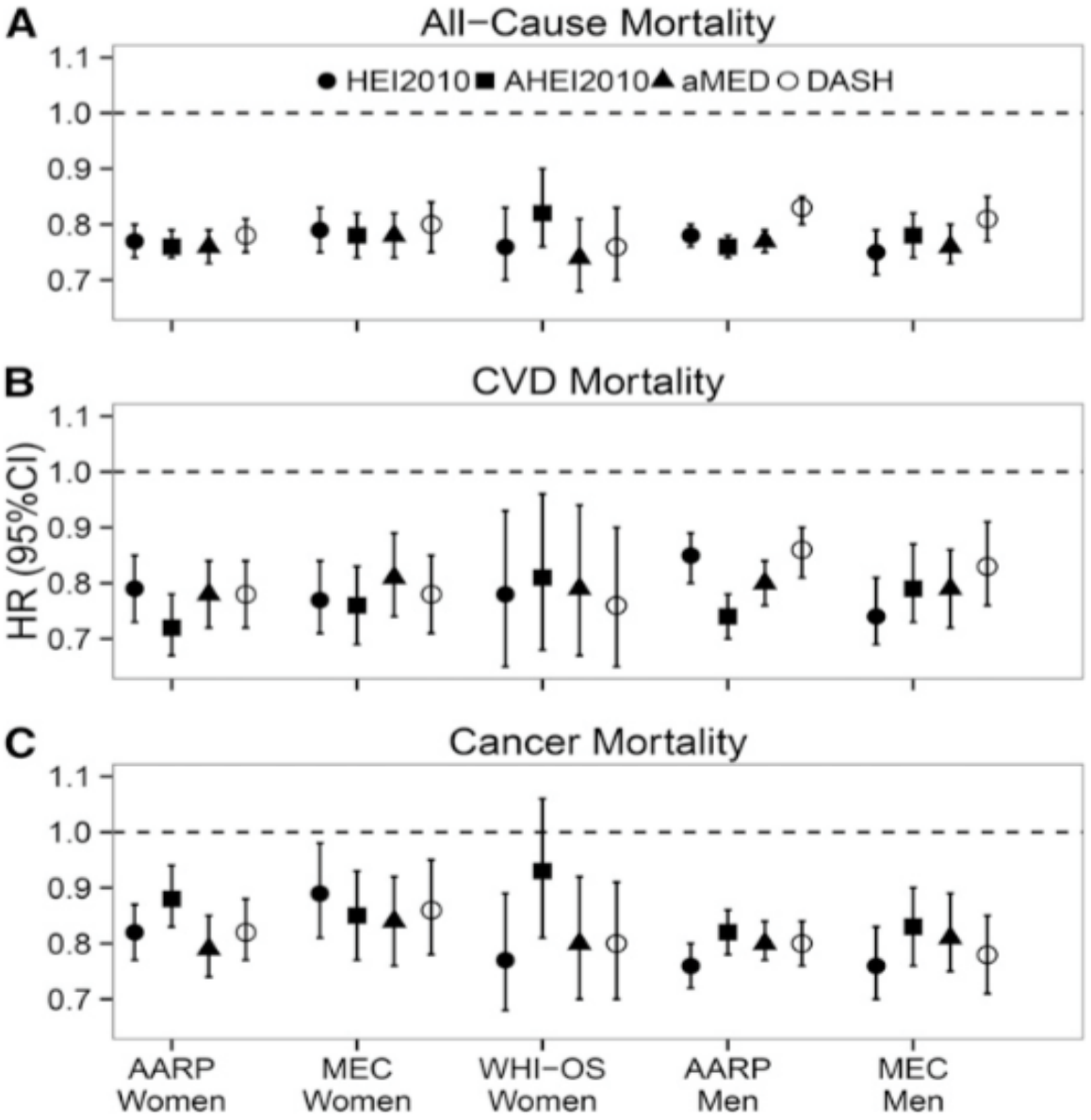


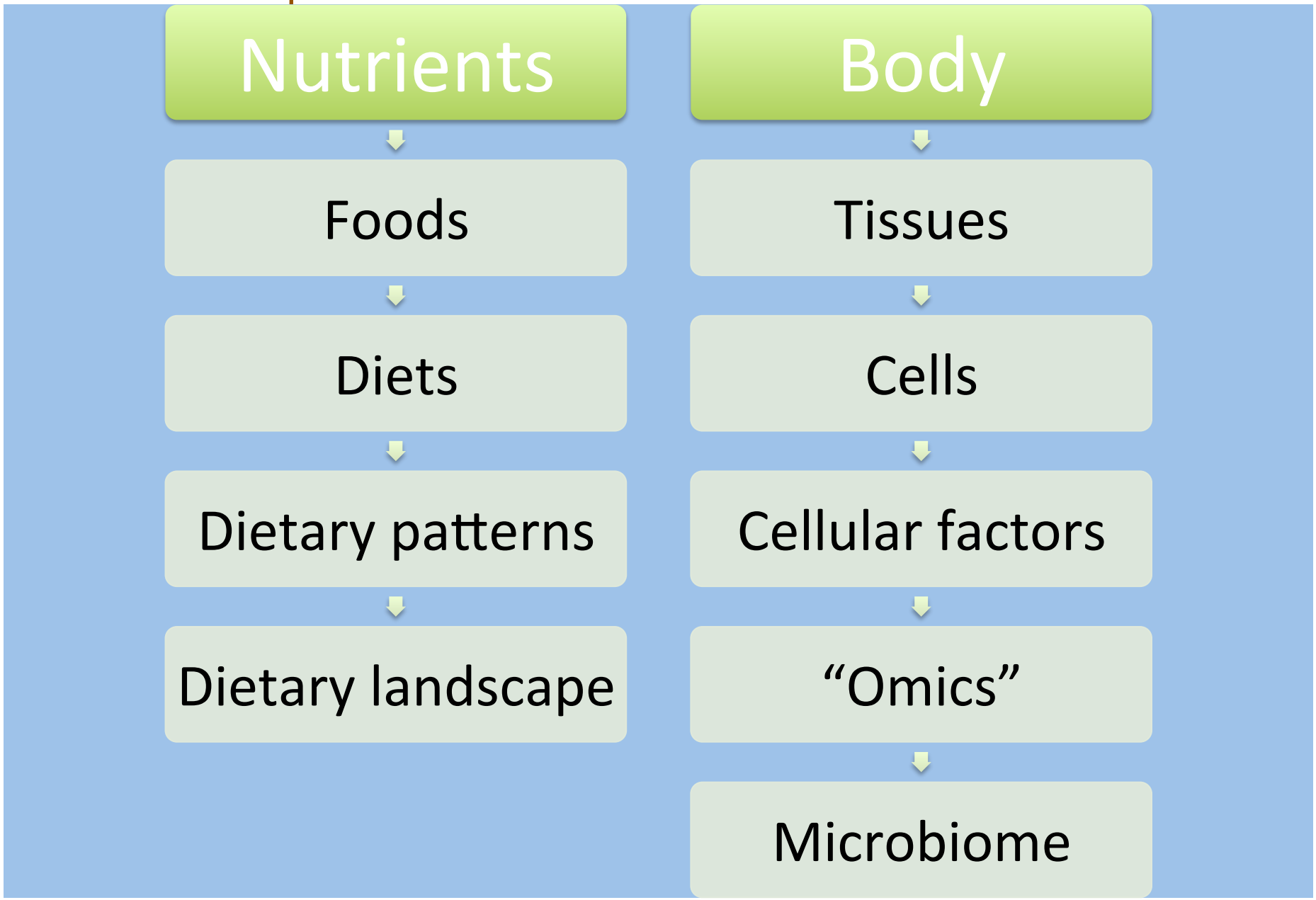
Figure 1 New Mediterranean Diet pyramid. Lifestyle guidelines for adult population. Adapted from: [11].

Dietary patterns and heath outcomes

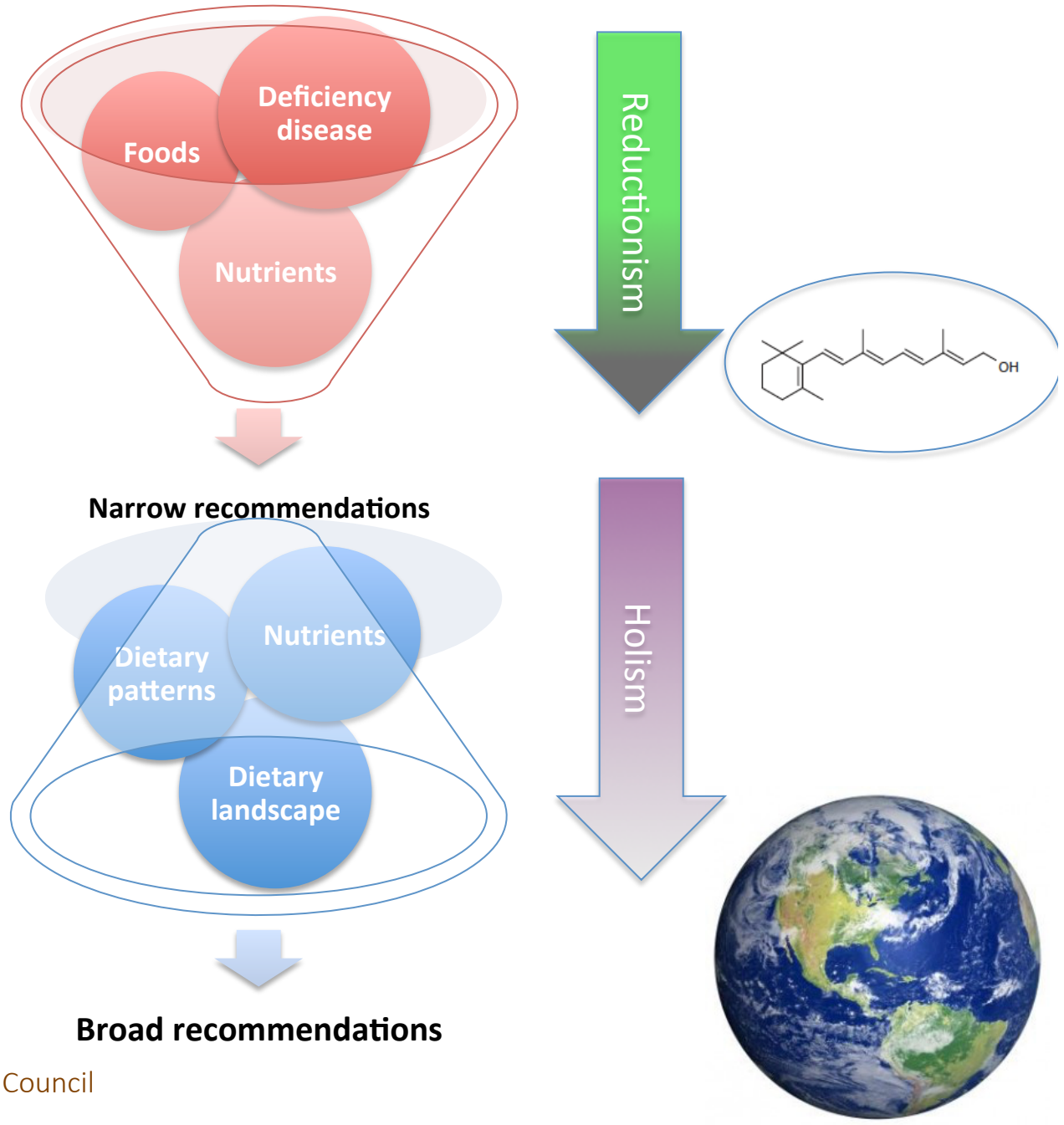
- Association of dietary quality indices with all-cause (A), CVD (B), and cancer (C) mortality by cohort and sex (quintile 5 vs. quintile 1)
- Healthy eating index vs. Mediterranean vs. DASH



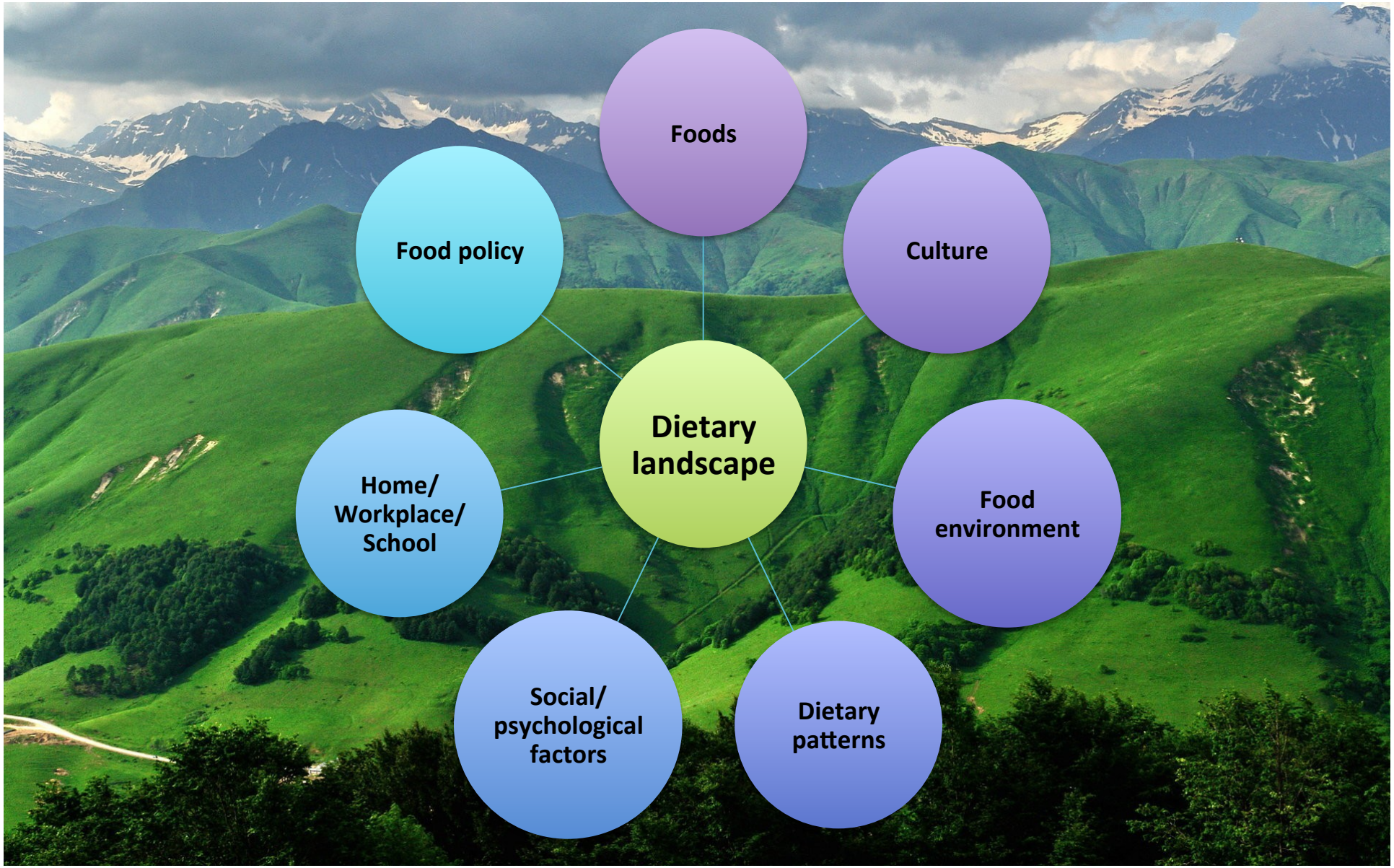
Liese, AD et al. *J Nutr* 2015;145:393–402


Nutrients
Foods
Diets
Dietary patterns
Dietary landscape
Body
Tissues
Cells
Cellular factors
“Omics”
Microbiome

- Evolution from linking health benefits to specific nutrients at specific doses, to understanding the broader landscape that impacts health



What is the “dietary landscape”?



IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

Evolution of nutrient recommendations

1941 — **1997** — **2010** — **2016+?**

Recommended intakes or dietary guidance for Bioactives

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

Dietary guidance for bioactives

Dietary Bioactives: Establishing a Scientific Framework for Recommended Intakes[1,2]

Wallace et al. *Adv Nutr* 2015;6:1–4.

Taylor C Wallace,[3,4]* Jeffrey B Blumberg,[5,6] Elizabeth J Johnson,[5,6] and Andrew Shao[7]

[3]Department of Nutrition and Food Studies, George Mason University, Fairfax, VA; [4]National Osteoporosis Foundation, Washington, DC; [5]Friedman School of Nutrition Science and Policy and [6]Antioxidants Research Laboratory, Jean Mayer USDA Human Nutrition Research Center on Aging, Tufts University, Boston, MA; and [7]Herbalife Ltd., Torrance, CA

Are Dietary Bioactives Ready for Recommended Intakes?[1,2]

Gaine et al *Adv. Nutr*. 4: 539–541, 2013

P. Courtney Gaine,[3]* Douglas A. Balentine,[4] John W. Erdman Jr.,[5] Johanna T. Dwyer,[6] Kathleen C. Ellwood,[7] Frank B. Hu,[8] and Robert M. Russell[9]

[3]North American Branch of the International Life Sciences Institute, Washington, DC; [4]Unilever, Englewood Cliffs, NJ; [5]University of Illinois, Urbana, IL; [6]Tufts University Medical School, Boston, MA; [7]College of Southern Maryland, La Plata, MD; [8]Harvard School of Public Health, Cambridge, MA; [9]Tufts University, Boston, MA; and National Institute of Health, Bethesda, MD

Eur J Nutr
DOI 10.1007/s00394-014-0666-3

SUPPLEMENT

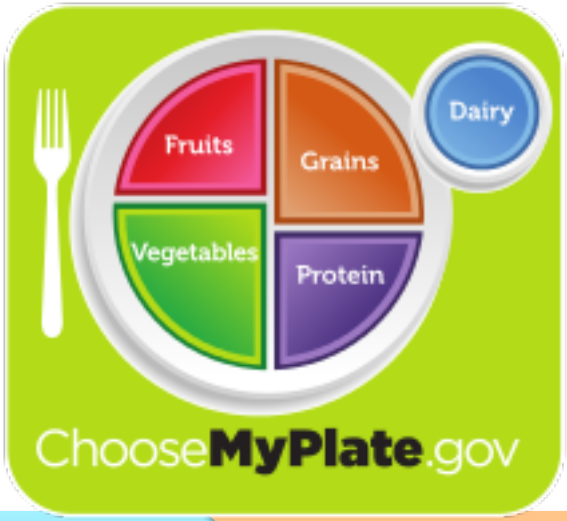
Lupton et al. *Eur J. Nutr* 2014 Apr;53 Suppl 1:1-9

Exploring the benefits and challenges of establishing a DRI-like process for *bioactives*

Joanne R. Lupton · Stephanie A. Atkinson · Namsoo Chang · Cesar G. Fraga · Joseph Levy · Mark Messina · David P. Richardson · Ben van Ommen · Yuexin Yang · James C. Griffiths · John Hathcock

IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

Evolving nutrition policy



1943 "Basic 7" → 1956 "Basic 4" → 1992 "Food Guide Pyramid" → 2005 "My Pyramid" → 2010 "My Plate"

Evolving nutrition policy cont.

- Empowering consumers to make their own healthy choices

- Future nutrition policy to take into account the full "Dietary Landscape"
- A personalized approach
- Equal balance between evidence-based recommendations and community-based implementation

2015 "My Plate" and more

2020+

"My *Personal* Plate"?

IADSA ANNUAL WEEK
PRAGUE
26-28 April 2016

REVIEW & SUMMARY

The Evolution of Nutrition
Andrew Shao, IADSA Chair Scientific Council

How have things evolved?

- Public health challenges?
- Scientific focus?
- Basis for recommendations?

What are some key learnings?

- Nutrition science has evolved significantly over time (and will continue)
  - Scientific focus has narrow (reductionism) and expanded (holism)
- Nutrition research has followed the trend of public health challenges in order to provide solutions
- Nutrition recommendations and policy have evolved in parallel with advances in science and technology and public health challenges

Thank You!