



FROM REDUCTIONISM TO HOLISM: THE EVOLUTION OF NUTRITION SCIENCE

CRN International Workshop
December 2, 2016
Hamburg, Germany



Outline

- Opening thoughts
- Successes
- Contemporary challenges
- Fatal flaws of the reductionist approach
- Transition to a holistic approach
- Closing thoughts

The new science of nutrition

- Relative to more established sciences, e.g. chemistry, physics and mathematics, nutrition science is a relatively new discipline
- Nutrition has rapidly evolved from a simple, nutrient and reductionist approach, to a complex systems approach
- “Nutrition science is defined as the study of food systems, foods and drinks, and their nutrients and other constituents; and of their interactions within and between all relevant biological, social and environmental systems”. *The Giessen Declaration*



The early days of nutrition

- Public health challenges
 - Communicable disease, short life-span
 - Overt nutrient deficiency
- Scientific focus
 - Discovery of vitamins and essential minerals, hunger and malnutrition



Casimir Funk



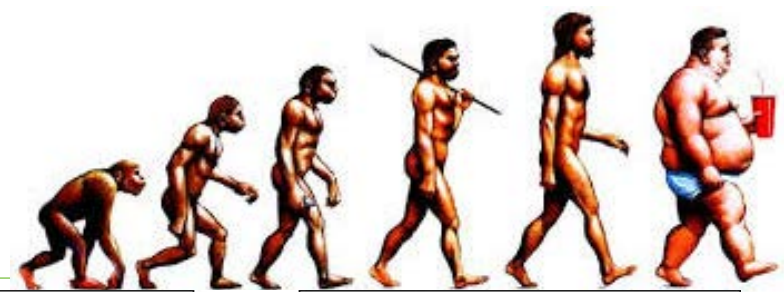
Early nutrition science: The single nutrient model

Successful model was based on three main premises

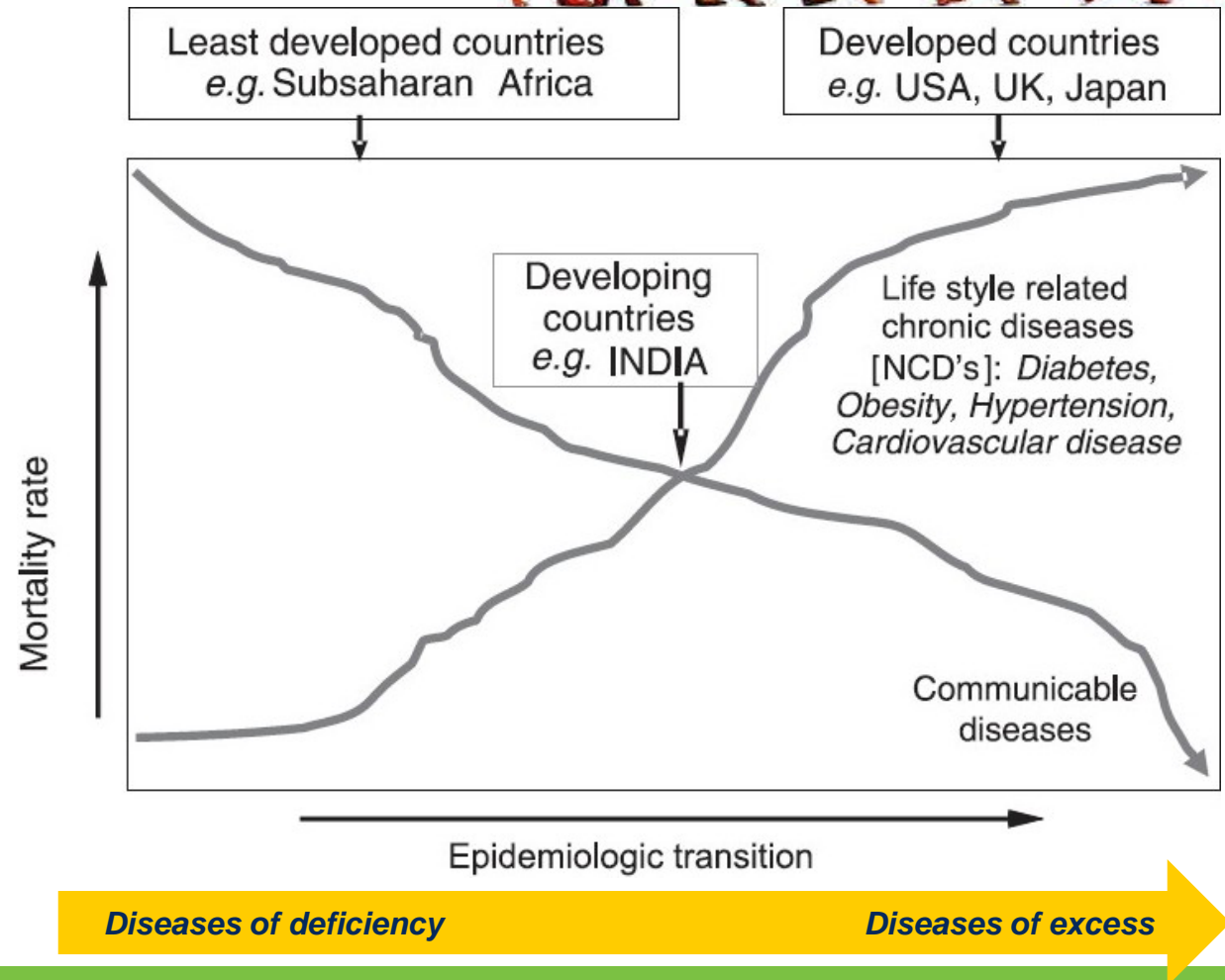
1. Simple cause-effect relationship exists between a specific disease and a particular nutrient
2. Each nutrient deficiency disease can be explained physiologically in terms of the role played by the respective nutrient
3. Providing the nutrient in the diet can prevent, and in many cases reverse, the disease

Raubenheimer and Simpson. *Annu. Rev. Nutr.* 2016. 36:603–26

Evolution to contemporary challenges



- Rapidly aging population
- Rapidly expanding population
- Physical inactivity
- Dietary imbalance
- Climate change and nutrition sustainability



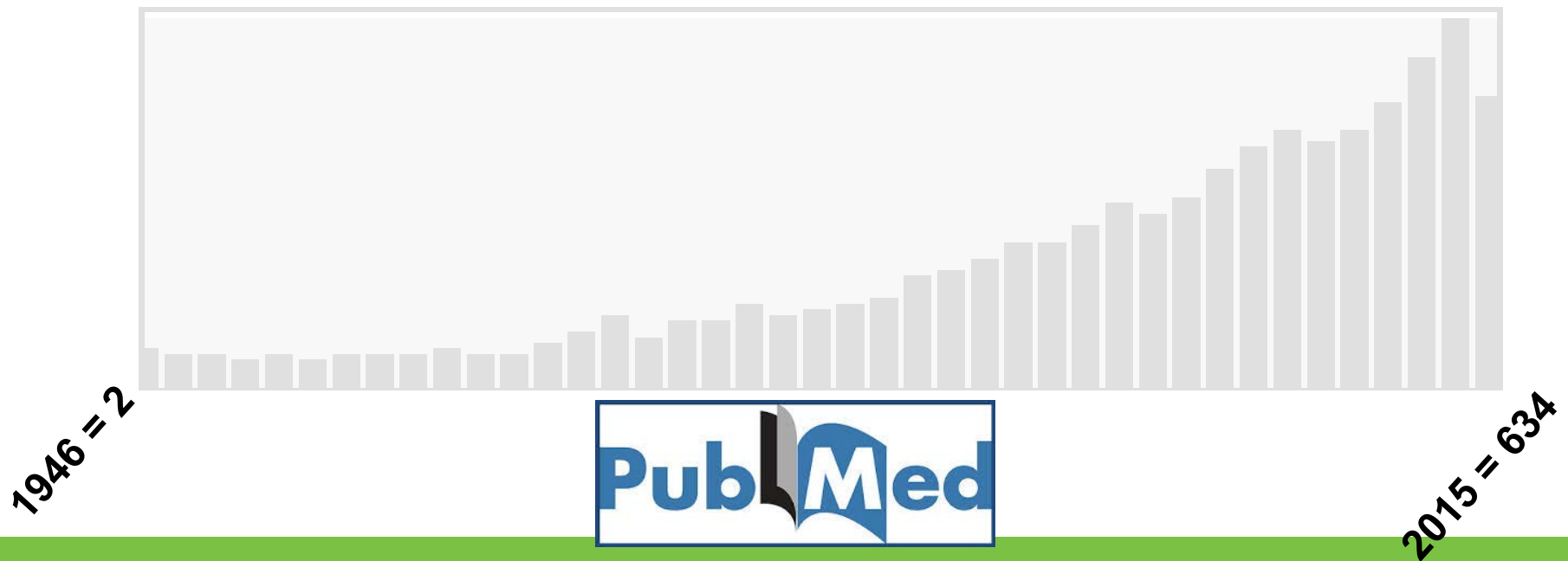
Modern nutrition successes....



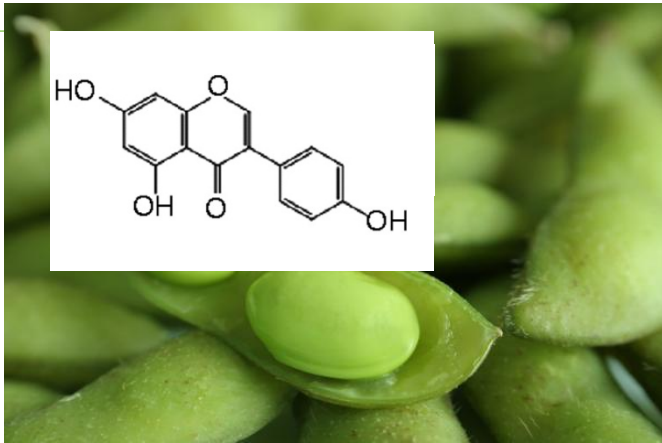
Research trends

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

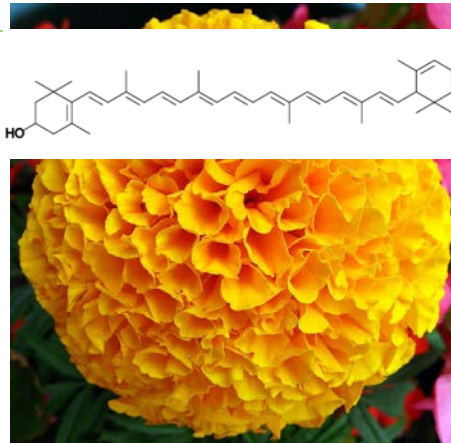
“Nutrition” OR “Diet” AND “Chronic disease” = 11572 citations



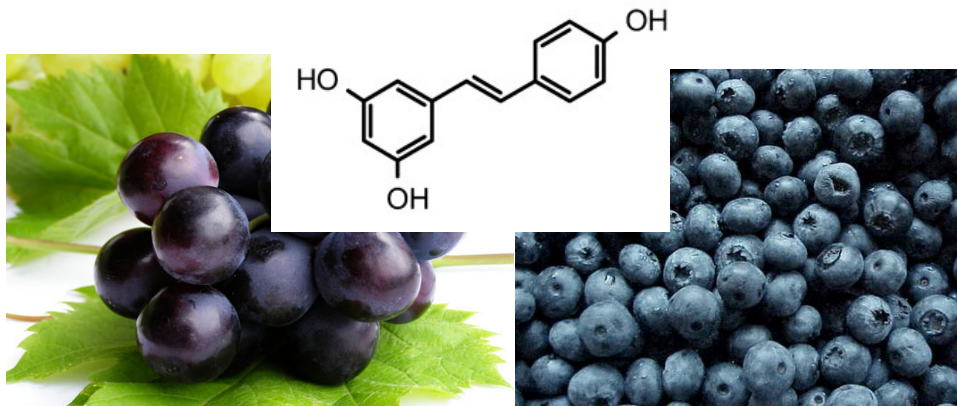
Beyond essential nutrients



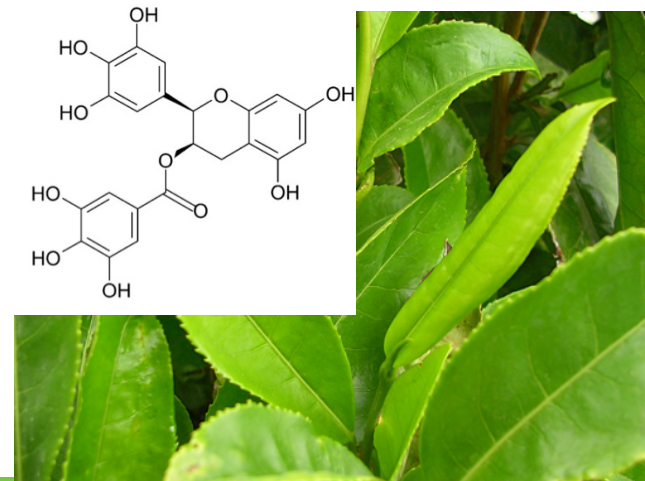
Isoflavones



Carotenoids

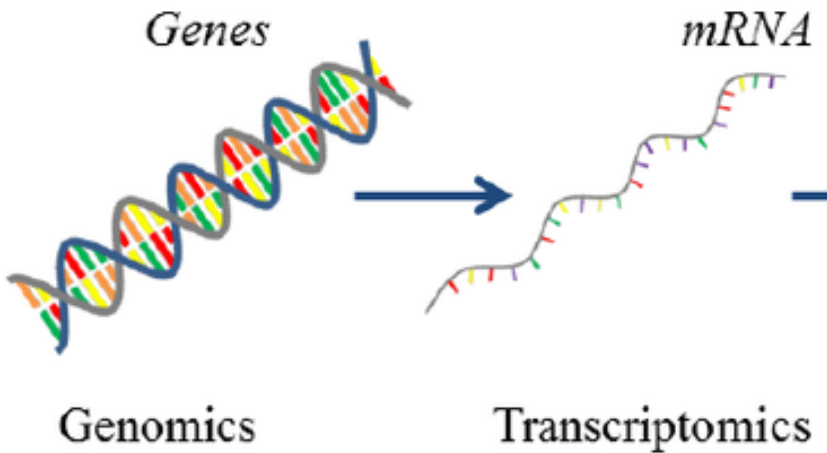


Anthocyanins



Catechins

“Omics”

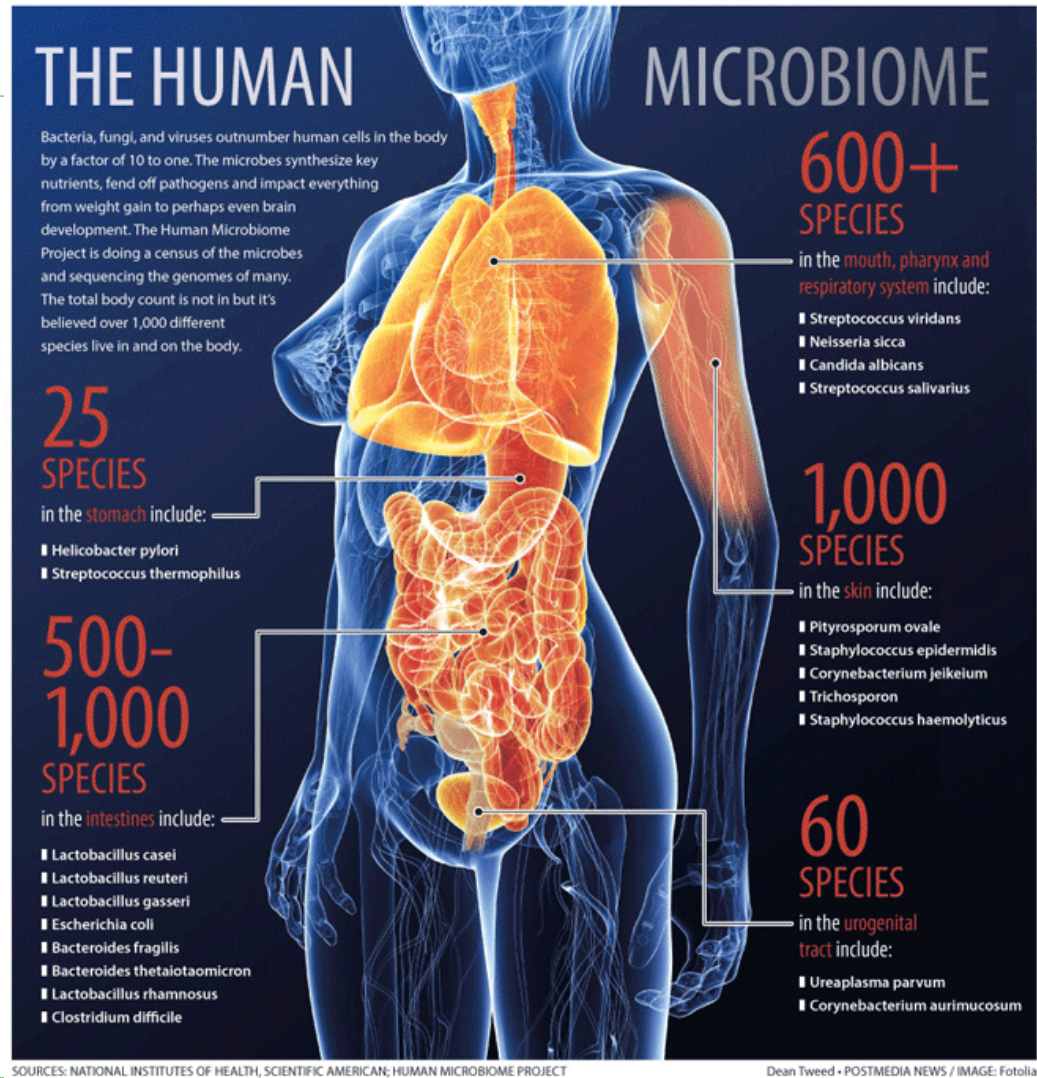


Researchgate.net



The microbiome

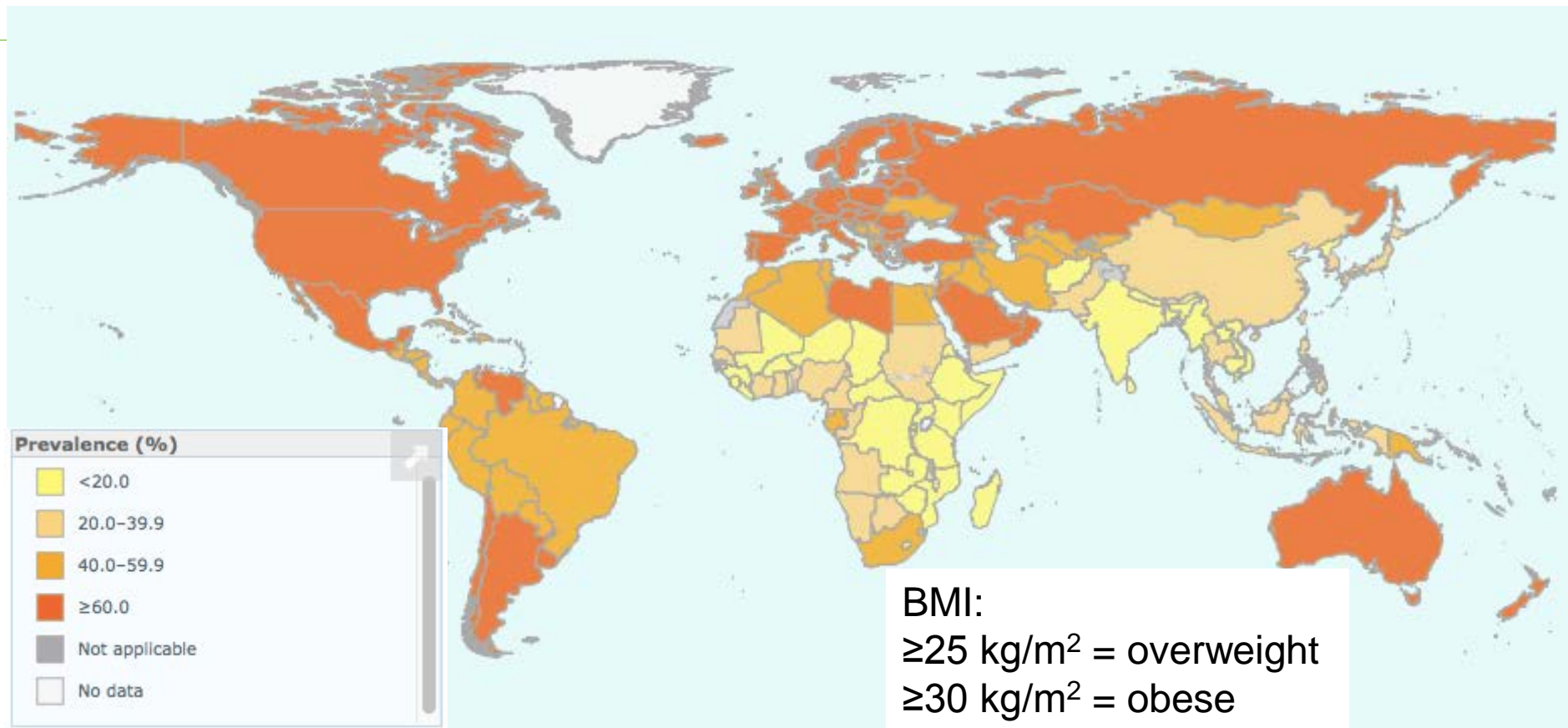
- Number of bacterial cells in (oral, gut) or on (skin) the body exceed our own by 10-fold (100 trillion vs. 10 trillion)
- The composition, nature and metabolism of these cells is influenced by diet and lifestyle and in turn influences health and well being



...And failures...



Global obesity epidemic continues



World Health Organization Global Health Observatory (GHO) data. Global overweight and obesity prevalence. Source: World Health Organization

http://www.who.int/gho/ncd/risk_factors/overweight/en/

Global diabetes trends

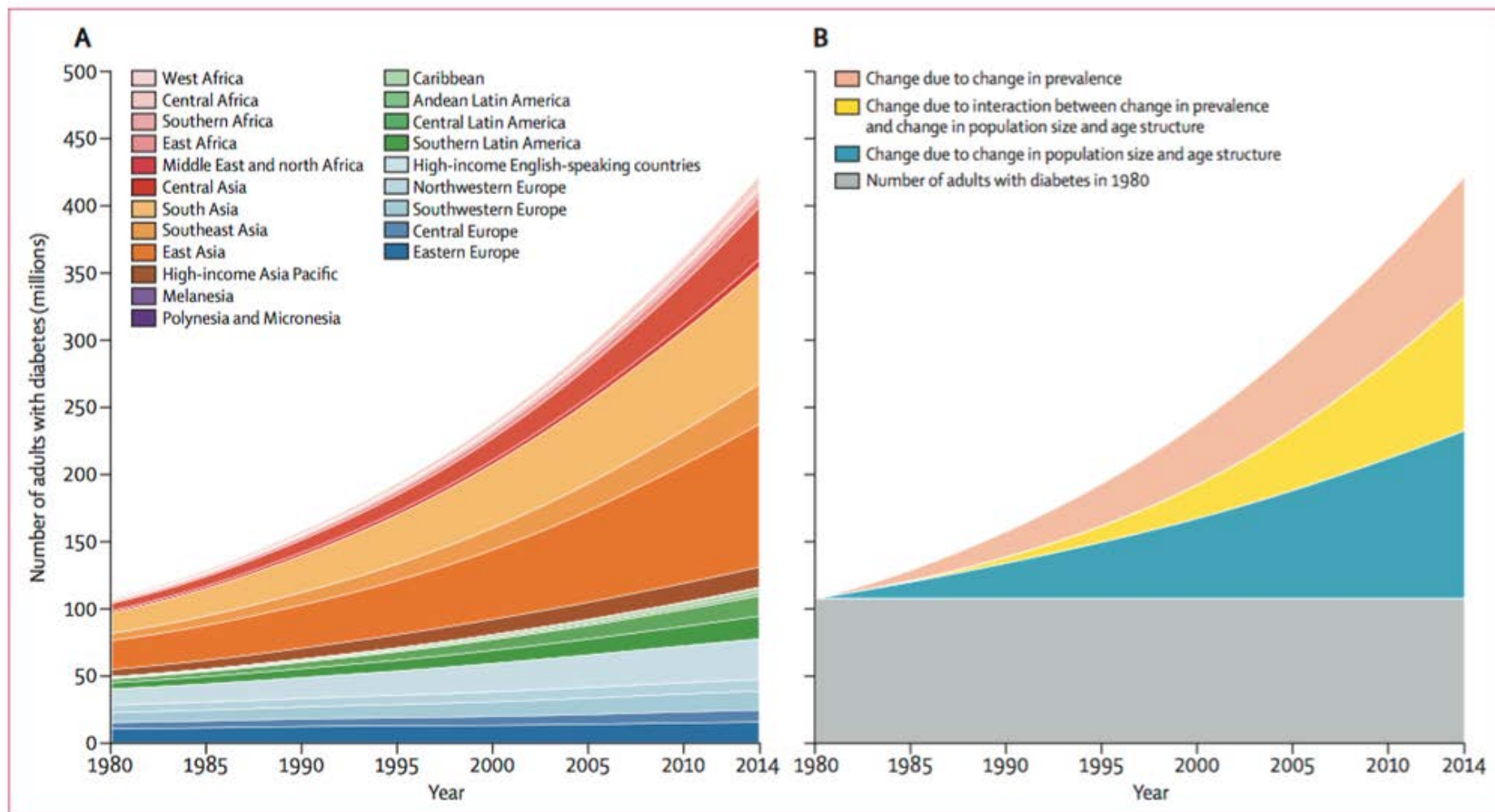
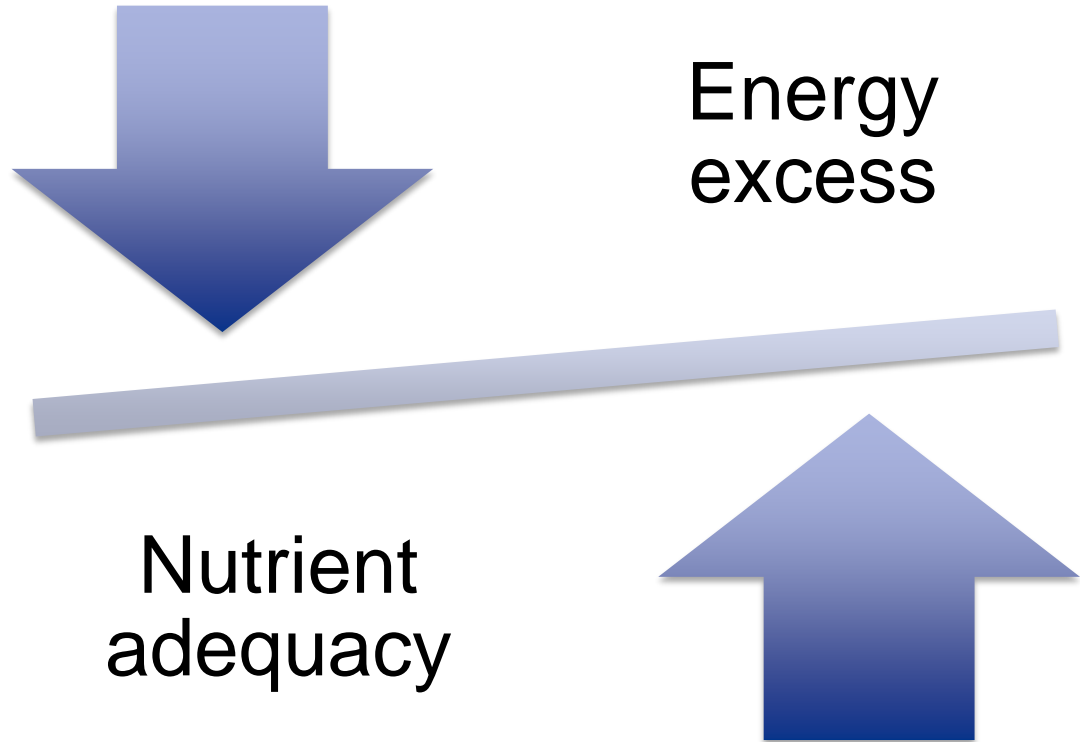


Figure 7: Trends in the number of adults with diabetes by region (A) and decomposed into the contributions of population growth and ageing, rise in prevalence, and interaction between the two (B)
For results by region see appendix pp 101–102.

Nutritional imbalance

*Diets have become
energy rich, yet
nutrient poor;
populations are
overfed, yet
undernourished*



Miller, et al. *J. Nutr.* 2009; 139: 1198–1202.

What went wrong?

- “Greedy reductionism”:
- “...in their eagerness for a bargain, in their zeal to explain too much too fast, scientists and philosophers . . . underestimate the complexities, trying to skip whole layers or levels of theory in their rush to fasten everything securely and neatly to the foundation”



Dennett DC. 1995. *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. New York: Simon & Schuster

Hierarchy of evidence

**Systematic
reviews &
meta-
analyses**



**Randomized
controlled
trials**

**Prospective cohort
studies**

Case-control studies

Case series

Case reports

Expert opinion

Animal research

In vitro research

Misapplication of evidence-based medicine

- Designed to assess safety and efficacy of drug therapy
- Considers the randomized-controlled trial (RCT) to be the “gold standard” (or only standard) of evidence
 - In many cases, not designed to address unique complexities and challenges presented by nutrients and other food components
- In absence of similar guidelines for nutrition, has been applied to nutrition and bioactive research for the purpose of informing policy decisions


“By analogy, when keys are missing, it is common to look for them under the lamppost where there is light rather than in the murky location where the keys were more likely dropped.”

JAMA. 2009;302(19):2152-2153



Looking for the “magic bullet”

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



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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

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*

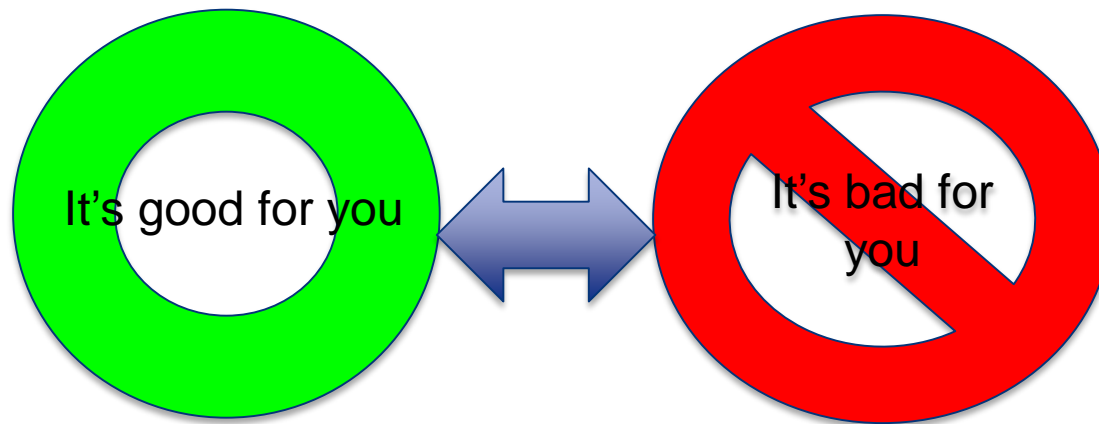
J. Nutr. 2008;138 1591-1595

Creighton University, Omaha, NE 68131

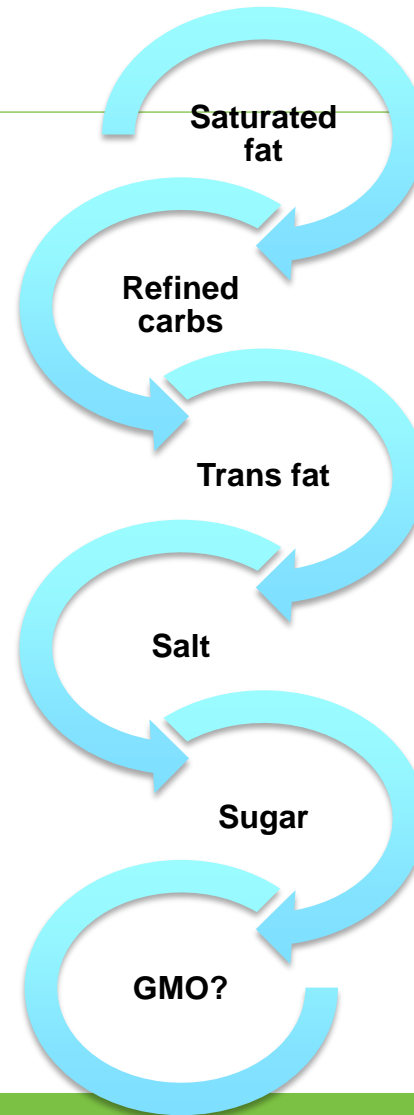
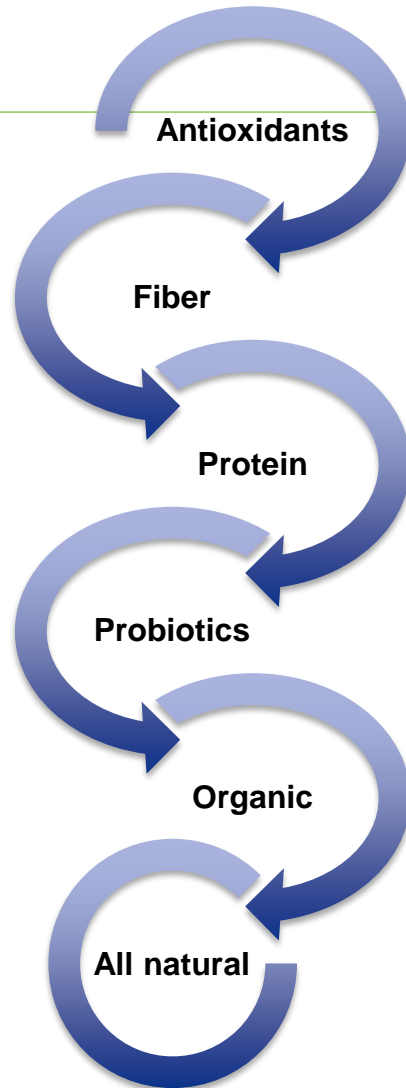
- Nutrients don't function in isolation and have beneficial effects on multiple tissues and organ systems; a focus on a single or “primary” outcome measure, which is favored by RCTs, is not practical.

Nutrition contradiction

- As nutrition science has evolved, public's perception of what is “good for you” vs. “bad for you” has “flip-flopped”
- Scientists have spent countless resources satisfying the demand for the nutrition “villain” and “hero”
- Perpetuated by reductionist approach on single macro & micronutrients

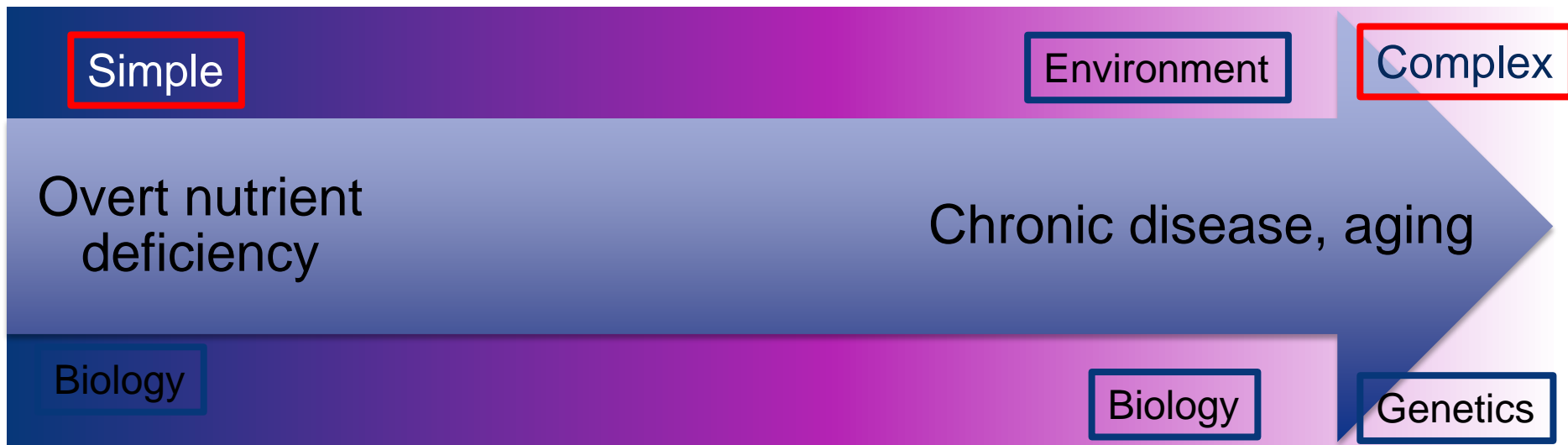


The nutrition “villain” and “hero”



From reductionism to holism

- In emphasizing specific nutrients, it fails to take into account the fact that food components interact in complex ways to give rise to emergent properties of diets that are not explicable at the level of individual chemical parts



Downey M. 2015. The putative 104 causes of obesity update. Downey Obes. Rep. <http://downeyobesityreport.com/2015/10/the-putative-104-causes-of-obesity-update>

The “ecology” of nutrition

Goals in Nutrition Science 2015–2020

David B. Allison^{1,2,3,4}, *Josep Bassaganya-Riera*⁵, *Barbara Burlingame*^{6,7},
*Andrew W. Brown*¹, *Johannes le Coutre*^{8,9,10*}, *Suzanne L. Dickson*¹¹, *Willem van Eden*¹²,
*Johan Garssen*¹³, *Raquel Hontecillas*⁵, *Chor San H. Khoo*¹⁴, *Dietrich Knorr*¹⁵,
Martin Kussmann^{10,16}, *Pierre J. Magistretti*^{17,18}, *Tapan Mehta*¹⁹, *Adrian Meule*²⁰,
*Michael Rychlik*²¹ and *Claus Vögele*²² *Frontiers in Nutrition*. Sept 2015, Vol 2(26)

- *“Nutrition is a field in which the need for interdisciplinarity is particularly pronounced, given the pervasive influence of nutrition on humans, from physiological to social, global, and planetary levels, and its extensive relationships with other domains including economics, politics, and environmental science”*



The New Nutrition Science project

Geoffrey Cannon¹ and Claus Leitzmann²

¹World Health Policy Forum, Juiz de Fora, Minas Gerais, Brazil; ²Institute of Nutrition Science, Justus Liebig University, Giessen, Germany

- To specify new principles, a new definition, and new dimensions and domains for nutrition science
- The Giessen Declaration
- *“...the human species has now moved from a time in history when the science of nutrition, and food and nutrition policy, have been principally concerned with personal and population health and with the exploitation, production and consumption of food and associated resources, to...all relevant sciences...should be principally concerned with the cultivation, conservation and sustenance of human, living and physical resources all together; and so with the health of the biosphere”.*

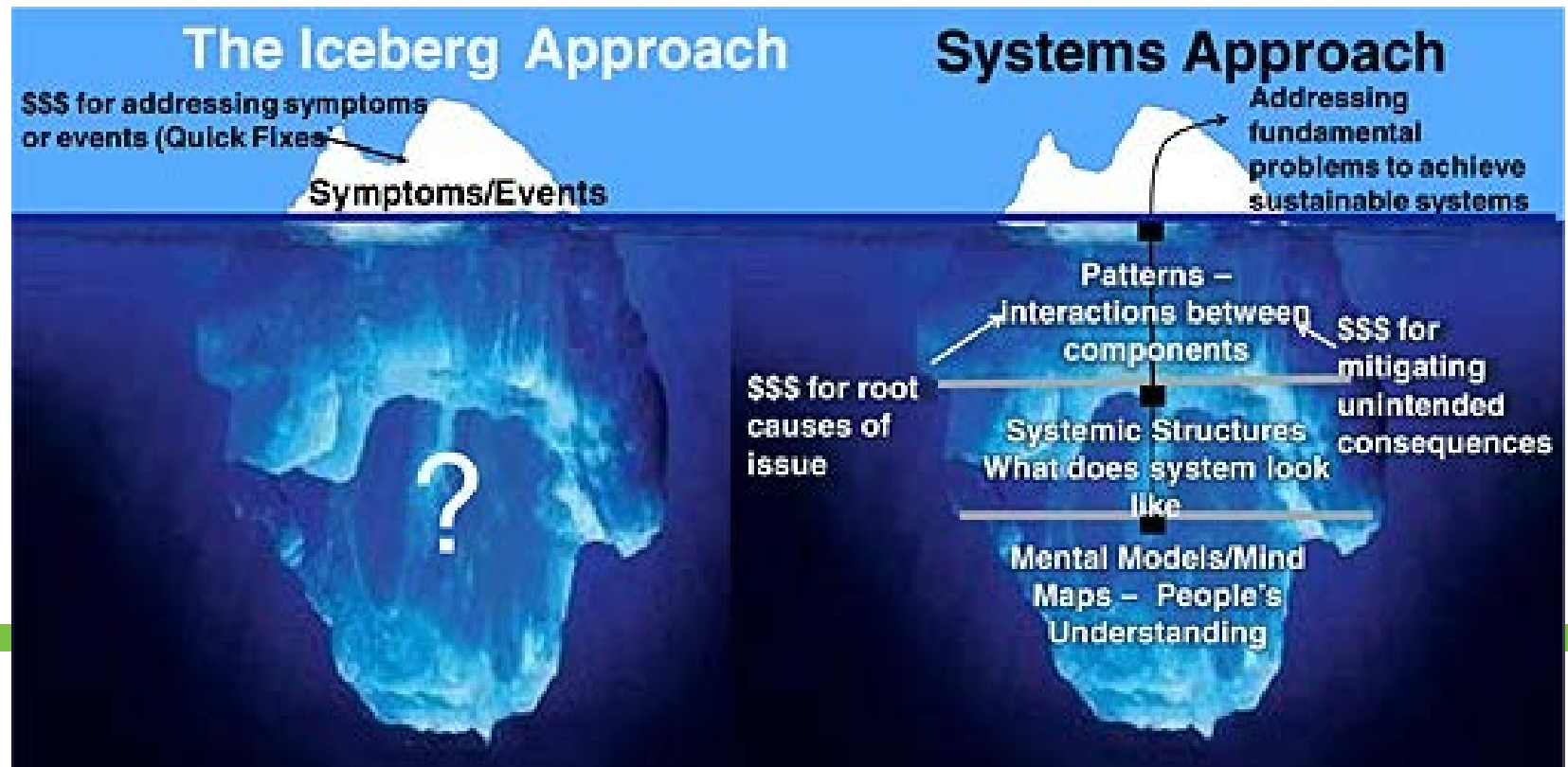
Public Health Nutrition: 8(6A), 673–694

A systems science perspective and transdisciplinary models for food and nutrition security

Ross A. Hammond^{a,1} and Laurette Dubé^b

^aCenter on Social Dynamics and Policy, The Brookings Institution, Washington, DC 20036; and ^bMcGill World Platform for Health and Economic Convergence, McGill University, Montreal, QC, Canada H3A 1G5

Reduces complexity through revealing key interactions that influence the outcomes of interest...a systems approach can help to identify common causal factors underlying the otherwise seemingly opposite problems of malnutrition and obesity.



Key Research Priorities for 2016-2021

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

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 (Q2T1): 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

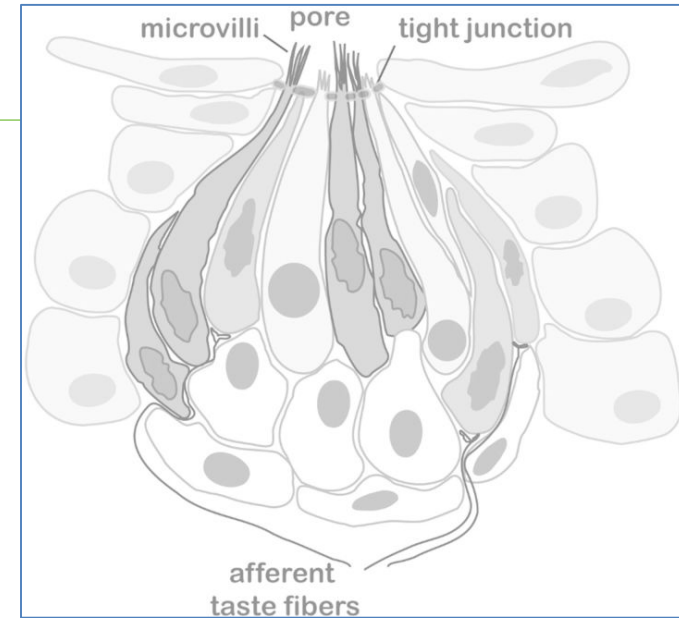


Editorial

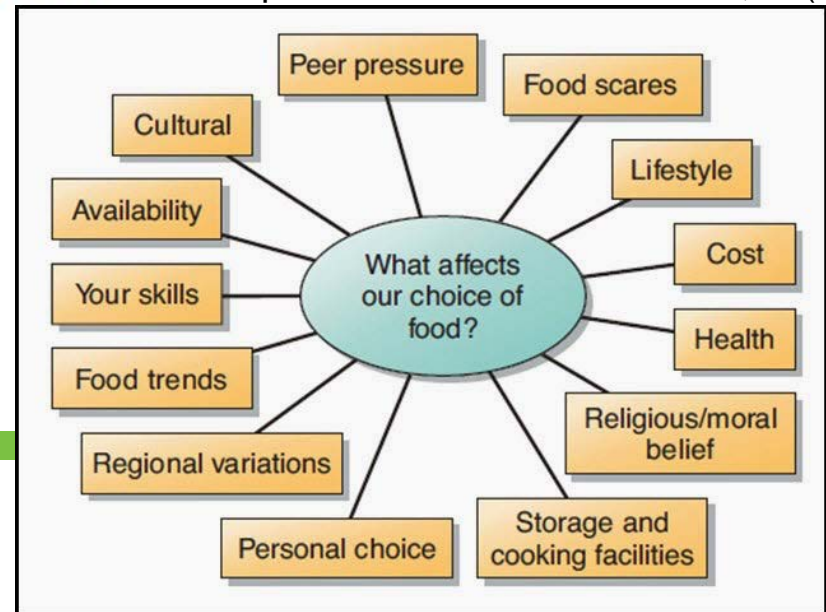
Food Choice and Nutrition: A Social Psychological Perspective

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

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

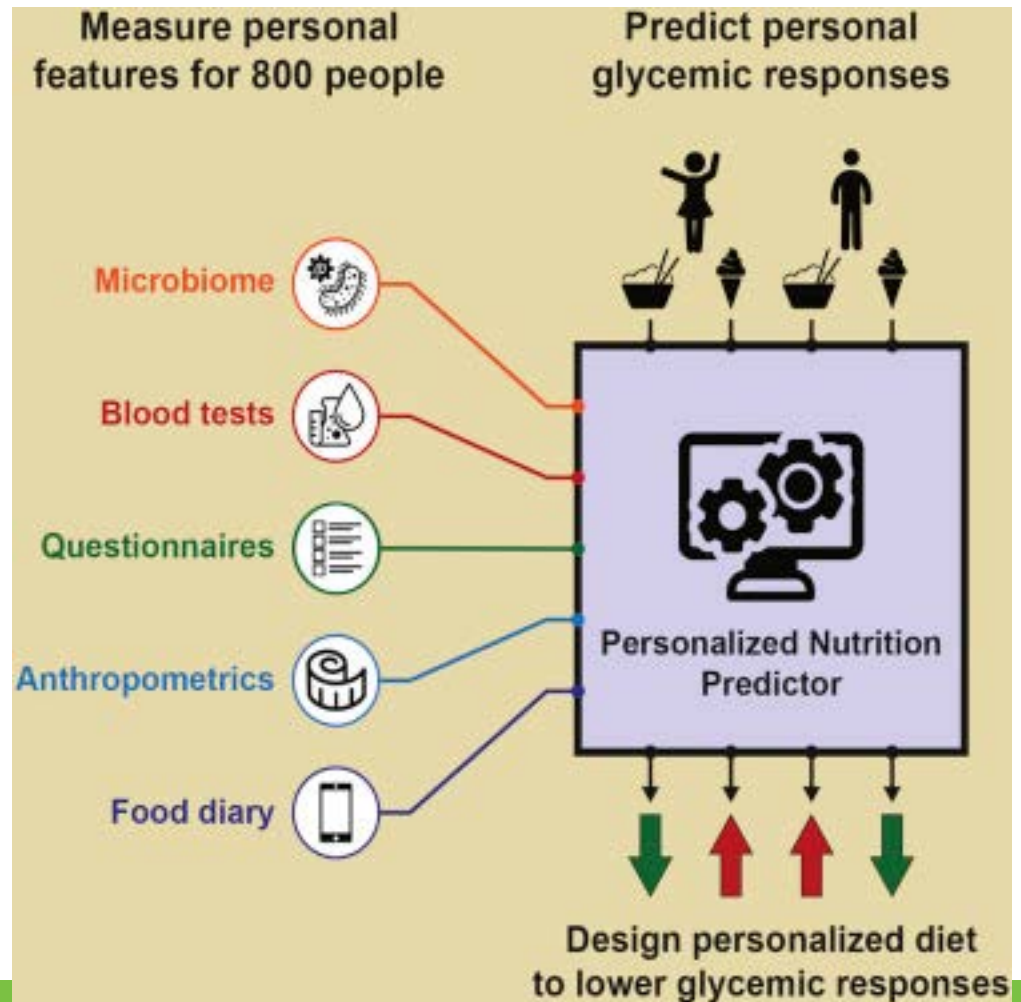


Loper et al. *Nutr Rev.* 2015 Feb; 73(2): 83–

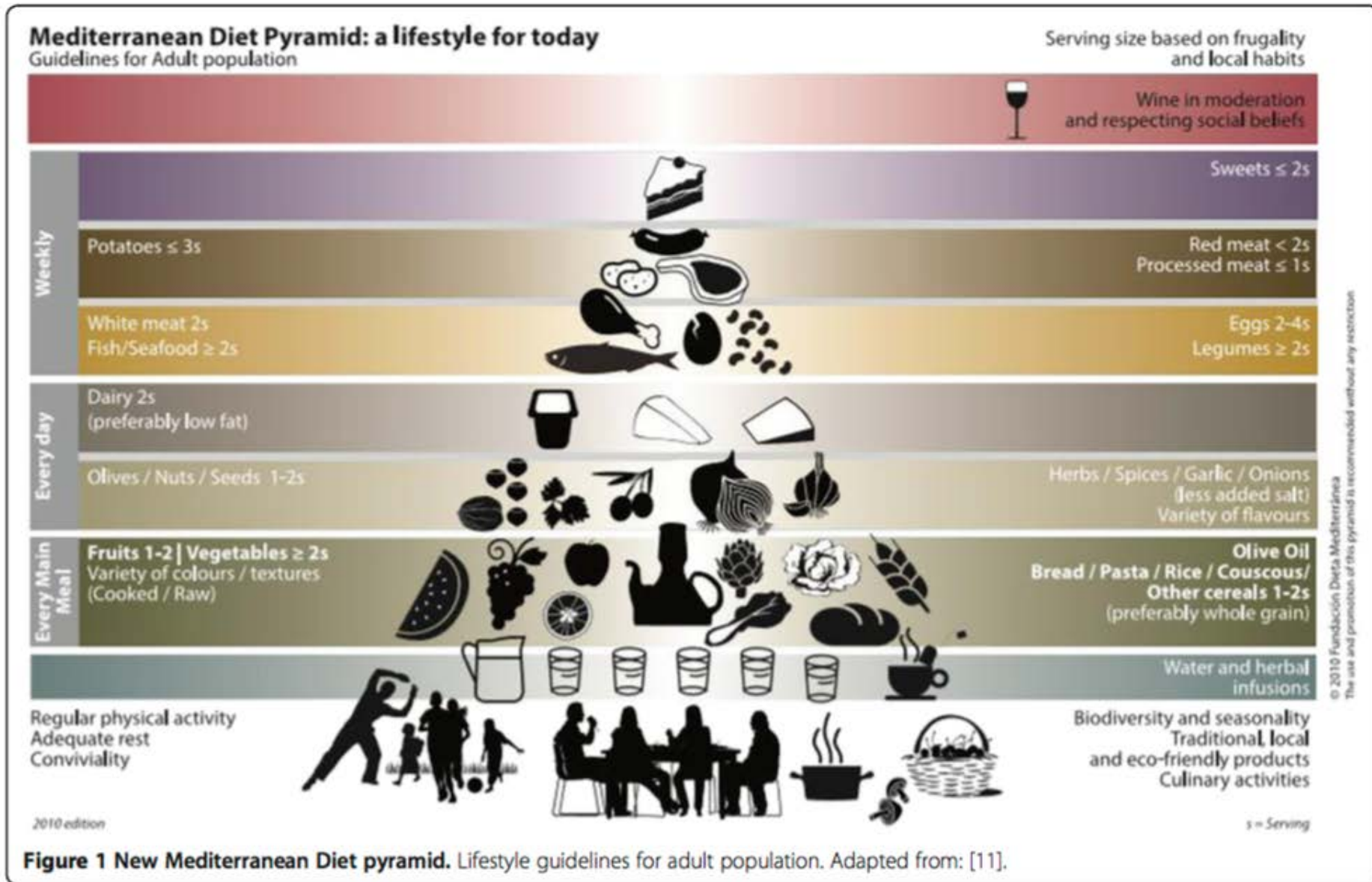


Taking advantage of technology advances and “big data”

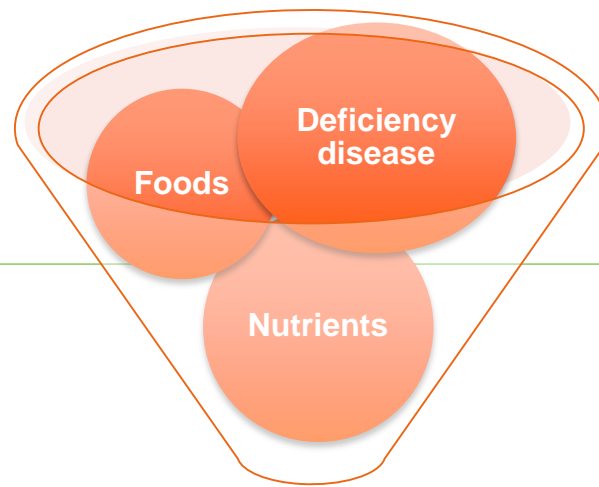
- Technology now allows use of “small data” capture to drive personalized diets
- Handheld devices now allow consumers to understand their own nutrient status
- Biomarkers of nutrition status replacing intake assessment as the basis for identifying dietary gaps



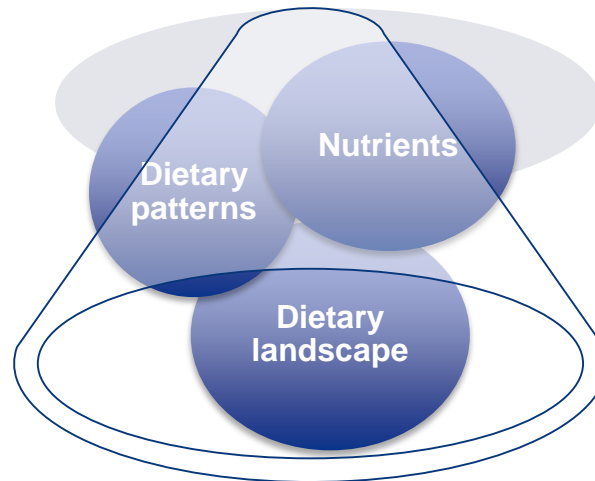
Emergence of dietary patterns



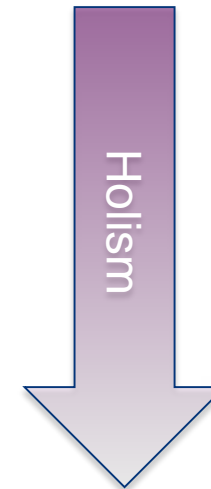
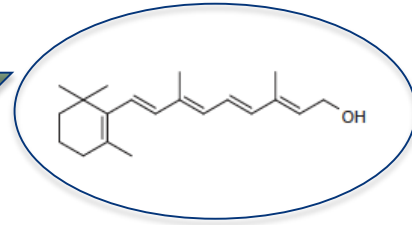
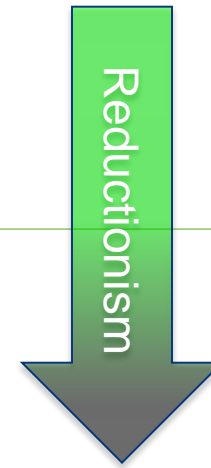
Evolution from linking health benefits to specific nutrients at specific doses, to understanding the broader landscape that impacts health



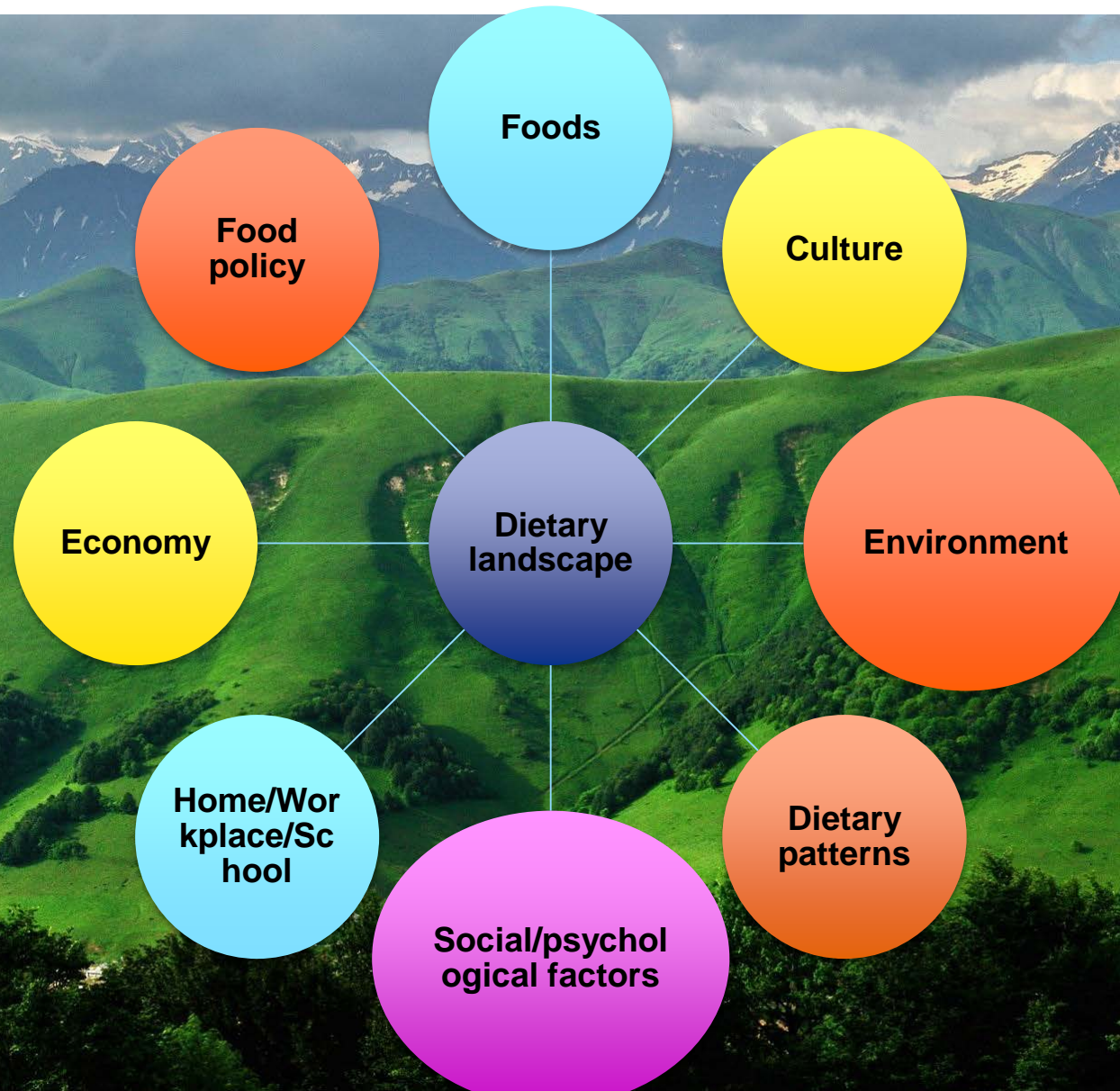
Narrow recommendations



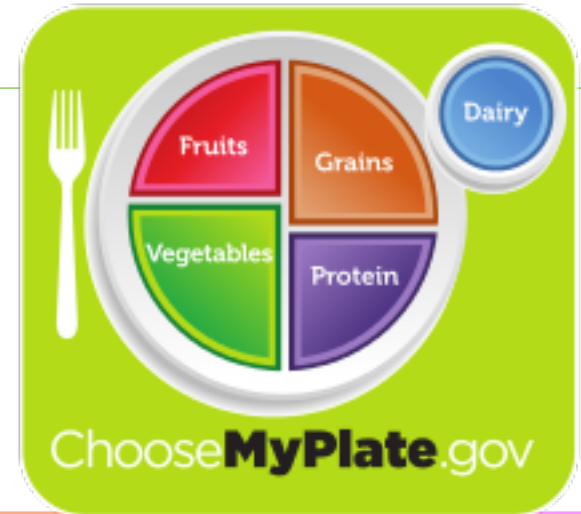
Broad recommendations



What is the “dietary landscape”?



Evolving nutrition policy



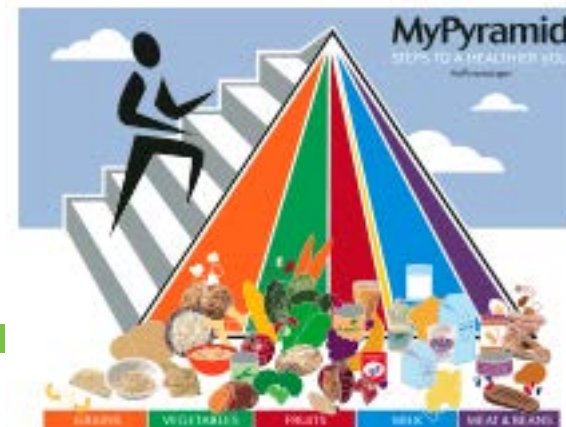
1943
"Basic 7"

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

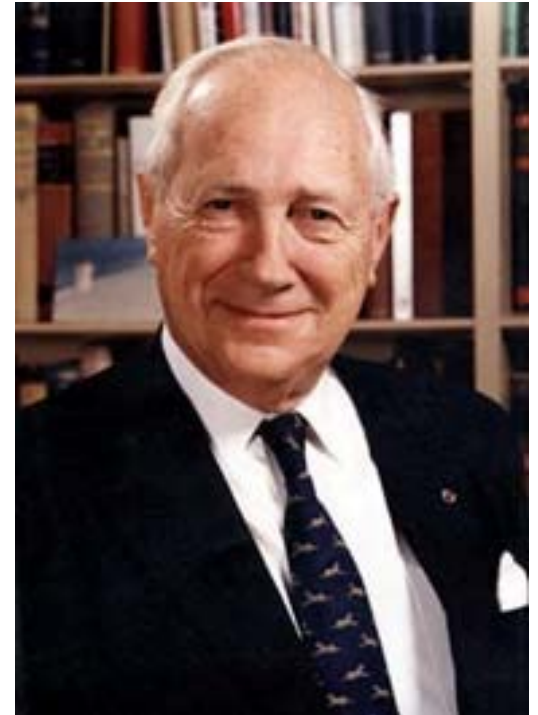
2020+
“My *Personal*
Plate”?

Closing thoughts

- Nutrition science has evolved significantly over time (and will continue)
 - Scientific focus has narrowed (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

“Nutrition is not a discipline, it is an agenda.”

— Jean Mayer former President of Tufts University, founder of the Friedman School of Nutrition Science and Policy



Thank You!

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