Existing approaches for evaluating health effects of “essential nutrients”

John W. Erdman, Jr., Ph.D.
Department of Food Science and Human Nutrition
University of Illinois at Urbana/Champaign

Existing Approach

For 65 years we have relied upon the Recommended Dietary Allowances (RDAs) and the Dietary Reference Intakes (DRIs) for recommendations on essential nutrients for individuals and populations in the United States

Essential Nutrient Definition
1940 RDA Committee

Chemical substances found in foods that are essential for human life and tissue growth and repair.

Essential nutrients were identified when dietary deficiency led to the development of a well-defined disease or a failure to grow.

Source: NRC 1941

Classical Tests for “Essentiality”

1. Feed a complete diet that is devoid of the substance.
2. Upon depletion, an adverse physiological or metabolic outcome occurs.
3. Addition of the substance back to the diet reverses the adverse event.

Recommended Dietary Allowances 1941

- Energy
- Protein
- 2 minerals (Ca, Fe)
- 6 vitamins (A, C, D, thiamin, riboflavin, niacin)

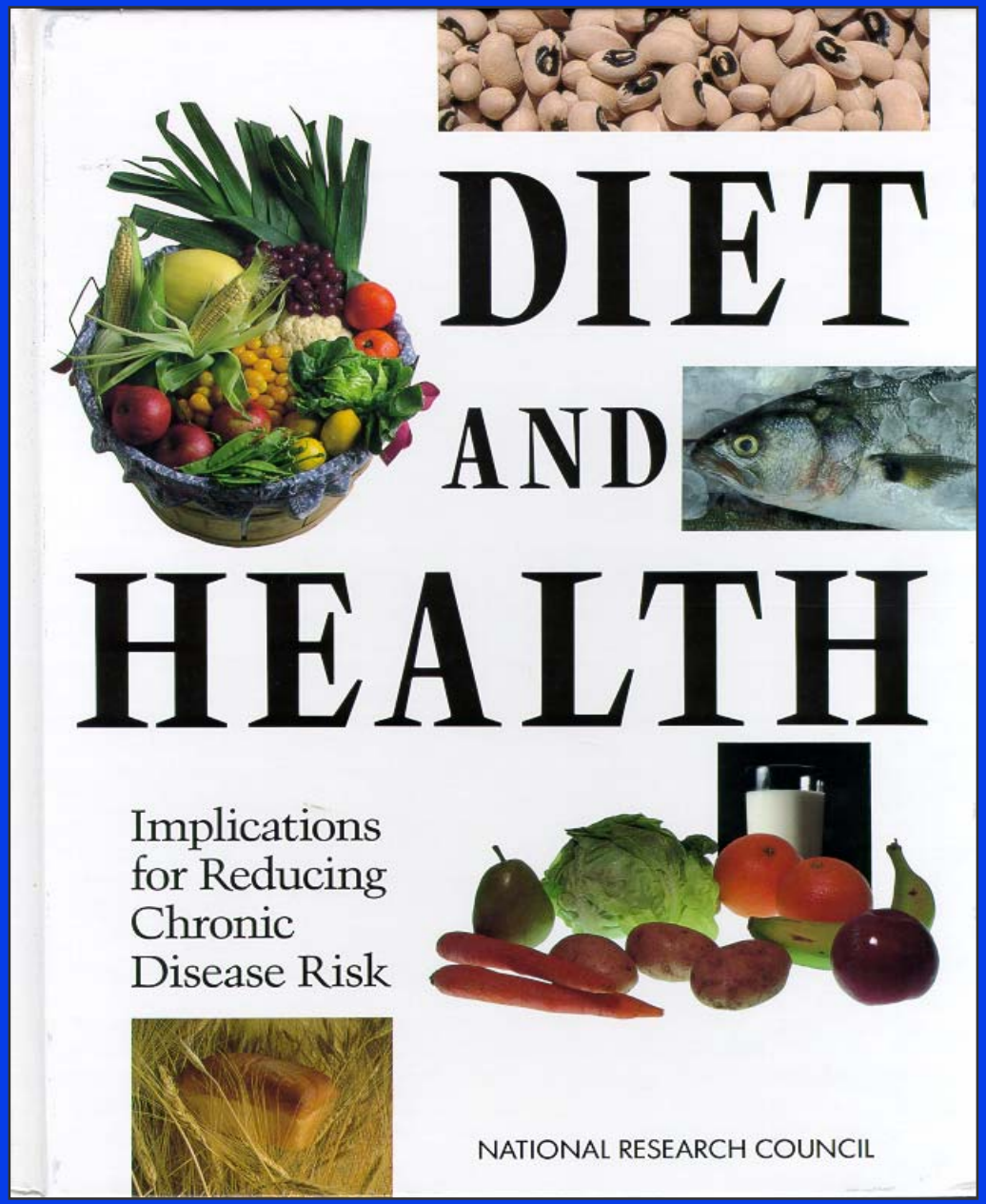
Recommended Dietary Allowances 1989

- Energy
- Protein
- 7 minerals (Ca, Fe, P, Mg, Zn, I, Se)
- 11 vitamins (A, C, D, thiamin, riboflavin, niacin, E, K, B_6, B_{12}, folate)
- Safe and adequate daily dietary intakes (biotin, pantothenate, Cu, Mn, F, Cr, Mo)

Definition of RDAs

". . . levels of intake of essential nutrients considered, in the judgment of the Food and Nutrition Board on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy persons."

NRC, 1974, 1980, 1989


DIET
AND
HEALTH
Implications
for Reducing
Chronic
Disease Risk
NATIONAL RESEARCH COUNCIL

Evolution of DRI's

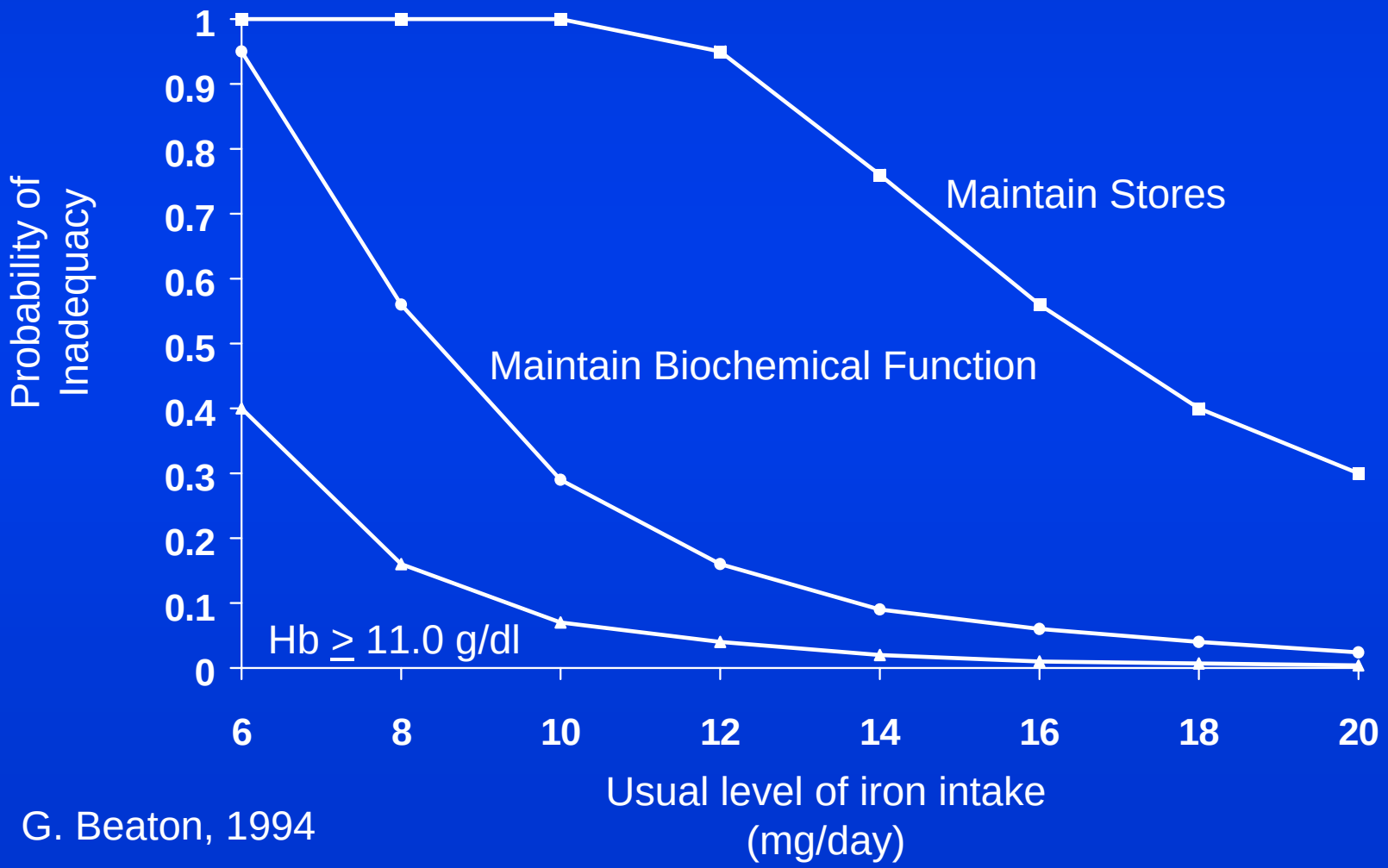
From 1989 - 1994 the Food and Nutrition Board began to rethink how RDA's were derived and whether recommendations should be based upon more than prevention of vitamin and mineral deficiency diseases.

FNB 1994 Concept Paper

Focused on Need to Include

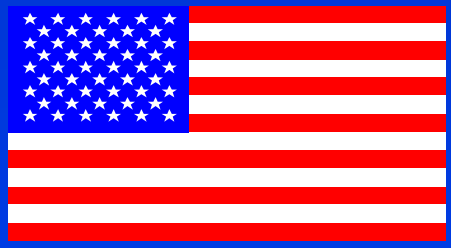
- Recommendations to meet variety of uses
- Concepts of reduction of risk to chronic disease
- Review of other food components
- Rationale for functional end points used
- Open dialog with interested groups
- Estimates of upper limits of intakes

Probability That Specified Usual Iron Intake Would Be Inadequate to Meet the Needs of a Randomly Selected Menstruating Woman[1]



G. Beaton, 1994

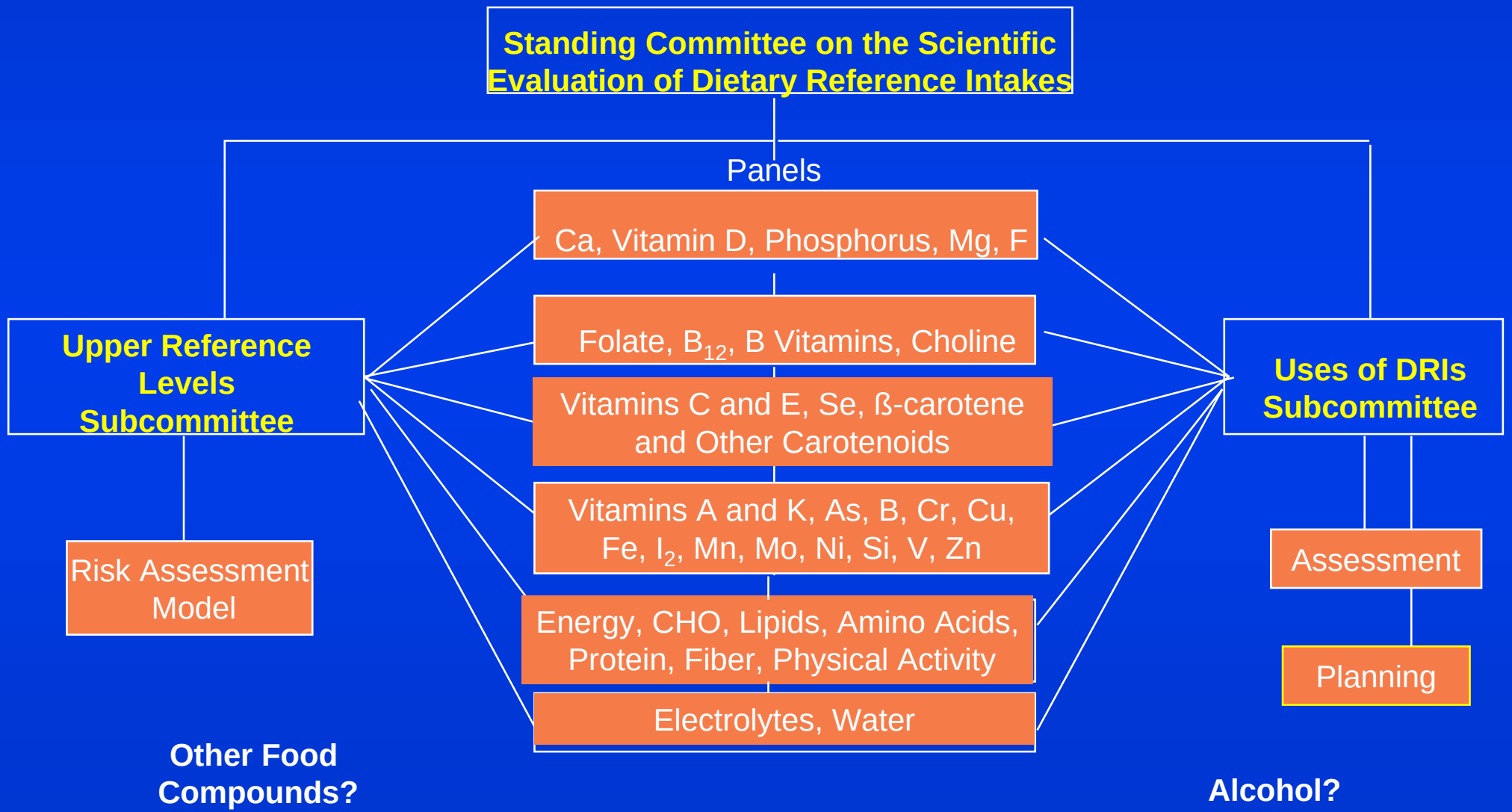
DRIs



Dietary Reference Intakes

Food and Nutrition Board

Dietary Reference Intakes

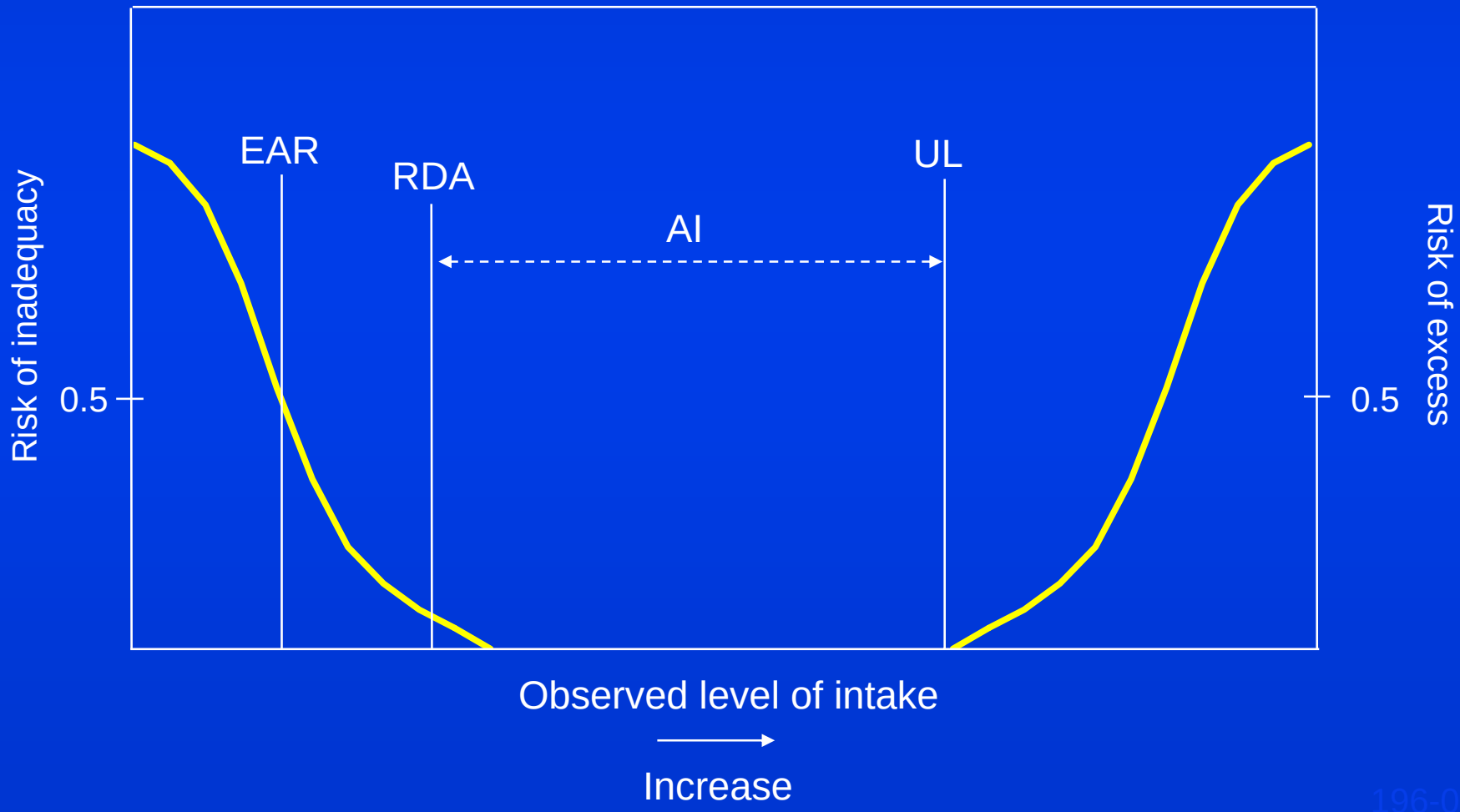


Dietary Reference Intakes (DRIs)

DRI is a collective term that includes nutrient-based dietary reference values:

- Estimated Average Requirement (EAR)
- Recommended Dietary Allowance (RDA)
- Adequate Intake (AI)
- Tolerable Upper Intake Level (UL)

Dietary Reference Intakes



Relationship of EAR and RDA

- Estimated Average Requirement (EAR) = requirement for 50% of the population

- Recommended Dietary Allowance (RDA) = requirement for 97.5% of the population, so plan diets for individuals using this DRI

$$RDA = EAR + 2\ SD$$

(if symmetrically distributed)

Dietary Reference Intakes (DRIs)

- Adequate Intake (AI):
  - Based on observed or experimentally determined approximations of the nutrient intake by a defined population or subgroup that appear to sustain a defined nutritional state

Dietary Reference Intakes (DRIs)

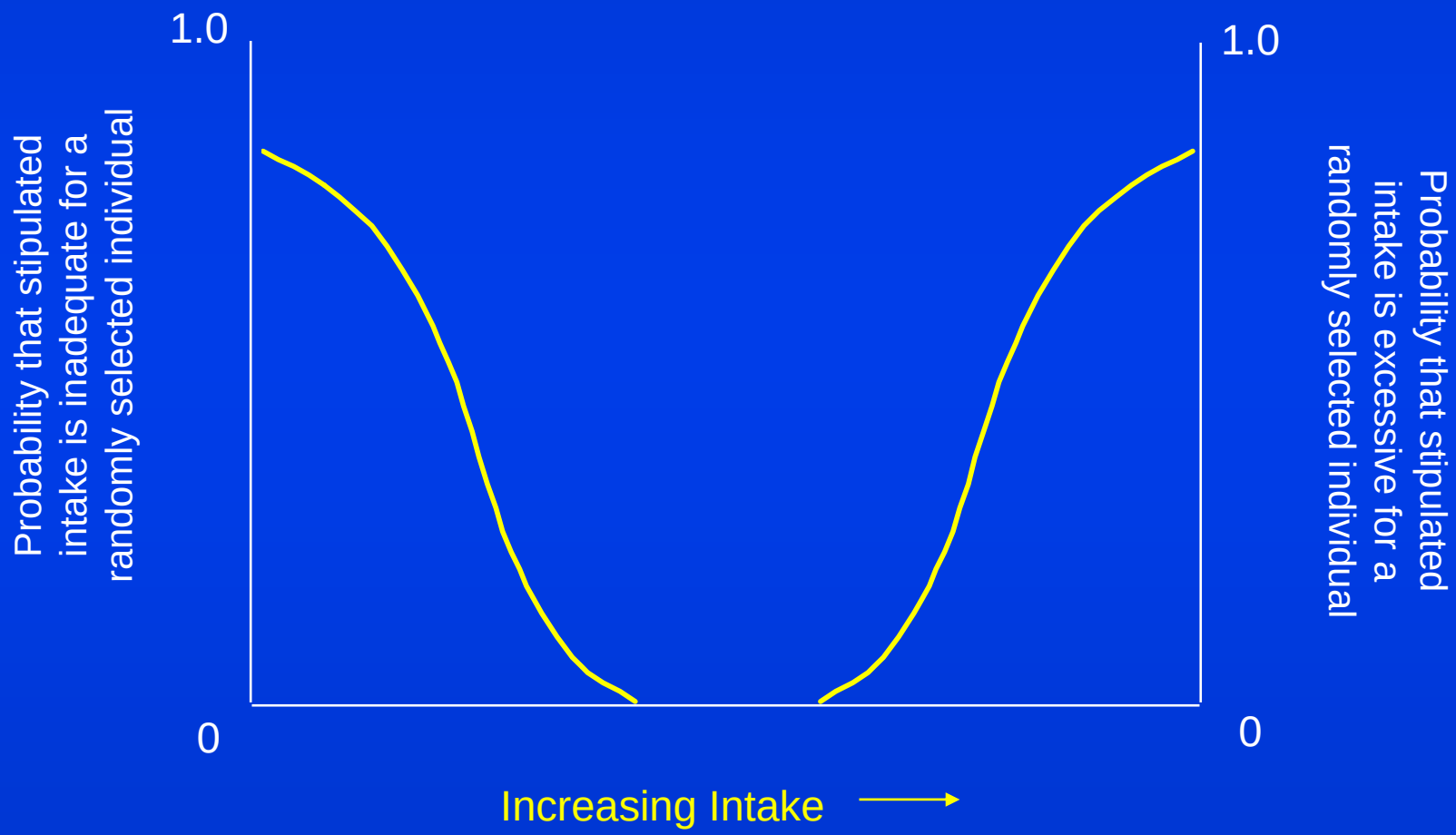
- Acceptable Macronutrient Distribution Range (AMDR):
  - Range of intakes for an energy-yielding macronutrient that is associated with reduced chronic disease while providing adequate intakes of essential nutrients

UL
Tolerable Upper Intake Level

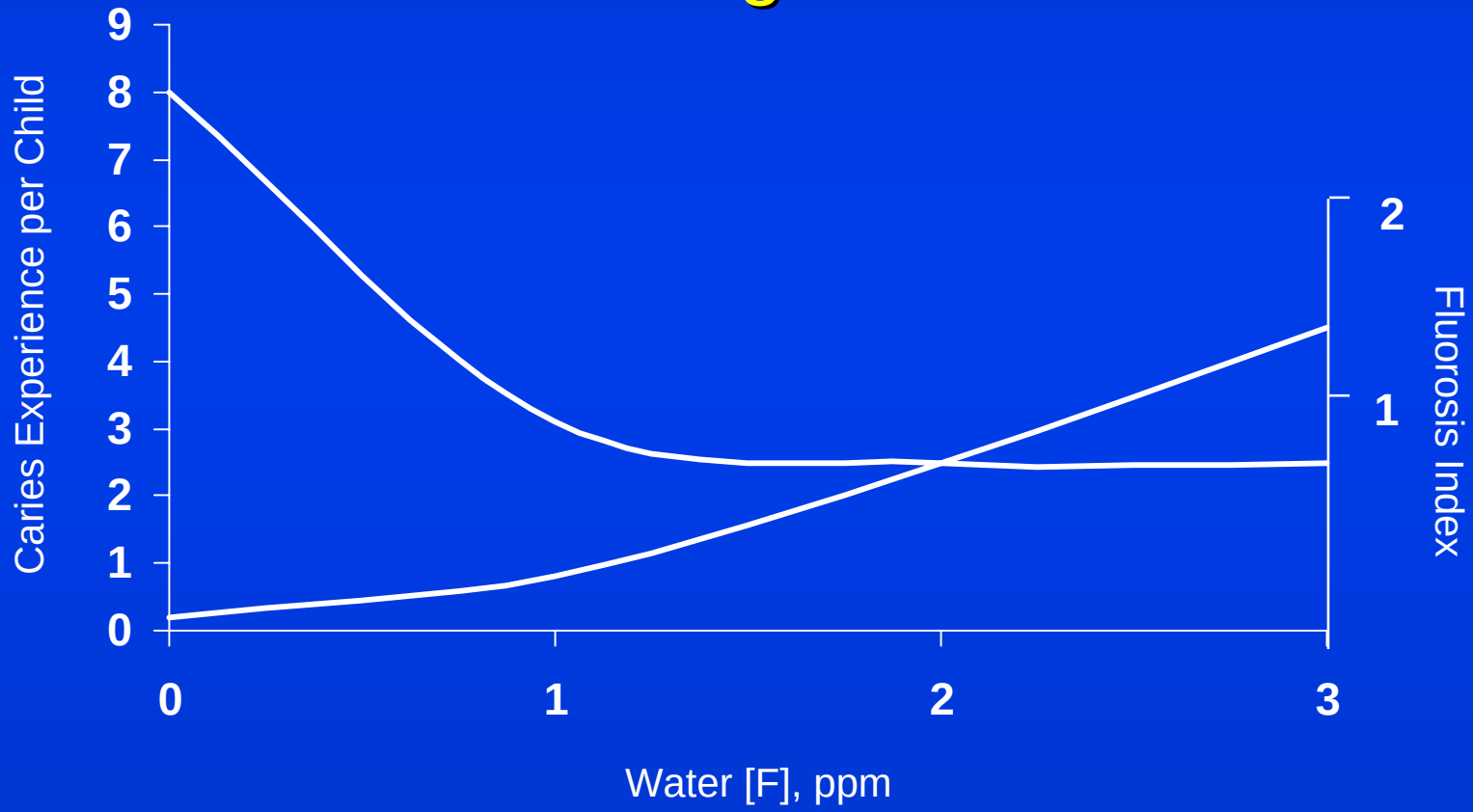
The highest level of daily nutrient intake that is likely to pose no risks of adverse health effects to almost all individuals in the general population

- Not a recommended level of intake
- Not a level that is desirable to attain

Benefit/Risk Curve



Caries Experience and Dental Fluorosis Index Versus Fluoride Concentration of Drinking Water



Criteria for Establishing RDAs for Essential Nutrients

Scientific Database

- Observed intakes in healthy populations
- Epidemiological observations
- Balance studies
- Depletion/repletion studies
- Animal experiments
- Biochemical measurements

Should the criteria for establishing health effects of bioactive food components differ from those for establishing RDAs for essential nutrients or must they be the same?

FNB 1998 Report

Criteria for selection (of dietary antioxidant):

- Substance is found in typical human diets
- Content of substance has been measured in foods commonly consumed
- In humans, the substance is associated with improved health outcome or decreased adverse effect

IOM. 1998. *DRIs. Proposed definition and plan for review of dietary antioxidants and related compounds.* National Academy Press.

What should be looked for?

- Scientifically valid experiments
- Measurements of relevant biomarkers
- Reliable intake data
- *In vivo*, rather that *in vitro*, experiments
- Role in health

Adapted from:IOM. 1998. *DRIs. Proposed definition and plan for review of dietary antioxidants and related compounds.* National Academy Press.

What is less helpful?

- Strictly observational data
- Over-reliance on animal data
- Associations, rather than causation

Adapted from: IOM. 1998. *DRIs. Proposed definition and plan for review of dietary antioxidants and related compounds.* National Academy Press.

Closing the scientific knowledge gap of food component-disease relationships

- Assess the strength of the relationship between substance and the disease
- Use an evidence-based system
  - Clarify relationship being considered
  - Review of literature
  - Evaluate quality of studies
  - Rate strength of entire body of evidence

Source: Lupton. J. Nutrition. 135:340-342 (2005)

Essentiality of Food Components

Are there non-essential nutrients?

Are there “dispensable” and “indispensable” nutrients?

Are bioactive dietary components “dispensable” nutrients?

Where does dietary fiber or fluoride fit?

Concluding Thoughts

- The DRIs provide a framework for assessment of the health effects of bioactive food component
- A less rigorous evidenced-based system (than used for DRIs) may be needed
- The AI (Adequate Intake) and AMDR (Acceptable Macronutrient Distribution Range) approaches could be considered

The Food Guide Pyramid