Introduction

Benjamin Caballero, MD, PhD
Johns Hopkins University
Section A

Overview of the Course and the Science of Nutrition
Topics

- Defining nutritional needs of individuals and groups
- Major nutrient groups
  - Macronutrients (protein, energy, fat)
  - Micronutrients (vitamins, minerals)
- Diet and disease—obesity, chronic diseases, undernutrition
- Nutrition during the life cycle—pregnancy, newborn, child, adolescent
You Are What You Eat

Giuseppe Archimboldo, The Four Seasons, 1573
Nutrition studies the interaction between the individual and the environment mediated by food.
The Science of Nutrition

Areas of Study

- Food production
- Diet composition (including non-nutritive substances)
- Food intake, appetite, food preferences
- Digestion and absorption of nutrients
- Intermediary metabolism, nutritional biochemistry
Areas of Study

- Biological actions of essential nutrients
- Nutrient requirements in individuals and populations
- Heath effects of nutrient deficiencies and excesses
- Long-term effects of diet constituents
- Therapeutic and preventive effects of foods
Food, Nutrition, and the Body

<table>
<thead>
<tr>
<th>Food</th>
<th>Nutrition</th>
<th>Body</th>
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<tbody>
<tr>
<td>Production</td>
<td>Carbohydrates</td>
<td>Genetics</td>
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<tr>
<td>Distribution</td>
<td>Proteins</td>
<td>Physiology</td>
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<tr>
<td>Hygiene</td>
<td>Fats</td>
<td>Lifestyle</td>
</tr>
<tr>
<td>Preparation</td>
<td>Vitamins</td>
<td>Needs</td>
</tr>
<tr>
<td>Food labels</td>
<td>Minerals</td>
<td></td>
</tr>
<tr>
<td>Meals</td>
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</table>
What Is a Healthy Diet?

- Fulfills energy needs (macronutrients)
- Provides sufficient amounts of essential nutrients (micronutrients)
What Is a Healthy Diet?

- Fulfills energy needs (macronutrients)
- Provides sufficient amounts of essential nutrients (micronutrients)
- Reduces risk of disease
- Is safe to consume (low contaminants or potentially harmful added substances)
## Evolution of the Human Diet

<table>
<thead>
<tr>
<th></th>
<th>Hunter-gatherers</th>
<th>Peasant agriculturists</th>
<th>Modern affluent societies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt (g/day)</td>
<td>1</td>
<td>5–15</td>
<td>10</td>
</tr>
<tr>
<td>Fiber (g/day)</td>
<td>40</td>
<td>60–120</td>
<td>20</td>
</tr>
<tr>
<td>Fat (g/day)</td>
<td>50–70</td>
<td>60–75</td>
<td>20</td>
</tr>
<tr>
<td>Sugar (g/day)</td>
<td>15–20</td>
<td></td>
<td>40+</td>
</tr>
<tr>
<td>Starch (g/day)</td>
<td>15–20</td>
<td>10–15</td>
<td>12</td>
</tr>
<tr>
<td>Protein (g/day)</td>
<td>1</td>
<td>60–120</td>
<td>20</td>
</tr>
</tbody>
</table>
Section B

DRI, RDA, and EAR
Some Definitions

Requirement
- Minimum amount of a nutrient needed to sustain a physiological state, function, or structure in an individual
Some Definitions

**Recommendation**
- Normalized estimate of nutrient needed to cover most individuals in a population group
Some Definitions

**Guideline**
- Advice on diet composition to population groups, aimed at maintaining health and preventing diseases
“What is the minimum cost per head per week for which food can be bought in such quantity and in such quality as will avert starvation disease from the unemployed population?”

— Dr. E. Smith, England, 1862
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
# Sources of Data for Definition of Requirements

<table>
<thead>
<tr>
<th>Source</th>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
</table>
| **Metabolic experiments** | • Controlled conditions  
• Isolated nutrients may be studied | • Small groups  
• Short-term  
• Inter-individual variability |
| **Food intake surveys**  | • Actual eating patterns of populations  
• Cultural factors | • Inaccurate methods  
• Lack of food composition data |
| **Factorial calculations** | • Likely to cover most of the population  
• Physiologically sound | • Tends to amplify errors due to limited or inaccurate information |
Dietary Reference Intakes (DRIs)

- Estimated Average Requirement (EAR)
- Recommended Dietary Allowance (RDA)
- Adequate Intake (AI)
- Tolerable Upper Intake Level (UL)
Scientific Basis for Establishing DRIs

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

- Chemical substances found in food
- Necessary for life, growth, and tissue repair
- Cannot be synthesized
Frequency Distribution of Individual Requirements

Increased Intake

EAR $\pm 2\text{ s.d.}$ RDA
Safe Intake Range

Risk of Inadequacy

Deficient

Estimated Average Requirement (EAR)

RDA

Upper Intake Level (UL)

(AI)

Adequate Intake

Risk of Excess

Observed Level of Intake

0.5

1.0

0.5

1.0
Recommended Dietary Allowance

- Sufficient to meet the daily nutrient requirements of most individuals in a specific life stage and gender group
- Set at a level that is at the top two to three percent of the requirement distribution
- Intended to serve as a goal for daily intake by individuals
Estimated Average Requirement

- Average requirement for healthy individuals in which functional/clinical assessment conducted and adequacy determined
- Limited in number due to few human studies
- Half of subjects’ needs met at this level (50% of subjects would not have their needs met)
Relationship of EAR and RDA

\[ \text{RDA} = \text{EAR} + 2 \ \text{SD}_{\text{EAR}} \]
Section C

AI, UL, and Dietary Guidelines
Adequate Intake

- Based on observed or experimentally determined approximations of the nutrient intake by a defined population or subgroup that appears to sustain a defined nutritional state
- Can be used as a guide to nutrient intake for the individual
Adequate Intake

- The AI may exceed the RDA for the same specified endpoint of nutritional adequacy, if the latter could be determined.
- The excess of an AI, relative to a true EAR or RDA, is likely to differ among nutrients, population groups, and distinct sociocultural settings.
The AI may be used as a goal for nutrient intake for the individual (it is derived from intakes that appear to sustain a defined nutritional state)
Comparison of the AI with the RDA

- **Similarities**
  - AIs and RDAs for individuals

- **Differences**
  - Less certainty about AI values (greater degree of judgment)
  - May deviate significantly from and exceed RDA, if could be determined
  - Use with greater care
Tolerable Upper Intake Level

- 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
- Determined by risk assessment methods
- Not intended to be a recommended level of intake (no evidence of benefit for healthy individuals in consuming nutrients above the RDA or AI)
Dietary Guidelines Versus DRIs

- **Dietary Guidelines**
  - Qualitative advice to the public about diet and chronic disease prevention (e.g., the Food Pyramid)

- **DRIs**
  - Quantitative advice to professionals about amounts of nutrients found to be of benefit
Dietary Guidelines

- USDA, FDA, DGC, NIH, professional organizations
- National nutritional and health goals
- Implementation of DRI by food assistance programs
- Nutrition education
- Food industry regulation
Criteria for Diet-Disease Relationships

- Strength of association
- Dose-response relationship
- Temporally correct association
- Consistency of association
- Specificity of association
- Biological plausibility
Pharmacological Effects of Nutrients

- Doses for therapeutic effect exceed levels in food
- Pharmacological action different from physiological function
- Chemical analogs more effective therapeutically but have no nutrient activity