Physiology
Adaptation

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Averages and distributions

- Quetelet – seeking the “average man.
  - variation = error

  **Vs**

- Darwin and Galton
  - variation = reality; inheritable

- The requirement average is just a number; the distribution is interesting and physiological
  - Inter-individual + intra-individual + measurement error
Inter- and intra-individual nutrient requirements vary with the...

- Prior intake
  - Protein and amino acids
  - Energy
  - Micronutrients

- Nutritional status - that can determine absorption

- Body composition
Harmonizing a measurement of nutrient requirement across different groups means...

- A careful characterization of subjects studied for their requirement
  - Habitual intake
  - Nutrient status
  - Body composition

- A careful adaptation of subjects to ‘habitual’ or ‘normal’ diets before measuring their requirement of the nutrient of interest.
  - Not grabbed off the road
Mean 12h (Fast or Fed) and 24 h leucine balance over a range of leucine intakes

Here- subjects were adapted to each level of intake for 7 days

Measurements of leucine oxidation were made over 24 hours
Adaptation of Urine N excretion to a lower protein intake

Subjects changed from:
High (~292 mgN/Kg/d) to Medium (~125 mgN/Kg/d)
Day 0 = High
Change on Day 1
Day 1-10: Medium

From Quevedo et al, Clin Sci, 1994
When should the protein requirement be measured?

• This was particularly a problem when the suggested change in nutrient (IAA) requirement was to a higher value.

• For IAA, we had to adapt subjects for 7 to 21 days to prove that a 7 day adaptation period was enough

• This might apply to many other nutrients too
What are the consequences of not adapting subjects before they were studied?

• If their intakes were higher – then higher than usual requirements

• Larger distributions – will affect the RDA

• Also raises the question – what is the ‘normal or habitual intake’ that should be fed?

• Interaction of nutrients – eg: protein and energy – one of the confounders of the early Rose determinations of IAA requirements
A varied body composition

• Requirements are scaled to body weight

• And not to body compartments like the Fat Free Mass- which is more metabolically active
BMR and Energy requirement

• The usual BMR prediction equation is based on weight, sex and age

• The equation depends on the population it was derived from

• Muscular, active young men (army recruits) would probably have a higher BMR
The Indian BMR

• Careful measurements by Shetty & Soares (1980’s-90’s) documented that Indian subjects’ BMR was lower than what was predicted by the WHO/FAO/UNI equation

• This has been repeated in many countries in Asia- but methods vary (RMR vs BMR).

• Consequences?
Scaling

• The lower BMR in Indians, became a higher BMR/Kg body weight or FFM.

• This was attributed to a higher visceral mass (HMRO) in the FFM – even though there was low muscularity

• In general, scaling a nutrient requirement to body weight (or a body compartment) presents the problem of a ‘non-zero’ intercept
Adaptation within individuals – a potential fallacy of the factorial method
Factorial method of estimating the requirement...and physiology

- Activity driven TEE plateaus after a certain point
- Non-muscular EE can reduce
- Behavioral adaptation
Adaptation and efficiency of absorption

Salvage of exogenous urea nitrogen enhances nitrogen balance in normal men consuming marginally inadequate protein diets

Tracey S. MEAKINS and Alan A. JACKSON
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Effect of Dietary Calcium and Age on Jejunal Calcium Absorption in Humans Studied by Intestinal Perfusion

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Adaptation of iron absorption in men consuming diets with high or low iron bioavailability

Janet R Hunt and Zamzam K Roughhead

Adaptation in human zinc absorption as influenced by dietary zinc and bioavailability

Janet R Hunt, Jeannemarie M Beiseigel, and LuAnn K Johnson
What is ’normal’?

- When different populations are considered - and a common nutrient requirement is determined
  - Geography, Poverty, Culture, Habits

- Altered body composition, altered susceptibility

- Functional endpoints – physiological usually, but where did we start?

- Target intake: The EAR is the minimum intake that assures balancing daily nutrient losses: but not the optimum.
  - “Necessary” versus “sufficient”