Nutrition for Fat & Energy Balance

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Carbohydrate Intake (g.kg\(^{-1}\)h\(^{-1}\))

<table>
<thead>
<tr>
<th>Glycogen Synthesis (mmol.kg(^{-1})h(^{-1}))</th>
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Energy Expenditure

Blair et al. (2004) AJCN 79: 913S

Energy Intake

Hi Lo

Typical Energy Balance

- CHO
- PRO
- FAT
- Resting Metabolic Rate
- Diet-Induced Thermogenesis
- Physical Activity

Energy Intake = Energy Expenditure

Fat Balance (g·day\(^{-1}\))

-150 -100 -50 0 50 100 150

Fat Balance = Fat Intake – Fat Oxidation

Element Composition of Man by Mass

- 61% Oxygen
- 23% Carbon
- 10% Hydrogen
- 3% Nitrogen
- 1% Calcium
- 1% Phosphorous
- 0.1% Potassium
- 0.1% Sulfur
- 0.1% Sodium
- 0.1% Chlorine

Other 49 trace elements compose the remaining 0.6% (< 0.1% each)

Adapted from Emsley, J. (1998) The Elements

Hydraulic Model Adapted from Kleiber 1936

Energy Content of Dietary Macronutrients

- CHO ~4.1 kcal·g\(^{-1}\)
- FAT ~9.4 kcal·g\(^{-1}\)
- PRO ~5.6 kcal·g\(^{-1}\)
- ALC ~7.1 kcal·g\(^{-1}\)

CHO ~3.7 kcal·g\(^{-1}\)
FAT ~8.9 kcal·g\(^{-1}\)
PRO ~4.1 kcal·g\(^{-1}\)
ALC ~6.0 kcal·g\(^{-1}\)

Heat Dissipation

Body Heat Content (~1500 kcal)

Chemosensitive Regulator

Body Temperature

CHO~92%
FAT~98%
PRO~79%
ALC~85%

Thermosensitive Regulator

Energy Available from Systemic Metabolites

CHO~95%
FAT~100%
PRO~100%
ALC~0%

i.e. Body Substance (e.g. glycogen, triglycerides, proteins, etc.)

i.e. Systemic Metabolites (e.g. glucose, NEFA, amino acids, etc.)

Catabolic Regulator

Oxidative Regulator

Anabolic Stimulus

Absorptive Regulator

Digest Filter

Metabolic Filter

Storage Filter

Eating Capacity

Regulator

Appetite

D

Body Heat Content (~1500 kcal)
“Bees make wax (lipid) from honey (carbohydrate). Pigs fatten on a grain diet. Indeed, all organisms, from bacteria to mammals, have the enzymes of \textit{de novo} lipogenesis.”

Hellerstein (2001) AJCN 74: p 707

\textbf{Measurement of \textit{de novo} Lipogenesis}

1) Body Composition and Nutritional Analysis
- Body fat storage > dietary fat intake = \textit{de novo} lipogenesis

2) Indirect Calorimetry
- The RQ for \textit{de novo} Lipogenesis is \textasciitilde{}5.6, so a resting RER \textasciitilde{}1 reflects whole-body net \textit{de novo} lipogenesis

3) Isotopic Tracers
- e.g. mass isotopomer distribution analysis (MIDA) assesses the incorporation of $^{13}$C acetate into VLDL, therefore indicative of hepatic \textit{de novo} lipogenesis.
Alcohol (ethanol; EtOH) can influence fat balance via several inter-related factors:

- **Stimulation of Appetite**
  - Increased energy/fat intake
  - Westerterp et al. 1999 AJCN 69

- **Efficiency of EtOH Absorption**
  - Increased energy yield
  - 73-80% of ingested energy

- **Positive Fat/Energy Balance**

- **Altered Lipid Metabolism**
  - Decreased lipid oxidation
  - Increased lipid synthesis

... *de novo lipogenesis is the pathway of last resort and, at least regarding converting carbohydrates to fats, humans are neither bees nor pigs.*

Hellerstein (2001) AJCN 74: p 708