

Lecture # 15
Ch 7: The Body's Energy Budget
(pg 221 - 227)
Ch 8: Energy
2/18/04

Energy Expenditure

- Thermogenesis - the body's generation of heat measured by direct calorimetry
- Measured to determine the amount of energy expended
- Total energy expenditure represents:
 - Basal metabolism
 - Exercise-induced (physical activity)
 - Diet induced (thermic effect of food)

Basal Metabolism

- Requires ~ 2/3 of daily energy expenditure
- Daily metabolic activities
 - body temperature
 - breathing, heart beat, body functions
- Basal metabolic rate (BMR)
 - Rate at which body spends energy for maintenance
 - Varies among individuals - age, weight, height, sex
 - Measured at rest and in fasting state
 - Measured as Resting Metabolic Rate (RMR)

Factors that Affect BMR

Table 8-1

- | | |
|-----------------------------|----------------------|
| • Age | • Fasting/starvation |
| • Height | • Malnutrition |
| • Growth | • Hormones |
| • Body composition | • Smoking |
| • Fever | • Caffeine |
| • Stresses | • Sleep |
| • Environmental temperature | |

Physical Activity

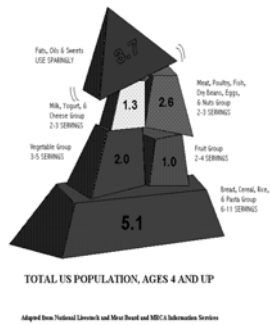
- Most variable / most changeable component of energy expenditure
- Influences weight
- Amount of energy needed for any activity depends on (Table 8-2)
 - Muscle mass, body weight, activity
- Activity duration, frequency and intensity influence energy expenditure

Thermic Effect of Food (TEF)

- Estimation of energy required to process food
 - Digestion, absorption, transport
 - Metabolism & storage
- Proportional to the food energy taken in
- Usually ~ 10% of energy intake
- Example 2000 kcal \times 10% = 200 kcal
- Influenced by meal size, frequency, composition
 - CHO > fat
 - Large meals > small meals

Economics of Feasting

- Excess kcalories favors fat formation
- It does not matter whether it is from CHO, PRO, or FAT

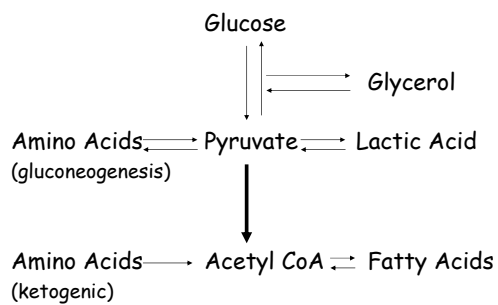


Feasting

- Overeating - intake exceeds energy needs
- Body stores a small amount of glycogen and a large amount of body fat
 - CHO - liver & muscle store glycogen
 - Fat - adipose stores as triglycerides
 - Protein - limited synthesis & excess nitrogen lost in urine

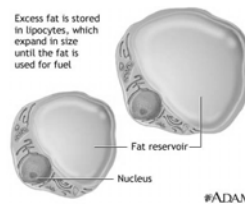


Overview of Metabolism



Storage of Triglycerides

- Fat cells enlarge & multiply regardless of caloric source



Control your fat intake !

- Dietary fat converted to body fat
 - most direct (requiring only a few metabolic steps)
 - most efficient (costing on a few kcal).
- Bottom Line:
 - The body uses less energy to convert dietary fat to body fat than to convert CHO to body fat.

Surplus Macronutrients: Where do they go?

- Surplus Protein
 - Excess not stored as protein
 - Protein synthesis first priority
 - Excess carbon skeletons used for energy or FAs
 - Nitrogen is excreted
- Surplus CHO
 - Glycogen used for storage
 - Excess converted to fat but energy costly
- Surplus Fat
 - Moves efficiently to body stores
 - Less costly in terms of kcals used to the body
 - Almost all excess is stored

From Feasting to Fasting

- Shift from fed state to fasting state
- Body's top priority
 - to meet the cell's needs for energy
- Requires the body to release glycogen and fatty acids for energy

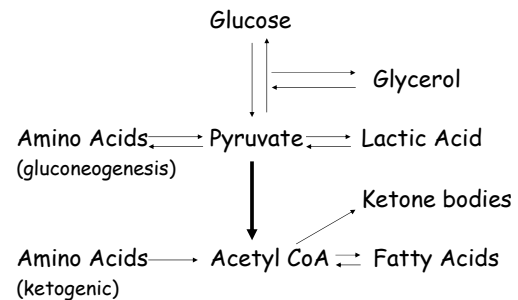
Early fasting

- Body draws on glycogen and fat stores for energy
 - Glycogen (liver) - provides energy to brain, CNS, RBC & other cells
 - Fat stores - provide energy to other cells in the form of fatty acids

Extended Fasting

- Glycogen stores depleted - this means NO glucose available to brain & RBC
- Gluconeogenesis begins
 - Protein breakdown for amino acid conversion to glucose
 - Nitrogen lost in urine
 - REMEMBER: BRAIN & RBC NEED GLUCOSE
- Fats converted to ketone bodies for extra energy
 - Brain adapts to ketone bodies for energy but RBC can ONLY use glucose

Overview of Metabolism



Key Steps in Ketosis

- Inadequate CHO intake or lack of insulin result in the body producing ketone bodies
- Fatty acid release from adipose floods liver's capacity to synthesize fats
- Liver convert fatty acids to acetyl CoA
- TCA cycle slowed by production of excess ATP
- Liver converts excess acetyl CoA to ketone bodies

Determining Energy Needs

- BMR - Basal Metabolic Rate
- TEE - Total Energy Expenditure
- EE - Energy Expenditure
- TEF - Thermic Effect of Food
- PA - Physical Activity

Average Energy Allowance

- Men: 2300 - 2900 kcal / day
- Women: 1900 - 2200 kcal / day
- REMEMBER: DRIs are age, gender, lifecycle specific

How to determine IBW

- Hamwi Method
- Females:
 - 100 lb first 5 ft then 5 lb for each inch over 5 ft
- Males
 - 106 lb first 5 ft then 6 lb for each inch over 5 ft
- Adjustments can be made for plus or minus 10% based on frame size

Adjustment for Overweight

- If body weight > 120% IBW then use the following equation to calculate body weight for BMR
- $(ABW - IBW) \times 0.25 + IBW = \text{Adjusted Body Weight for BMR}$
 - ABW = actual body weight
 - IBW = ideal body weight

Estimating Energy Requirements

1. BMR - Table 8-3: NRC Equations for BMR
 - Quick Method
 - $M = \text{kg} \times 24 \text{ kcal} / \text{d}$ & $W = \text{kg} \times 23 = \text{kcal} / \text{d}$
2. Physical Activity - Tab 8-4 Energy Expend PA
 - Based on DRIs - min of 30 min moderate intensity PA offers some health benefits but NOT enough to maintain healthy body weight
 - Need 60 min of moderate intensity PA every day
 - Moderate intensity = walking a pace ~ 4 mph
3. Thermic Effect of Food

Harris- Benedict Equations for BMR pg 250

- BMR for men
- $66 + (13.7 \times \text{wt kg}) + (5 \times \text{ht cm}) - (6.8 \times \text{age yr})$
- BMR for women
- $655 + (9.6 \times \text{wt kg}) + (1.8 \times \text{ht cm}) - (4.7 \times \text{age yr})$
- $\text{BMR} \times \text{AF} \times \text{TEF} = \text{TEE}$
- Height to centimeters
 - Height in inches $\times 2.54 = \text{ht in cm}$

Calculating Total Energy Needs Example: pg 250

- 20 yo male who weighs 160 lbs
- Method # 1
 1. BMR Calculation
 - Convert wt to kg = $160 / 2.2 = 72.7 \text{ kg}$
 - Find formula based on age on Table 8-3
 - Calculate BMR
 - $(15.3 \times \text{wt}) + 679 = 1791 \text{ kcal/d}$
 2. TEE
 - Table 8-4 Select appropriate energy level
 - $\text{BMR} \times \text{Activity Factor}$
 - $1791 \times 1.6 = 2866 \text{ kcal} / \text{day}$

Method # 2: TEE

- Shortcut method for BMR
 - Men = 1 kcal/kg/hr
 - Women = 0.9 kcal/kg/hr
- 160 lb/ 2.2 = 72.7 kg (round to 73 kg)
- $73\text{kg} \times 1 \text{ kcal/kg/hr} \times 24 \text{ hr} = 1752 \text{ kcal}$
- $1752 \times 1.6 \text{ PA} = 2803 \text{ kcal/day}$

Method # 3: TEE

- Kcal based on kg body weight
- Table 8-4 for light activity
 - 38 kcal / kg / day
 - $73 \text{ kg} \times 38 \text{ kcal} = 2774 \text{ kcal/day}$