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Outline

Energy

Types of energy

Measuring energy

Energy systems

Indirect calorimetry

RER

Estimating REE using Mifflin-St Joer

Measures of Energy

Energy =

Forms of energy

Mechanical\*

Chemical\*

Heat\*

Electrical

Light

Nuclear

 Sun is the ultimate energy source

Energy Concepts

Energy is neither created nor destroyed

Transformed from one type to another

Human Energy

Mechanical energy

Capacity to do metabolic work

Chemical energy

Storage form of energy

Heat energy

Product of metabolism

Measuring physical activity and energy expenditure

Heart rate monitoring

Ergometers

Calorimetry

Direct

Indirect

Doubly labeled water technique – gold standard

Metabolic equivalents (METs)

Smartphone applications/GPS/accelerometers

What is the most commonly used  measure of energy?

Define calorie

Calorie v. calorie v. kilocalorie (kcal)

Calorie v. joule

Atwater values

Calories in macronutrients and alcohol

4.30 kcal One gram of CHO

9.45 kcal One gram of fat

5.65 kcal One gram of protein

7.00 kcal One gram of alcohol

ATP formation

ATP

PCr

CHO

Fat

Protein

Major energy stores in the human body

Human energy systems

 Predominant energy systems

Anaerobic power (ATP-PCr; phosphagen)

 60-100 meters (6-10 seconds)

 Anaerobic capacity (glycolysis; ~~lactic acid~~)

  400-800 meters (43-103 seconds)

 Aerobic power (oxidative, ~~glycolysis~~)

  5,000-10,000 meters (12-26 minutes)

The ATP-PCr energy system **ATP breakdown for energy**

The ATP-PCr energy system Resynthesis of ATP from PCr

The oxygen energy system: oxidative phosphorylation

(Glycolysis ->) Pyruvate -> acetyl-CoA

**Oxidation** of glycogen or glucose

Lipolysis -> beta oxidation

Oxidation of fatty acids

Proteolysis (limited energy production)

Oxidation of glucogenic or ketogenic amino acids

 The oxygen energy system

Schematic of Anaerobic Glycolysis

Metabolism

Metabolism =

Total daily energy expenditure

Energy for basal metabolism

Energy for processing of food intake

Energy for physical activity

BMR v. RMR

Basal metabolism

Basal metabolic rate (BMR)

Energy needed to stay alive when awake

Only sleeping metabolic rate is lower

Basal energy expenditure (BEE)

Basal metabolism over 24-hour period

Resting metabolism

Resting metabolic rate (RMR)

BMR plus small amounts associated with eating (TEF), prior activity

About 10 percent higher than BMR

Resting energy expenditure (REE)

Resting metabolism over 24 hour period

TEF is expressed as the % of meal energy content

5-10% for a mixed meal

Estimate daily resting energy expenditure

Estimate not as accurate as BMR/RMR test

Other methods include effects of activities of daily living (ADLs)

Simple methods to estimate RMR

1 Calorie/kilogram body weight per hour

The crossover concept of carbohydrate and fat utilization during exercise

Indirect calorimetry

Breath by breath

ID substrate utilization

Substrate Utilization RER and RQ

Differing amount of O2 is needed and CO2 is produced when oxidizing CHO and fat

Oxidation of Carbohydrates, Proteins, and Fats

RER for Carbohydrate (Glucose)

RER for Fat (Palmitate)

Oxygen Consumption Response to Steady-State Exercise

Maximal Oxygen Consumption – VO2max

Energy Systems at Work

http://www.youtube.com/watch?v=PXRqrtQVaz0&feature=relmfu

http://www.youtube.com/watch?v=-dm-ds5rRaM

http://www.youtube.com/watch?v=XlXuJP\_9DjA&feature=relmfu

http://www.youtube.com/watch?v=fM9mNySTAoY&feature=related

https://www.youtube.com/watch?v=nCflycqc11s

http://www.youtube.com/watch?v=6aYqtHLwwaU&feature=related

http://www.youtube.com/watch?v=Tk8BC\_S3\_gQ

https://www.youtube.com/watch?v=VbWsQMabczM

https://www.youtube.com/watch?v=fOGXvBAmTsY

Components of Energy Expenditure

Estimating needs:  needed for case studies

Use Mifflin-St. Joer for REE (includes TEF)

+

Estimate non-exercise activity thermogenesis (NEAT)

+

Estimate exercise activity thermogenesis

= caloric need

Males: REE = (10 x wt) + (6.25 x cm) – (5 x age) + 5

Females: REE = (10 x wt) + (6.25 x cm) – (5 x age) - 161