1. Metabolism (Ch5)

http://eebweb.arizona.edu/eeb_course_websites.htm

Housekeeping, 23 April 2008

Upcoming Readings
Wed 23 Apr: Ch 4, 5
LAB 23 Apr: Kevin Oh emailed
Final Proposal due in lab 23 April or beginning of lecture 25 April
Fri 25 Apr: Ch 4, 5

Lab discussion leaders: 23 April
1pm - none
3pm - Nina
World Class Human Runners

(Hill et al. 6.9)
Metabolism

- Chemical reactions in the body
- Temperature-dependent rates
- Not 100% efficient, energy lost as heat
  (not ‘lost’ if used to maintain Tb)

1. Anabolic
   - Creation, assembly, repair, growth
     (positive nitrogen balance)

2. Catabolic
   - Energy release from complex molecules
     (carbs, fats, proteins)
   - Energy storage in phosphate bonds (ATP) and
     metabolic intermediates (glucose, lactate)

Chemical Energy

(Eckert 16-1)
10% Rule

Energy Available for:
- Growth, Maintenance, Reproduction
- SDA (specific dynamic action)

No free lunch!
Male emperor penguin
>100 days w/o food when incubating eggs

K vs. r selected
(logistic curve)

- Larger animals invest proportionally less in reproduction
- Sperm is cheap
- Direct and indirect costs
Metabolic Rate

-measurable conversion of chemical energy into heat

-used to understand:
  - energy budgets
  - dietary needs
  - body size implications
  - habitat effects
  - costs of various activities
  - mode of locomotion
  - cost of reproduction
Much more difficult for **water breathing animals** to maintain body temperatures above ambient because **rate of heat transfer is greater than rate of O₂ transfer** in water (high specific heat).

**Fish Example:**

- Differences in **vascular organization**
- Tuna with **warm, aerobic muscle** medially
- **Countercurrent blood flow** (don’t lose heat to cold water across gills)
Metabolic Rates

- **Basal Metabolic Rate**, BMR
  - minimal environmental and physiological stress
  (appropriate ambient temperature, post-digestive, resting etc.)

- **Standard Metabolic Rate**, SMR
  - similar to BMR, but at a given Tb

- **Field Metabolic Rate**, FMR
  - average metabolic rate of animal in natural setting
  - hard to measure
Metabolic Rates

**Basal Metabolic Rate, BMR**
- important components:

1. **Membrane** form and function
   - maintenance of *electrochemical gradients*
   - *proton* pumps in mitochondrial membranes
   - *Na/K-ATPase* pumps in plasma membrane

2. **Protein** synthesis

3. **ATP** formation
Metabolic heat production
(chemical energy ‘lost’ as heat during metabolism)

- Endotherms
- surface area to volume ratio
- Larger ectotherms can be heterothermic
  - leatherback (*Dermochelys coriacea*)
  - pythons (female brooding clutch)
  - tuna and increased core temperature

Digestive Systems

Transit time (time to digest), cost, and anatomy variable:
- Food quality
- Body Size
- Temperature (ectotherms)
Gut Plasticity

Alter gut size, activity (reversible)
- Sustained increased metabolism can increase bird gut length by 1/5
- Mammals increase GI tract mass 3-4x post-hibernation
Gut Plasticity

Alter gut size, activity (reversible)

- Some infrequently-feeding snakes:
  - intestine 2x larger within 2 days
  - microvilli length and area up 400%
  - glucose transport rate up as much as 22x
  - other transporters also up-regulated (e.g., a.a. absorption)

Alkaline Tide...