Objectives

- When given the concentrations of fat, protein, and carbohydrates, be able to calculate the energy (kcal) of a food using Atwater and modified Atwater factors.
- Know how to calculate resting energy requirements using both equations.
- If provided a table with life stage factors, be able to apply them appropriately to estimate daily energy requirements.

Energy

- Calories
  - Amount of heat needed to raise 1 gram of water from 14.5°C to 15.5°C
  - A kilocalorie = 1000 calories
  - Food energy
    - Gross energy = the amount of heat liberated when food is burned in a bomb calorimeter
    - Digestible energy = gross energy minus the energy lost in feces
    - Metabolizable energy = digestible energy minus energy lost in urine and gastrointestinal (GI) gas
    - Net energy = metabolizable energy minus energy lost in the process of digestion

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Example: You have a diet that is 40% protein, 35% carbohydrate, and 25% fat on an as fed basis. How many calories are in 100 grams of this food?

40% of 100 grams = 40 grams x 4 kcal = 160 kcal from protein

35% of 100 grams = 35 grams x 4 kcal = 140 kcal from carbohydrates

25% of 100 grams = 25 grams x 9 kcal = 225 kcal from fat

(525 kcal per 100 grams of food)
• Respiratory Quotient (RQ)
  o As nutrients are oxidized for energy, they produce CO₂ and consume O₂
  o Respiratory Quotient is a ratio of CO₂ produced to O₂ consumed
  o CO₂/O₂ has different values for lipids, carbs, and proteins
    ▪ Lipids = 0.71
    ▪ Proteins = 0.81
    ▪ Carbohydrates = 1.0
  o Can be used to estimate which fuel source is being metabolized predominately by individuals
  o May want to avoid high carbohydrate diets if patient has high blood CO₂ levels (severe respiratory disease).

• Daily energy requirements (DER) are the average daily energy requirements of an animal (also called maintenance energy requirements [MER]). DER can be divided into four parts:
  o Resting energy requirement (RER)—energy needed to maintain normal body functions such as respiration. Typically makes up 60%–80% of DER.
  o Exercise energy requirement (EER)—energy exerted through muscular activity and exercise.
  o Thermic effect of food (TEF)—energy burned through digestion and absorption. Makes up about 10%–15% of DER.
  o Adaptive thermogenesis (AT)—energy used to stay warm or cool.

Formulating and Diet Plan

1. Nutrition Should be Assessed in Every Patient—“5th Vital Assessment”
   a. Physiologic factors like age, species, breed, gender, environment, and disease should be considered when making feeding plans.

2. Body Condition Scoring
   a. System of estimating body fat using visual assessment and palpation
   b. Two commonly used scales
      i. 9-point scale—Developed by Purina pet foods
         1—emaciated, 5—ideal, 9—obese
      ii. 5-point scale—Developed by Hill’s Pet Nutrition
         1—emaciated, 3—ideal, 5—obese

3. Body Fat Index
   a. New method of estimating body fat in overweight and obese dogs and cats. Assess a higher degree of obesity than traditional body condition scoring.

4. Morphometric Measurements
   a. Uses measurements of certain body areas to assess body fat. Only appropriate for obese patients (8 or 9/9)

5. Calculating Resting Energy Requirements for Dogs and Cats
   \[70 \times \text{Body Weight}^{0.75} \quad \text{or} \quad [(30 \times \text{BW}_{\text{kg}}) + 70]\]

The equation raised to the 0.75 power is more accurate. The linear equation can be used in animals between about 6–60 pounds.

Example: 5 kg cat
\[70 \times 5^{0.75} = 70 \times 3.34 = 234 \text{ kcal/day}\]
\[30 \times 5 + 70 = 150 + 70 = 220 \text{ kcal/day}\]

6. Daily Energy Needs = Y \times \text{RER}
   a. After calculating the RER for an animal, you need to multiply by a life stage factor.

In the example above, if the 5 kg cat was a neutered male, you could take the 234 kcal/day you calculated and multiply by a life stage factor of 1.2 to estimate daily energy needs. 234 \times 1.2 = 280 \text{ kcal/day}.

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Canine Factor</th>
<th>Feline Factor</th>
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</table>
Adult intact 1.8 1.4
Neutered 1.6 1.2
Senior 1.4 1.1

Obese prone 1.2 1.0
Weight loss 0.8–1.0 0.8

Growth 2–3 2–5
Gestation 1–3 1.6–2
Lactation 1.4 1.1

*** In overweight patients, RER should always be calculated based on ideal weight. Don’t forget to use kilograms instead of pounds!

If you do not have a scientific calculator with an $X^y$ function, you can take the body weight and cube it and then take the square root of that number twice.

Example of the “hard way”: Body weight = 10 kg

Cube the body weight: $10 \times 10 \times 10 = 1,000$

Take the square root of the result twice: $\sqrt{1,000} = 31.62$

$\sqrt{31.62} = 5.62$ kg

$5.62 \times 70 = 393$ kcal/day

**Recommended Reading**