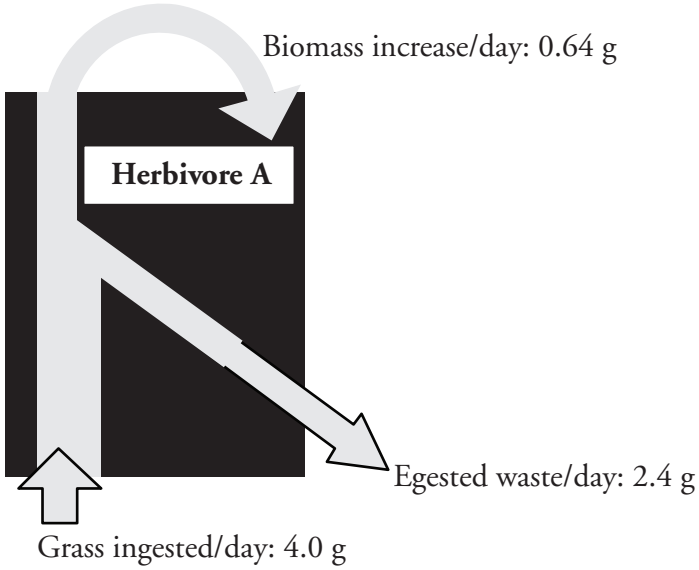
Energy Transfer in Living Organisms

How does energy move through an organism?

Why?

The **law of conservation of energy** states that energy can be neither created nor destroyed; it can only be transferred to another form. In living things energy is transferred as organic matter (molecules of carbohydrate, fats, starch, etc.). But does an organism use all of the energy that is provided by the organic matter available? How is the law of conservation of energy applied to living organisms?

Model 1 – Food Conversion in a Herbivore



1. According to Model 1, how many grams of grass does herbivore A eat each day?

2. Refer to Model 1.
   a. How much did herbivore A grow from eating this grass?

   b. What term is used to represent growth in Model 1?

3. What is meant by "egested waste" as it is used in Model 1?

4. Is all of the mass of the ingested grass accounted for in the growth and waste of herbivore A? If not, how much is "missing"? Show a mathematical calculation to support your answer.

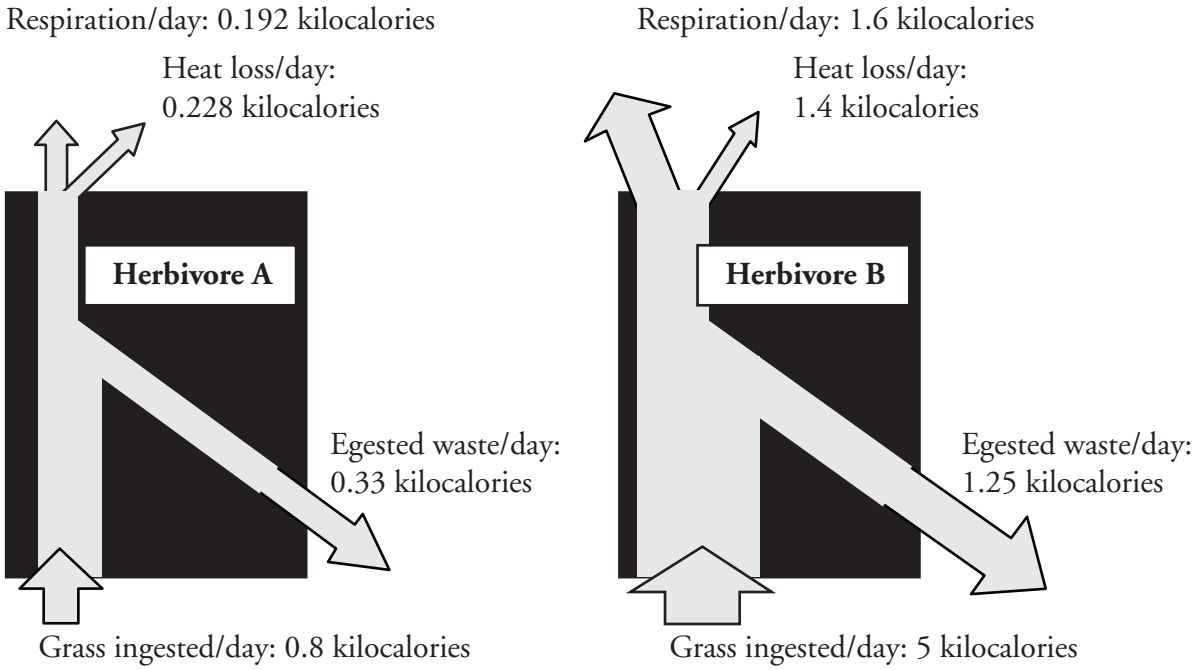
5. In addition to growth and waste production, what else does herbivore A's body do with the food it ingests?

6. As cells undergo cellular respiration, what products are produced, and how are they released from the body?

7. Draw an arrow in Model 1 to represent respiration and label it with the appropriate title and mass.

STOP

Model 2 – Energy Efficiency in Two Organisms



8. What unit of energy is used in Model 2?

9. Refer to the energy value of the ingested grass in Model 2.
   a. What is the energy value of the grass eaten by herbivore A each day?

   b. What is the energy value of the grass eaten by herbivore B each day?

   c. Which herbivore would you predict to be the larger animal? Explain.

10. In Model 2, what are the three ways that the energy taken in by the herbivores is used?

11. For each herbivore calculate the total energy output.
    a. Herbivore A =
    b. Herbivore B =
12. Does the total amount of energy output for each herbivore add up to the total amount of energy eaten by each herbivore?

13. Use the information given in Model 1.
    a. What accounts for the differences noted in Question 12?

    b. Add labels to Model 2 to show this energy.

Read This!

Biologists often refer to organic matter by the potential energy that is released when the substance undergoes a chemical change to make carbon dioxide and water. This could occur by burning the organic matter or by an organism using the organic matter in cellular respiration.

14. According to Model 1, herbivore A eats 4 g of grass per day. Using Model 2, how much potential energy does this represent?

15. According to Model 2, how much energy does herbivore A require for cellular respiration each day?

16. Energy lost as either heat to the environment or egested as waste is not considered to be an efficient use by the organism. What percentage of the potential energy of the grass is not efficiently used by herbivore A?

17. What percentage of the potential energy of the grass is not efficiently used by herbivore B?

18. Do the herbivores have the same efficiency in using the grass toward useful purposes? Explain in two or more complete sentences.

19. Herbivores A and B are eaten by carnivores.

    a. Which category of energy related to the organisms in Model 2 is directly available to the carnivore who eats the herbivores: grass, respiration, biomass or waste?

    b. What percentage of the original "grass energy" is available to the carnivore if it eats herbivore A?

    c. What percentage of the original "grass energy" is available to the carnivore if it eats herbivore B?

20. Which herbivore is the more efficient food choice for the carnivore? Why?