Chapter 2-8: Energy Flow in Living Things

The total amount of energy that exists in the universe remains constant, but energy can change from one form to another. For example, the chemical energy in gasoline can be released and transformed into heat energy and the energy of motion.

This type of transformation of energy occurs in many of the processes that take place in living things. In this plate, we will examine the flow of energy through living things and identify the molecule that serves as the main energy source in all life processes.

> This plate shows how energy exists in different forms at different times in living things. As you encounter the terms, color the appropriate structures in the diagram.

All of the energy on the Earth comes from the **sun (A)**; the **sun's energy (A_1)** is what drives chemical reactions and the processes of life. This solar energy is trapped in a photosynthesizing organelle of the plant called the **chloroplast (B)**; we discuss this organelle in detail later in the book.

A number of chemical reactions take place in the chloroplast to transform solar energy into chemical energy. **Carbon dioxide (C)** and **water (D)** are necessary for the process of **photosynthesis (E)**, and the products of photosynthesis include **carbohydrates (F)**, which are represented by a candy bar, and molecular **oxygen (G)**. The bonds of the carbohydrates now contain some of the sun's energy; photosynthesis has transformed the sun's energy into the chemical energy of the carbohydrate. Oxygen is given off as a waste product of photosynthesis, and it is expelled from the plant cell into the atmosphere.

> Having explained how the sun's energy is converted to the chemical energy found in carbohydrates, we will now discuss another transformation of energy. Continue your reading below, and focus on the right side of the diagram as we continue to study energy flow in living things.

Plants, humans, and many other living things use carbohydrates as their essential source of energy. Carbohydrates are transported to an organelle called the **mitochondrion (H)**, where they are combined with oxygen molecules in the process of **respiration (I)**, illustrated by the arrow. During chemical reactions in the mitochondrion, the energy from carbohydrates is released and used to form the energy-rich molecule **adenosine triphosphate (J)**. (Adenosine triphosphate is commonly abbreviated as ATP.) Carbon dioxide and water are byproducts of respiration; notice that they are both essential for photosynthesis. To summarize, the energy of the sun is first transformed into the energy of carbohydrates and then into the energy in the ATP molecule.

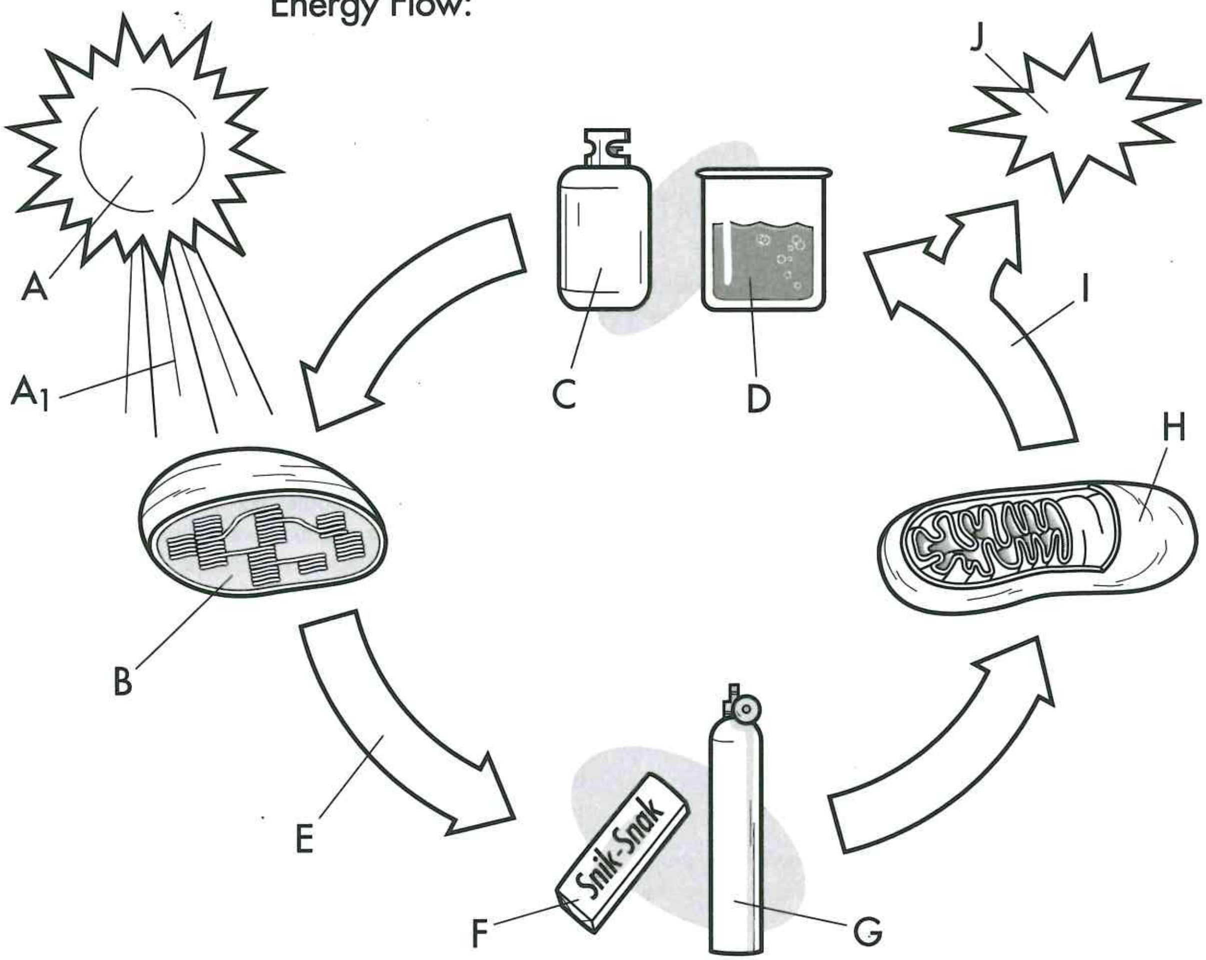
> We will conclude with a brief examination of the ATP molecule. Recall that the energy of the ATP molecule comes from the sun. As you read, color the appropriate structures in the diagram.

The adenosine triphosphate (ATP) molecule (J) is shown at the bottom of the plate. You should use a light shade to color the interior of the box, and darker colors should be used for the components of ATP. These components include an **adenine molecule (J_1)** and a **ribose molecule (J_2)**. Adenine is one of the four nitrogenous bases found in DNA and RNA, and ribose is a five-carbon carbohydrate. Attached to the ribose molecule are three **phosphate groups (J_3)**.

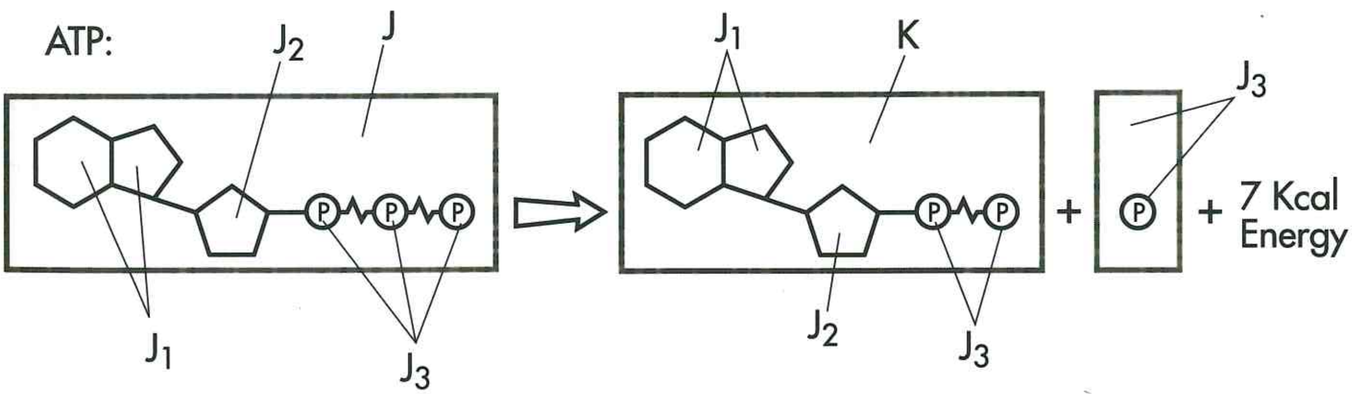
Living things use energy in the form of ATP, breaking it down into **adenosine diphosphate (K)** and an inorganic phosphate group. Adenosine diphosphate (ADP) contains adenine (J_1) and a ribose molecule (J_2), but only two phosphate groups (J_3). During this breakdown, seven kilocalories of energy are given off for use by the cell.

In the following plates, we will study the processes by which ATP is created, such as glycolysis, the Krebs cycle, electron transport, and chemiosmosis.

Energy Flow:



ATP:



Energy Flow in Living Things

- ○ Sun .... A
- ○ Sun's Energy .... A_1
- ○ Chloroplast .... B
- ○ Carbon Dioxide........ C
- ○ Water .... D
- ○ Photosynthesis........ E
- ○ Carbohydrates .... F
- ○ Oxygen................ G
- ○ Mitochondrion .... H
- ○ Respiration I
- ○ Adenosine Triphosphate .... J
  - ○ Adenine .... J_1
  - ○ Ribose .... J_2
  - ○ Phosphate Groups .. J_3
- ○ Adenosine Diphosphate .... K