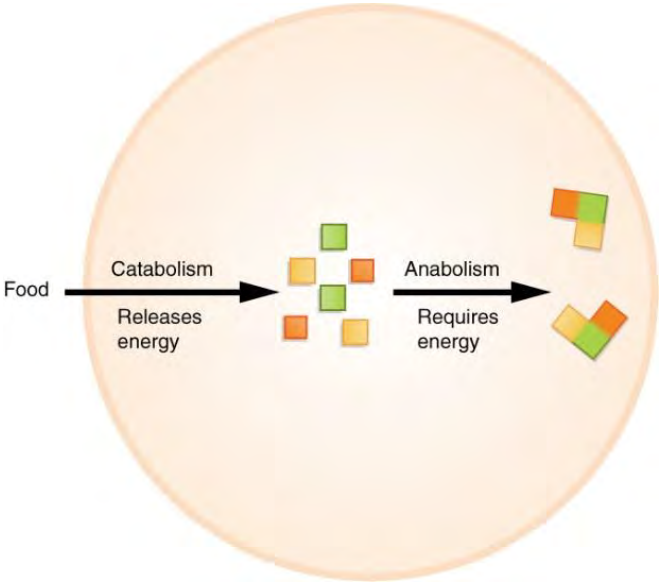
Taken together, these processes are called metabolism. **Metabolism** is the sum of all anabolic and catabolic reactions that take place in a cell (Figure 5.21). Both anabolism and catabolism occur simultaneously and continuously within cells. These metabolic reactions allow cells to maintain homeostasis.



The chemical reactions that make up metabolic pathways do not take place on their own. Each reaction is facilitated, or catalyzed, by a protein called an enzyme. Enzymes are important for both anabolic and catabolic reactions and will be discussed in section 5.7.

Figure 5.21 Metabolism includes both anabolic and catabolic reactions. (credit: Betts et al. / Anatomy and Physiology OpenStax)

CONCEPTS IN ACTION - View this animation to learn more about metabolic processes. Which organs of the body likely carry out anabolic processes? What about catabolic processes?

Check your knowledge

Categorize the following events as catabolic or anabolic reactions:

- Digesting a potato chip.
- Our muscle cells making an enzyme.
- A smooth endoplasmic reticulum removing a toxin.
- A plant producing cellulose for the cell wall.

Answers: catabolic, anabolic, catabolic, anabolic

Section Summary

Cells perform life functions through various chemical reactions. A cell's metabolism refers to all the chemical reactions that take place within it. Catabolic reactions involve breaking down complex chemicals into simpler ones and are considered energy-releasing reactions. Anabolism refers to metabolic processes that build complex molecules out of simpler ones and are processes that require energy.

Exercises

1. Most organisms get their energy either directly or indirectly from the sun. Provide an example of an organism that gets its energy directly from the sun and one example that gets its energy indirectly from the sun.
2. Which of the following is not an example of an energy transformation?
    a. plants using the sun to make sugar
    b. animals eating plants
    c. animals eating animals
    d. all of the above are energy transformations
3. The energy currency used by cells is _____.
    a. ADP
    b. ATP
    c. AMP
    d. Adenosine
4. Is photosynthesis an anabolic or catabolic reaction? Explain your answer.

Answers

1. Producers, such as plants, can directly capture sunlight and convert it into chemical energy. Consumers such as such as cows, obtain their chemical energy by consuming producers, such as grass. Cows indirectly get their energy from the sun.
2. (d)
3. (b)
4. Photosynthesis is an example of an anabolic reaction. In anabolic reactions, smaller, simpler molecules such as carbon dioxide and water are combined into larger, more complex substances like glucose. Anabolic reactions, such as photosynthesis, require an input of energy.

Glossary

adenosine triphosphate (ATP): is the primary energy currency of all living cells

anabolic: describes the pathway that requires a net energy input to synthesize complex molecules from simpler ones

catabolic: describes the pathway in which complex molecules are broken down into simpler ones, yielding energy as an additional product of the reaction

metabolic pathway: a series of related chemical reactions is referred to as a

metabolism: all the chemical reactions that take place inside cells, including those that use energy and those that release energy

5.5 Law of Thermodynamics

Learning objectives

By the end of this section, you will be able to:

- *Explain how thermodynamics and energy are related*
- *State the first and second laws of thermodynamics*
- *Understand what entropy is and how that relates to energy*
- *Be able to define and explain all bolded terms*

Thermodynamics refers to the study of energy and energy conversions. **Energy** can be defined as the ability to do work or to create some kind of change in matter. To appreciate what energy is and how it can be converted from one form to another, it is important to understand two laws that govern energy.

Laws of Thermodynamics

The **first law of thermodynamics** states that the total amount of energy in the universe is constant and conserved. In other words, there has always been, and always will be, the same amount of energy in the universe. Energy exists in many different forms. According to the first law of thermodynamics, energy may be transformed from one form to another, and it may be transferred from one system to another, but it cannot be created or destroyed.

Energy transfers and transformations take place around us all the time. Light bulbs transform electrical energy into light and heat energy. Plants perform one of the most biologically useful energy transformations on earth; they convert the energy of sunlight to chemical energy stored in organic molecules such as glucose (Figure 5.22).

All living organisms must obtain enough energy from their surroundings to support their metabolism. Living cells have evolved to meet this challenge. Chemical energy stored in organic molecules such as sugars can be transformed through chemical reactions into molecules of ATP. The energy in ATP molecules can then be used by cells to do work. Examples of work include building complex molecules, transporting materials, powering the motion of cilia, and contracting muscle fibers to create movement. Some examples of energy transformations are shown in Figure 5.23.

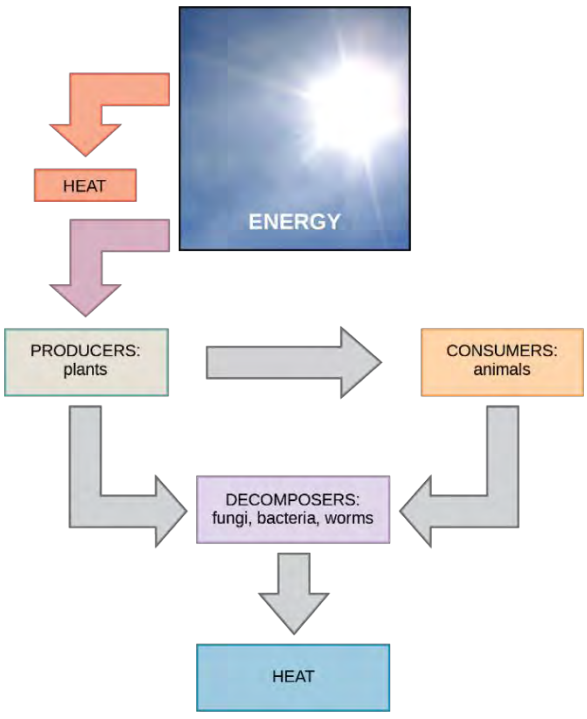


Figure 5.22 Most life forms on earth obtain their energy from the sun. (credit: Clark et al. / Biology 2E OpenStax)