Chapter 7: Photosynthesis

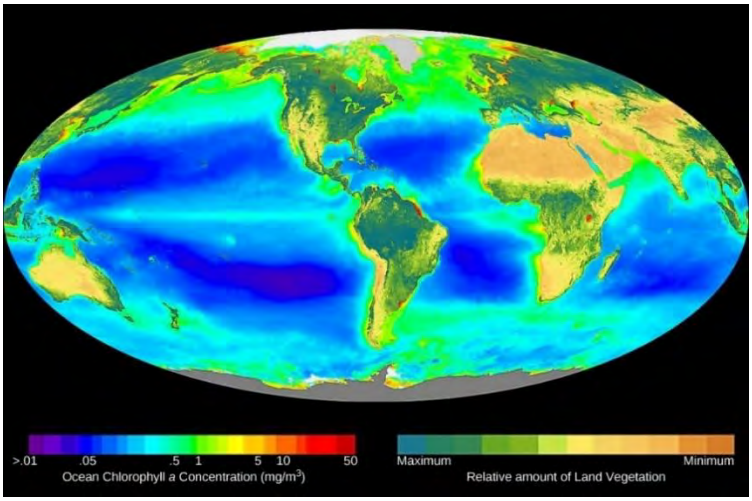

Figure 7.1 This world map shows Earth's distribution of photosynthetic activity determined by chlorophyll a concentration. On land, chlorophyll is evident from terrestrial plants, and within oceanic zones, from chlorophyll of phytoplankton. (credit: modification of work by SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE / Biology 2E OpenStax)

All organisms from bacteria to humans require energy to carry out their metabolic processes. Many organisms obtain energy by eating; that is, by ingesting other organisms. But where does the stored energy in food come from? The vast majority of this energy can be traced back to photosynthesis. In this chapter, students will learn how the process of photosynthesis works.

7.1: Overview of Photosynthesis

Learning objectives

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

- *Summarize the process of photosynthesis*
- *Explain the relevance of photosynthesis to other living things*
- *Identify the reactants and products of photosynthesis*
- *Describe the main structures involved in photosynthesis*
- *Be able to define and explain all bolded terms*

Photosynthesis is essential to all life on earth. It is the only biological process that can capture light energy from the sun and convert it into chemical energy found in the covalent bonds of sugar. Plants, algae, and a group of bacteria called cyanobacteria are the only organisms capable of performing photosynthesis (Figure 7.2). These organisms are called **photoautotrophs,** literally "self-feeders using light," because they use light to generate their own food. Other organisms, such as animals, fungi, and most other bacteria, are called **heterotrophs** because they must rely on photosynthetic organisms for their energy needs. A third group of bacteria synthesizes sugars, but not by using light energy. These organisms extract energy from inorganic chemical compounds and are referred to as **chemoautotrophs**.

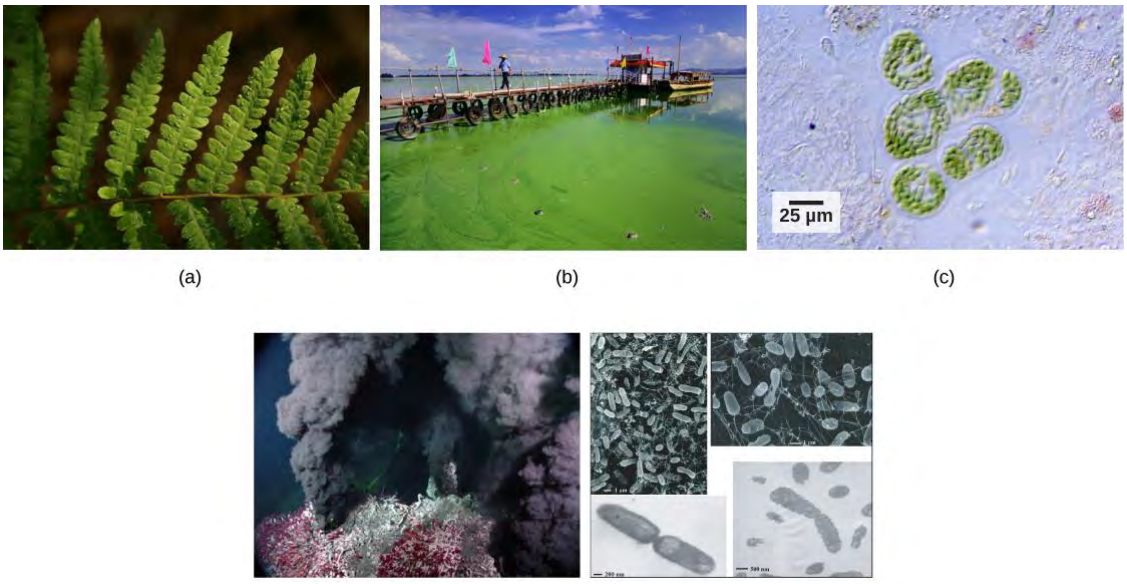

Figure 7.2 Photoautotrophs including (a) plants, (b) algae, and (c) cyanobacteria synthesize their organic compounds via photosynthesis. In a (d) deep-sea vent, chemoautotrophs, such as these (e) thermophilic bacteria, capture energy from inorganic compounds to produce organic compounds. (credit a: modification of work by Steve Hillebrand, U.S. Fish and Wildlife Service; credit b: modification of work by "eutrophication&hypoxia"/Flickr; credit c: modification of work by NASA; credit d: University of Washington, NOAA; credit e: modification of work by Mark Amend, West Coast and Polar Regions Undersea Research Center, UAF, NOAA / Biology 2E OpenStax)

Solar Dependence and Food Production

Photosynthesis is a chemical process by which certain cells convert kinetic light energy to potential chemical energy stored in carbohydrates made from carbon dioxide and water. Autotrophs use these carbohydrates to generate ATP through cellular respiration. Excess carbohydrates are stored in their tissues, and certain heterotrophs consume them to generate their own ATP through cellular respiration. The waste products of aerobic cellular respiration, carbon dioxide and water, can then be used as the starting reactants for photosynthesis. In this way, photosynthesis and aerobic cellular respiration are interrelated metabolic pathways (Figure 7.3).

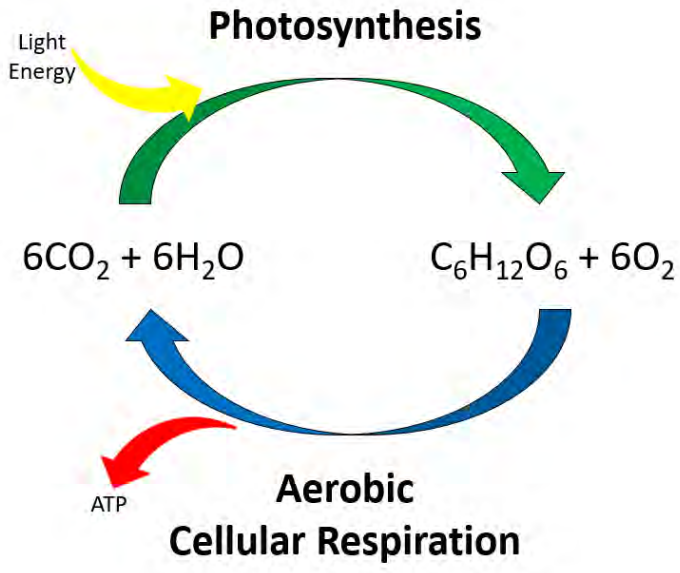

Figure 7.3 Photosynthesis and aerobic cellular respiration are interrelated metabolic pathways. (credit: Jason Cashmore)

Photosynthesis powers 99 percent of Earth's ecosystems. When a top predator, such as a wolf preys on a deer (Figure 7.4), the wolf is at the end of an energy pathway. The pathway begins with light energy from the sun. Light energy is captured by photoautotrophs that carry out photosynthesis to produce carbohydrates. Heterotrophs such as the deer consume the carbohydrates in the vegetation. When a wolf eats a deer, it obtains energy that was initially produced by plants.

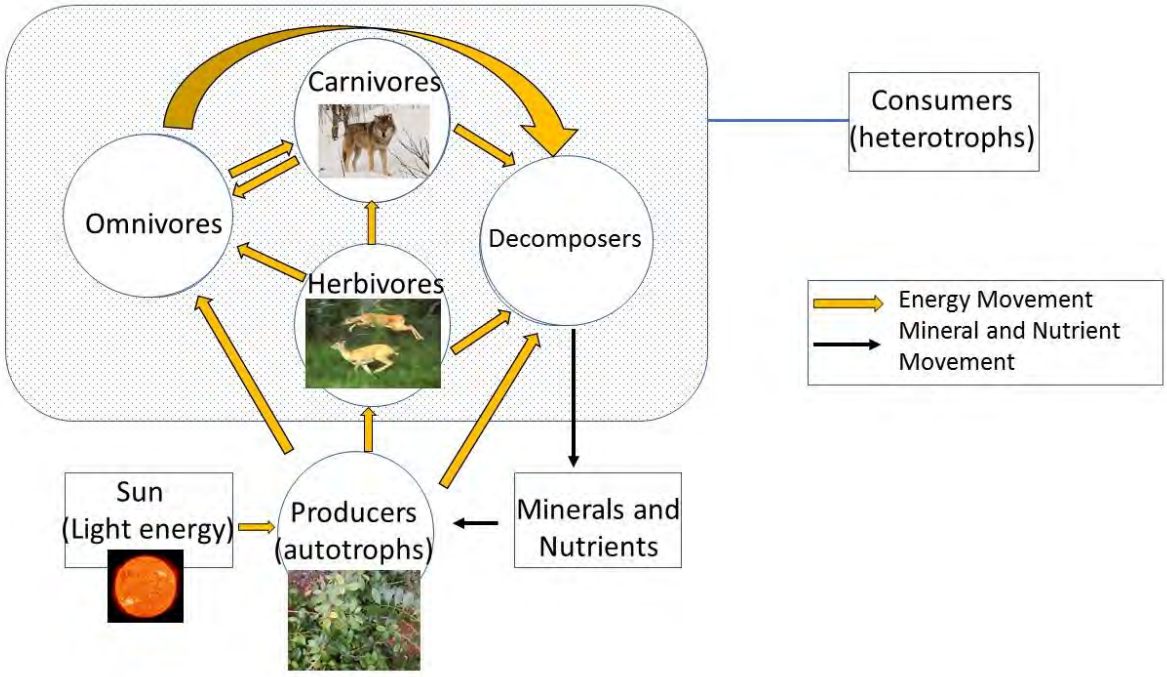

Figure 7.4 The predator that eats these deer receives a portion of the energy that originated in the photosynthetic vegetation. (credit: Elizabeth O'Grady original pictures by: wolf - Mas3cf / deer - modification of work by Steve VanRiper / plant - Katpatuka /sun - NASA/SDO)

CONCEPTS IN ACTION- Click the following link to learn more about photosynthesis.