

Photosynthesis

Photosynthesis is a process by which green plants and certain other organisms use the energy of light to convert carbon dioxide and water into the simple sugar glucose. In so doing, photosynthesis provides the basic energy source for virtually all organisms. An extremely important byproduct of photosynthesis is oxygen, on which most organisms depend.

Photosynthesis occurs in green plants, seaweeds, algae, and certain bacteria. These organisms are veritable sugar factories, producing millions of new glucose molecules per second. Plants use much of this glucose, a carbohydrate, as an energy source to build leaves, flowers, fruits, and seeds. They also convert glucose to cellulose, the structural material used in their cell walls. Most plants produce more glucose than they use, however, and they store it in the form of starch and other carbohydrates in roots, stems, and leaves. The plants can then draw on these reserves for extra energy or building materials. Each year, photosynthesizing organisms produce about 170 billion metric tons of extra carbohydrates, about 30 metric tons for every person on earth.

Photosynthesis has far-reaching implications. Like plants, humans and other animals depend on glucose as an energy source, but they are unable to produce it on their own and must rely ultimately on the glucose produced by plants. Moreover, the oxygen humans and other animals breathe is the oxygen released during photosynthesis. Humans are also dependent on ancient products of photosynthesis, known as fossil fuels, for supplying most of our modern industrial energy. These fossil fuels, including natural gas, coal, and petroleum, are composed of a complex mix of hydrocarbons, the remains of organisms that relied on photosynthesis millions of years ago. Thus, virtually all life on earth, directly or indirectly, depends on photosynthesis as a source of food, energy, and oxygen and also thus making it one of the most important biochemical processes known.

Plant photosynthesis occurs in leaves and green stems within specialized cell structures called chloroplasts. One plant leaf is composed of tens of thousands of cells, and each cell contains 40 to 50 chloroplasts. The chloroplast, an oval-shaped structure, is divided by membranes into numerous disk-shaped compartments. These disk-shaped compartments, called thylakoids, are arranged vertically in the chloroplast like a stack of plates or pancakes. A stack of thylakoids is called a granum, the grana lie suspended in a fluid known as stroma.

Photosynthesis is a very complex process, and for the sake of convenience and ease of understanding, plant biologists divide it into two stages. In the first stage, the light-dependent reaction, the chloroplast traps light energy and converts it into chemical energy contained in nicotinamide adenine dinucleotide phosphate (NADPH) and adenosine triphosphate (ATP), two molecules used in the second stage of photosynthesis. In the second stage, called the light-independent reaction (formerly called the dark reaction), NADPH provides the hydrogen atoms that help form glucose, and ATP provides the energy for this and other reactions used to synthesize glucose. These two stages reflect the literal meaning of the term photosynthesis, to build with light.