Photosynthesis

Fundamentals

Photosynthesis is one of the most important biological processes in nature: it is a precondition for life on earth because it is the process by which oxygen for breathing is created.
It occurs only in the parts of a plant that contain the green pigment chlorophyll, which acts as an absorber. Many bacteria (for example, in the ocean or in the soil) are also capable of photosynthesis.
The visible component of the sun's radiation (light) delivers the energy for photosynthesis.


Tree in late summer or early fall

At the same time, the infrared component provides the temperature that is required for the process. Only under these conditions can the plant convert carbon dioxide and water to sugar (glucose).
Fat, starch, and protein are formed from the glucose in other non-light-dependent reactions.
The term photosynthesis is therefore based on the fact that this process can occur only in the presence of light (Greek photos = light).

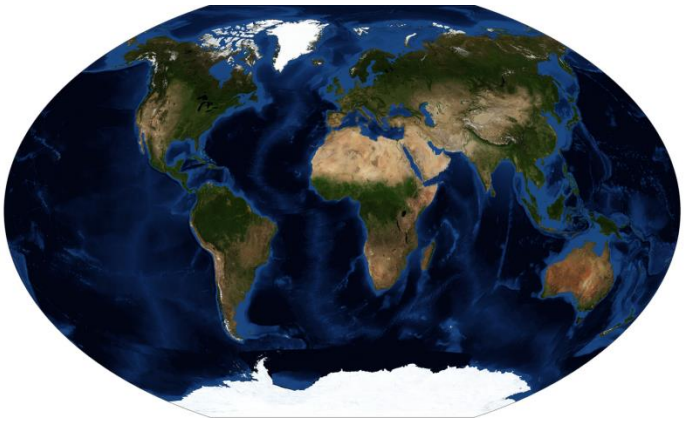
Chemical processes

The photosynthesis process that occurs during the day consists of a light reaction and a dark reaction. In the light reaction, chemical energy in the form of ATP and the reducing agent NADPH are first of all produced using light energy. ATP and NADPH are used in the subsequent dark reaction to produce glucose without light.
The total reaction of photosynthesis consisting of both light and dark reactions can be formulated as follows:

$$6\ CO_2 + 12\ H_2O \longrightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$$

The energy transformation per mole of glucose amounts to + 2.994 kJ.
The oxygen produced during photosynthesis comes from the water molecules.

Significance of photosynthesis



Source: GinkgoMaps project
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The 21 percent of oxygen in the air today is the result of billions of years of photosynthetic activity by the forested areas of the earth. For this reason, these regions are known as the “green lungs” of the earth.
They produce approximately
1×10^{11} tons of oxygen annually.

It is estimated that photosynthesis was “invented” by nature about 3.5×10^{9} years ago. The earth’s atmosphere at that time contained methane, among other constituents, but no oxygen. Photosynthesis is the only natural process that can permanently store solar energy on earth (about 0.1 percent of the irradiated energy of the sun).