Discussion Questions

• How is light energy harvested in photosynthesis and what is the reaction center?

Photosynthesis

Photosynthesis is the process of converting light energy \( (E = h \nu) \) to chemical energy and storing it in the chemical bonds of sugar-like molecules. This process occurs in plants and some algae (Kingdom Protista). Plants need only light energy, \( \text{CO}_2 \), and \( \text{H}_2\text{O} \) to make sugar. The process of photosynthesis takes place in the chloroplasts (chboro = green; plasti = formed, molded), specifically using chlorophyll (phyll = leaf), the green pigment involved in photosynthesis.

How is light energy harvested in photosynthesis and what is the reaction center?

As early as 1640, people have demonstrated that photosynthesis was a means of converting carbon dioxide in the air into plant material. Thus, photosynthesis has been studied by many scientists, and there are many sites related to photosynthesis. Some of these sites describe their recent research activities, whereas others are for educational purposes. Even books and journals are introduced in this link.

The photosynthesis is a very complicated process, and we can only give an introduction here. Photosynthesis reduces carbon dioxide into carbohydrates,

\[
\text{6 CO}_2 + 12 \text{H}_2\text{O} + \nu \rightarrow \text{C}_6\text{H}_12\text{O}_6 + 6 \text{O}_2 + 6 \text{H}_2\text{O}
\]

Thus, both electrons and energy are required. The electrons come from water molecules, and the energy is first absorbed by pigments known as chlorophylls and carotenoids. The former absorb blue (wavelength 430 nm) and red (wavelength 670 nm) light and the later absorb blue-green light (wavelengths between 400 and 500 nm). Green and yellow light are not absorbed. Reflection of these types of light makes plants appear green.

There are many varieties of pigments. They are bonded to proteins which provide pigment molecules with the appropriate orientation and position with respect to each other. After absorption by pigment, light energy is transferred to chlorophylls that are bonded to special proteins. Pigments and protein involved with this actual primary electron transfer event together are called the **reaction center**. A large number of pigment molecules (100-5000), collectively referred to as **antenna**, "harvest" light and transfer the light energy to the same reaction center. The purpose is to maintain a high rate of electron transfer in the reaction center, even at lower light intensities.

What are produced and consumed in plants respiration?

Photosynthesis is responsible for the production of oxygen and carbohydrates in plants. All living organisms respire, and so do plants. In the respiration, oxygen is consumed and carbon dioxide is produced.

respiration takes place all the time, but respiration is masked by higher rate of photosynthesis when the light intensities is high.
What is the Calvin-Benson cycle?

Working with the green algae chlorella, Melvin Calvin and Andy Benson, at the University of California at Berkeley, elucidated the following pathway for the conversion of carbon dioxide into carbohydrates:

Contributors

- Chung (Peter) Chieh (Professor Emeritus, Chemistry @ University of Waterloo)