Reference 2

Photosynthesis

Living things that carry out photosynthesis play an incredibly important role in supporting life on Earth. Photosynthesis is the key biochemical process responsible for capturing energy from the Sun and channeling it into other living systems. This process also releases oxygen as one product. Plants and other photosynthetic organisms, such as algae, microbes, and some protists, use photosynthetic products to fuel the cellular processes they need to live and grow. Humans and other animals cannot do this. We depend on photosynthetic organisms as our energy sources, either directly as food or indirectly as food for the animals we eat.

How Does Photosynthesis Work?

Photosynthesis transforms the carbon from carbon dioxide (CO_2) in the air into carbohydrates. This process, called carbon fixation, is a chemical reaction that requires energy. The energy comes from the Sun in the form of sunlight. Water, which is needed for the reaction to proceed, is transformed into oxygen gas (O_2) as a product of photosynthesis. The overall process (figure R2.1) can be visualized in terms of inputs, energy and organisms, and outputs:

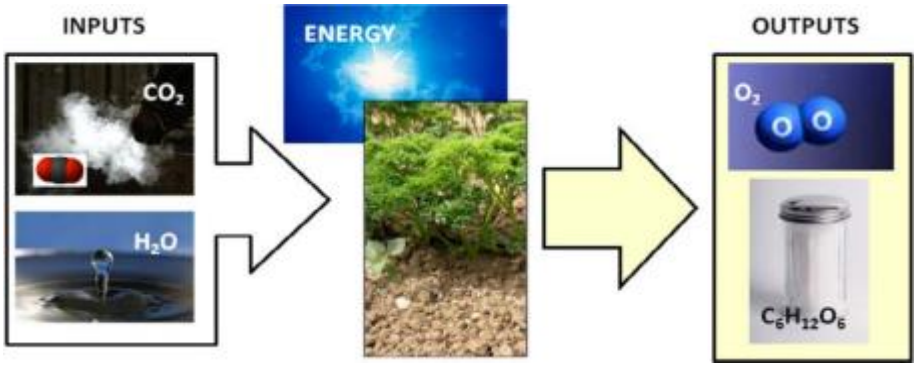

Figure R2.1: Pictorial representation of the photosynthesis process.

Photosynthesis can also be summarized in a simple biochemical equation:

6 CO_2 + **6 H_2O** + **light** → **$C_6H_{12}O_6$** + **6 O_2**

carbon dioxide | water | energy | carbohydrate | oxygen

The carbohydrates produced by photosynthesis can be used in cellular processes or stored for later use. Glucose is the chemical energy source for cellular respiration and also provides chemical structures for the synthesis of new proteins, carbohydrates, and fats needed to make cells, leaves, roots, flowers, seeds, or spores. If more sugar is produced than the plant can use, glucose molecules are linked together to form starch and stored either temporarily or for the long-term, such as during the winter.

Photosynthesis Takes Place in Chloroplasts

Photosynthesis is a series of reactions in which plants use the Sun's energy to synthesize complex, energy-rich molecules from smaller, simpler molecules. In eukaryotic cells all of these reactions take place in the structures known as chloroplasts (figure R2.2). Even when they are removed from a cell in a laboratory, chloroplasts can carry on the entire process of photosynthesis by themselves.

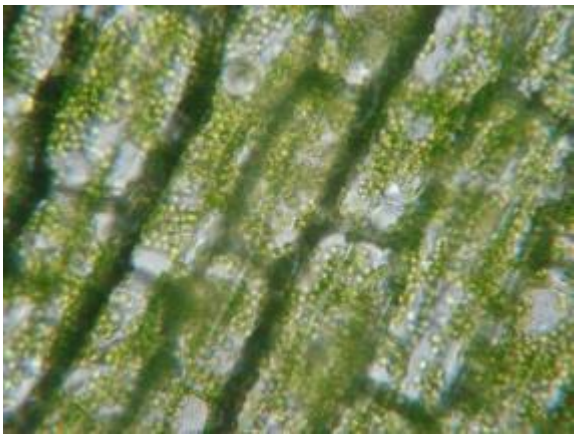

Figure R2.2: Inside each plant cell are many green oval bodies. These bodies, called chloroplasts, are the organelles that capture light for photosynthesis.

Electron micrographs, such as the one in figure R2.3, reveal the internal structure of chloroplasts. They show a highly organized array of internal membranes called thylakoids. Thylakoids may form stacks of flattened disk-shaped structures called grana. Chlorophyll, other pigments, and enzymes are embedded in the thylakoids. Surrounding the thylakoids is the stroma, a colorless substance that contains other enzymes as well as DNA, RNA, and ribosomes.

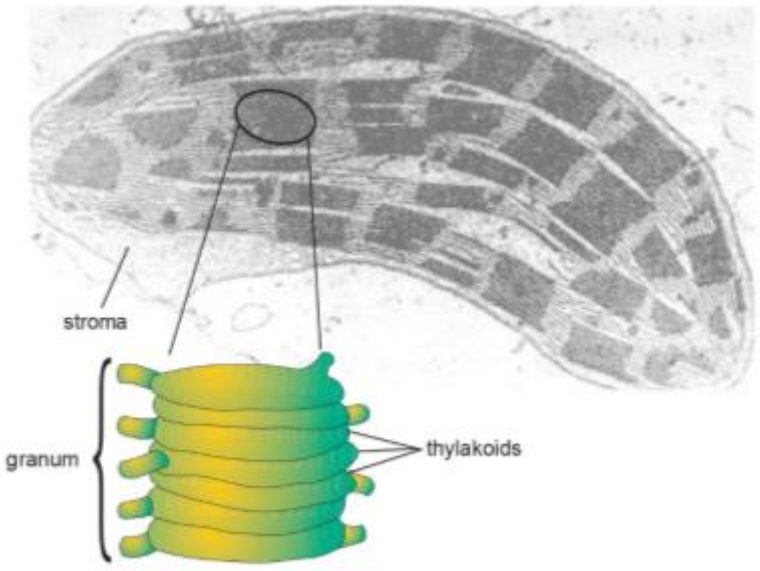

Figure R2.3: This electron micrograph shows a chloroplast in a leaf of corn that has been magnified 24,000 times. The darker areas are stacks of thylakoids called grana. The drawing shows the structure of a granum enlarged still more.