

Chapter 7– Where it Starts – Photosynthesis

Lecture Outline

Impacts, Issues: Sunlight and Survival

- A. Photosynthesis makes food (sugar and other compounds) by using sunlight as an energy source and carbon dioxide as the carbon source, releasing water and oxygen.
 - 1. Autotrophs, such as plants, are self-nourishing; heterotrophs must be nourished by others.
 - 2. Yearly world-wide production of sugar by plants = 220 billion tons.
- B. First prokaryotes were chemoautotrophs (energy and carbon comes from inorganic sources or simple organic sources like methane).
 - 1. As oxygen accumulated in the atmosphere, prokaryotes that were able to use pathways that could detoxify the evolving oxygen radicals survived and flourished.
 - 2. Ozone also began to form and shielded life from the lethal ultraviolet rays of the sun.

I. Sunlight as an Energy Source

A. Properties of Light

- 1. Organisms use only a small range of _____ for photosynthesis, vision, and other processes.
- 2. Most of these wavelengths are the ones we see as _____ light, a small part of the electromagnetic spectrum from the sun.
- 3. Light energy is packaged as _____, which vary in energy as a function of wavelength. (The shortest are gamma rays with the highest energy; longer are radio waves with the lowest energy.)

B. A Look Inside the Chloroplast

- 1. Photosynthesis occurs in the chloroplast in _____ stages.
 - a. The semifluid interior (_____) is the site for the second series of photosynthesis reactions.
 - b. Flattened sacs, _____, interconnected by channels weave through the stroma; the first reactions occur here
- 2. In the thylakoid membranes, pigments are organized in clusters called _____, each consisting of 200–300 pigment molecules capable of trapping energy from the sun.

C. From Sunlight to Photosynthesis

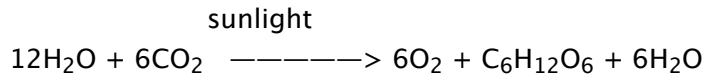
- 1. Pigment molecules on the _____ membranes absorb photons.
- 2. Chlorophyll a and b pigments absorb _____, but reflect green (leaves).
- 3. A pigment absorbs light of specific _____ acting as an antenna for receiving photon energy.

II. Overview of Photosynthesis Reactions

A. Two Stages of Reactions

- 1. Light-dependent reactions convert light energy to chemical bond energy of _____.

- a. Water is split to release _____.
 - b. NADP⁺ picks up electrons to become NADPH to be used later.
2. The light-independent reactions assemble _____ and other organic molecules using ATP, NADPH, and CO₂.
 3. Overall, the equation for glucose formation is written:



III. Light-Dependent Reactions

A. What Happens to the Absorbed Energy?

1. The pigments in the thylakoid membrane “_____” photon energy from sunlight.
 - a. Absorbed photons of energy boost electrons to a _____ level.
 - b. The electrons quickly return to the lower level and _____ energy.
 - c. Released energy is trapped by chlorophylls located in the _____ reaction center.
2. The entry of electrons from a photosystem into an electron transfer chain is the first step in the light-dependent reactions.

B. Making ATP and NADPH

1. Electron transfer chains move _____ and hydrogen ions from the stroma into the thylakoids.
 - a. Hydrogen ions accumulate inside the _____ compartment.
 - b. As the hydrogen ions flow out through _____ into the stroma, ATP synthase enzymes link P_i to ADP to form ATP.
2. By the process of photolysis, _____ is split to form oxygen (diffuses out) and hydrogen ions, which are maintained at high numbers in the thylakoid.
3. Electrons are also transferred via another photosystem to _____ to form NADPH.

C. Noncyclic Pathway of ATP and NADPH Formation

1. The _____ pathway of ATP formation transfers electrons through two photosystems and two electron transfer systems (ETS) simultaneously.
2. One pathway begins when chlorophyll in photosystem _____ absorbs energy.
 - a. A boosted electron moves through a _____ system, which releases energy for ADP + P_i → ATP.
 - b. The electron fills the “hole” left by the electron boost in photosystem I.

- c. The electron from photolysis of water fills the “_____” left in Photosystem II and produces oxygen as a by-product.
3. The other pathway begins when chlorophyll in photosystem I absorbs _____.
 - a. The boosted electron from Photosystem I passes to the _____, and finally joins NADP to form NADPH (which along with ATP can be used in synthesis of organic compounds).
 - b. The energy hole is filled by _____ from Photosystem II.

IV. Light-Independent Reactions: The Sugar Factory

A. These reactions constitute a pathway known as the _____ cycle.

1. The participants and their roles in the synthesis of carbohydrates are:

- a. _____, which provides energy;
- b. _____, which provides hydrogen atoms and electrons; and
- c. _____, which provides the carbon and oxygen from carbon dioxide.

2. The reactions take place in _____ of chloroplasts and are not dependent on sunlight.

B. _____ diffuses into a leaf across the plasma membrane of a photosynthetic cell.

1. _____ and NADPH are used to build a carbohydrate.

V. Autotrophs and the Biosphere

A. Pastures of the Seas

1. The oceans are teeming with _____ and protists, which provide food for nearly all other marine organisms.

2. In an ocean ecosystem, the tiniest _____ are food for the crustaceans, which are eaten by fishes, seabirds, and even whales.

a. One spring bloom of these organisms stretched from _____ past Spain.

b. Such large masses influence the global climate by _____ up nearly half of the carbon dioxide used in carbon fixation.

3. Human activities, such as _____ and setting fires for vast clear cutting, release more carbon dioxide than photoautotrophs can take up; additionally tons of waste and other pollutants are daily entering the oceans and may ultimately impact the photosynthetic function of these photoautotrophs.

