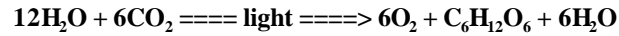


MOLECULAR CELL PHYSIOLOGY - Photosynthesis

- I. Photosynthesis - The process which occurs in the chloroplasts of green plants in which simple sugars are formed from carbon dioxide and water in the presence of light and chlorophyll
 - A. Two major parts of photosynthesis
 1. Light reactions: conversion of light energy into ATP and NADPH
 2. Dark reactions: use of energy (ATP & NADPH) to form carbohydrates
 - B. Purpose of photosynthesis
 1. Main biosynthetic pathway by which carbon and energy enter the web of life
- II. Where it occurs
 - A. Chloroplast
 1. Light reactions - granum (several thylakoids) and thylakoid membranes
 2. Dark reactions - stroma
- III. Light reactions (also light-dependent reactions)
 - A. Light-trapping molecule
 1. Chlorophyll (antenna chlorophyll pick up light)
 - a) Transmits green and absorbs red and blue, etc.
 - b) Right wavelength of energy excites an electron of chlorophyll
 - c) Inductive resonance carries excitation energy from molecule to molecule
 - d) Energy (P700 or P680) is transferred to an acceptor molecule
 - B. Two options for electron excitation energy
 1. Cyclic (short) pathway
 2. Non-cyclic (long pathway)
 - C. Cyclic photophosphorylation
 1. (Photosystem I) LIGHT - P700 - P700* (Chl a/b redox) - [ETS: Fe-S protein-Ferredoxin-Plastoquinone] - P700 + ATP
 - D. Non-cyclic photophosphorylation (Photosystem II and then I)
 1. (Photosystem II) LIGHT - (OEC) - P680 - P680* (Pheophytin a) - [ETS: Plastoquinone-Plastocyanin + ATP - (Photosystem I) W/LIGHT - P700 - P700* (Chl a/b redox) - [ETS: Fe-S protein-Ferredoxin] - NADPH (NADPH from 2 e⁻ and 1 H⁺)
 2. Electrons replaced by water (O₂ is released and H⁺ goes into thylakoid)
 3. Split of water referred to as photolysis
 4. ATP comes from proton gradient (H⁺ stored in thylakoid leaves to makes ATP)
 - E. Use of products from photosynthesis
 1. ATP - energy
 2. NADPH - reducing equivalents for organic synthesis
- IV. Dark reactions (also light-independent reactions)
 - A. Major purpose - use energy from light reactions to fix CO₂ into organic molecules
 - B. Reagents of dark reactions
 1. ATP and NADPH
 2. CO₂
 3. Ribulose biphosphate
 4. Enzymes (especially RUBISCO - Ribulose biphosphate carboxylase / oxygenase)
 - C. Why fix CO₂?
 1. Store and use chemical energy in the form of organic compounds
 - D. Steps of CO₂ fixation:
 1. CO₂ and H₂O (1 carbon) are added to ribulose biphosphate (5 carbons) to form two molecules of 3-phosphoglyceric acid (3-PGA) (total of 6 carbons)
 2. Catalysis of this reaction by RUBISCO
 3. 3-PGA is reduced to 3-PGAL with the help of NADPH and ATP
 4. 3-PGAL is converted to either fructose diphosphate or, eventually ribulose biphosphate
 5. Fructose diphosphate goes to other aspects of metabolism and ribulose biphosphate goes back to the original cycle of CO₂ fixation

MOLECULAR CELL PHYSIOLOGY - Photosynthesis (continued)

E. Overall reaction of photosynthesis



F. Other types of CO₂ fixation - under hot conditions (to prevent O₂ competition)

1. C₄ plants - fix CO₂ by combining it with PEP to form OAA (PEP carboxylase)
2. OAA (Malate after reduction) from mesophyll releases CO₂ to bundle sheath where RUBISCO carries on its usual process)
3. Recyclization occurs when Malate is converted to pyruvate and, subsequently PEP for another round of CO₂ fixation

G. Now what happens?

1. We have carbohydrate - a principle form of organic energy
 - a) Respiration will harvest energy and convert it to the universal currency - ATP