

## Important Notes: Photosynthesis (SBI0202 - Unit 02, Topic 01)

### Photosynthesis Overview

- Definition: Process by which green plants (and some organisms) convert light energy into chemical energy.
- Reactants: Water, carbon dioxide, and minerals.
- Products: Oxygen and energy-rich organic compounds (like glucose).

### Importance of Photosynthesis

- Primary method for introducing energy into the biosphere.
- Produces oxygen essential for aerobic respiration.
- Base of food webs: Supports all higher life-forms either directly or indirectly.

### Photosynthetic Organisms

- Found in both eukaryotes (plants, algae) and prokaryotes (cyanobacteria, sulfur bacteria).
- Example: *Elysia chlorotica* (a sea slug that temporarily uses chloroplasts for photosynthesis).

### Overall Photosynthesis Reaction

- A light-driven oxidation-reduction process.
- Involves transformation of light energy into chemical bonds.

### Rate of Photosynthesis

Measured by:

- Oxygen production per unit plant mass/area or chlorophyll weight.

Influencing factors:

- Light intensity
- Temperature
- CO<sub>2</sub> concentration
- Water and mineral availability
- Internal plant factors

## Chloroplasts

- The site of photosynthesis in green plants.

## Photosynthesis Stages

### 1. Light-Dependent Reactions

- Location: Thylakoid membrane
- Steps:
  - Light absorption
  - Splitting of water (photolysis)
  - Formation of ATP (via photophosphorylation) and NADPH
- Photosystems I & II are involved
- Convert light to chemical energy

### 2. Light-Independent Reactions (Calvin-Benson Cycle)

- Location: Stroma of the chloroplast
- Steps:
  1. Carboxylation
  2. Reduction
  3. Isomerization/Condensation
  4. Phosphorylation
- Product: Sucrose, amino acid skeletons (alanine, glutamate, aspartate)

## Regulation & Limitations

- Calvin Cycle is regulated to prevent energy waste in the dark.
- Photorespiration:
  - Triggered under hot, dry, high-light conditions.
  - Oxygen competes with CO<sub>2</sub> for the enzyme RuBisCO, reducing photosynthetic efficiency.

## Carbon Fixation Pathways

- C<sub>3</sub> Plants: Use the Calvin cycle directly.
- C<sub>4</sub> Plants: Special mechanism to reduce photorespiration.
- CAM Plants: Fix carbon at night to conserve water (Crassulacean Acid Metabolism).

## Molecular Biology of Photosynthesis

- Genes for photosynthetic machinery are found in both chloroplast DNA and nuclear DNA.
- mRNA is translated into polypeptides, transported into the chloroplast, and assembled into functional units.