Dr. Kamal Kant Patra , (Botany) Department of School of Science, YBN University , Ranchi

TEACHING MATERIAL ON

Botany

(Department of School of Science)

Dr. Kamal Kant Patra , (Botany) Department of School of Science, YBN University , Ranchi

LECTURE NOTE ON LIGHT-DEPENDENT REACTIONS

BY DR KAMAL KANT PATRA, ASSOCIATE PROFESSOR, DEPARTMENT OF BOTANY, SCHOOL OF SCIENCE, YBN UNIVERSITY, RANCHI

Introduction to Light-Dependent Reactions

Light-dependent reactions are the first phase of photosynthesis, occurring in the thylakoid membranes of chloroplasts. These reactions harness light energy to produce ATP and NADPH, which are essential for the subsequent light-independent reactions (Calvin cycle).

Overview

- Light energy is absorbed by chlorophyll and other pigments.
- Water molecules are split to release oxygen (O_2).
- ATP and NADPH are generated as energy carriers.

Key Components of Light-Dependent Reactions

1. Photosystems

Photosystems are protein-pigment complexes that absorb light and drive electron transfer.

Types of Photosystems

1. **Photosystem II (PSII)**:
    - Reaction center chlorophyll: P680.
    - Absorbs light at 680 nm.
    - Plays a role in water splitting (photolysis).
2. **Photosystem I (PSI)**:
    - Reaction center chlorophyll: P700.
    - Absorbs light at 700 nm.
    - Involved in the production of NADPH.

2. Electron Transport Chain (ETC)

- A series of protein complexes embedded in the thylakoid membrane.
- Transfers electrons from PSII to PSI, facilitating the generation of a proton gradient.

3. ATP Synthase

- An enzyme that synthesizes ATP from ADP and inorganic phosphate (Pi) using the proton gradient created by the ETC.

4. Water-Splitting Complex (Oxygen-Evolving Complex)

- Associated with PSII.
- Splits water molecules to release electrons, protons, and oxygen.

Steps of Light-Dependent Reactions

1. Light Absorption by Photosystem II

- Light energy excites electrons in the chlorophyll molecules of PSII.
- Excited electrons are transferred to the primary electron acceptor.
- The lost electrons are replaced by splitting water molecules ("photolysis"):

2. Electron Transport and Proton Gradient Formation

- Electrons from PSII are passed down the ETC to PSI.
- As electrons move through the ETC, energy is released and used to pump protons (H^+) into the thylakoid lumen.
- This creates a proton gradient (higher H^+ concentration inside the thylakoid lumen than in the stroma).

3. Light Absorption by Photosystem I

- Light energy excites electrons in the chlorophyll molecules of PSI.
- Excited electrons are transferred to another primary electron acceptor.

- These electrons are then passed to $NADP^+$ to form NADPH:

4. ATP Synthesis

- The proton gradient drives protons back into the stroma through ATP synthase (chemiosmosis).
- This movement powers the synthesis of ATP:

Outputs of Light-Dependent Reactions

1. **ATP**:
    - Provides energy for the Calvin cycle.
2. **NADPH**:
    - Supplies reducing power for the Calvin cycle.
3. **Oxygen (O_2)**:
    - Released as a byproduct of photolysis.

Importance of Light-Dependent Reactions

- Convert solar energy into chemical energy (ATP and NADPH).
- Generate oxygen, which is essential for aerobic life on Earth.
- Provide energy carriers that drive the synthesis of carbohydrates in the Calvin cycle.

Summary

The light-dependent reactions are a vital part of photosynthesis, where light energy is captured and converted into chemical energy in the form of ATP and NADPH. These reactions also produce oxygen as a byproduct, contributing to the oxygenation of Earth's atmosphere.