

## **ENZYMATIC REGULATION OF PHOTOSYNTHESIS AND THE ROLE OF CHEMICAL FACTORS IN CHLOROPLAST METABOLISM**

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Photosynthesis is a highly organized biochemical system that enables green plants to transform solar radiation into chemical energy. This transformation occurs inside chloroplasts and depends on coordinated enzymatic reactions. Enzymes function as biological catalysts that regulate reaction speed, substrate specificity, and metabolic balance. The stability and productivity of photosynthesis largely depend on the chemical environment within plant cells.

The photosynthetic process consists of two interconnected stages: light-dependent reactions and the Calvin cycle. In the light reactions, water molecules are oxidized, producing oxygen, electrons, and protons. The released electrons move through an electron transport chain embedded in the thylakoid membrane. This electron flow drives ATP synthesis via ATP synthase and reduces NADP<sup>+</sup> to NADPH. Both ATP and NADPH serve as essential energy carriers for carbon fixation.

The Calvin cycle, located in the stroma, involves enzymatic carbon assimilation. The key enzyme RuBisCO catalyzes the fixation of carbon dioxide to ribulose-1,5-bisphosphate. This reaction forms organic intermediates that eventually lead to glucose synthesis. The catalytic efficiency of RuBisCO strongly depends on stromal pH, magnesium ion concentration, and CO<sub>2</sub> availability.

Chemical factors significantly influence enzymatic activity. Enzyme conformation is sensitive to ionic balance, substrate concentration, and redox conditions. For instance, magnesium ions activate RuBisCO by stabilizing its active center, while optimal pH ensures proper enzyme folding. A decrease in essential mineral elements such as nitrogen or iron limits chlorophyll production and reduces electron transport efficiency. Understanding enzymatic regulation has practical significance in agriculture. By optimizing mineral fertilization and maintaining soil nutrient balance, it is possible to enhance enzyme synthesis and increase photosynthetic capacity. Modern biotechnological approaches also aim to improve RuBisCO efficiency through genetic modification, potentially increasing crop yield and carbon sequestration.

Additionally, studying enzyme–chemical interactions contributes to developing stress-resistant plant varieties capable of maintaining stable photosynthesis under drought, salinity, or temperature stress.

**Table 1**

**The relationship between enzyme activity and chemical conditions can be summarized as follows**

<b>Chemical Factor</b>	<b>Target Enzyme</b>	<b>Physiological Effect</b>
CO <sub>2</sub> concentration	RuBisCO	Increases carbon fixation rate
Mg <sup>2+</sup> ions	RuBisCO activation	Stabilizes enzyme structure
Nitrogen availability	Protein synthesis	Enhances enzyme production
pH level	Stromal enzymes	Maintains catalytic efficiency

When chemical homeostasis is disturbed, enzyme kinetics slow down, resulting in decreased ATP production and carbohydrate synthesis. Therefore, maintaining balanced intracellular chemistry is crucial for optimal photosynthetic performance.

In conclusion, photosynthesis is a chemically regulated enzymatic network rather than a simple light-driven process. The interaction between enzymes and chemical factors determines the overall efficiency of carbon assimilation and biomass production.

### **REFERENCES USED**

1. Taiz, Lincoln, L., Zeiger, Eduardo, E., Møller, Ian Max, I. M., & Murphy, Angus, A. (2015). *Plant Physiology and Development*. Sinauer Associates.
2. Nelson, David L., D. L., & Cox, Michael M., M. M. (2017). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company.
3. Berg, Jeremy M., J. M., Tymoczko, John L., J. L., Gatto, Gregory J., G. J., & Stryer, Lubert, L. (2019). *Biochemistry*. W.H. Freeman.
4. Salisbury, Frank B., F. B., & Ross, Cleon W., C. W. (1992). *Plant Physiology*. Wadsworth Publishing Company.
5. Buchanan, Bob B., B. B., Gruissem, Wilhelm, W., & Jones, Russell L., R. L. (2015). *Biochemistry and Molecular Biology of Plants*. Wiley Blackwell.