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# Study and Advancement in Improving Photosynthetic Efficiency

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## DESCRIPTION

Photosynthesis is the largest mass and energy-conversion process on Earth, and it is the material basis for almost all biological activities. The efficiency of converting absorbed light energy into energy substances during photosynthesis is very low compared to theoretical values. Based on the importance of photosynthesis, this article summarizes the latest progress in improving photosynthesis efficiency from various perspectives. The main way to improve photosynthetic efficiency is to optimize the light reactions, including increasing light absorption and conversion, accelerating the recovery of non-photochemical quenching, modifying enzymes in the Calvin cycle, introducing carbon concentration mechanisms into C3 plants, rebuilding the photorespiration pathway, *de novo* synthesis, and changing stomatal conductance. These developments indicate that there is significant room for improvement in photosynthesis, providing support for improving crop yields and mitigating changes in climate conditions. Photosynthesis refers to the process in which autotrophs convert light energy from the sun into chemical energy to convert inorganic carbon into complex organic carbon and release oxygen. Photosynthetic activity has enabled a large accumulation of organic matter and oxygen on Earth. Heterotrophic organisms use the organic matter and energy generated by photosynthesis to reproduce, grow, and evolve. The process of photosynthesis can be basically divided into two stages: Light and dark reactions. The light-reactions stage includes the primary reaction, electron transport, and photophosphorylation; the dark-reactions stage is also called the carbon-assimilation reaction. The process in which pigment molecules produce electrons by capturing solar energy is called Photosynthetic Electron Transport (PET). PET includes Linear Electron Transport (LET) and Cyclic Electron Transport (CET). The light reactions of photosynthesis are the starting points of the whole photosynthesis process, providing adenosine triphosphate (ATP) and Nicotinamide Adenine Dinucleotide Phosphate (NADPH) as the energy sources for the subsequent dark reactions, and part of the ATP and NADPH generated enters the photo-respiratory pathway. Carbon assimilation is the carbon-reaction stage of photosynthesis, which is essentially a process of inorganic carbon fixation and conversion to organic carbon. There are various ways to fix carbon, with most autotrophs utilizing the Calvin cycle.

In recent decades, new progress has been achieved in the study of the key mechanisms of photosynthesis, but the actual efficiency of photosynthesis in converting absorbed light energy into energy substances is very low compared to theoretical values. During light reactions, photosynthesis in autotrophs is limited by the light-capture range and electron-transport efficiency. During dark reactions, the efficiency of a series of enzyme activities is low, with stomatal and mesophyll limitations, and the efficiency of converting absorbed light energy into energy substances is very low compared with the theoretical value. Improving photosynthetic efficiency involves improving light capture and conversion capacities in the light-reaction stage, optimizing the electron-transport chain, increasing Rubisco carboxylase activity, and reducing photorespiration. Light reactions occur at the chloroplast thylakoid membrane, and the reaction rate is related to the light intensity. Protein complexes on chloroplast thylakoid membranes can bind with a variety of photosynthetic pigment molecules, which absorb and transfer light energy and convert it to chemical energy. In higher plants, common pigment molecules include chlorophyll a, chlorophyll b, and carotenoids (β-carotene, lutein, violaxanthin, neoxanthin, etc.,). These pigment molecules are excited by wavelengths of 400 nm-700 nm in solar radiation and enter the excited state from the ground state.

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## CONFLICT OF INTEREST

The author declares there is no conflict of interest in publishing this article.

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