Title of Project : New Photosynthesis: Re-optimization of the solar energy conversion system

Jun Minagawa
(National Institutes of Natural Sciences, National Institute for Basic Biology, Professor)

Research Project Number : 16H06552 Researcher Number : 80280725

【Purpose of the Research Project】

Photosynthesis requires solar energy, which has the potential to damage photosystems (photoinhibition). During the course of evolution, plants have developed mechanisms to dissipate such excess light to achieve an optimal balance between utilization of light energy (photosynthesis) and dissipation of light energy (photoprotection). However, this balance is not always achieved in many cultured plants, and today's science is expected to re-optimize this balance to improve photosynthetic efficiency. The goal of this project is to understand the mechanisms that regulate the proton motive force across thylakoid membranes, which is required for this re-optimization.

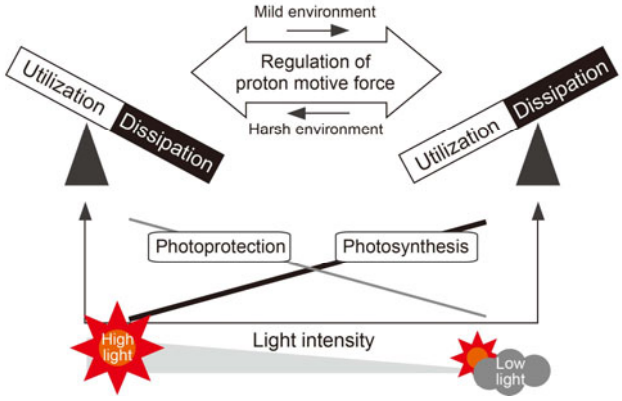

Fig. 1. To prevent photoinhibition in excess light, plants need to elevate the capacity of photoprotection, even if that involves sacrificing the efficiency of light utilization.

【Content of the Research Project】

In this proposed study, we will try to elucidate the regulatory mechanisms of photosynthesis by incorporating a new perspective, the regulation of the proton motive force. Group A01 will study the mechanisms by which the proton motive force is generated, including photochemical reactions and electron transport. The group will also study the mechanisms by which the proton motive force is regulated, including the cytochrome b_6f complex, ATP synthase, ion transporters, and the NPQ (non-photochemical quenching) mechanism that dissipates excess light energy as heat, which is activated by low pH. Group A02 will explore novel methodologies to investigate proton motive force regulation.

【Expected Research Achievements and Scientific Significance】

The proposed research will incorporate new perspectives into basic photosynthesis research with the goal of improving photosynthetic efficiency. We expect to establish strategies to re-optimize the photosynthetic performance of any organism under any environment. This could translate to a new way of converting any land to arable land for crops or any pond to culture pond for algae. This research will maximize the potential of photosynthesis in photosynthetic organisms.

【Key Words】

Proton motive force: ΔpH and membrane potential (Δψ) are generated when protons are transported across the thylakoid membranes. The sum of ΔpH and Δψ constitutes the proton motive force, which is utilized to synthesize ATP by an ATP synthase. Modulating the ratio of ΔpH and Δψ would alter the balance between light utilization and photoprotection.

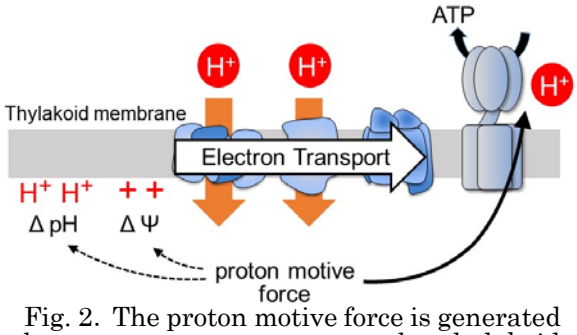

Fig. 2. The proton motive force is generated by proton transport across the thylakoid membranes, which is coupled with the photosynthetic electron transport.

【Term of Project】

FY2016-2020

【Budget Allocation】

1,057,500 Thousand Yen

【Homepage Address and Other Contact Information】

http://photosynthesis.nibb.ac.jp/
minagawa@nibb.ac.jp