Laboratory of Photosynthetic Biology Research

Graduate School of Science

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Today, the sun shines brilliantly on the earth. The primitive Earth's surface, created some 4.5 billion years ago, was a scorching hot world with magma spewing out of the ground, but before long it was transformed into an oasis where life was born and a wide variety of plants and animals were active. All life activities on the earth are supported by the sun's inexhaustible light energy. The beautiful blue earth. Photosynthesis is an important biological reaction system that is indispensable for maintaining the current global environment, efficiently converting light energy into chemical energy that can be used by living organisms. Our research seeks to understand this light-energy conversion mechanism at the molecular level and to explain it using terms of physics and chemistry.

Energy conversion mechanism of photosynthetic reaction centers

The photosynthetic reaction center complexes, which are membrane proteins, are responsible for the process of light energy conversion by plants and photosynthetic microorganisms. In the complexes, absorbed light energy is transferred to the dimeric chlorophyll pigments (special pair of P), which is then excited to P* and forms a charge-separated state of P+A- between the special pair and the primary electron acceptor (A). The energetic electrons are then transferred through various electron-transfer components in a bucket relay-like fashion, eventually producing the reducing power (NADPH) necessary for the anabolic reaction. We are using biochemical, spectroscopic, and molecular biological techniques to elucidate the reaction mechanisms of light-energy conversion.

Electron transfer pathways linked to photosynthetic reaction centers

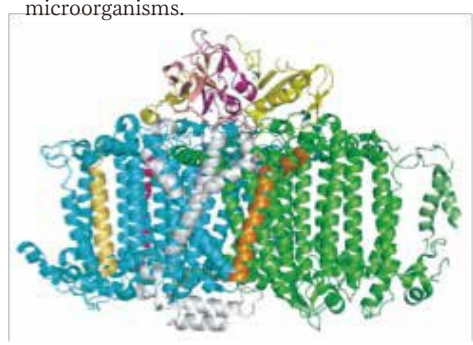
In order for photosynthetic reaction centers to absorb light energy and efficiently produce reducing power, it is important for the reaction centers to have an efficient turn over mechanism. This pathway has been investigated to a great extent in chloroplasts of higher plants and cyanobacteria, but it is still poorly understood in green sulfur bacteria and heliobacteria, which are our research targets. We speculate that the cyclic electron transfer pathway may be configured coupling with the cytochrome bc complex. We believe that this is an ancestral form of the reaction system found in chloroplasts and cyanobacteria and is an important pathway for understanding the principle of proton-motive force formation across the membrane.

Biosynthetic pathway of photosynthetic pigments

The biosynthetic pathway of chlorophylls, photosynthetic pigments, is so complex that one wonders how it emerged during biological evolution. Because various enzymes encoded in gene clusters are involved, it is actually a very fascinating research area for many researchers, from biochemists to molecular biologists, and even organic chemists. We are working on the structural and functional analysis of enzymes that introduce methyl groups into chlorophyll and on the reduction process of linear alcohol groups (phytol chains).

Molecular Basis of Biological Hydrogen Production

Hydrogenase and nitrogenase are enzymes that produce hydrogen gas, a highly valuable alternative energy source. However, these enzymes are quickly inactivated in the presence of oxygen. We are focusing on the absolute anaerobic conditions required by these enzymes and are aiming to establish a molecular basis for hydrogen production systems using anaerobic photosynthetic microorganisms.



Photosystem 1 reaction center responsible for light energy conversion

Photosynthesis is a broad research field. It is a world where people from all walks of life come together. Let's try to find a solution by yourself! You are sure to make some fun discoveries.

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