PRIMARY PHOTOCHEMICAL PROCESSES IN PLANT PHOTOSYSTEM I REACTION CENTER

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All the photosynthetic reaction center (RC) complexes belong to the two types: the photosystem (PS) I / green sulfur bacteria and PS II / purple bacterial type, judging from the homologies of proteins and cofactors. They seem to have differentiated in the early era of Earth's history and have efficient electron transfer (ET) systems that enable conversion of solar energy with high quantum efficiency. In this talk we present mechanism and dynamics of excitation transfer and primary and secondary ET in the PS I RC and compare with that in purple bacterial RC.

The structure of PS I RC has recently been clarified by X-ray analysis, which revealed the arrangement of chlorophyll (Chl) molecules in the electron transfer system [1]. This is mostly analogous to those of purple bacterial RCs, but there are distinct differences. How do the differences affect the primary photochemistry? In this contribution, the electronic excitation transfer and primary charge separation in the PS I RC from spinach was observed upon excitation of the primary electron donor Chl (P700).

The preferential excitation was made possible in the RCs with 6 RC Chls and only 7 - 10 antenna Chls. Upon excitation of P700, the rate of ET was measured by the rise of radical pair(s) of Chls monitored at 740 nm (P700-neutral), where absorption by the excited monomer Chls is minimal. The rise consists of two components: < 0.3 ps (30 %) and 4 - 5 ps (70 %). The subpicosecond rise indicates that a substantial portion of excited P700 (P700*) are directly converted to the charge-separated state without excitation transfers to the other Chls. The excitation which transfers to the other Chls decays on the picosecond time scale. By numerical simulations which take into account excitation hopping among the RC chlorophylls, the intrinsic rate constant of the primary electron transfer from P700* is estimated to be 1 ps^{-1} or greater. This rate constant estimated at room temperature is about three times as large as those reported for the primary electron transfers in purple bacterial RCs. It is possible that P700* shows an absorption at around 740 nm, which gives an instrumental response-limited rise (above-