Building Photosynthesis from Synthetic Organic Molecules

Toshi Nagata

Institute for Molecular Science, Myodaiji, Okazaki 444-8787, Japan

e-mail address: toshi-n@ims.ac.jp

Photosynthesis is a chemical process in which light energy is converted to chemical free energy without intervention of electricity or heat. Towards our better understanding of the molecular mechanism of photosynthesis, it is an interesting approach to mimic individual processes of natural photosynthesis by use of artificial molecules.

In the first part of this lecture, I will describe the overview of natural photosynthesis and see how various molecules work together to achieve light-chemical energy conversion. In the second part, I will talk about research in our group, with particular emphasis on artificial models of "quinone pools." The talk will include three topics:

(1) The synthesis and photochemistry of "single-molecular" quinone pools (Fig. 1) [1]. The multiple quinones in the periphery of the molecule could be reduced by irradiation of the single porphyrin at the center in the presence of excess amount of thiols.

(2) A unique photochemistry, in which alcohols serve as a terminal electron donor for reduction of quinones to quinols [2]. The reaction is a combination of a photoinduced electron transfer and a TEMPO-catalyzed oxidation of alcohols (Fig. 2).

(3) Synthesis and photochemistry of porphyrin/cobalt complex linked compounds (Fig. 3) [3]. We found that these compounds catalyze photochemical conversion of quinols back to quinones.

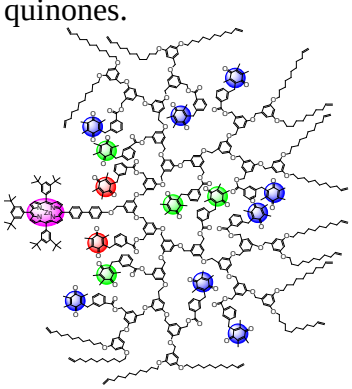

Figure 1. A single-molecular quinone pool.

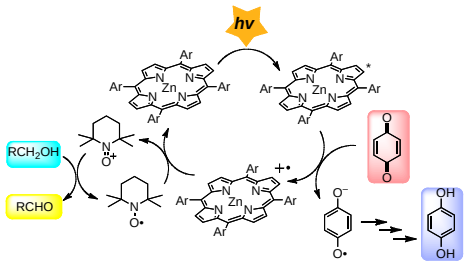

Figure 2. Photooxidation of alcohols by porphyrin-quinone-TEMPO system.

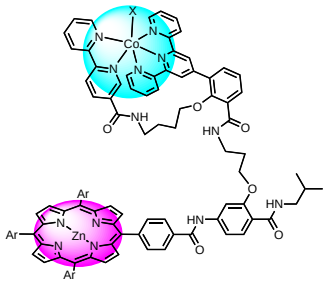

Figure 3. A porphyrin-cobalt complex linked molecule.

[1] T. Nagata and Y. Kikuzawa, *Biophys. Biochim. Acta* **1767**, 648-652 (2007).

[2] T. Nagasawa, S. I. Allakhverdiev, Y. Kimura and T. Nagata, *Photochem. Photobiol. Sci.* **8,** 174-180 (2009).

[3] H. Kon and T. Nagata, *Chem. Eur. J.* **18,** 1781-1788 (2012).