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EDITORIAL

Special Issue of Photosynthetic Research

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Abstract This Special Issue of Photosynthesis Research honors Louis M. N. Duysens, Roderick K. Clayton, and George Feher, three pioneering researchers whose work on bacterial photosynthesis laid much of the groundwork for our understanding of the role of the reaction center in photosynthetic light energy conversion. Their key discoveries are briefly summarized and an overview of the special issue is presented.

Keywords Reaction center · Duysens · Clayton · Feher · Photosynthesis

Introduction

Today our understanding of the reaction center (RC) as the primary site for capturing light energy in photosynthesis is so advanced that it is hard to imagine 50 years ago when little was known about this important complex. The elucidation of the nature of the RC and its role in photosynthesis was initiated by ground-breaking discoveries by pioneering researchers in the field. This issue of Photosynthesis Research honors three scientists: Louis M. N. Duysens, Roderick K. Clayton, and George Feher, who contributed greatly to the early development of the concept of the RC in photosynthetic bacteria and who provided details of the structure and function of this important pigment protein.

In his classic study of light-induced absorbance changes in photosynthetic bacteria, Duysens (1952) discovered a small change in the absorption spectrum of a pigment in whole cells of *Rsp. rubrum* that represented the reversible bleaching of a small fraction of the bacteriochlorophyll (BChl) present in the sample. He showed that this change was due to a photo-oxidation of a pigment which he designated P to represent a special pigment active in photosynthesis. This was the first spectroscopic evidence for the specialized BChl that we now know as P870, the primary electron donor in photosynthesis. This experiment supported the idea of a photosynthetic unit proposed by Emerson and Arnold (1932) based on oxygen evolution studies in *Chorella*, where they showed that most of the chlorophyll present in the cell was not active in the initial photochemical reaction.

The concept of the RC was further developed by Clayton in a series of pioneering experiments. He showed that the reversible bleaching occurred even at cryogenic temperatures (Arnold and Clayton 1960), a characteristic of the primary photochemistry. He discovered a particularly useful mutant strain (called R-26) of *Rhodopseudomonas sphaeroides* (now *Rhodobacter sphaeroides*) lacking carotenoids in which bulk of the BChl pigments were more unstable than the pigments in the RC (Clayton and Smith 1960). Using this strain he found conditions under which much of the inactive BChl was irreversibly destroyed, unmasking the active pigment P870 which could be identified by its reversible bleaching upon light illumination

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(Clayton 1963). This led to the first isolation of a soluble RC complex by treatment of the bacterial membranes with the detergent Triton X-100 (Reed and Clayton 1968).

Further characterization of the RC protein and its primary reactants was accomplished by George Feher using biochemical techniques and magnetic resonance spectroscopy. The detergent—lauryl dimethyl amine oxide was used to purify the RC preparation allowing the determination of the cofactors—4 BChl, 2 BPhe, Fe^{2+}, and ~2 UQ and the characterization of the 3 protein subunits called L, M, and H (Feher 1971; Okamura et al. 1974). Using EPR and ENDOR spectroscopy he was able to help identify the primary donor as a bacteriochlorophyll dimer (Feher et al. 1975) as proposed by Norris et al. (1971) and to detect the broad EPR signal of the reduced acceptor (Feher 1971) and to identify it as an Fe^{2+} $Q^{\cdot -}$ complex (Feher et al. 1972; Okamura et al. 1975).

From these initial pioneering studies the full characterization of the RC has expanded to an amazing degree by the work of many research groups. The isolation and characterization of RC from the more complex green plant photosystem I and photosystem II have been accomplished. The detailed 3-dimensional structures of bacterial and green plant photosystems are known from X-ray diffraction studies. The light-induced electron transfer steps resulting in the separation of charges across the RC in the range of picoseconds to seconds have been determined. The mechanisms of electron transfer and proton transfer have been investigated using the powerful tool of site-directed mutagenesis.

This issue of Photosynthesis Research presents some reports on current studies in RC research. The focus of research has shifted from the earlier days and now more emphasis is placed on physical mechanisms, larger scale integration of the RC into the membrane, and the challenge of constructing artificial RCs. Some of the outstanding questions are: What molecular mechanisms are involved in energy transfer and electron transfer? How does the RC interact with other components in the membrane? How can the knowledge obtained from biological studies be used to design artificial RCs for solar energy conversion? These current studies continue the legacy of scientific investigation left by the pioneers honored in this special edition and further advance our knowledge of photosynthesis.

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