REVIEW

STUDY ON THE STRUCTURAL BASIS OF PERIPHERAL LIGHT HARVESTING COMPLEXES (LH2) IN PURPLE NON-SULPHUR PHOTOSYNTHETIC BACTERIA

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ABSTRACT

Photosynthesis provides an example of a natural process that has been optimized during evolution to harness solar energy efficiently and safely, and finally to use it to produce a carbon-based fuel. Initially, solar energy is captured by the light harvesting pigment-protein complexes. In purple bacteria these antenna complexes are constructed on a rather simple modular basis. Light absorbed by these antenna complexes is funnelled downhill to reaction centres, where light drives a trans-membrane redox reaction. The light harvesting proteins not only provide the scaffolding that correctly positions the bacteriochlorophyll a and carotenoid pigments for optimal energy transfer but also creates an environment that can modulate the wavelength at which different bacteriochlorophyll molecules absorb light thereby creating the energy funnel. How these proteins can modulate the absorption spectra of the bacteriochlorophylls will be discussed in this review.

Keywords: *photosynthesis, peripheral light harvesting complex, H-bonding, energy transfer*

INTRODUCTION

In the early processes of photosynthesis, sunlight is absorbed and this excitation energy is then funnelled to the reaction centre (RC), where the primary charge separation takes place (Fig. 1A) [1-2]. The initial absorption of solar energy occurs in light harvesting pigment-protein complexes that surround the reaction centres (Fig. 1) [3-5]. In principle, photosynthesis could have evolved just with RCs. However, this would have meant that except under very high intensity light there would be a relatively long time-gap between two photons reaching the same RC. This would have cause a major problem because several of the redox reactions that take place within the RCs require multiple one-electron turnovers. If the RCs had to wait too long between the arrivals of the consecutive photons then back reactions would become favourable. In this case the whole charge-separation process would become inefficient. One of the important function of a LH system is to increase cross-sectional area for photon capture in order to supply the RCs with sufficient numbers of photons, so that the forward electron-transfer reactions take place frequently enough and the back reactions are reduced to a minimum [2].

In the purple bacteria there are two types of light harvesting (LH) complexes, the peripheral (LH2) and the core (LH1). Both LH complexes contain a pair of small (5-7 kDa) transmembrane polypeptides, called α and β, that oligomerise to form the intact native complexes. The N-termini of these apoproteins are located at the cytoplasmic surface of the photosynthetic membrane and

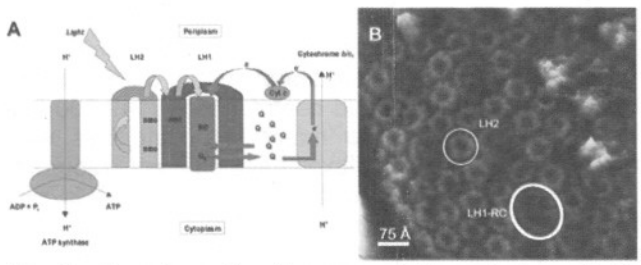

Fig 1. A schematic diagram of the photosynthetic membrane of a typical purple bacterium (A). The major integral membrane protein involved in the light reaction of photosynthesis are displayed. The yellow arrows show energy transfer and the red arrows the redox reactions involved their simple cyclic electron transport pathway. The reaction centre (RC) reduces the secondary electron acceptor (ubiquinone, Q_B) which has to pass through the LH1 complex in order to deliver its reducing equivalents to cyclic electron pathway. (B) An image of the photosynthetic membrane from *Phs. molischianum* taken by atomic force microscopy (AFM) [52] (kindly provided by Dr. Simon Scheuring). The peripheral light harvesting (LH2) and the core (LH1-RC) complex are indicated in circles.

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