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Two-level system of electron transport and conformational changes in the reaction centers of purple bacteria

T.V. Serdenko, Y.M. Barabash

Department of Physics of Biological System, Institute of Physics, Natl. Acad. of Sci. of Ukraine. Prospect Nauki, 46, Kiev-03039, Ukraine.
E-mail: tais.serdenko@gmail.com

In the process of reaction center (RC) photoinduction, there is charge transfer from the donor (bacteriochlorophyll) to the secondary acceptor (ubiquinone). It provides the existence of a long charge separation state, which creates transmembrane potential. The charge transfer in the RC is accompanied by structural changes as the result of electron-conformational interactions.

The oxidation kinetics of the RC donor can be shown as the sum of three exponents with various weights and decrements (decrements are constant in time). Therefore, the system with four states should be used to describe the processes of the electron transfer in RC. Conformational change in the protein complex occur because of electron-conformational interactions. On the one hand, hydrocarbon skeleton affects the electronic charge distribution; on the other hand, electronic state affects the coordinates of the nuclear hydrocarbon skeleton. During photoinduction relaxation rate can vary in 100-1000 times. Such change can not be the result of one elementary act. We can assume that this structure change may occur as the result of accumulation of the elementary acts set in the process of charge separation. Exponential weight and decrements do not describe the independent states of protein complex subsystem. These decrements can be the set of elementary parameters, which can describe the electron transfer kinetics. The system of four differential equations with constant coefficients was solved.

We can ascribe physical meaning only for two coefficients (k_{12} and k_{21}) and for another ten minimum coefficients not. However, without these ten coefficients it is impossible to describe the electron transfer kinetics. Coefficient k_{12} is proportional to the intensity of the excitation light in the process of donor oxidation. The k_{21} describes the electron return from the donor to the acceptor and is proportional to the excitation light intensity.

To estimate the results reproducibility double photoinduction algorithm with various intervals between impulses and different duration was proposed. After photoinduction we should wait 1500 s before the following impulses.