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Purple-bacterial light harvesting benefits more from energy funnelling than from delocalisation

Sima Baghbanzadeh

Department of Physics, Sharif University of Technology

Abstract

Light-harvesting complexes of purple bacteria have two properties that are thought to contribute to the efficiency of their exciton transport: an energy funnel that directs excitons towards the reaction centre as well as substantial excitonic delocalisation, which can enhance transport through supertransfer. To determine the relative importance of these two features, we compared models of the light-harvesting apparatus with thousands of counterfactual situations in which the extent of delocalisation and the energy landscape were altered. We find that the influence of delocalisation is usually minor and sometimes deleterious, especially when compared to the decisive importance of a funnel in the energy landscape. Consequently, delocalisation is most likely a side-effect of the dense chlorophyll packing that evolved to increase light absorption per reaction centre.