MOLECULAR UNDERSTANDING OF EFFICIENT DNA REPAIR MACHINERY OF PHOTOLYASE

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Photolyases repair the UV-induced pyrimidine dimers in damage DNA with high efficiency, through a cylic light-driven electron transfer radical mechanism. We report here our systematic studies of the repair dynamics in $E.coli$ photolyase with mutation of five active-site residues. The significant loss of repair efficiency by the mutation indicates that those active-site residues play an important role in the DNA repair by photolyase. To understand how the active-site residues modulate the efficiency, we mapped out the entire evolution of each elementary step during the repair in those photolyase mutants with femtosecond resolution. We completely analyzed the electron transfer dynamics using the Sumi-Marcus model. The results suggest that photolyase controls the critical electron transfer and the ring-splitting of pyrimidine dimer through modulation of the redox potentials and reorganization energies, and stabilization of the anionic intermediates, maintaining the dedicated balance of all the reaction steps and achieving the maximum function activity.