Molecular Basis of Photobiology in the Light of Quantum Chemistry: From DNA Photochemistry to Phototherapy with Psoralens

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Quantum chemistry is nowadays an essential tool to get an accurate insight at a molecular level into photoinduced biological processes. The present account will illustrate how the mechanisms of excitation and energy display in different molecular systems of biological interest can be analyzed by means of accurate *ab initio* quantum-chemical methods such as CASSCF and CASPT2, within the context of the Photochemical Reaction Path approach and the conical intersection seam concept. As an example it will be shown the response of monomers and dimers of DNA/RNA nucleobases to UV radiation, their energy decay radiative and nonradiative paths, through accessible conical intersection funnels, leading to a ultrafast energy release or the formation of relevant photoproducts, both along the singlet and triplet manifold. The use of QM/MM techniques will be also proved to be useful to introduce the effect of the environment. Another interesting application of the previous methods to photobiology is the study of the mechanisms involved in the so-called PUVA therapy, in which different furocoumarins are employed as photodrugs to fight against skin diseases like psoriasis and vitiligo and some types of cancer. The furocoumarin has a two-fold phototherapeutic action: forming adducts with thymine bases interfering the replication of the affected DNA and producing reactive singlet oxygen via photosensitization able to destroy the selected cell. A search for the best pharmacon in the family of furocoumarins based on its photochemical properties has been performed on quantum-chemical grounds.