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Quantum entanglement in nano bioorganic systems

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Together with my collaborators I have been investigating the self-assembly of molecules that result in supramolecular bioorganic and minimal cellular systems, as well as the biochemistry of these assemblies. The self-assembly and biochemistry depend on quantum mechanics laws which induce hydrogen and Van der Waals bondings. Therefore our work has been done through modelling based on quantum mechanical time dependent density functional theory, which also makes it possible to study quantum entanglement in such systems (TD-DFT).

In the work presented here, quantum entanglement takes the form of a quantum superposition of the active components in synthesized self-assembled and self-replicating living systems. When a quantum calculation of an entangled biosystem is made that causes one protocell photoactive biomolecule of such an entangled pair to take on a definite value (e.g., electron density redistribution tunnelling or electron spin density redistribution tunnelling), the other protocell photoactive biomolecule of this pair will be found to have taken the appropriately correlated value (e.g., electron density redistribution tunnelling or electron spin density redistribution tunnelling) in two quantum entangled excited states of this bicellular system. In our simulations, the starting separation distance of the supramolecular bio systems changed during geometry optimization procedures, taking on final values that mimic those associated with real-world intermolecular interaction processes. Furthermore, the modelling indicates that quantum entanglement occurs between the prebiotic subsystems which enhances the photosynthesis of the combined systems. The enhancement occurs because two additional quantum entangled excited states are created through the simultaneous excitation of the combined system's two prebiotic kernels or. two protocells. The additional photosynthesis made possible by the quantum entanglement potentially provides a selective advantage through an enhancement of usable energy leading to faster growth and self-replication of minimal living cells, which in turn can lead to accelerated evolution.

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Synthetic photosynthetic cyanobacteria to produce fine chemicals directly from CO_2

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Photosynthetic cyanobacteria have attracted significant attention as a "Microbial factory" to produce biofuels and various fine chemicals, mostly due to their abilities to utilize CO_2 and sunlight directly as carbon and energy sources, respectively. We will report our recent progress on engineering cyanobacterium *Synechocystis* sp. PCC 6803 to produce 3-hydroxybutyrate (3HB), 3-hydroxypropionic acid (3HP) and butanol directly from CO_2 and on strengthening Synechocystis for better tolerances against toxic products.

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