NatureQuantumET

The role of coherence in photosynthetic light-harvesting: does energy transfer proceed via a quantum-coherent mechanism?

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ICIQ People | Elisabet Romero Research Group

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SUMMARY

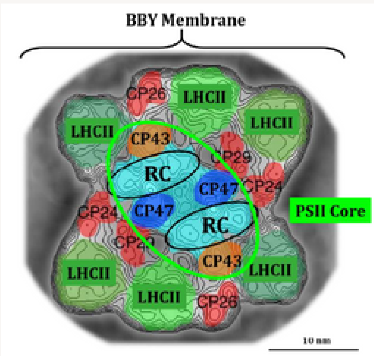
In photosynthesis, the efficient solar-energy collection, transfer and conversion is accomplished by pigment-protein complexes, consisting of light-absorbing molecules (pigments) embedded into a protein matrix. During the early steps of photosynthesis, light-harvesting complexes absorb solar energy and transfer the resulting excitation energy to the reaction centre with remarkable speeds (10-100 ps timescale) and with low energy losses. Therefore, natural light-harvesting complexes teaches us valuable lessons about how photoexcitation can be directed and amplified using assemblies of light-absorbing molecules.

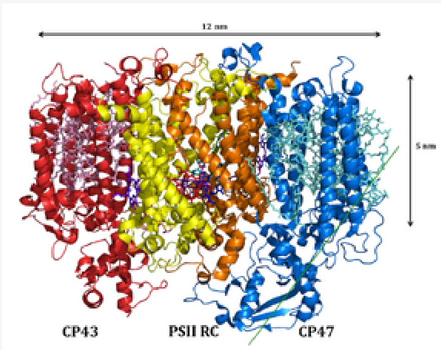
Once the energy reaches the reaction center, the excitation energy is converted into electrochemical energy by a series of electron transfer processes. In plants, the photosystem II reaction center (PSII RC) performs charge separation with near 100% efficiency despite its highly disordered energy landscape. Therefore, to better understand the energy and electron transfer processes occurring in lightharvesting and reaction center complexes can aid in the design of artificial systems to construct more efficient and robust photovoltaic devices.

Since the first report presenting evidence of coherence effects in photosynthetic light-harvesting, this topic has raised great interest within the scientific community. The presence of coherence has been demonstrated, now the interest is shifted to confirm the concept of coherence-enhanced function.

The concept of coherence-enhanced energy and electron transfer processes in photosynthesis is an ongoing matter of passionate debate within the scientific community because it encloses a fundamental question: Is Photosynthesis, and by extension Nature, utilizing coherence to achieve its amazing efficiency? Or in other words:Is coherence playing an essential role in determining the high speed and efficiency of photosynthetic light-harvesting and charge separation?

The answer to these questions will extend our understanding about photosynthetic light harvesting and charge separation, that is energy and electron transfer processes, respectively, both with fundamental relevance and great promise for technological applications (for instance in the fields of optoelectronics, nanophotonics, photovoltaics, quantum computing, etc).





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