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A natural solution for artificial light-harvesting FREE

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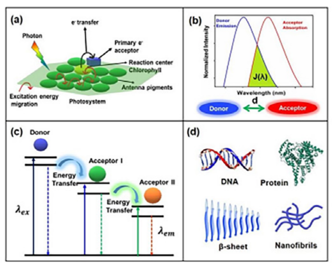
Multidimensional biomolecules such as nucleic acids, proteins, and peptides can provide a scaffold for artificial light-harvesting systems.



Plants, algae, and some bacteria convert light energy into chemical energy through photosynthesis. Biomaterials-based artificial light-harvesting systems (LHS) attempt to mimic photosynthesis for environmentally friendly energy generation.

Pramanik and Mukherjee examined the potential of biomolecules such as DNA, proteins, and peptides as LHS scaffolds to organize chromophores into a defined spatial proximity and facilitate efficient energy transfer. They discussed the energy transfer system, fluorescent molecule considerations, applications, and associated limitations.

“Pigment-protein complexes in the natural light-harvesting systems absorb solar light and efficiently transfer the light energy via a cascade of resonance energy transfer processes to a reaction center, where light energy transforms into chemical energy through charge separation,” said author Saptarshi Mukherjee.

In nature, many chromophores — molecules that absorb a specific wavelength of light — contribute to a single reaction center. This ensures the donor molecules cover the full spectrum of light. However, in the non-aqueous scaffold of many artificial systems, densely packed donor molecules interfere with each other and limit energy production.

Instead, the authors focused on aqueous environments that replicate natural structures. Nucleic acids, proteins, and peptides provide multidimensional matrices that can be modified to precisely organize and host fluorescent molecules called fluorophores.

Selecting such donor molecules takes careful and judicious consideration. Currently, organic fluorophores outperform artificial alternatives like quantum dots. The organization of such molecules can also impact energy transfer efficiency.

“The realization of the development of artificial multidimensional light-harvesting networks could have extensive applications,” said Mukherjee. “These include solar energy devices, light-based information encryption, bio-based white light-emitting diodes, photon transmission devices, photochemical catalysts, molecular computing, information storage, sensing, and disease diagnostics.”

Source: “Bio-templated energy transfer system for constructing artificial light-harvesting antennae, white light generation, and photonic nanowires,” by Srikrishna Pramanik and Saptarshi Mukherjee, *Chemical Physics Reviews* (2023). The article can be accessed at https://doi.org/10.1063/5.0163152.