Reinventing the Leaf: A Manufactured Biohybrid Photosynthetic System

Pontius, Wyatt

Two daunting problems facing humankind today are global warming and global hunger. Isolated chloroplast photosynthesis, which produces carbohydrates and sequesters carbon dioxide, is capable of mitigating both issues. Prior research has yielded scant improvements to photosynthesis. This research builds upon previous improvements utilizing novel innovations. A two-pronged photosynthesis improvement was performed to improve the light-absorption and lifespan of the chloroplasts. ssDNA-coated semiconducting single wall carbon nanotubes (ssDNA-SWNTs) were imported inside the chloroplasts, which were encapsulated inside alginate beads later embedded within silica gel. Eight modification combinations were tested. Light absorption, oxygen production, DPIP reduction, and photosynthetic lifespan were measured. The ssDNA-SWNTs expanded the integrated intensity to 373% that of unmodified chloroplasts, subsequently increasing oxygen production and DPIP reduction rates nearly 50% each. Silica gel support increased lifespan from four hours to 37 days. Alginate bead encapsulation alone was ineffective but, when coupled with silica gel support, extended functionality to 6 weeks. The synergistic optically-transparent materials enhanced the lifespan of photosynthesis in chloroplasts while preserving the absorption spectrum. The biohybrid system including all three innovations significantly outperformed the control. This prototype provides a leap forward in photosynthetic technology and could be deployed to mitigate global warming, fight global hunger, and even terraform Mars at a low cost.

Awards Won:
Intel ISEF Best of Category Award of $5,000
First Award of $5,000