Human Photosynthesis: Functional Chloroplast Sequestration in Human Mesenchymal Stem Cells

Perlman, Brent (School: Byram Hills High School)

Photosynthesis is vital to the survival of life on Earth, providing organisms with the ability to harness energy from sunlight and evolve oxygen. Although of the utmost importance, photosynthesis is a process that mammals—specifically humans— are unable to naturally conduct. Recognizing the previous success of an endosymbiotic approach to inducing chloroplast uptake in murine fibroblasts (Nass, 1969), this study documents the novel ability of human mesenchymal stem cells (hMSCs) to endosymbiotically incorporate and sequester isolated spinach chloroplasts in coculture. Chloroplast-hMSC symbionts remained viable and retained the de novo ability to conduct human photosynthesis over an 11-day culture period. Chloroplast sequestration had no apparent effect on hMSC metabolic activity at the end of the culture period. Going further, this study also attempts to analyze the ability of human fibroblasts (HFs) to uptake isolated chloroplasts and conduct photosynthesis over a three-day culture period. Hitherto unreported in the literature, this study demonstrates the ability of isolated spinach chloroplasts to remain viable and photosynthetically functional for at least three days when cultured in sterile hMSC media containing broad-spectrum antibacterial and antifungal supplements. My novel process for sterile culture of viable, isolated chloroplasts provides future chloroplast therapies with great clinical promise. With potential applications in post-ischemia interventions, engineering of full organs in vitro, targeted cancer treatments, and even in vivo production and delivery of biopharmaceuticals, sterile chloroplast culture and the phenomenon of human photosynthesis may revolutionize the path of future scientific advancement.

Awards Won:

Fourth Award of $500