Docket #: S24-026

Bio-engineered mitochondria for targeted delivery to cells, tissue, and organs

Aging-associated mitochondrial dysfunction (mito-dysfunction) affects every cell system in our body. Mito-dysfunction includes reduced quality of mitochondrial DNA (mtDNA), irregular generation of reactive oxygen species, and membrane potential. In the context of the cardiovascular system, mito-dysfunction exacerbates inflammatory immune cell activity, vascular inflammation, and oxidative stress. These factors are primary drivers of cardiovascular disease (CVD). Mitochondrial transfer (mito-transfer) has shown promise in rescuing dysfunctional cells, replacing damaged mitochondria in cells. This approach holds significant potential for fixing a root cause of aging-associated dysfunctions.

An inventor at Stanford has bioengineered mitochondria for targeted drug delivery using Click Chemistry. This highly selective biochemical reaction, involving azide and alkyne functional groups, can be harnessed to tag cellular components like phospholipids abundant in the outer mitochondrial membrane. This innovative approach leverages taggable phospholipids to act as hooks for receptor-mediated internalization by cells. This allows antibodies or other homing molecules to be attached directly to mitochondria, which can facilitate their uptake without the need for encapsulation. The inventor has already shown that the mito-transfer method improves the activation and proliferation of aged T-cells and the anti-inflammatory polarization of macrophages, providing evidence that this invention could be a valuable therapeutic application to target conditions involving mitochondrial dysfunction.

Applications

- Cellular drug delivery via taggable mitochondria

- Therapies for cardiovascular, immune, or aging-associated diseases
- Antibody conjugate delivery

Advantages

- Transportation method bypasses the need for encapsulation via microvesicles
- Quick cellular uptake than direct mitochondrial transplantation by leveraging receptor-mediated uptake

Patents

- Published Application: WO2025184537

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