



Cilia-based Formulation for the Treatment of Disease

Chapman Case # 2025-002

Market Need

Conventional nanoparticle drug delivery systems (liposomes, dendrimers, micelles) often face challenges such as rapid clearance, immunogenicity, and poor tumor targeting. Despite promising advances with extracellular vesicles like exosomes, these systems are limited in drug loading capacity, targeting specificity, and in vivo stability. There remains a critical need for a naturally biocompatible, scalable, and targeted delivery system that improves efficacy while minimizing systemic toxicity, especially for cancers expressing folate receptors (e.g., melanoma, ovarian, breast).

Chapman Solution

[Dr. Surya Nauli](#) of Chapman University and his research team developed a groundbreaking Primary Cilia-based Delivery Platform. These naturally occurring cellular organelles are isolated from mammalian cells and engineered to carry chemotherapeutic agents such as doxorubicin (DOX). The surface of cilia is functionalized with folic acid (FA) to selectively target folate receptor-positive tumors. The lead compound, Cil-FA-DOX, demonstrated enhanced tumor penetration, efficient drug release in acidic tumor environments, and significantly reduced off-target toxicity.

Competitive Advantages

Feature	Cilia-FA-DOX	Exosomes	Synthetic Nanocarriers
Target Selectivity	FA-guided tumor targeting	Passive	Receptor-based, often limited
Drug Loading (DOX)	4.9×10^{10} molecules/cilium	$\sim 5.1 \times 10^3$ molecules/exosome	Variable
Release Efficiency	83.6% over 72 h (pH 5)	78.7%	Unpredictable
Immunogenicity	None observed	Low-moderate	Moderate-high
Cardiotoxicity Risk	None	Low	High (for DOX)
Circulation Time	Prolonged (lipid membrane stability)	Shorter	Variable

Applications

- Targeted cancer therapy for folate receptor-positive tumors (melanoma, ovarian, breast, etc.)
- Novel carrier platform for large or sensitive therapeutic molecules (proteins, RNA, antibodies)
- Potential utility in precision gene therapy and regenerative medicine

Key Publication

- [Application of Bioactive Materials Primary Cilia as a Novel Delivery Vehicle](#). Bioactive Materials. May 2025.

Intellectual Property

- Patent application filed

Stage of Development

- Validated in vitro and in vivo (murine melanoma model)
- Demonstrated tumor targeting, cellular uptake, safety, and efficacy

