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Engineered exosomes as next-generation drug delivery vehicles for targeted cancer therapy

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Exosomes—natural nanoscale extracellular vesicles—are gaining attention as biocompatible and non-immunogenic drug delivery vehicles. However, their therapeutic use is limited by insufficient targeting efficiency and loading capacity. This study investigates the engineering of exosomes to enhance their drug delivery potential for targeted cancer therapy.

Methodology: Exosomes were isolated from human mesenchymal stem cells (MSCs) via ultracentrifugation and characterized using nanoparticle tracking analysis (NTA), transmission electron microscopy (TEM), and Western blotting for CD63, CD81, and TSG101 markers. To improve targeting, exosomes were surface-modified with folic acid (FA) using click chemistry for receptor-mediated uptake in folate receptor-positive cancer cells.

Results: Engineered FA-exosomes exhibited enhanced uptake (3.4-fold increase) in folate receptor-overexpressing cancer cells compared to unmodified exosomes. Doxorubicin-loaded FA-exosomes demonstrated superior cytotoxicity, reducing cancer cell viability by over 70% in vitro. In vivo studies showed preferential tumor accumulation and significant tumor volume reduction ($p < 0.01$) without off-target toxicity, compared to free doxorubicin or unmodified exosomes.

Conclusion: This study demonstrates that surface-engineered exosomes offer a promising strategy for targeted cancer drug delivery. The combination of biocompatibility, enhanced targeting, and efficient payload delivery positions exosomes as a powerful platform for next-generation oncological therapies.