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Targeted IL-7 Lipid Nanoparticles for Efficient In Vivo T-Cell Engineering

Researchers at Stanford have developed an IL-7–conjugated lipid nanoparticle (LNP) platform designed to substantially improve mRNA delivery to T cells for direct in vivo T-cell engineering.

While in vivo Chimeric Antigen Receptor (CAR)-T cell therapy has gained traction as a scalable and accessible alternative to traditional ex vivo manufacturing, current LNP systems struggle with low T-cell transfection efficiency and minimal mRNA translation after uptake. These barriers often require separate cytokine administration, repeated dosing, or higher particle loads, all of which complicate treatment and reduce therapeutic effectiveness. The Stanford team addressed these issues by conjugating interleukin-7 (IL-7), a cytokine essential for T-cell survival and protein translation, directly onto the LNP surface alongside T-cell–targeting ligands.

By combining a CAR-encoding mRNA payload with localized IL-7 signaling on the same nanoparticle, the platform enhances T-cell activation, mRNA translation and overall viability at the moment of particle uptake. In preclinical mouse models, IL-7–modified LNPs increased mRNA expression in T cells by approximately 1.5–2.3-fold compared to unmodified LNPs and enabled robust in vivo generation of functional CAR-T cells capable of mediating tumor clearance. This approach offers a compact, modular vehicle for targeted delivery, immunomodulation and genetic programming of T cells, and provides a promising path toward safer, more scalable and more accessible in vivo CAR-T therapies.

Stage of Development
Research - in vivo

Applications

- In vivo CAR-T cell therapy for hematologic cancers and solid tumors

- mRNA delivery to primary T cells for immunotherapy or research use
- Immune-cell imaging and real-time tracking technologies

Advantages

- Improved T-cell transfection via IL-7–mediated enhancement
- Eliminates requirement for ex vivo T cell engineering and expansion
- Co-delivery of cytokine and mRNA in one particle, simplifying treatment
- Higher CAR expression and T-cell viability compared to standard LNPs
- Compatible with a broad range of CAR constructs and tumor targets

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