Lipid nanoparticle technology for mRNA delivery: bridging vaccine applications with fundamental insights into nano-bio interactions

Escalona Rayo, O.

Curriculum vitae

Oscar Escalona Rayo was born on April 3, 1989, in Mexico City, Mexico. After completing high school, he pursued undergraduate and graduate studies at the National Autonomous University of Mexico (UNAM), where he obtained both his Bachelor's degree in Pharmacy and Master's degree in Chemistry. During this period, he conducted research in drug delivery and nanomedicine. Following the completion of his Master's degree, Oscar worked as a research scientist in pharmaceutical development at Perrigo Mexico, where he was involved in formulation development and applied pharmaceutical research. In 2020, he joined the Supramolecular and Biomaterials Group at Leiden University, where he carried out his doctoral research under the supervision of Prof. dr. Alexander Kros, with co-supervision by dr. Bram Slütter, head of the Immune Activation and Tolerance group. His PhD project focused on lipid nanoparticle (LNP) technology for mRNA delivery, combining vaccine-related applications with fundamental studies of nano–bio interactions, with the aim of advancing the rational design of next-generation nucleic acid delivery systems. During his PhD, he completed advanced coursework in Supramolecular Chemistry and Microscopy, which complemented his research and strengthened his multidisciplinary expertise. In addition, he actively supervised Bachelor's and Master's students during their research internships, providing guidance in experimental design, data analysis and interpretation, and scientific communication. Oscar has co-authored several peer-reviewed publications in high-impact journals and presented his work at multiple conferences, contributing to the fields of nanomedicine, mRNA therapeutics, and LNP development. He is currently a postdoctoral researcher at Leiden University as part of an ERC Synergy Grant. Following his postdoctoral training, Oscar has accepted a competitive tenure-track Associate Professor position at UNAM, where he will lead an independent research program in nanomedicine and nucleic acid delivery and contribute to education and student supervision.

List of publications

Manuscripts described in this thesis:

1. **Escalona-Rayo O**., Zhang Y., van Os W.L., Aschmann D., Grünewald M., Aguirre-García M., Freire R.V.M., Cornet L., Slütter B., Kros A. Exploring the nano–bio interface between mRNA-lipid nanoparticles and macrophages. **Manuscript in preparation**.

2. **Escalona-Rayo O**.[#], Schilder T.J.B.[#], van Os W.L., Mostert T.P., White-Matthew B., Slütter B., van Kasteren S.I., Kros A. Clickable ionizable lipid-based probes enable intracellular visualization of mRNA-lipid nanoparticles. **Manuscript in preparation**.

3. Ostroumov D., Benne N., Lozano Vigario F., **Escalona-Rayo O**., Dodz K., Sauer S., Suhl L.L., Wedemeyer H.H., Kühnel F., Slütter B., Wirth T.C. Sequential STING and CD40 agonism drives massive expansion of tumor-specific T cells in liposomal peptide vaccines. Cellular & Molecular Immunology 2025;22:150-60.

4. **Escalona-Rayo O**.[#], Papadopoulou P.[#], Slütter B., Kros A. Biological recognition and cellular trafficking of targeted RNA-lipid nanoparticles. Current Opinion in Biotechnology 2024;85:103041.

5. **Escalona-Rayo O**., Zeng Y., Knol R.A., Kock T.J.F., Aschmann D., Slütter B., Kros A. In vitro and in vivo evaluation of clinically-approved ionizable cationic lipids shows divergent results between mRNA transfection and vaccine efficacy. Biomedicine & Pharmacotherapy 2023;165:115065.

6. van Strien J., **Escalona-Rayo O**., Jiskoot W., Slütter B., Kros A. Elastin-like polypeptide-based micelles as a promising platform in nanomedicine. Journal of Controlled Release 2023;353:713-726.

7. Zeng Y., **Escalona-Rayo O**., Knol R., Kros A., Slütter B. Lipid nanoparticle-based mRNA candidates elicit potent T cell responses. Biomaterials Science 2023;11:964-974.

#These authors contributed equally

Other publications:

1. Jardon S., **Escalona-Rayo O**., García C.G., Quintanar D., Soto C.I., Urbán M.Z., Mendoza S.E. Glycyrrhizic acid loaded poly-ε-caprolactone nanoparticles decrease PRRSV infection in MARC-145 cells. Open Journal of Veterinary Medicine 2023;13(12):221-236.

2. **Escalona-Rayo O**., Fuentes-Vázquez P., Jardon-Xicotencatl S., García-Tovar C.G., Mendoza-Elvira S., Quintanar-Guerrero D. Rapamycin-loaded polysorbate 80-coated PLGA nanoparticles: optimization of formulation variables and in vitro anti-glioma assessment. Journal of Drug Delivery Science and Technology 2019;52:488-499.

3. **Escalona-Rayo O**.[#], Fuentes-Vázquez P.[#], Leyva-Gómez G., Cisneros B., Villalobos R., Magaña J.J., Quintanar-Guerrero D. Nanoparticulate strategies for the treatment of polyglutamine diseases by halting the protein aggregation process. Drug Development Industrial Pharmacy 2017;43(6):871-888.

4. **Escalona-Rayo O**., Quintanar-Guerrero D. Polymeric nanogels: a new alternative for drug delivery (Nanogeles poliméricos: una nueva alternativa para la administración de fármacos). Revista Mexicana de Ciencias Farmacéuticas 2014;45(3):17-38.

#These authors contributed equally

Parts of the research described in this dissertation were presented at the following conferences and meetings:

- CRS 2nd BNLF Meeting, Leiden, the Netherlands (oral presentation)
- CHAINS-NWO, 2024, Veldhoven, the Netherlands (poster presentation)
- Dutch Peptide Symposium, 2023, Leiden, the Netherlands (poster presentation)
- CHAINS-NWO, 2022, Veldhoven, the Netherlands (poster presentation)