

Research group: NanoTherapies

Evaluation of Polymeric Nanoparticle Stability and Mucosal Barriers for Nose-to-Brain Gene Delivery

Project Description

Gene therapy offers a promising alternative for treating various complex diseases, with nanomedicine playing a pivotal role in its clinical translation. Among the diverse platforms available, polymeric nanoparticles (NPs) are widely utilized due to their biodegradability, biocompatibility, and highly customizable surface chemistry.

However, to successfully translate these formulations into effective treatments, critical challenges must be addressed, including overcoming biological barriers, minimizing toxicity, and ensuring formulation stability. Maintaining stability is particularly crucial, as physical or chemical degradation over time directly compromises therapeutic efficacy.

This project focuses on developing and evaluating polymeric NP formulations tailored for nose-to-brain delivery. This pathway requires the nanoparticles to navigate and remain stable within a complex mucosal environment before reaching their target.

Objective

The primary goal of this project is to evaluate the colloidal and biological stability of diverse polymeric nanoparticles over time, and to determine how these stability profiles impact their performance, toxicity, and transfection efficiency in mucosal and biological models.

Technical Skills You Will Acquire

This multidisciplinary project offers hands-on training in state-of-the-art materials characterization and biological evaluation techniques:

- **Physicochemical and Structural Characterization:**
 - **NMR Spectroscopy:** Characterizing polymer structure and functionalization.
 - **Dynamic Light Scattering (DLS) & Zeta Potential:** Monitoring nanoparticle size, polydispersity, and surface charge stability over time.
 - **FRET (Förster Resonance Energy Transfer):** Assessing nanoparticle assembly, structural integrity, or cargo release.
- **Biological and Mucosal Barrier Assays:**
 - **Mucus Stability & Interaction:** Evaluating NP diffusion and behavior in simulated or real mucus environments.
 - **MTT Assay:** Assessing *in vitro* cytocompatibility and toxicity profiles.
 - **Transfection Efficiency:** Measuring the functional delivery and expression of gene cargo in relevant cell models.

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