Stabilized mRNA Therapeutics with Precise ROS-triggered Delivery (2024-025)

New method for improving the delivery of mRNA drugs for treating diseases with high ROS, such as cancer, respiratory, neurodegenerative, and digestive diseases.

Market Overview

Recently, the use of mRNA was validated to create vaccines against COVID-19; hence, there is significant potential for using them as vaccines and treatments for many other conditions. While mRNA drugs have led to a potential paradigm shift in disease treatment, they face challenges that impede the successful translation of these molecules into drugs. They are very large molecules, are intrinsically unstable, and prone to degradation by nucleases, and they can abnormally activate the immune system. While some of these challenges have been partially solved by chemical modification of mRNA and nanoparticle-mediated delivery, intracellular delivery and off-target effects of mRNA still represent a major hurdle. The novel mRNA technology developed by Clemson researchers overcomes the delivery and targeting challenges with existing mRNA, increasing stability and controlling release location helping fully exploit their effectiveness for many

Technical Summary

This invention describes the methods and compositions of complex coacervates for stabilization and delivery of mRNA therapeutics by targeting elevated levels of reactive oxygen species (ROS). ROS overproduction has been implicated in the development of various chronic and degenerative diseases such as cancer, respiratory, neurodegenerative, and digestive diseases. The technology uses complex coacervation to improve mRNA delivery, involving the liquid-liquid charge-based phase separation of mRNA into dense liquid droplets. Coacervated mRNA protects the mRNA from enzymatic degradation, facilitates endocytosis, and enables targeted and ROS-triggered release through a novel chemical modification. The current data suggests the modality could be viable for delivering mRNA into cells and tissues with high ROS, like tumor microenvironments, or for radiotherapy.

Application

Delivery of mRNA therapeutics to treat chronic and degenerative diseases

Development Stage

Proof of Concept

Advantages

- Novel mRNA delivery system that can target tissues and cells with high levels of ROS.
- Potential to improve the targeting safety of mRNA-based therapeutics for cancer and other chronic indications.
- Modified coacervates remain stable in low ROS conditions but activate in the presence of elevated ROS levels.

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Provisional	United States			2014-074	Dr. Jessica Larsen Chloe Forenzo

About the Inventors

Jessica Larsen, Ph.D.

Carol and John '63 Cromer Endowed Associate Professor at Clemson University

Dr. Jessica Larsen received her Ph.D. in Chemical Engineering from Auburn University. She is currently an Endowed Associate Professor in Chemical and Biomolecular Engineering at Clemson University. Her research interests include drug delivery, biomaterials, and nanotechnology. In specific, her lab has focused on "using brain disease to treat brain disease" through diagnostic validation and delivery, delivery through the blood-brain barrier, and regeneration and gene editing in the central nervous system.

Chloe Forenzo

Ph.D. Student in Chemical Engineering at Clemson University

Chloe Forenzo graduated with her B.S. in Chemical and Biomolecular Engineering from Clemson University in 2022. She is currently a third-year Ph.D. Candidate in the Center for Nanotherapeutic Strategies in the Central Nervous System under Dr. Jessica Larsen at Clemson University. Chlo's research involves combining charge-based liquid-liquid phase separation with reactive oxygen species responsivity to enhance the delivery of messenger RNA.

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