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INTELLIGENT MAGNETOELECTRIC DRUG-DELIVERING NANOPARTICLES (IMDDNS) FOR REAL-TIME SENSING AND ADAPTIVE THERAPY IN THE TUMOR MICROENVIRONMENT

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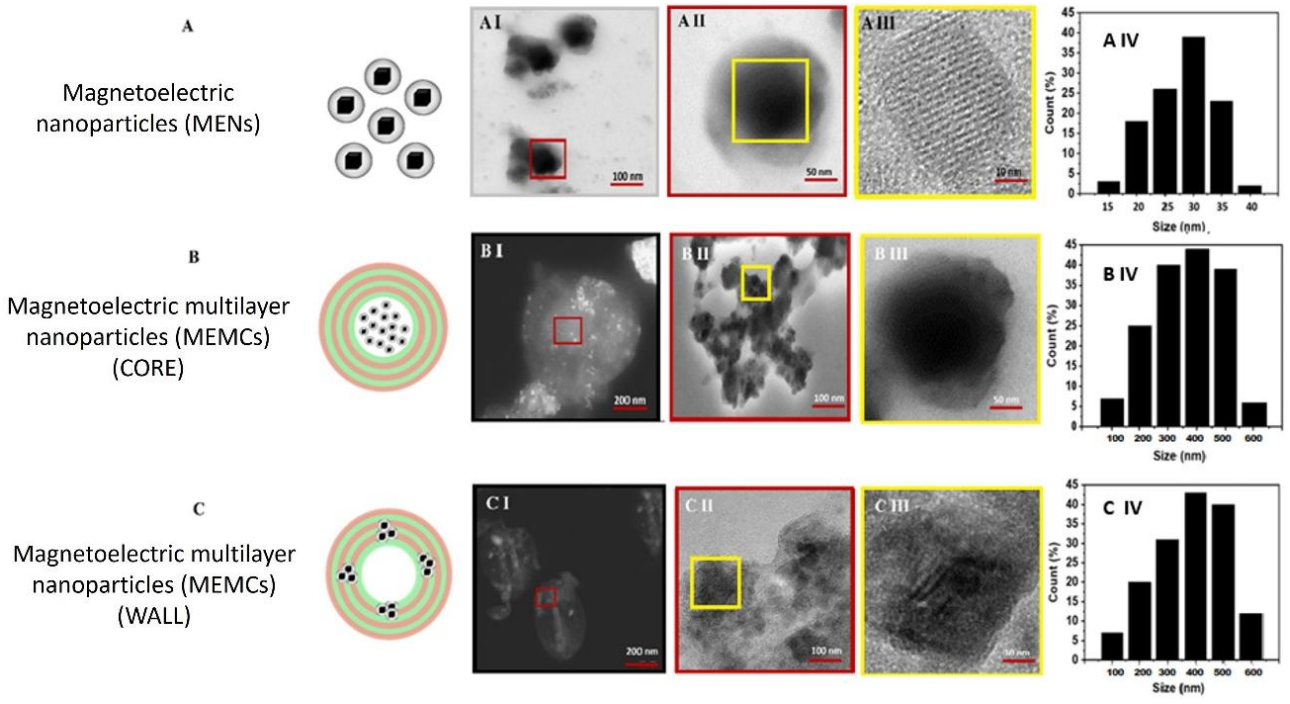
Abstract

The complexity and heterogeneity of the tumor microenvironment (TME) present significant challenges to effective cancer therapy. To address these challenges, we have developed IntelliMeg, Intelligent Magnetoelectric Nanoparticles engineered for real-time environmental sensing and adaptive therapeutic delivery. This innovative platform integrates advanced materials science with molecular biology, offering a sophisticated approach to targeted cancer treatment.

The synthesis of cobalt ferrite@barium titanate (CFO@BTO) nanoparticles took a place using a co-precipitation method, followed by comprehensive characterization through TEM, SEM, XRD, and SQUID to ensure optimal size, morphology, and magnetoelectric properties. Surface functionalization of these nanoparticles is achieved by conjugating targeting ligands and therapeutic agents, enhancing their specificity and therapeutic efficacy.



Schematic representative of Magnetoelectric nanoparticles (MENS) and magnetoelectric multilayer capsules (MEMCs) structures (A I, B I, C I). Other images are representative TEM images of the Magnetoelectric nanoparticles (MENs), ME. Multilayer polymer capsules with incorporated Magnetoelectric nanoparticles (MENs) inside the cavity (**CORE**) and between polymer layers (**SHELL**). (A IV, B IV, C IV) size distribution

A distinctive feature of IntelliMeg is the integration of DNA nanorobots. These nanorobots are modulated by cancer marker concentrations, enabling precise mRNA cleavage and subsequent therapeutic gene silencing. Our DNA nanorobots have four modules: activation, computational, sensory, and delivery [1]. IntelliMeg NPs play the role of delivering DNA nanorobots to specific sites. To address the dynamic conditions within the TME, multiple sensing modalities were incorporated into the nanoparticle design. FITC-dextran serves as a pH sensor, platinum porphyrins detect oxygen levels, and DCFDA is used for ROS sensing [2]. The successful integration and functionality of these sensors are

confirmed through fluorescence spectroscopy, ensuring precise and reliable detection capabilities. This platform has the potential to significantly improve treatment outcomes.

Our research highlights the transformative potential of IntelliMeg as a cutting-edge platform for intelligent cancer therapy. This approach not only enhances the precision of treatment but also establishes a foundation for future advancements in theranostic applications, thereby addressing critical challenges in oncology.

References

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