How Nanotechnology Transforms the Delivery of Biological Drugs

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Nanomaterials offer substantial potential for advancing precision medicine by improving the delivery of therapeutic agents to their intended biological targets. Our laboratory has been at the forefront of the rational design of nanocarrier systems for the targeted delivery of biologics, including monoclonal antibodies (mAbs), small interfering RNA (siRNA), and messenger RNA (mRNA).

In the context of mAbs for cancer precision medicine, we have engineered polymeric nanocapsules and nanoassemblies composed of lipids and amphiphilic polymers designed to target intracellular oncoproteins. These nanocarriers enable the intracellular delivery and controlled release of antibodies, thereby allowing them to interact with oncogenic proteins located within tumor cells. This strategy has led to significant reductions in tumor volume and mass across various murine cancer models.

Our research in polynucleotide-based therapies dates back to the 1990s, when we demonstrated the successful delivery of plasmid DNA (pDNA) using PLGA nanoparticles and chitosan-based nanostructures. In recent years, our focus has shifted toward hybrid polymer/lipid nanocarriers, which represent a versatile and promising platform for advanced therapies, vaccines, and RNA-based personalized medicine. Compared to conventional lipid nanoparticles, these hybrid systems exhibit unique physicochemical properties and enhanced biological performance. We have explored their application in treating neurological disorders, cancer (siRNA and cell therapies), and cystic hepatic fibrosis.

In this presentation, I will highlight the key determinants and challenges associated with overcoming biological barriers to achieve optimal therapeutic efficacy.

More information about these projects and associated publications can be found at:

http://www.usc.es/grupos/mjalonsolab/

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