

Development of calcium phosphate nanoparticles for targeted and controlled delivery of bioactive molecules

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Calcium phosphate (CaP) is a natural mineral and the main inorganic component of bones and teeth. Its synthetic analogues exhibit excellent biocompatibility, bioactivity, and biodegradability, making CaP nanoparticles (CaP NPs) highly attractive for various biomedical applications, particularly as nanocarriers for biomolecules such as peptides, drugs, proteins, and nucleic acids. In this lecture, I will present a representative application of CaP NP-mediated drug delivery developed by our research group. Specifically, we engineered inhalable CaP NPs for the targeted delivery of a therapeutic peptide aimed at treating cardiovascular disease. Designed to cross the alveolar-pulmonary barrier upon inhalation, these nanoparticles reach cardiomyocytes and effectively release their therapeutic cargo. In a mouse model of cardiomyopathy, treatment with these inhalable nanoparticles led to significant restoration of cardiac function. Further validation was achieved in Göttingen minipigs with heart failure and reduced ejection fraction, using a dry powder formulation in which peptide-loaded CaP NPs were embedded in mannitol-based microparticles. This work highlights the versatility of CaP NPs in drug delivery and their promise for enabling innovative, non-invasive strategies in cardiovascular therapy.