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Bioceramics from calcium orthophosphates

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Various types of grafts have been traditionally used to restore damaged bones. In the late 1960's, a strong interest was raised in studying ceramics as potential bone grafts due to their biomechanical properties. A bit later, such synthetic biomaterials were called bioceramics. In principle, bioceramics can be prepared from diverse materials, but this review is limited to calcium orthophosphate-based formulations only, which possess the specific advantages due to the chemical similarity to mammalian bones and teeth. During the past 40 years, there have been a number of important achievements in this field. Namely, after the initial development of bioceramics that was just tolerated in the physiological environment, an emphasis was shifted towards the formulations able to form direct chemical bonds with the adjacent bones. Afterwards, by the structural and compositional controls, it became possible to choose whether the calcium orthophosphate-based implants remain biologically stable once incorporated into the skeletal structure or whether they were resorbed over time. At the turn of the millennium, a new concept of regenerative bioceramics was developed and such formulations became an integrated part of the tissue engineering approach. Now calcium orthophosphate scaffolds are designed to induce bone formation and vascularization. These scaffolds are often porous and harbor different biomolecules and/or cells. Therefore, current biomedical applications of calcium orthophosphate bioceramics include bone augmentations, artificial bone grafts, maxillofacial reconstruction, spinal fusion, periodontal disease repairs and bone fillers after tumor surgery. Perspective future applications comprise drug delivery and tissue engineering purposes, because calcium orthophosphates appear to be promising carriers of growth factors, bioactive peptides and various types of cells.

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Nanolipoblockers: Biomaterial therapeutics aimed at the ground zero of atherosclerosis and heart disease

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Statement of the Problem: The uncontrolled accumulation of oxidized low-density lipoproteins (LDL) within the walls of blood vessels, called atherosclerosis, lies at the core of cardiovascular diseases and causes a staggering toll on adult mortality and rising health care costs.

Methodology & Innovation: Biomaterials as anti-atherosclerotic therapeutics for inhibiting cholesterol accumulation and the related inflammation. A generation of unimers whose surface features such as surface anionic density; amphiphilicity; and nanoscale architecture can be systematically varied was designed. Competitive binding to scavenger receptors was used as a key mechanism of action. Serum-stable nanoparticles were fabricated from the unimers using flash nanoprecipitation and the NLB nanoparticles were administered *in vivo* to treat the progression of atherosclerosis.

Findings & Conclusions: We report that assemblies of such nanolipoblockers (NLBs) can systematically block the scavenger receptor molecules that traffic highly oxidized LDL into macrophages and inhibit the resulting atherogenic phenotype. In parallel, a multimodal strategy of depleting cellular cholesterol was examined by using the NLBs as drug delivery carriers *in vivo*. The NLBs lowered intimal levels of accumulated cholesterol and inhibited macrophage retention relative to non-treated controls. A number of more recent project directions, including studies of molecular mechanisms of action, design of more stable nanoparticle formulations of the NLBs, and emergent pathways for translational medicine will also be highlighted in this talk.

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