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Exploring borate bioactive glass nanoparticles: From material design to bone regeneration potential

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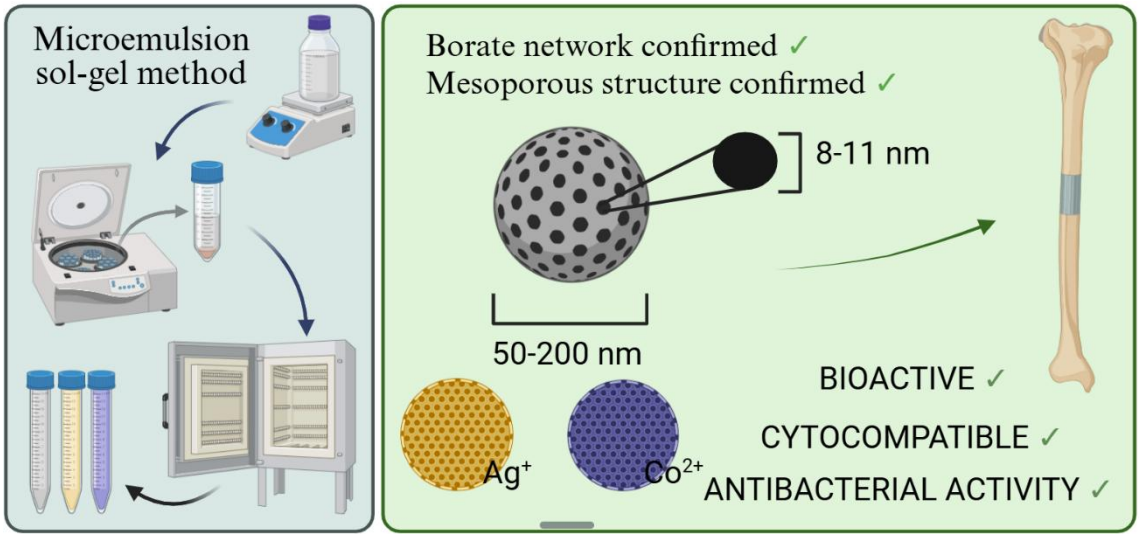
Project.

Topic / keyword. Bioactive glass, bone regeneration

Abstract.



Growing interest in bioactive materials is arising from the increasing clinical demand for effective bone graft substitutes as a result of trauma, bone-related diseases, or surgical interventions. Search for materials that not only provide mechanical support but also

actively promote cell integration and bone healing. Among these, bioactive glasses stand out as one of the most promising classes of biomaterials. These materials can bond directly to bone and stimulate tissue regeneration through surface reactions that occur in physiological environments [1,2]. Since the development of the original silicate-based 45S5 Bioglass® by Larry Hench in 1969, research into bioactive glasses has significantly expanded and the 45S5 remains a gold standard in the field [3]. While silicate-based bioactive glasses have shown excellent bioactivity, borate-based glasses are gaining increasing attention. In these materials, boron oxide (B_2O_3) replaces part or all of the silica in the glass network, resulting in faster degradation rates, enhanced and tunable ion release profile, and demonstrated potential to promote osteogenesis and angiogenesis. Despite these promising characteristics, borate-based bioactive glasses are still less extensively studied compared to their silicate counterparts [1]. This research, therefore, focuses on the synthesis and characterization of novel borate-based bioactive glass compositions, gaining mesoporous borate bioactive glass nanoparticles (MBGNs) doped with higher and lower concentrations of silver (Ag^+) and cobalt (Co^{2+}) ions. The resulting particles were nanoscale and exhibited mesoporosity, providing a high surface area that enhances ion exchange and bioactivity. Acellular bioactivity tests conducted in simulated body fluid confirmed the formation of a hydroxyapatite-like layer on all samples, indicating their potential to form bonds with bone tissue. Additionally, cytotoxicity assays were performed to assess the biocompatibility of the doped MBGNs. The aim of this research is to deepen the understanding of borate bioactive glass nanoparticles (MBGNs) and their potential for future biomedical applications. Building on the findings of this study, future research will focus on incorporating ion-doped borate MBGNs as fillers in polymeric scaffolds and coatings for use in bone tissue engineering.

References.

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