Biocompatible Chitosan Scaffolds for Bone Tissue Engineering and Cancer Cell Eradication

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Abstract

The treatment of bone tumours presents a dual challenge: eliminating residual cancer cells and promoting bone regeneration after surgical removal. Multifunctional scaffolds provide an innovative solution by addressing both issues simultaneously.
This work presents the development of a hybrid scaffold designed to support bone regeneration while also enabling localized cancer therapy (Figure 1). Chitosan was selected as the scaffold matrix due to its excellent biocompatibility and osteoinductive capacity. To enhance the scaffold's mechanical integrity and bioactivity, nano-hydroxyapatite—closely resembling the mineral component of bone—was incorporated. Magnetite nanoparticles were also added to reinforce mechanical strength and enable magnetic hyperthermia for targeted cancer cell destruction.
The scaffolds were produced using freeze-drying, which yielded highly porous, interconnected structures ideal for bone tissue engineering. Compared to pure chitosan scaffolds, the hybrid systems showed improved mechanical stability, lower degradation rates, and excellent swelling behaviour, beneficial for cell attachment and nutrient transport. Their biocompatibility was verified through the successful culture of Saos-2 osteogenic sarcoma cells, which exhibited high viability in live/dead assays. Magnetic hyperthermia tests demonstrated that the scaffolds could generate therapeutic heat; exposure to 42 °C for 10 minutes resulted in a notable decrease in cancer cell viability, confirming the scaffolds' potential to combat residual tumour cells through localized hyperthermia.
In summary, the developed chitosan-based hybrid scaffold shows promise as a dual-function platform for both bone regeneration and post-surgical cancer treatment via magnetic hyperthermia.

Figure

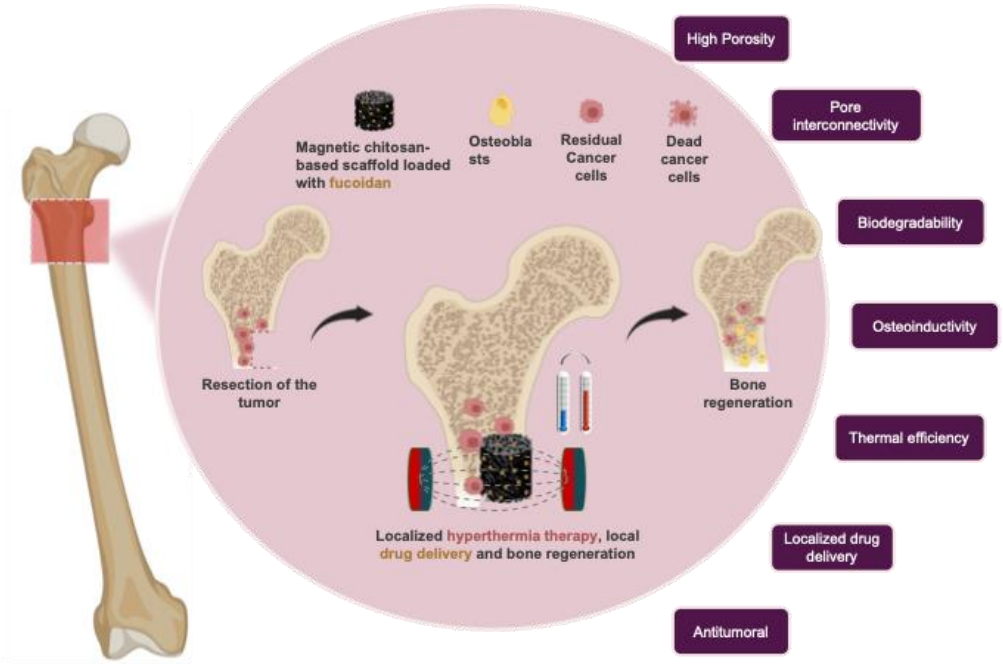

Figure 1: Scheme of the development of the scaffold to support bone regeneration and localized cancer therapy.