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Influence of pathological microenvironments on mesenchymal stem/stromal cell fate: role of long non-coding RNAs in bone-related diseases

Key words: Mesenchymal stem/stromal cell (MSC); Long non-coding RNA (lncRNA); Microenvironment; Cell differentiation; Bone disease

Summary

Pathological bone microenvironments—inflammatory, hypoxic, and ECM-altered niches—rewire MSC fate decisions through lncRNA networks. This review systematically catalogs lncRNA-mediated regulatory axes that drive osteogenic/adipogenic imbalance, highlights exosome-mediated lncRNA transfer as a key communication mechanism, and outlines therapeutic strategies to restore MSC function in bone-related diseases.

Highlights

- Pathological niches (inflammation, hypoxia, ECM stress) provoke lncRNA dysregulation that shifts MSC lineage commitment.
- LncRNAs control osteogenesis vs. adipogenesis via miRNA sponging, epigenetic scaffolding, and transcriptional modulation.
- Exosome-shuttled lncRNAs (e.g., *MALAT1*, *H19*) propagate disease signals and suppress osteogenic programs.
- Disease-specific lncRNA signatures serve as diagnostic biomarkers and reveal convergent regulatory nodes.
- Targeting lncRNA networks or engineering exosomes offers cell-free therapeutic opportunities for bone repair.

Schematic illustration

