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Role of the immune microenvironment in bone regeneration and progress in immune-modulating bone nanobiomaterials

Key words: Immune microenvironment; Bone defect; Bone regeneration; Immunomodulation; Bone nanobiomaterial

Research Summary

This review focused on the role of the immune microenvironment in bone regeneration and the negative impact of dysregulated inflammation. Additionally, the application of nanobiomaterials with immunomodulatory function in the treatment of inflammatory bone defects is discussed.

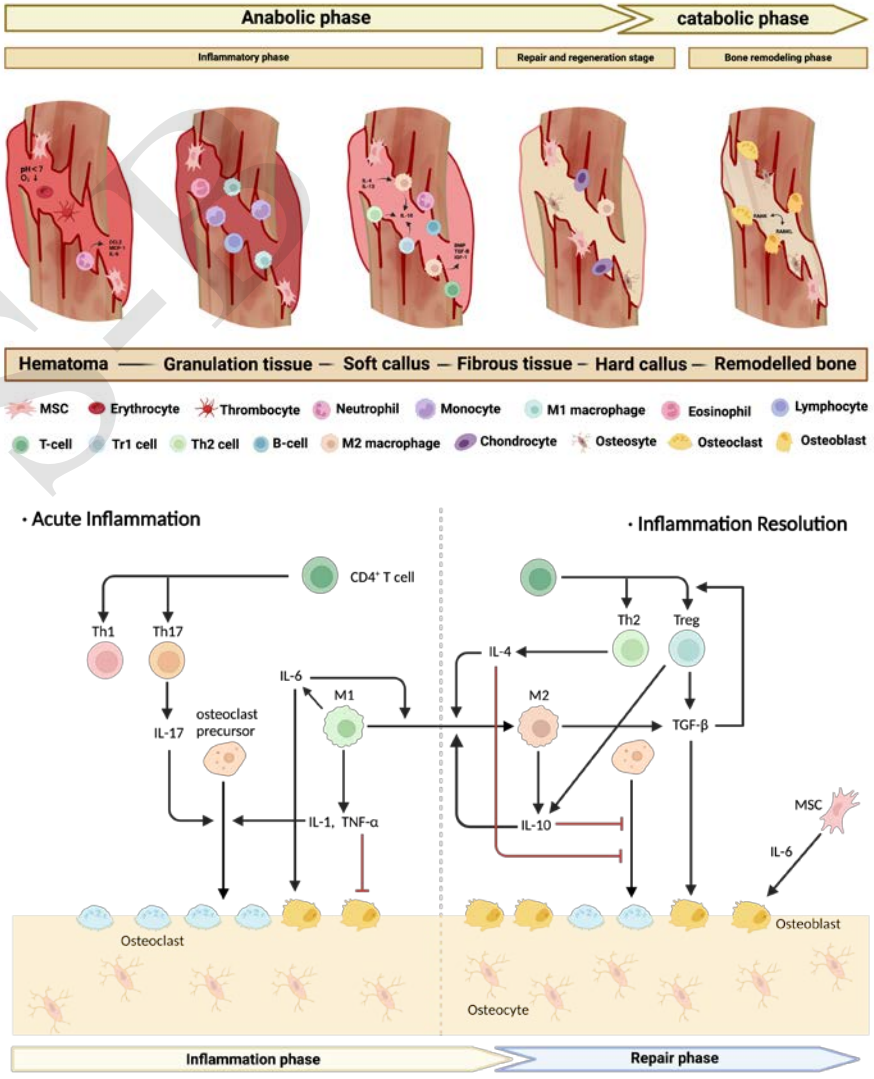
- **Role of the immune microenvironment in bone regeneration**
- **Effect of an abnormal immune microenvironment on bone regeneration**
- **Immunomodulatory bone nanobiomaterials**

Innovation points

- **Introduction** of the entire process of bone tissue healing and the cells and cytokines involved in each process.

- **Summary** of the interactions between the immune and skeletal systems in bone regeneration.

- **Emphasis** on the effects of persistent chronic inflammation on bone regeneration, for example in periodontitis, diabetes, and physiologic aging.



Innovation points

A series of action pathways of immunomodulatory bone nanomaterials

1 | The inherent characteristics of the biomaterials, particularly their surface physicochemical properties.

2 | The release of relevant ions in the material.

3 | The construction of nano drug delivery systems with small molecule drugs.

Challenge for clinical application: the discrepancies between animal models and human physiology, variability in immune responses, complex fabrication processes, lack of standardized evaluation for immunomodulation, and insufficient regulatory frameworks.