

Immunomodulatory hydrogel

Immunomodulatory [hydrogels](#) are materials designed to interact with the [immune system](#), offering a versatile [platform](#) for various biomedical [applications](#). Hydrogels are three-dimensional networks of hydrophilic polymers that can absorb and retain water, providing a structure similar to natural tissues. When these hydrogels are engineered to have immunomodulatory properties, they can influence immune responses for therapeutic purposes.

Here are some key aspects and applications of immunomodulatory hydrogels:

[Biocompatibility](#) and [Tissue Engineering](#):

Hydrogels with immunomodulatory properties can be designed to be biocompatible, allowing them to integrate seamlessly with host tissues. They are used in tissue engineering applications to create scaffolds that not only support cell growth but also modulate the immune response to promote tissue regeneration.

[Drug Delivery Systems](#):

Immunomodulatory hydrogels can serve as effective drug delivery systems, releasing therapeutic agents in a controlled and sustained manner. These hydrogels can be loaded with immunomodulatory drugs to regulate immune responses locally, such as promoting anti-inflammatory effects or enhancing the immune response against specific pathogens or cancer cells.

[Vaccines](#):

Hydrogels can be utilized as vaccine carriers, allowing for controlled release of antigens and adjuvants. The immunomodulatory properties of these hydrogels can enhance the immune response to vaccines, potentially improving the efficacy of vaccination.

[Wound Healing](#):

Immunomodulatory hydrogels can be applied in wound healing to regulate inflammation and promote tissue repair. They may release growth factors or other bioactive molecules that modulate immune cell behavior, facilitating a more controlled and efficient healing process. [Anti-Inflammatory Therapies](#):

Hydrogels can be engineered to release anti-inflammatory agents, providing a local and sustained therapeutic effect. These materials may be applied in conditions where chronic inflammation is present, such as in autoimmune diseases or chronic wounds. [Cancer Immunotherapy](#):

Immunomodulatory hydrogels can be used in cancer immunotherapy to create local environments that stimulate the immune system against cancer cells. They may deliver immune checkpoint inhibitors or other therapeutic agents to enhance the anti-tumor immune response. [Regulation of Immune Cell Behavior](#):

Hydrogels can influence immune cell behavior by providing physical cues, presenting specific signaling molecules, or serving as a matrix for immune cell infiltration. These materials may be designed to either enhance or suppress immune responses based on the therapeutic goals.

[Personalized Medicine](#):

The tunable nature of hydrogels allows for the development of personalized immunomodulatory therapies tailored to individual patient needs. Research in the field of immunomodulatory hydrogels continues to expand, offering exciting possibilities for the development of innovative therapies across various medical disciplines. These materials hold promise for addressing complex immune-related disorders and improving the outcomes of diverse biomedical interventions.

Skin wounds significantly impact the global **health care system** and represent a significant burden on the **economy** and **society** due to their complicated dynamic healing processes, wherein a series of immune events are required to coordinate normal and sequential healing phases, involving multiple immunoregulatory cells such as **neutrophils**, **macrophages**, **keratinocytes**, and **fibroblasts**, since dysfunction of these cells may impede skin **wound healing** presenting persisting **inflammation**, impaired **vascularization**, and excessive **collagen** deposition. Therefore, cellular target-based **immunomodulation** is promising to promote **wound healing** as cells are the smallest unit of life in **immune response**. Recently, **immunomodulatory hydrogels** have become an attractive avenue to promote skin **wound healing**. However, a detailed and comprehensive **review** of cellular targets and related hydrogel design strategies remains lacking.

He et al. reviewed, the roles of the main **immunoregulatory cells** participating in skin wound healing are first discussed, and then we highlight the cellular targets and state-of-the-art design strategies for immunomodulatory hydrogels based on immunoregulatory cells that cover defect, infected, diabetic, burn and tumor wounds and related scar healing. Finally, they discuss the barriers that need to be addressed and future prospects to boost the development and prosperity of immunomodulatory hydrogels ¹⁾

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He Y, Cen Y, Tian M. **Immunomodulatory hydrogels** for skin **wound healing**: cellular targets and design strategy. J Mater Chem B. 2024 Jan 29. doi: 10.1039/d3tb02626d. Epub ahead of print. PMID: 38284157.

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