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Commentary

Biocompatible Polymers as Promising Therapeutic Substrates for Engineered Probiotic Bacteria

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DESCRIPTION

For the potential therapy of several illnesses, the use of transgenic bacteria as live medicinal agents has been suggested. The effectiveness of living bacteria-mediated therapy still depends on the growth of safe and efficient treatment methods. Due to their adaptable physicochemical characteristics, good bioactivities, and superior preservation of labile payloads, hydrogels have shown particular potential for the distribution of living bacterial treatments. The hydrogel design guidelines for living bacteria-mediated therapy, review recent developments in the delivery of living bacterial agents *via* hydrogels for the treatment of common diseases, such as cancer, skin fungal infections, wound healing, and digestive health, and talk about the field's current challenges and potential future directions for these approaches.

With the development of synthetic biology and biomaterials technology, it is anticipated that the significance of hydrogel-based alive bacteria-mediated treatment will continue to rise. In recent decades, bacteria, a major microbial species that plays a significant role in the development of human health and disease, have been promoted as emerging living therapeutic candidates for the treatment of disease and the maintenance of health, including the treatment of cancer therapy, genitourinary tract diseases, skin wounds, and digestive diseases. Despite the growing interest in the topic of bacteriotherapy, there are still some significant obstacles to overcome before it may be used in clinical settings.

The critical aspects for living bacteria-mediated therapy include how to selectively restrict the *in vivo* clearance and inactivation of live bacterial therapies and sustain adequate local responses after injection. According to analyses from preclinical and clinical investigations, bacterial treatment also needs to have ambiguous toxicity and harmful side effects. Innovative approaches are therefore urgently required to solve these issues. Controlling colonisation and delivery is one of the most efficient ways to improve bacteriotherapy because it not only helps the microorganism successfully overcome the major difficulties associated with it but also increases the concentration of bacterial therapies and reduces toxicity to healthy tissues.

For instance, the approach of altering the bacterial surface through physical, chemical, or biological techniques has frequently been used to enhance the additional capacities of the bacteria, improve their delivery behaviour, and promote the efficacy of bacteriotherapy in order to overcome the aforementioned challenges. The therapeutic application of surface-modified bacteria is still constrained by a number of challenges (such as bacterial survival, the first-pass impact, systemic infection concerns, etc.), despite significant advancements in the treatment of diseases caused by live bacteria. Another viable alternative is local administration, which can decrease the microbial clearance rate and the danger of systemic infection while also increasing the concentration of tailored therapeutic bacteria at the target region.

The local delivery of tailored medicinal bacterial strains and bacteriotherapy has found promise in the application of living bacteria hydrogel compositions. Desirable classes of biomaterials are Three-Dimensional (3D) hydrogels because of their adaptable physicochemical and biological characteristics. These semisolid materials are frequently utilised in 3D-printed living materials, synthetic biology, medical implants, biosensors, and cell culture. Particularly, hydrogels have received a lot of interest as prospective drug delivery platforms since they not only allow for the spatial and temporal regulation of the release of different therapies but also provide a straightforward way of administration for complex medication regimens.

Hydrogels have also offered a variety of special benefits for the administration of bioactive therapeutics. These materials, for instance, exhibit outstanding mechanical compliance, adjustable chemical permeability, and strong biocompatibility that are comparable to the extracellular matrix and helpful for preserving the biological activities of bioactive therapies. The development of innovative gel cream bioactive drug delivery methods has been ongoing in recent decades to improve the treatment of a variety of illnesses as a result of the benefits mentioned above. Growing interest has been shown, in particular, in the creation of hydrogel delivery methods for living bacteria.

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Hydrogels have a number of special qualities that make them particularly well suited for the delivery of living bacterial therapies as compared to other carriers. First, although having a significantly bigger volume than tiny molecule medications, these massive fabrics can accommodate the bacteria with enough room. Second, hydrogels excellent biocompatibility and adaptable physicochemical characteristics are advantageous for sustaining bacterial viability and enhancing therapeutic efficiency. Third, their reconfigurable pore structure and mechanical attributes offer physical barriers that not only shield living bacteria from possible clearance and inactivation but also administer bacterial therapeutic substances in a safe and controlled way.

Furthermore, by altering the hydrogels' biodegradability, internal charge, and chain hydrophilicity, one may control the adhesion and release behaviour of the bacteria. Because of these innate characteristics, hydrogels are attractive delivery systems for living bacterial therapies. These investigations suggest that due to their high physiological tissue resemblance and adaptable physicochemical features, hydrogels are appealing delivery systems for living bacterial medicines. Hydrogels are a sort of flexible carrier that may be used to deliver a variety of medicines and potent combination therapies. They can protect and intelligently release alive bacterial payloads to the location of the lesion.