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Advancements in Novel Drug Delivery Systems: Broadening the Scope of Targeted Therapies and Precision Medicine

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INTRODUCTION

Solid microneedles are often coated with drugs that dissolve after insertion into the skin, while hollow microneedles are designed to inject liquid formulations. Microneedle patches have gained significant attention due to their ability to deliver both small molecules and larger biological drugs, such as vaccines and insulin, which are typically challenging to administer through the skin. Transdermal drug delivery systems provide several advantages over traditional drug administration routes, including improved bioavailability, controlled drug release, and enhanced patient compliance. Nanoparticles also provide the added benefit of controlled drug release, ensuring that the drug is delivered over an extended period, reducing the frequency of application. Additionally, nanoparticles can be functionalized with ligands that target specific cells or tissues, enabling more precise and effective treatment. Nanotechnology-based transdermal systems have shown great promise in delivering a wide range of drugs, including anti-inflammatory agents, pain relievers, and hormones. Microneedles represent a breakthrough in transdermal drug delivery technology. These tiny, minimally invasive needles can create microchannel in the skin, allowing drugs to bypass the stratum cornea and enter the deeper layers of the skin. Microneedles are typically arranged on a patch and can be either solid or hollow.

DESCRIPTION

Transdermal drug delivery is a rapidly evolving field that offers a non-invasive and patient-friendly approach to administering therapeutic agents through the skin. This method allows drugs to be absorbed directly into the bloodstream, bypassing the digestive system and avoiding the need for injections. In addition to their efficacy, microneedle patches are pain-free and can be self-administered, making them an attractive option for patients. Iontophoresis is another advanced technique used in transdermal drug delivery. This method involves the application of a small electrical current to drive charged drug molecules through the skin. Iontophoresis enhances the movement of drugs across the stratum cornea without damaging the skin. It has been successfully used to deliver a variety of drugs, including local anaesthetics, anti-inflammatory agents, and peptides. One of the major benefits of iontophoresis is its ability to deliver drugs on-demand, allowing for precise control over the amount and timing of drug release. In addition to these technologies, transdermal patches have become one of the most popular forms of TDDS. These adhesive patches are applied directly to the skin and contain a reservoir of the drug, which is gradually released over time. Patches provide a steady and controlled release of medication, maintaining therapeutic drug levels in the bloodstream for extended periods. This method is particularly useful for delivering drugs with a narrow therapeutic window, where maintaining stable blood concentrations is critical.

CONCLUSION

Transdermal patches have been successfully used for various conditions, such as chronic pain, hypertension, and hormone replacement therapy. While transdermal drug delivery offers many advantages, it is not without limitations. The skin's barrier properties restrict the types of drugs that can be effectively delivered transdermal. Drugs must be small, lipophilic, and potent enough to achieve therapeutic effects at low concentrations. Additionally, the potential for skin irritation or allergic reactions is a concern, particularly with long-term use of transdermal systems. While challenges remain, particularly in overcoming the skin's natural barriers, the future of transdermal drug delivery looks promising as research continues to drive innovation in this area.

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