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Smart Nanoplatforms: Chitosan Nanoparticles for Next-Generation Antimicrobial Strategies

Smart Nanoplatforms: Chitosan Nanoparticles for Next-Generation Antimicrobial Strategies

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Abstract
Antimicrobial resistance (AMR) is a growing global health concern that limits the effectiveness of many antibiotics. To address this challenge, nanotechnology is being explored for innovative antimicrobial solutions. Chitosan, a natural biopolymer derived from chitin, offers unique advantages such as inherent antimicrobial activity, safety, and biodegradability. When formulated into nanoparticles, chitosan becomes a smart nanoplatform capable of both directly attacking pathogens and delivering therapeutic agents.
Chitosan nanoparticles (CNPs) disrupt microbial membranes, inhibit biofilm formation, and enable controlled drug release. They can also be combined with antibiotics or metals to enhance treatment and restore antimicrobial sensitivity. Recent advances include stimuli-responsive systems, where CNPs release drugs in response to changes in pH, temperature, or enzymes, ensuring precise delivery at infection sites. These features reduce side effects and improve treatment outcomes.
Although large-scale production, regulatory approval, and long-term safety remain challenges, CNPs show strong potential as next-generation antimicrobial strategies. By combining natural bioactivity with nanotechnology, chitosan nanoparticles represent a promising tool in managing infections and combating resistance.
Keywords: Chitosan nanoparticles, antimicrobial resistance, smart nanoplatforms, biofilm inhibition, drug delivery

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