## Manipulation of Nanoparticles to Control Multidrug Resistant Bacteria

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## Introduction

Antibiotic resistance against bacterial microbes is considered as an alarming phenomenon that needs to be addressed urgently to have better therapeutic solutions. Bacterial strains, which gained resistance to antibiotics, are referred to as "Multidrug resistant (MDR) bacteria" [1]. According to Rai et al. [2] the resistant bacteria include both Gram positive and Gram negative species such as multidrug resistant (MDR) *Klebsiella pneumonia*, vancomycin-resistant *Enterococcus faecium* (VRE), methicillinresistant *Staphylococcus aureus* (MRSA), *Enterobacter* spp. and *Pseudomonas aeruginosa*.

Tanwar et al. [3] defined antibiotic resistance as the insensitivity of the microbe to a compound to which it was previously sensitive. The major problems of microbial resistance is their environmental dissemination and absence of new compounds capable of controlling these microbes [4]. One way of control is by killing these pathogens through overcoming their resistance to most antibiotics.

Nanotechnological applications are offering promising solution for this problem through killing these microbes before they acquire resistance [1]. Meanwhile, successful usages of nanotechnology in our life have generated new methods for the development of effective antimicrobial compounds or nanoantimicrobials, capable of overcoming this problem of microbial drug resistance. The development and safe manipulation of these nanoantimicrobials will make a new promise to cure these health problems [2].

Panyam and Labhasetwar [5] stated that nanoparticles could deliver antibacterial agents to their sites of action so quickly and in significant amounts that microbes cannot gain resistance to them. Because of the minute size of these nanoparticles, they can penetrate easily through the microbial epithelial and capillary tissues. It is deduced that reducing particle size from 275 nm to 100 nm or lesser; could increase drug absorption almost about three times.

Polymeric nanoparticles such as those made of cellulose, starch, gelatin and chitosan have potent antimicrobial activities because of their various positive properties [6]. Chitosan nanoparticles kill bacteria either by interacting with negatively charged DNA or by creating pores in their cell membranes which cause leakage of vital cellular contents [7].

In reference to Santos et al. [8] silver (AgNPs) and gold (AuNPs) nanoparticles act on different components and functions of the microbial cell, thus creating much more difficulty for developing drug resistance. Moreover, Singh et al. [9] added that both chemically and green synthesized AgNPs have excellent antimicrobial potencies against drug resistant pathogens. In accordance, recent studies of Patra and Baek [10], Thapa et al. [11] confirmed that AgNPs possess significant antimicrobial activities against various microorganisms including MDR pathogens.

Abed et al. [12] developed nano-sized device coupled with antibiotics, capable of intracellular delivery of beta lactam antibiotics into bacteria to overcome their resistance. Combining nano-carriers with drugs other several advantages over traditional therapy such as; a)-controlled drug release at certain sites of action which increase its efficiency, b)-bioavailability of drugs in appropriate concentrations together with their prolonged effects, c)-improved solubility of hydrophobic drugs and d)-more than one drug could also be delivered at target cells [13]. Nanoparticles inhibit bacterial growth by inhibiting cell wall, protein synthesis and by causing alterations in their cell membrane [14].

Wacker et al. [15] concluded that despite the several advantages and efficient applications of nanoparticles in combating MDR pathogens, their toxicity and safety problems opposed their potent and safe use. Later, Rai et al. [2] explained that presence of nanoparticles in the environment which could be internalized via the respiratory system, digestive system or direct entry through damaged skin, are the main reasons limiting their manipulation.

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