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Short Communication

Nanotechnology in Prevention of Antibiotic Resistance

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Infectious diseases persist one of the foremost causes of mortality and morbidity worldwide. The current coronavirus outbreak has brought infectious diseases to the forefront of our minds. The crisis is unparalleled and devastating. Antibiotics are generally used to inhibit and treat the bacterial infections. They have a significant impact in combating several infectious diseases like pneumonia, meningitis, typhoid, fever, tuberculosis, and also Covid-19 in this 21st century. Excessive and bizarre use of antibiotics in the previous few decades leads to bacterial resistant to the presently available antibiotics. According to the WHO, the rapid emergence of antibiotic resistance is one of the prevalent threats to universal health, food security, and today's advancement.

Owing to the unique morphological and physicochemical properties including improved therapeutic efficacy, nanoparticles (NPs) are considered as the most promising tool to address this challenge evolved, and a research interest has been broadly curved towards nanotechnology-based devices for searching out the solution. When opposed with such an imbalance between the prompt evolution of bacteria and discovery of new antibiotics, researchers have focused their attention to develop different nanomaterials for preventing this antibiotic resistance. It has been evidenced that nanotechnology has the sufficient proficiency to tackle the difficulty raised through either improving the potency of existing antibiotics or generating entirely new antibacterial mechanisms without antibiotics.

Nanomaterials can convey programmed release of a single or multiple antibiotics to the bacteria in such a mechanism that drug potency is increased by reducing the drug exposure. These nanomaterial-based drug candidates are proficient to overcome the cellular barriers and transport antibiotics to the cytoplasm for destroying intracellular bacteria. Nanomaterials can also cause lethal damages to the pathogens without using antibiotics through physical or biochemical methods.

MARA - Molecular Analytical Robotics Assays project sponsored by the FET Open program of the European Commission, directed by Austrian Institute of Technology is one of the significant milestones from recent research improvements in the DNA-based nanotechnology which can assist to reduce the excessive usage of antibiotics by constructing them more targeted. It resulted in slow down the improvement of antibiotic resistance.

Titanium dioxide (TiO_2) and zinc oxide (ZnO) loaded metallic nanomoities can cause cell membrane damage and generate reactive oxygen species to destroy bacteria. Nanomaterials stabilized by polymers can act as active therapeutic agents against numerous antibiotic resistant infectious diseases. For example, silver bromide (AgBr) nanoparticles stabilized with a cationic polymer were extremely proficient to eradicate both gram-positive and gram-negative bacterial strains.

However, few experimental confirmations gathered from Pubmed, Google scholar, Researchgate, and other research oriented databases over the last century suggest that the continuous exposure of metallic NPs especially loaded with silver and copper might ease the spread of antibiotic resistance among bacteria by means

of either mutation or without any substantial genetic deviations in different bacterial species as well as horizontal gene transference of antibiotic-resistant genes.

The wide spread antibiotic resistance has laid immense pressure on pharmaceutical sector to find out new antibacterial agents and modify the existing drugs. Hence further research work is still required in order to elucidate the entire mechanism of action of nanoparticles as bactericidal, reduce toxicity of nanoparticles in human body and design better drug delivery for human system using nano-drug carriers.

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