# Analysis of Nanomaterial-Antibiotic Complexes to Limit Antibiotic Resistance

Ghosh, Abhijeet (School: George Walton Comprehensive High School)

Antimicrobial resistance is expanding at an alarming rate, becoming the greatest global challenge of the 21st century with bacteria developing resistance to some of the best antibiotics and becoming near untreatable in severe cases. Additionally, new antibiotics are far from reaching the market. To mitigate the predicted 10 million deaths each year by 2050, research is steeply accelerating to develop novel methods for improving the efficacy of the existing antibiotics. Recently, nanomedicine offered a promising avenue. Nanocarriers (nanoparticle-antibiotic complexes) have been shown to substantially improve antibiotic's applications and work as targeted adjuvants, significantly hindering bacterial resistance development. Nanoparticles increase bacterial cell membrane permeability, generate reactive oxygen species, slow down antibiotic expulsion, thereby resulting in bacterial cell death faster. However, despite being a highly efficient drug delivery system, cytotoxicity of nanoparticles against complex organisms presents a significant safety challenge. This study explored the in vitro effectiveness and safety of three distinct nanocarriers: silver, gold, and chitosan, loaded with ampicillin against E. coli, alongside their in vivo off-target effects using C. elegans. The findings established the effectiveness of silver-NP-ampicillin complexes in combating antimicrobial resistance explained by the increased bond strength between silver and ampicillin, preventing their entry into the eukaryotic cells, accumulation inside the bacterial cells, and the slow release of ampicillin, requiring a lower dose of ampicillin to have the same antibacterial effect as with the higher dose of plain ampicillin.

**Awards Won:**