Design of potent antimicrobial and biocompatible gold nanoparticles

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Abstract:

With significant advances in nanotechnology over recent years, nanomaterials with unique chemical and physical properties have gained increasing interests in biotechnological, biomedical and pharmaceutical fields[1]. Gold nanoparticles are prime candidates as novel carriers to deliver drug, DNA and enzymes owing to their larger surface area to volume ratio and no toxicity to human cells[2]. Among potential drug molecules, the conjugation of antimicrobial peptides with metal nanoparticles has several advantages such as increasing the half-life of the antimicrobial peptides, enhancing the activity against microorganisms as well as improving the chemical stability under a wide range of storage conditions. The process of conjugating antimicrobial peptides with metal nanoparticles is a complex chemical process and requires multiple steps involving the synthesis of metal nanoparticles, surface functionalization and finally coating of the peptides.

In this work, we have shown one pot synthesis of gold nanoparticles and their capping with antimicrobial peptide (name not disclosed due to confidentiality) in the presence of HEPES buffer. Different sizes of spherical gold nanoparticles are synthesized using antimicrobial peptide at buffer pH ranging from 5 to 7.5. The rate of reduction of gold ions in aqueous solution is controlled by cysteine residue of peptide, which plays an important role in controlling the size of the gold nanoparticles. Fourier transform infrared spectroscopy (FTIR) revealed that the capped antimicrobial peptides on the gold nanoparticle surface have random coiled secondary structures while the native peptides contain α-helix and β-sheet structures[3]. Antimicrobial peptides adopt α-helical structures in the presence of membrane, which trigger them to act as potent antimicrobial agents[3]. Antimicrobial peptide capped gold nanoparticles exhibit potent antimicrobial activity against Gram positive (*Staphylococcus aureus*) and Gram negative (*Escherichia coli*) bacteria as compared to peptide alone in the presence of human serum. The enhanced antimicrobial activity is due to the combined action of antimicrobial peptide and gold nanoparticles, which increases the permeability of bacterial cell membranes, resulting in the leakage of cell contents and eventually cell death. We further showed that the synthesized gold nanoparticles are biocompatible to Human Umbilical Vein Endothelial Cells (HUVECs) and Normal Human Dermal Fibroblast cells (NHDF) up to 100 μg/mL while 20 μg/mL antimicrobial peptide alone is cytotoxic to these cells, indicating that the peptide coated gold nanoparticles can be used as potent antimicrobial materials to treat infectious diseases.

References:

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