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Active Nanoparticles for Delivery of Antibiotics

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Abstract – Microbial infections are increasing at an alarming rate across the world. Delivery of antimicrobial agents in effective concentration at the site of infection is a major hurdle in the treatment of infections. Among the infections, Staphylococcus aureus-mediated infections are often chronic in nature and highly resistant to antibiotic therapy. Therefore, it is possible that the ability of bacteria to persist intracellularly offers the bacteria a route to evade antibiotic treatment, which could subsequently lead to recurrent infections. So a drug delivery system which could effectively deliver the drug both intracellularly and extracellularly is needed to treat these infections.

In recent years, nanotechnology based drug delivery systems have gained attention in pharmaceutical and medical research. Outcomes of the studies from different researchers show that biodegradable and biocompatible polymeric nanomaterials are promising tools for drug delivery and effective in controlling microbial infections.

A preliminary study conducted in this lab proved that poly(D,L-lactide-co-glycolide) (PLGA) nanoparticles loaded with quantum dots were able to diffuse into mouse osteoblasts. In the current study PLGA nanoparticles loaded with the β-lactam antibiotic nafcillin were prepared by single emulsion/solvent evaporation method. Different copolymers of PLGA such as PLGA 50:50 and PLGA 75:25 were used for the study. Particle size, zeta potential and drug loading of these nanoparticles were determined. A drug release study of these particles was performed in an incubator shaker at 37°C in phosphate buffer saline. It showed a biphasic release; a burst release phase, and a slow release phase. A range of 32-47% of the drug was released within the first 48 hours and the remaining drug was released in an extended period of 35-40 days. Mathematical modeling of this drug release profile was also done to yield information for future rational designing of therapeutic nanomaterials. Modeling results show that a reservoir model is the best fit for the release of nafcillin from PLGA nanoparticles.

Viability studies of the nanoparticles were performed. The outcome of this study has proved that nafcillin loaded PLGA nanoparticles are an effective drug delivery system. These nanoparticles are useful tools in the treatment of microbial infections.