Biomaterials for drug and antimicrobial nanoparticle delivery

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Advances in biomaterials science are critical to the development of next generation biomedical devices and innovation in tissue engineering. In addition to functioning as devices and scaffolds, biomaterials can also be designed to locally deliver therapeutics, whether these are small molecules, large biomacromolecules, or nanoparticles. The biomaterial must be tailored to allow the desired spatiotemporal delivery of the cargo of interest. In this talk, we will discuss the development of several biomaterials systems for the delivery of therapeutic molecules and nanoparticles for a variety of medical applications.

First, we will describe the development of two biomaterial systems for cardiovascular stent applications. In the first example, the antiproliferative drug everolimus was delivered from an endothelial cell specific and hemocompatible coating of recombinant spider silk for use as stent coatings.[1] Next, we developed amphiphilic core crosslinked star polymers with a core of PEG and a corona of PCL. These star polymers acted as nanocarriers for hydrophilic drugs that required delivery from hydrophobic polymer matrices. Specifically, the hydrophilic core of these star polymers was loaded with the hydrophilic anticoagulant heparin and blended into a matrix of PCL to increase loading and delivery of the hydrophilic therapeutic from the hydrophobic matrix for biodegradable stent applications.[2]

We are also actively developing nanoparticle systems to combat multidrug resistant bacteria. Specifically, we focus on creating selenium nanoparticle systems that have broad spectrum activity against Gram positive, Gram negative, and multidrug resistant bacteria at cytocompatible doses. We envision these particles being used in coatings or scaffolds to provide antimicrobial activity, with target applications in the orthopaedic and wound healing spaces. In the second example, a pH-responsive alginate-based wound dressing was developed to allow increased delivery of antibiotics or selenium nanoparticles upon changes in wound pH that indicate the presence of a bacterial infection.[3]

References:

[1] Mayer, et al. REDV-functioanlised recombinant spider silk for next generation coronary artery stent coatings: heamocompatible, drug-eluting, and endothelial cell-specific materials. Under review.
[2] Somszor, et al. 2021. Amphiphilic core cross-linked star polymers for the delivery of hydrophilic drugs from hydrophobic matrices. *Biomacromolecules*. 22(6):2554-62.
[3] Huang, et al. 3D printed and smart alginate wound dressings with pH-responsive drug and nanoparticle release. Under review.