Amgen Seminar Series in Chemical Engineering

in

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Biocompatibility or Toxicology? Oxidative Stress as a Focal Point of Nanomaterial Design

By

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Of the weapons employed by the body's defense mechanisms, oxidative stress appears to be the most ubiquitous, non-specific, and damaging. When oxidative mechanisms have been induced (e.g., the leukocyte respiratory burst), it can result in a degenerative cycle of chronic inflammation and cell death, which further stimulates the release of more harsh oxidants. However, under mild conditions, this oxidative stress stimulates tissue regeneration and cellular upregulation of protective mechanisms (e.g., ischemic preconditioning), improving the overall viability and prognosis of tissue health. A delicate balance of pro-oxidant and antioxidant mechanisms constitutively exist to ensure that only the beneficial effects are observed. For nanomaterials, oxidative stress poses an especially troubling challenge to their biocompatibility. Indeed, no material is in all biological settings and situations 100% non-inflammatory, non-toxic, non-teratogenic, non-carcinogenic, non-thrombogenic, and non-immunogenic. Yet, while it is classically considered a mechanism of toxicity, regulation of oxidative stress can be a new tool by which we tune and widen the biocompatibility window of nanomaterials. Here we present some initial efforts in creating materials with inherent antioxidant capabilities to tune and control biocompatibility for the effect of controlling chronic inflammation.

Bio: Dr. Thomas Dziubla, Ph.D. is Professor of Chemical Engineering and the Chair of the Department of Chemical and Materials Engineering at the University of Kentucky. He received his B.S. and Ph.D in Chemical Engineering from Purdue University (1998) and Drexel University (2002), respectively. In 2002–2004, he was an NRSA postdoctoral fellow in the Institute for Environmental Medicine at the University of Pennsylvania School of Medicine, where he worked on the design of degradable polymeric nanocarriers for the delivery of antioxidants. His research group is interested in the design of new functional polymeric biomaterials which can actively control local cellular oxidative stress for improved biomaterial integration and disease treatment. In 2019, he was inducted into the American Institute for Medical and Biological Engineering College of Fellows. He holds 5 patents, has authored over 75 peer reviewed publications, has edited a book on Oxidative Stress and Biomaterials, and is an editor of the Journal of Biomedical Materials Research Part B. Along with Dr. Zach Hilt, he is the Co-founder of Bluegrass Advanced Materials, LLC, a company that is currently developing and commercializing technologies based upon research from their laboratories.

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