The Materials Science & Engineering Program Presents:

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Micro/Nano-Engineering of Material Surfaces for Tissue Engineering and Regenerative Medicine

Surfaces that contain micro- and nanoscale features in a well-controlled and “engineered” manner have been shown to significantly affect cellular and subcellular function of various biological systems. Our research is focused towards using the tools of micro- and nanotechnology for application in orthopedic biomaterials and drug delivery. The goal of current research is to design implants that induce controlled, guided, and rapid healing. In addition to acceleration of normal wound healing phenomena, these implants should result in the formation of a characteristic interfacial layer with adequate biomechanical properties. To achieve these goals, however, a better understanding of events at the bone-material interface is needed, as well as the development of new materials and approaches that promote osseointegration. Our work proposes the use of well-controlled nanostructured interfaces to enhance implant osseointegration. We hypothesize that controlled nanoscale architectures can promote osteoblast differentiation and matrix production, and enhance short-term and long-term osseointegration. Moreover, the ability to create model nano-dimensional constructs that mimics physiological systems can aid in studying complex tissue interactions in terms of cell communication, response to matrix geometry, and effect of external chemical stimuli. By understanding how physical surface parameters influence cellular adhesion and differentiation, we can more effectively design biomaterial interfaces that can be used in a clinical setting. Further, these novel nanostructured surfaces can reliably deliver therapeutic substances from the surface of an implanted medical device. Current delivery methods after implantation include release of protein adsorbed directly on implant surface, in collagen sponges, or in porous coatings and controlled release of protein encapsulated in a biodegradable polymer. These conventional technologies for drug-eluting devices have been successful, but limited in the range of control it provides in terms of release and loading. The short biological half-life, the lack of long-term stability and tissue-selectivity, and their potential toxicity demand platforms that can deliver drugs in a localized and controlled manner. The delivery of drugs from the surface of load bearing orthopedic implants such as total joint replacements is ideal. Complications associated with orthopedic implants can be quite severe. The ability to design implant interfaces which simultaneously enhance osseointegration and deliver therapeutics which may enhance bone growth or fight off infection can have large clinical benefit and help reduce the need for costly and traumatic surgery. Thus, in this work we have also explored the possibility of using these nanostructured surfaces as drug eluting coatings.

Biosketch

Dr. Popat is an Assistant Professor in the Department of Mechanical Engineering/School of Biomedical Engineering at Colorado State University. Prior to that, he was working as a Research Specialist in the Department of Physiology at University of California, San Francisco. He has authored over 40 peer-reviewed publications in journals such as Langmuir, Biomaterials, Journal of Orthopedic Research, Journal of Biomedical Materials Research, etc. and has presented his work at numerous national and international level conferences. He received his Ph.D. in Bioengineering from University of Illinois at Chicago in 2003, M.S. in Chemical Engineering from Illinois Institute of Technology, Chicago in 2000 and B.S. in Chemical Engineering from M. S. University in India in 1998.