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Innovative Bio MEMS devices leveraging nano-fluidic control for drug delivery and cell transplantation

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Nanofluidic controlled delivery devices have the potential for transformative impact across multiple critical medical fields due to their ability to provide sustained release over extended clinical timeframes and mimic endocrine glands by responding to biological stimuli. In this context, biocompatible materials can be engineered at the nanoscale to manipulate and tune functional interactions with molecules and fluids. We have invented two implantable platforms to leverage this capability: A silicon nano-channel membrane and a surface-modified polymer system for drug delivery and cell transplantation, respectively. The silicon membranes are fabricated through cutting-edge implementation of techniques optimized within the microelectronics industry to present dense and mono-dispersed arrays of nano-channels that tightly regulate diffusive transport. These membranes can be integrated within bioinert capsules for minimally-invasive, subcutaneous implantation and sustained release of drugs and biomolecules. The implants have been demonstrated to enable constant, zero-order release for more than 6 months while maintaining consistent serum concentrations within desired therapeutic windows. Further innovations include integration of active control systems to permit remote tuning/activation (telemedicine) and release synchronization with natural circadian rhythms (chronotherapy). Similarly, the polymeric cell transplantation system leverages the newest innovations in polymer chemistry to provide an immunoprotective environment for bioactive allografts. Primarily developed for pancreatic islet transplantation, the "Nano-gland" isolates cells from inflammation and rejection mechanisms while permitting glucose, insulin, nutrient, and waste exchange with the interstitial environment. The system has also been tested with insulin-producing islet like aggregates (ILIPAs) differentiated from mesenchymal stem cells. Composite devices utilizing both platforms have been developed to allow cell transplants to benefit from controlled release of immunosuppressives or factors for cell growth and vascularization. This lecture will focus on silicon and polymer Bio-MEMS technologies as applied to implantable drug delivery systems for the tunable and sustained release of therapeutics and immunoprotective transplantation of insulin-producing cells.

Biography

R Lyle Hood obtained his Bachelor's Degree at University of Houston and his Masters and Ph.D. at Virginia Tech in 2013. His dissertation described the invention and development of a novel fiberoptic catheter design for treating brain and bladder cancers. He is currently a postdoctoral fellow at the HMRI working with silicon nanochannel technologies for therapeutic controlled release and cell transplantation. He has published over a dozen patents and peer-reviewed manuscripts relating to device design and drug delivery.

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