Development of Multifunctional Bioceramics and External Field Stimulated Cell Functionality Modulation: A New Paradigm

In the interdisciplinary field of biomaterials, the phenomenological interaction of a biological cell on a material substrate under normal culture conditions is broadly known and researchers use many approaches to tailor surface modulus or wettability in an effort to enhance cell-material interaction. It is also known that the electrical properties possessed by bone assists the formation/growth, fracture healing as well as controls other metabolic activities [Nature 90, 1217 (1961)]. In this context, the results of a strikingly different approach with the overall objective to develop an integrated approach of understanding the role of material properties together with external field stimulation on cell fate processes in isolation/combination will be presented in this talk. This talk would also address the challenges in designing the synthetic materials to mimic bone-like electrical or piezoelectric properties as well as how to tailor the properties to facilitate better bone cell proliferation or cell differentiation, in general, both in the presence or absence of external electric field stimulation [Biomaterials (2013)]. It will be shown how the intermittent delivery of pulse electric field stimulation can enhance cell growth on electroconductive biomaterial substrates, which are fabricated using a novel processing route (Spark Plasma Sintering). The effectiveness of the above approach will be demonstrated using multiple cell lines (bone cells, neuronal cells, muscle cells, gram positive and gram negative bacteria) as well as on materials with varying stiffness and conductivity properties. This novel approach overcomes the conventional biological approach of various biochemical growth factor additions to enhance cell growth/differentiation in vitro.

- Greeshma Thrivikraman, Prafulla Kumar Mallik and Bikramjit Basu; Substrate conductivity dependent modulation of cell proliferation and differentiation in vitro; Biomaterials 34 (2013) 7073-7085.
- Shilpee Jain, Ashutosh Sharma and Bikramjit Basu, Vertical electric field stimulated neuronal cell functionality on porous amorphous carbon electrodes; Biomaterials 34 (2013) 9252-9263.

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