Stephen J Beebe, J Material Sci Eng 2012, 1:3
http://dx.doi.org/10.4172/2169-0022.S1.001

OMICS Group Conferences
Accelerating Scientific Discovery

International Conference and Expo on
Materials Science & Engineering

October 22-24, 2012 DoubleTree by Hilton Chicago-North Shore, USA

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Bioelectrics in basic science and medicine

Technologies using electric fields have become a major focus at Old Dominion University in Norfolk, Virginia, USA in the Frank Reidy Research Center for Bioelectrics. There are four main technologies that presently makeup Bioelectric applications. These include electroporation, nanosecond pulsed electric fields, picosecond pulsed electric fields and cold plasmas.

The parent technology in Bioelectrics is electroporation, which uses milli- and/or micro-second electric pulses to permeabilize cells and tissues for delivery of membrane impermeable molecules. It is now being used for electro-gene delivery with vascular endothelial growth factor (VEGF) for revascularization in wound healing and cardiovascular and peripheral vascular disease. Plasmids expressing IL-12 are being delivered for immune system activation in melanoma treatment, now in phase II clinical trials. DNA vaccine delivery by electroporation is also being investigated. More recently, electroporation has been extended to include nanosecond pulsed electric fields (nsPEFs), a pulse power technology that was originally designed for military applications. It stores intense levels of electric energy and then unleashes nanosecond bursts of instantaneous power into cells and tissues. This is significant because it creates unique intracellular conditions of high power and low energy. Because the pulses are so short, when using low pulse repetition rates, the method is essentially non-thermal. It is presently being used for cancer ablation of skin and internal tumors and for platelet activation for wound healing in injury and diabetes. An extension of nsPEFs is to make the pulses even shorter using picosecond pulsed electric fields. This is being developed as an imaging system to detect cancer and other aberrant tissues using an antenna. The fourth technology is cold plasmas, a fourth state of matter. Applications of these ionized gasses are being developed for decontaminating wounds, water, food and surfaces. Other possible applications that are of specific interest, but not yet fully investigated and/or developed, are pain control, fat ablation and decontamination of indwelling catheters.

Biography

Stephen J. Beebe, molecular cell biologist / biochemist received his PhD in 1982 from the Medical College of Ohio, (now the Medical School at University of Toledo) in Medical Sciences (Pharmacology/ Biochemistry). He was a post-doctoral fellow at the Howard Hughes Medical Institute and Department of Molecular Physiology and Biophysics at Vanderbilt University, Nashville Tennessee. He was Fulbright Scholar at the University of Oslo, Norway and at the National Hospital and Department of Medical Biochemistry before taking a position as Assistant Professor in the Jones Institute for Reproductive Medicine and then an Associate Professor in the Department of Physiological Science and the Center for Pediatric Research at Eastern Virginia Medical School in Norfolk, Virginia. He is now a Professor at Old Dominion University in the Frank Reidy Research Center for Bioelectrics in Norfolk Virginia.

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