Bio Electric Surface - Publishable summary

According to the World Health Organisation (WHO), cardiovascular diseases cause half the deaths in the EU. It is also the main cause of years of life lost (over 30 per cent) thus causing huge pressure on the labour force and family earnings. The problem is becoming more acute in Central and Eastern European countries. Due to the ageing population in the EU, osteoporosis related bone fractures have almost doubled in the last decade. It is estimated that 40 percent of women over 50 years in age will suffer from fractures due to low density bone. The European Commission considers the application of nanotechnology an important research strategy to address these problems. For this, design and control of biomaterial at the nanometer scale is set as a strategic research priority. Europe is, however, seriously underrepresented in the global market for nanotherapeutics, where the United States dominates with three-quarters of the market share. While the drive for nanoscale understanding of biological interaction can be high, the application of this knowledge in marketable devices should also be prioritised.

In this European Commission funded project, scientists from across Europe and Israel have been carrying out electrical modification of biomaterials surface to manipulate surface charge that will mediate bio/non bio interactions *in vivo*. The project, coordinated by University of Limerick, has commenced in October 2008 and the project team has already developed techniques to probe this surface charge to obtain a quantitative insight into biological interactions (e.g. proteins and cells) at biomaterials' surfaces at the nanometre scale.

Such an insight is important because the first reaction between biological species and a biomaterial takes place at the biomaterial surface. When a biomaterial is placed inside the body, a biological response is triggered almost instantaneously at the top few nanometres of the biomaterial. For devices that remain in the body for a medium to long term, biological interactions can cause encrustation, plaque formation and aseptic loosening in these device surfaces. These problems contribute to patient's trauma and even increase the risk of death.

The BioElectricSurface team has been working with the aim to decrease patients' trauma and the risk of death through a detailed understanding of nanoscale interactions of biological systems with biomaterials' surfaces. In this preceding year the BioElectricSurface consortium has developed methods for electrical modifications of three leading biomaterials: hydroxyapatite (HA), polyurethane (PU) and Titanium dioxide (TiO_2). Biological interactions with these electrically modified surfaces were also studied. Preliminary study showed a selective response of biological species such as antibodies and cells towards charged surfaces. The team is now developing techniques to further enhance this knowledge of biological interactions with charged surfaces and to exploit this knowledge in biomedical devices.

Biomaterials that are currently used in such devices, e.g. in cardiovascular and urinary stents and coatings in hip prosthesis, do not specifically address this interfacial phenomenon in device designs. A detailed knowledge of such interactions at the nanometre scale obtained from this project will not only produce a selective biological response but also pre-screen many inappropriate designs of biomedical devices long before any expensive animal or potentially risky clinical trials. The project thus explores the convergence of nanomanipulation and biophysical, biochemical and materials characterisation. The goal is to develop novel therapeutic devices in four specific biomedical applications: cardiovascular stents, urological stents, orthopaedic implants and grafts, and anti-microbial fabrics.

Further information on the outcome of this project can be found at www.bioelectricsurface.eu or by contacting the following address directly:

Dr. Syed Ansar Md. Tofail,
Project Coordinator, BioElectricSurface,
Materials and Surface Science Institute (MSSI), University of Limerick, Ireland;
Phone: 353-61-234132, Fax: 353-61-213529; email: tofail.syed@ul.ie