Biomaterial Surfaces & Interfaces
Room Milo - Session BI-WeM

Biomolecule/Material Interactions

Moderator: Duncan McGillivray, University of Auckland, New Zealand

9:00am **BI-WeM4 Reconstruction Process and Orientation of Membrane Proteins in Artificial Cell Membrane Systems**, ***Ryugo Tero,*** Toyohashi University of Technology, Japan **INVITED**

The lipid bilayer is the fundamental structure of cell membranes, at which the transportation of materials and signals in and out of cell membranes take place. Ion channels are one of representative membrane proteins promoting these reactions. They retain their proper structures and function only when they are incorporated in lipid bilayer membranes. It is necessary to reconstruct the membrane proteins into artificial lipid membranes to investigate the structure and function of membrane proteins out of cells. n this study we reconstructed the ion channels into solid-supported lipid bilayers (SLBs), which is an artificial lipid bilayer at solid-liquid interfaces, using proteoliposomes. We investigated the distribution and orientation of ion channels in the SLBs using fluorescence microscopy and atomic force microscopy (AFM).

9:40am **BI-WeM6 Surface Adsorbed Antibody Characterization using ToF-SIMS with Principal Component Analysis and Artificial Neural Networks**, *N.G. Welch, R.M.T. Madiona, T.B. Payten, R.T. Jones, N. Brack,* La Trobe University, Australia*; B.W. Muir,* CSIRO, Australia*;* ***Paul Pigram,*** La Trobe University, Australia

Artificial neural networks (ANNs) form a class of powerful multivariate analysis techniques, yet their routine use in the surface analysis community is limited. Principal component analysis (PCA) is more commonly employed to reduce the dimensionality of large time-of-flight secondary ion mass spectrometry (ToF-SIMS) data sets and highlight key characteristics. The strengths and weaknesses of PCA and ANNs as methods for investigation and interpretation of a complex multivariate sample set will be considered. Using ToF-SIMS, spectra were acquired from an antibody and its proteolysis fragments with three primary-ion sources to obtain a panel of 72 spectra and a characteristic peak list of 775 fragment ions. The use of ANNs as a means to interpret the ToF-SIMS spectral data is explored, highlighting the optimal neural network design and computational parameters, and considering the technique limitations. Employing Bi_3^+ as the primary-ion source, ANNs can accurately classify antibody fragments from the parent antibody based on ToF-SIMS spectra.

10:20am **BI-WeM8 Controlled Peptide Surfaces of Various Ratios that Guide Neural Stem Cell Differentiation.**, ***HalaShakib Dhowre,*** *C. Towlson, HS. Sahaf, N.A. Russell,* University of Nottingham, UK

Cell instructive biointerfaces represent an essential aspect for the advancement of regenerative medicine. Currently, a major issue in biointerface design is the limited ability to mimic the complex interactions of the natural processes in the extracellular matrix (ECM) with artificially designed surfaces and interfaces [1]. While biomaterial surfaces have been shown to be able to elicit specific cell responses (e.g. adhesion, proliferation, differentiation), precise control akin to that of natural cellular environments is still lacking[2].

AIM:

The present work aims to address this challenge by designing new synthetic peptide surfaces with well controlled composition and functionality able to impact control over the differentiation of neuronal stem cells with the ultimate goal to understand and control how neuronal networks function.

METHODS:

Compositionally well defined surface concentrations of two short laminin peptide sequences, Arg-Gly-Asp (RGD) and Ile-Lys-Val-Ala-Val (IKVAV) were prepared of various ratios via the "grafting from" stepwise approach and the surface modification was confirmed with surface analysis techniques to indicate successful peptide functionalisation. The neural stem and progenitor cells (NSPC) were set up from embryonic rat hippocampi (E18). Immunocytochemistry (ICC) observed cell viability and differentiation to specific NSPC lineages for Nestin, βIII-Tubulin and GFAP.

RESULTS:

Surface characterising techniques (WCA, AFM and ToF-SIMS) verified the successful amino acid build-up to peptides on the surfaces, allowing modification of the surfaces with RGD and IKVAV. Enhanced NSPC adhesion, proliferation and differentiation were observed on the peptide surfaces. ICC demonstrated Nestin expression decrease after the removal of the growth factors (EGF and FGF) and an increase in the expression of βIII-Tubulin and GFAP; thus illustrating cells differentiating from stem cells to neurons or astrocytes due to peptide surface influence.

CONCLUSION:

Well defined peptide surfaces were designed successfully, the various ratios of RGD and IKVAV surfaces demonstrated cell adhesion, proliferation and influences desirable effects in controlling different populations of stem cell fate. These surfaces may advance new insight in understanding how surface properties affect the regulation of physiological relevance in directing neural cell differentiation, which will be essential to understand how neural networks function.

References

1. Zelzer, M. & Ulijn, R.V., Chem.Soc.Rev., **39**,3351-3357 (2010)

2. Ricoult, S.G. et al., Biomaterials., 35, 727-736 (2014)

3. Cooke, M.J. et al., J.Biomed.Mater.Res-Part A., **93**,824-832 (2010)

10:40am **BI-WeM9 Inelastic Neutron Spectroscopy Studies of Biosurfaces: the Chemistry of Hydrogen Surface Interaction**, ***Anton Stampfl,*** Australian Nuclear Science and Technology Organisation, Australia

Adsorption, surface complexation and reactivity of biological molecules on inorganic surfaces and interfaces is pervasive throughout an enormous range of fields such as chemistry (geochemistry, biochemistry), biotechnology (medical implants, biosensors, tissue engineering, bioelectronics, biomimetics and artificial photosynthesis), radiation technology (radiation damage and detection), colloid chemistry, surface chemistry and physics. Hydrogen and its interaction at surfaces clearly plays a pivotal role in the ultimate functionality of many biologically-based surfaces. Through the hydrogen's subtle interaction with the tethering surface, or interface, and the surrounding wet environment can and does lead to a multifaceted response to changes in temperature, pH, radiation etc.

Inelastic neutron spectroscopy is the domain of vibrational spectroscopic studies on bulk materials. At first sight, surface studies using such a method, with relatively low neutron flux rates and largish sample size, seems a totally hopeless task. There are, however, exceptions to this rather bullish view, where the surface dominates the scattered signal due to huge surface to volume ratios and large scattering cross-sections from adsorbate molecules, that incorporate for example, hydrogen, which neutrons are supremely sensitive to.

The deposition of amino acids and carbonyl-sulphide onto oxide surfaces is a fruitful area of discovery in the field of prebiotic formation of peptides and an example of how neutron spectroscopy makes significant contributions to the understanding of the subtle chemistry between adsorbate, substrate and surrounding environment. In this series of studies the deposition of amino-acids onto alumina from solution and in the presence of OCS is investigated by both inelastic neutron spectroscopy and high resolution photoemission which allows both the vibrational and electronic structure to be determined for these incredibly interesting systems. Studies focused on the extent of adsorption at various pH's, the character of each adsorbate (zwitterionic, basic, acidic), and the number of discrete surface sites of adsorption. Results show strong chemisorption of amino acids through an ester type bond with the alumina surface across a range of pH. Direct sorption of the amine group with alumina is observed only at pH 9. Formation of multilayers and/or peptides can also occur in conjunction with OCS absorption.

11:00am **BI-WeM10 Exploring Protein and Mesoporous Silica Nanoparticle Interactions**, ***Brian Trewyn,*** *M. Moyer,* Colorado School of Mines, USA

Tandem and cascade reactions have the potential to save time and resources, advantages not frequently observed in individual, stepwise reactions. The versatile, ordered pore structure of mesoporous silica nanoparticle (MSN) materials is an ideal support for multiple, active catalysts that potentially have orthogonal optimal conditions. Herein, we

will demonstrate that enzymes covalently tethered to MSN can be paired to inorganic species to catalyze multistep reactions. Additionally, MSN can be used to entrap large, multisubunit proteins as individual subunit monomers. Upon release, we will demonstrate that the subunits reassociate to form biochemically active proteins.

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