Biomaterial Interfaces
Room Ballroom A - Session BI-ThP
Biomaterial Interfaces Poster Session

BI-ThP-1 Interactions of KSCN with Phospholipid Monolayers Studied by Sum Frequency Generation and X-Ray Fluorescence, ***Sadia Afroz***, Pennsylvania State University; *Bastian Mueller, Emanuel Schneck,* TU Darmstadt, Germany; *Paul S. Cremer,* Pennsylvania State University

Thiocyanate (SCN^-) is a weakly hydrated anion that can interact relatively strongly with lipid membranes compared to other anions in the Hofmeister series. To date, the specific mechanisms governing this processes remain poorly characterized. To shed light on ion-lipid membrane interactions, we introduced KSCN into the subphase below 1,2-dilauroyl-sn-glycero-3-phosphocholine (DLPC) monolayers. This saturated lipid was chosen because it remains in the fluid phase at room temperature. Both the two-dimensional pressure of the monolayer and the salt concentration were varied. SFG was used to follow vibrational signals associated with the interfacial water structure, the lipid headgroups, the ordering of the alkyl chains, as well as the SCN^- anions. Such data are vital for characterizing the system, but the concentration of interfacial ions is not directly quantifiable. As such, we also employed total reflection X-ray fluorescence which can monitor the interfacial concentration of both K^+ and SCN^- concentrations. Details of these interactions as well as their implications for Hofmeister chemistry will be discussed.

BI-ThP-2 The Neurotoxin Vipoxin Induces Changes in Mechanical Properties of Breast Epithelial Cells, *William Linthicum,* Oxford Instruments; *Qi Wen,* ***Nancy Burnham***, Worcester Polytechnic Institute; *Svetla Petrova, Konstantin Balashev,* Sofia University, Bulgaria

The investigation of how drugs or toxins alter cell mechanics is gaining significant traction in biomedical science, driven by the dual objectives of elucidating their mechanisms of action and enhancing drug screening processes. In this study, Atomic Force Microscopy (AFM) was employed to examine and analyze the mechanical responses of cells exposed to the neurotoxin Vipoxin. This method enables the precise measurement of key mechanical parameters such as cell stiffness and viscoelasticity before and after toxin introduction in the cell culture. It was demonstrated that the cells' stiffness and viscosity decreased with increasing Vipoxin concentration. Additionally, Total Internal Reflection Fluorescence Microscopy (TIRFM) was utilized to monitor morphological changes in the cells over time. These morphological changes were quantitatively analyzed using fractal analysis of the acquired images. The observed changes in cell shapes implied the reorganization of the cell cytoskeleton, thus providing insight into the cell mechanics under the influence of Vipoxin.

BI-ThP-5 Pulsed Plasma Surface Functionalized Nanosilver for Gene Delivery, ***Ajinkya Trimukhe***, University of Milan Bicocca, Italy; *Prasad Pofali,* Pravara Institute of Medical Sciences, India; *Amogh Vaidya,* University of Texas Southwestern Medical Center; *Uday Koli, Prajakta Dandekar, Rajendrasing Deshmukh, Ratnesh Jain,* Institute of Chemical Technology, India

The efficient intracellular delivery of nucleic acids remains limited by the lack of vectors that are both effective and biocompatible. In this study, we synthesized silver nanoparticles, that were surface-engineered using low-pressure pulsed RF plasma polymerization with acrylic acid in vapor phase to introduce carboxylic functionalities, followed by covalent coupling to chitosan oligosaccharide (COS) through EDC chemistry, yielding metallo-polymeric nanocarriers (MPNCs). Surface functionalization characterization confirmed successful functionalization: FTIR and XPS evidenced carboxylation and amide bond formation, while DLS showed an increase in hydrodynamic size from AgNPs to AgNPs/COOH (166.3±23.04 nm) and then to MPNCs with attached DNA (276.0±17.75 nm). Zeta potential shifted from negative values for AgNPs (-13.4±1.39 mV) to strongly positive values for MPNCs, supporting electrostatic complexation with plasmid DNA (27.0±1.1 mV). Gel retardation assays demonstrated stable nanoplex formation at a plasmid:MPNC ratio of 1:6, and the complexes remained stable across a broad pH range. Importantly, the MPNCs protected plasmid DNA against both DNase I degradation and sequence-specific restriction digestion. Cell viability assay demonstrated that the COS used to encapsulate the modified nanosilver using EDC (92.05±9.46% and 102.79±2.85%), was substantially less cytotoxic than bare AgNPs (0% and 0%), and AgNPs/COOH (0% and 0%) equivalent to Triton X-100 (positive control); MPNCs at 0.5 mg/ml (87.06±3.98% and 93.55±1.65%) maintained high viability in A549 and HeLa cells respectively. Cellular uptake studies (in-vitro) further showed that MPNC-bound plasmid-DNA was internalized efficiently, with GFP expression detected in A549 cells and quantified by flow cytometry, reaching about 10% transfection efficiency at 24 h. Overall, the work demonstrates that pulsed plasma surface functionalization, combined with COS conjugation, can transform silver nanoparticles into a stable, biocompatible, positively charged non-viral vector with meaningful gene delivery performance.

BI-ThP-7 Physics–Driven Mechanisms Governing the Pharmacokinetics and Immune Fate of Gold Nanoparticles: The ADIE Framework Perspective, ***Bashiru Sodipo***, Kaduna State University, Nigeria; *Hafsah Oyedokun,* Kaduna University, Nigeria

The clinical translation of gold nanoparticles (GNPs) in nanomedicine hinges on a mechanistic understanding of their pharmacokinetics (PK) at the nano–bio interface. Traditional ADME (Absorption, Distribution, Metabolism, Elimination) model is effective for small molecules and biodegradable polymers. But it fails to capture the unique behaviour of inorganic GNPs, which are non-biodegradable, and not subject to enzymatic metabolism. Also, the interactions of GNPs in-vivo are not random biochemical processes. This Perspective introduces the ADIE (Absorption, Distribution, Immune interaction, and Elimination) framework. Immune interaction replaces metabolism as the pivotal phase. The journey of GNPs in-vivo is governed by transport physics and interfacial energetics. Convection and diffusion dictate distribution of the GNPs. While the collision of the nanoparticles with blood biomolecules and protein corona (PC) formation is governed by stochastic Brownian motion. The PC dictates immune recognition through competitive adsorption and thermodynamic binding energies. Also, it determines opsonization and clearance pathways. The elimination of GNPs is mainly via renal elimination. This is governed by size-exclusion physics and stealth coating (surface chemistry) property of the inorganic nanoparticles. While hepatic sequestration results from immune recognition. ADIE model offers a predictive foundation for designing GNPs with optimized biodistribution and clearance. Also, it advances the rational development of nanomedicines by integrating principles of transport physics, interfacial thermodynamics, and immune interaction.

BI-ThP-10 Decoding Antifouling Failure: How Primary Microfouling Communities Compromise Biocide Release, ***Kailey Richard***, National Research Council Research Associateship Program at US Naval Research Laboratory; *Kenan Fears,* Naval Research Laboratory

For decades, copper-based marine coatings have been the primary defense against biofouling. However, their failure, suspected to be caused by microbial copper tolerance, is a growing concern. Primary colonizers, like bacteria and diatoms, can develop resistance, forming biofilms that may slow biocide release and accelerate macrofouling. This study investigates the role of key fouling species in this process, with a focus on diatoms. To achieve this, we exposed *Navicula incerta* and the green alga *Enteromorpha* sp. to copper biocides, copper (II) ions and copper (II) pyrithione, to assess their level of tolerance, their influence on the biocides chemical state, and their impact on copper release rates. Furthermore, this study investigates the interactions between bacterial and diatom communities, by establishing bacterial biofilms on coatings prior to the introduction of diatoms to observe the effects on subsequent diatom adhesion and growth.

Author Index

Bold page numbers indicate presenter

— A —
Afroz, Sadia: BI-ThP-1, **1**
— B —
Balashev, Konstantin: BI-ThP-2, 1
Burnham, Nancy: BI-ThP-2, **1**
— C —
Cremer, Paul S.: BI-ThP-1, 1
— D —
Dandekar, Prajakta: BI-ThP-5, 1
Deshmukh, Rajendrasing: BI-ThP-5, 1
— F —
Fears, Kenan: BI-ThP-10, 1
— J —
Jain, Ratnesh: BI-ThP-5, 1
— K —
Koli, Uday: BI-ThP-5, 1
— L —
Linthicum, William: BI-ThP-2, 1
— M —
Mueller, Bastian: BI-ThP-1, 1
— O —
Oyedokun, Hafsah: BI-ThP-7, 1
— P —
Petrova, Svetla: BI-ThP-2, 1
Pofali, Prasad: BI-ThP-5, 1
— R —
Richard, Kailey: BI-ThP-10, **1**
— S —
Schneck, Emanuel: BI-ThP-1, 1
Sodipo, Bashiru: BI-ThP-7, **1**
— T —
Trimukhe, Ajinkya: BI-ThP-5, **1**
— V —
Vaidya, Amogh: BI-ThP-5, 1
— W —
Wen, Qi: BI-ThP-2, 1