length (0.1-50 µm), diameter (6-397 nm), dustiness (0.2-4.9 %), metal contaminants (0.3-6.2 %), surface area (18–238 m2/g), and density (0.007–0.22 g/cm3). Endotoxin and PAH levels were below detection limit and zeta potential were similar for all materials. Genotoxicity was evaluated in human lung epithelial cell line, BEAS-2B, at 0-24 µg/ml. Acute toxicity, inflammation, inflammasome signaling, and phagocytic activity were evaluated in the differentiated human monocyte cell line, THP-1, at 0-60 µg/ml. Collagen production, TGFβ levels, and αSMA signaling were evaluated in primary human lung fibroblast cells at 0-9.6 µg/ml. Unsupervised approaches were initially used to identify classes of materials with similar outcomes followed by supervised learning approaches to identify specific physicochemical characteristics driving toxicity responses. It was clear certain physicochemical characteristics were the primary drivers of specific outcomes. Often, a multifactorial approach, meaning a combination of physicochemical characteristics, best described a particular outcome. Analysis of complementary endpoints in a concurrent *in vivo* study indicated some *in vitro* tests shared similar predictability suggesting some utility for predictive *in vitro* toxicity evaluation. These included specific measures of inflammation and pathological outcomes. The general conclusions of the analysis suggest that the class of materials, carbon nanotubes and nanofibers, can be subdivided based on specific endpoints, some aspects of *in vitro* outcomes predict *in vivo* toxicity, and the methodological approach can possibly be adapted beyond the finite scope of this study.

2160 The Role of Macrophage Surface Receptors on the Uptake and Binding of Protein-Coated MWNTs

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Multi-walled carbon nanotubes (MWNTs) pose a human respiratory hazard because they can cause pulmonary fibrosis, which may lead to mesothelioma. A key event in the fibrotic pathway is the interaction of MWNTs with macrophages that may result in chronic inflammatory responses, but the mechanisms are not clear. An important question is whether macrophages have MWNT receptors that might initiate or modulate signals involved in inflammation. A complicating factor is that *in vivo* a protein corona, derived from serum proteins such as bovine serum albumin (BSA), may influence the interaction of MWNTs with cells. The interaction of BSA-coated carboxylated MWNTs (cMWNTs) and pristine (pMWNTs) with mouse RAW 264.7 macrophage cells was studied using a gel electrophoresis assay to quantify cell-associated MWNTs (Wang et al., *Anal. Chem.* 2009, 81, 8, 2944-2952). Both MWNT types accumulated as a function of time and concentration. To assess the potential role of cell surface receptors on macrophages, the binding of BSA-coated cMWNTs and pMWNTs to RAW 264.7 cells at 4°C in medium without serum was measured. At low temperature phagocytosis is inhibited, so that only binding of MWNTs on the cell surface is measured. Further, the absence of serum eliminates complications in interpreting the data that could arise due to the interaction of other serum proteins with the MWNTs to form an undefined protein corona. These studies directly demonstrated binding of both MWNT types to the cell surface that was a saturable function of MWNT concentration, supporting the idea that receptors bind BSA-coated MWNTs. The effect of BSA on the binding of BSA-coated MWNTs to the cells at 4°C showed that BSA reduced binding by 50%. Previous work suggests that scavenger receptors on macrophages bind cMWNTs (Wang et. al., Nanotoxicology, 2018, 12, 7, 677-698, DOI: 10.1080/17435390.2018.1472309). We found here that dextran sulfate, a known antagonist of Class A scavenger receptors, inhibited the binding of BSA-coated MWNTs to RAW 264.7 cells by a maximum of 50%. This suggests that on these macrophages there might be dextran sulfate sensitive and insensitive receptors.

2161 Toxic Effects of Molybdenum Trioxide Nanoparticles (MoO_3 NPs) on Rat Pleural Mesothelial Cells (RPMCs) and Lavaged Cells from the Lungs of Golden Syrian Hamsters

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MoO_3 NPs are used in industrial, agricultural and biomedical applications due to their physical characteristics. The risk of exposure and possible adverse health effects to humans increases during the manufacturing and handling of such materials. The purpose of this study was to investigate the toxicity of MoO_3 NPs in cultured cells and in the cells isolated from bronchoalveolar lavage fluid (BALF) from Golden Syrian hamsters. Cultures of RPMCs (CCL-216) were exposed to MoO_3 NPs (100, 200, 300, 400, 500, 600, 700 or 800µg/mL) for 24 hours and compared to a vehicle control. Cytotoxicity was assessed by MTT and LDH assays. A concentration of 400µg/mL MoO_3 NPs was further evaluated (~LC_{50}). Capsase 1 and 3 protein levels were also measured in both groups. In addition, hamsters were exposed via inhalation and divided into four groups: 1) no exposure, 2) exposure to aerosolized water for 4h/day for 8 days, 3) exposure to 5mg/m^3 MoO_3 NPs for 4h/day for 8 days (*5-NP*) and 4) a group given a recovery period of one week (*5-REC*) following a *5-NP* exposure. Cultures of RPMCs treated with MoO_3 NPs had increased levels of: LDH (178%), caspase 3 (14%) and caspase 1 (29%) as compared to a control. BALF from the *5-NP* group had increased: total protein levels (62%), total cell counts (58%), neutrophils (870%) and multinucleated macrophages (465%) as compared to controls. BALF from the *5-REC* group had displayed parameters similar to controls, but had an increase of lymphocytes (938%) compared with controls. Tissue sections from the lungs of MoO_3 NPs treated groups of hamsters had membrane blebbing and hyperplasia of the airway epithelia with areas of cell proliferation at the periphery of the lung. Hamsters of the *5-NP* group had increased TUNEL positive cells in airway epithelia. Results from this study indicate cytotoxicity in RPMCs treated with 400µg/mL MoO_3 NPs may be mediated by both oncosis and apoptotic pathways. Animals exposed to 5mg/m^3 MoO_3 NPs had an initial acute inflammatory reaction as indicated by an alteration of BALF cells and protein levels that resolved to a chronic reaction with increased lymphocytes and hyperplasia in the airways. Cellular membrane blebbing in airway epithelia and an increase in TUNEL positive cells in hamsters exposed in the *5-NP* group support apoptosis as a possible pathway of injury.

2162 *In Vivo* Lung Toxicity Associated with Boron Nitride Nanotubes with Different Purities

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Boron nitride nanotubes (BNNTs), a newly emerging nanomaterial with enhanced physicochemical properties, are increasingly incorporated into industrially relevant applications. Currently, commercial production of BNNTs is synthesized with 30-60 % residual compounds and impurities. The goal of this study was to assess the lung toxicity associated with *in vivo* exposure to BNNTs with various purities. Three BNNT samples with a gradient of purity were provided by the National Research Council, Canada, to assess lung toxicity *in vivo*: a low purity as-produced sample with ~50% BNNT (BNLP), an intermediate purity sample (BNMP), and a highly purified sample with >90% BNNT (BNHP). Hexagonal boron nitride (h-BN, <100 nm in diameter) was used as a control material for one of the by-products during synthesis affecting the purity of the BNNT material. All BNNT samples tested were shown to be agglomerated bundles of BNNTs (~3 to 5 walls/tube) with boron and h-BN as the primary impurities. Sample purity was confirmed by electron microscopy (EM). The BNNT samples prepared in dispersion medium (DM) were 0.5-1.5 µm in length and 5-30 nm in diameter. Male C57BL/6 mice were exposed by oropharyngeal aspiration to 4 or 40 µg of sample/mouse dispersed in DM or DM alone on day 0. Animals were euthanized at 4 h, 1 d, 7 d, 1 m, and 3 m post-exposure and lung lavage was performed to evaluate lung injury and inflammation. At 4 h post-exposure, lactate dehydrogenase (LDH) activity and neutrophils influx, indicators of lung injury and inflammation, were significantly increased by high dose of BNMP and BNHP. At 1 d and 7 d post-exposure, the effects were greatest in the high dose of all three tested BNNT samples, with BNHP>BNMP>BNLP, and persisted in the BNHP group up to 1 m post-exposure. Irritant response, indicated by eosinophils increase, was observed in the high dose of BNNT groups at 1 d and 7 d post-exposure, with BNHP>BNMP>BNLP. Lung lymphocytes continued to increase in the BNHP group up to 1 m post-exposure. The results indicated that the tested BNNT samples induced acute toxicity and inflammation only at high concentration and the effects were more pronounced with increasing purity. The reference material used to represent one of the by-products of synthesis, h-BN, did not show significant lung toxicity, suggesting lung effects where present may be due primarily to BNNTs.

2163 Analysis of Nanoparticle Uptake by Disease Vector of Economic Importance

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The spread of vector-borne pathogens by arthropod hosts continue to cause human, animal and plant diseases of public health and economic importance. Using the integrated vector management approach, this study utilizes nanoparticles as potential targeted anti-pathogenic agents for the control of citrus greening disease. *Candidatus Liberibacter asiaticus*, the bacterial pathogen of citrus greening disease is spread by the Asian citrus psyllid (*Diaphorina citri Kuwayama*). Symptoms of the disease include blotchy mottle, yellow shoots, and improperly developed fruits. The significant decrease in edible

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Preface

This issue is devoted to the abstracts of the presentations for the Continuing Education courses and Scientific Sessions of the 59th Annual Meeting of the Society of Toxicology, held at the Anaheim Convention Center, Anaheim, California, March 15–19, 2020.

An alphabetical Author Index, cross-referencing the corresponding abstract number(s), begins on page 542.

The issue also contains a Keyword Index (by subject or chemical) of all the presentations, beginning on page 580.

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