Natural Secreted Nano Vesicles as a Source of Novel Biomass Products for Circular Economy

All living cells produce small vesicles surrounded by a lipid membrane, sizing 30-1000 nm (exosomes 30-100 nm). The objectives in this project is to purify the vesicles and study the roles in nature.

Porous aerogels derived from cross-linked cellulose nanofibers (CNF) were designed and tailored as highly efficient aerosol filters. The CNF was prepared from recycled milk container board. All aerogels achieved good filtration performance in the measured particle size range. Development of new filter material to remove impurities (such as airborne virus material) from air are directly needed at the moment. In this project we developed and tested new materials that are applicable for respiratory face masks.

We also explored the role of bioaerosols in ice nucleation capacity in the atmosphere. This is very crucial in formation of precipitation and regional water cycle. We performed laboratory experiments to determine size distribution of milk and cancer cell exosomes.

This new information is applicable to determine and optimize dosage of medical substances in human body. We have created ways to purify vesicles effectively from kidney cancer cells, spruce cells, blood, urine, milk, feces, and sweat. We have examined the fine structure of the vesicles, which molecules are on the vesicle membrane, and determined the molecules that these vesicles carry. The genetic labeling tools developed presumably provide opportunities to determine the “bio-addresses” at the organ tissue level. This is central to the tissue targeting of different drugs.

Dairy milk is a rich source of extracellular vesicles (EVs), that may have applicability in biomedicine. We have characterized bovine milk extracellular vesicles (EVs) and their protein, lipid and nucleic acid (DNA and RNA) composition. We are especially interested in microRNAs

(miRNA), which are known to regulate gene expression in animals and plants and in some viruses. From bovine milk EVs we have identified 300 miRNAs and observed that these vary very little between individuals. Comparative analysis has revealed that nearly half of the sequenced bovine milk miRNAs are identical to human miRNAs. The potential of milk EVs in mediating cross-species gene regulation will be further studied.

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