Understanding the molecular structure and biophysical properties of the pulmonary surfactant system: from the pneumocyte to the air-liquid interface

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Pulmonary surfactant is thought to form a multi-layered interfacial film into the air-liquid interface, where it is located to carry out its biophysical function: reduce surface tension to estabilize the respiratory surface along breathing dynamics. Nevertheless, not much is known about the structure of newly synthesized lung surfactant as it is assembled into lamellar bodies. Lamellar bodies (LBs) are the specialized organelles in which these complexes are stored before being secreted and adsorbed into the air-liquid interface. Understanding how lipids and proteins are organized has been quite difficult because of the absence of a native model of freshly synthesized pulmonary surfactant. Therefore, synthesis, packing, secretion, and reorganization of LBs to form the multi-layered interfacial film, are still poorly understood processes in terms of lipid-protein interactions and biophysical properties. Here, we describe a new approach to obtain a surfactant with similar properties to pristine pulmonary surfactant: human amniotic fluid lung surfactant (AFS).

AFS is a highly structured, dehydrated and organised lipid-protein complex suggesting LB-like structural features. Biophysical behaviour analysed using a captive bubble surfactometer shows an efficient interfacial adsorption and spreading. Moreover, AFS is a dynamic-sensitive surface active material, which is able to reduce surface tension during fast compression-expansion cycles even though it does not produce the same low surface tensions throughout slow compression-expansion cycles. Furthermore, AFS is more resistant to serum or meconium inhibition than surfactant obtained from bronchoalveolar lavages of porcine lungs used commonly as reference. This research opens new opportunities to investigate lipid-protein interactions and the supramolecular structure of membranes in the lung surfactant system, as well as the development of new surfactant preparations of potential therapeutic application.