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Human bronchial mucosa equivalents in extreme space conditions

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In view of the growing international interest towards manned long-term space exploration, possible effects of exposure to microgravity conditions affecting the respiratory system are subject of interest by major space agencies (NASA and ESA primarily). It becomes very relevant to understand how space conditions may affect the bronchial mucosa. We have developed an advanced 3d tissue model of the human bronchial mucosa that includes bronchial epithelial cells (ciliated and goblet cells) and fibroblasts where it is possible to study [1]: structure and functionality of the ciliary apparatus, mucus production and the production of antimicrobial peptides [2]. Our in vitro culture model not only presents accurate histological features of the human bronchial mucosa but it also has excellent resistance to different chemo-physical variables (such as temperature, CO2 levels and nutrients) that play a major role before and during transport from earth to the International Space Station (ISS). We have conducted experiments that have validated the ability of the model to resist, with minimal variations, to temperatures lower than growth optimum (up to 4°C for short periods), to reduced concentrations of CO2 (0.02% indefinitely, providing a significant reduction in maintenance and transport cost) and to prolonged starvation (at least up to 96 hours). 3D cultures were analysed at the end of the treatments evaluating their morphology and monitoring their Trans Epithelial Electric Resistance. The results obtained demonstrated how this culture model is able to guarantee a likely test bench to conduct experiments in microgravity conditions on the ISS that can easily overcome the critical phases of the journey (transport) and any unexpected events that may occur. The data that will be obtained from these experiments will derive exclusively from automated cultures without the need to obtain biological samples from astronauts, which until today has been the only source of study regarding the respiratory system subjected to microgravity.

References

[1] Bucchieri et al. (2017) Functional characterization of a novel 3D model of the epithelial-mesenchymal trophic unit Exp Lung Res. 43(2):82-92.
[2] Bucchieri et al. (2015) Cigarette smoke causes caspase-independent apoptosis of bronchial epithelial cells from asthmatic donors. PLoS One 20;10(3):e0120510.