ADVANCED NON-ANIMAL MODELS IN BIOMEDICAL RESEARCH

Respiratory Tract Diseases

Research on human diseases

relies extensively on animal models, however, effective new therapies for serious respiratory conditions are still lacking.

Reliance on animal models

is failing to identify novel therapies, because they often poorly represent human physiology and pathology.

Research is shifting towards

sophisticated bioengineering

approaches that better recapitulate lung development, anatomy and physiological functions in cell-based (in vitro) systems.

The development of lung-on-a-chips

microdevices allow the reconstitution of the most relevant architecture and functions of living human organs.

Lung organoid culture systems

are ripe for development in disease modelling and treatment.

A "breathing lung-on-a-chip"

microdevice recreates physiological breathing movements.

The emerging use of more human-relevant models,

e.g. 3D human tissue cultures, spheroids,organoids, and icrofluidic / 'lung-on-a-chip' systems shows immense promise for the development of model systems that more accurately mimic human respiratory diseases.

BIOLOGICAL QUESTIONS AND TECHNICAL CHALLENGES TO BE OVERCOME:

Systematic approach

to elucidate the mechanisms that control differentiation of specific cell lineages in vitro, allowing more controlled tissue engineering and translational applications of human pluripotent stem cells.

Integrate the proximal (airway) and distal alveolar

compartments of the lung into a single, reproducible model.

Growing complex tissue / organoids

in a well-defined physical environment.

Development of modular

'human-on-a-chip systems',

integrating an entire respiratory tract on a chip, incorporating nasal, upper airways and lower airways chips.

The generation of patient-derived

organoids from biopsies

will provide powerful research tools for a wide range of translational and medical approaches, such as drug efficacy and toxicity studies.

Standardisation

of all aspects of culture in organoids and lung-on-a-chip technologies to be used as disease surrogates.

Future developments

in this area require the nurturing of a multidisciplinary approach, requiring cooperation between disease focused biologists, bioengineers and mathematical modellers, so as to develop an all-encompassing understanding of how the structural environment of the lung relates to normal and diseases states.