Alveoleye - an alveoli-on-a-chip model

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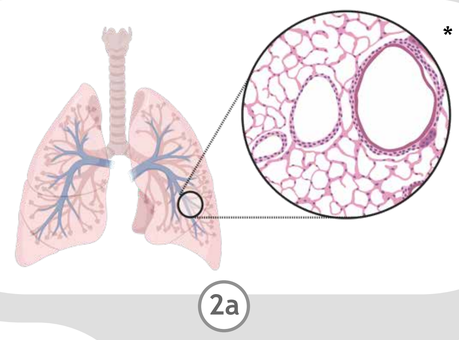
Introduction

Advanced ***in vitro* models** are increasingly used to study tissue physiology, disease mechanisms, and drug responses, providing controlled and **reproducible alternatives** to traditional experimental systems[1,2,3].

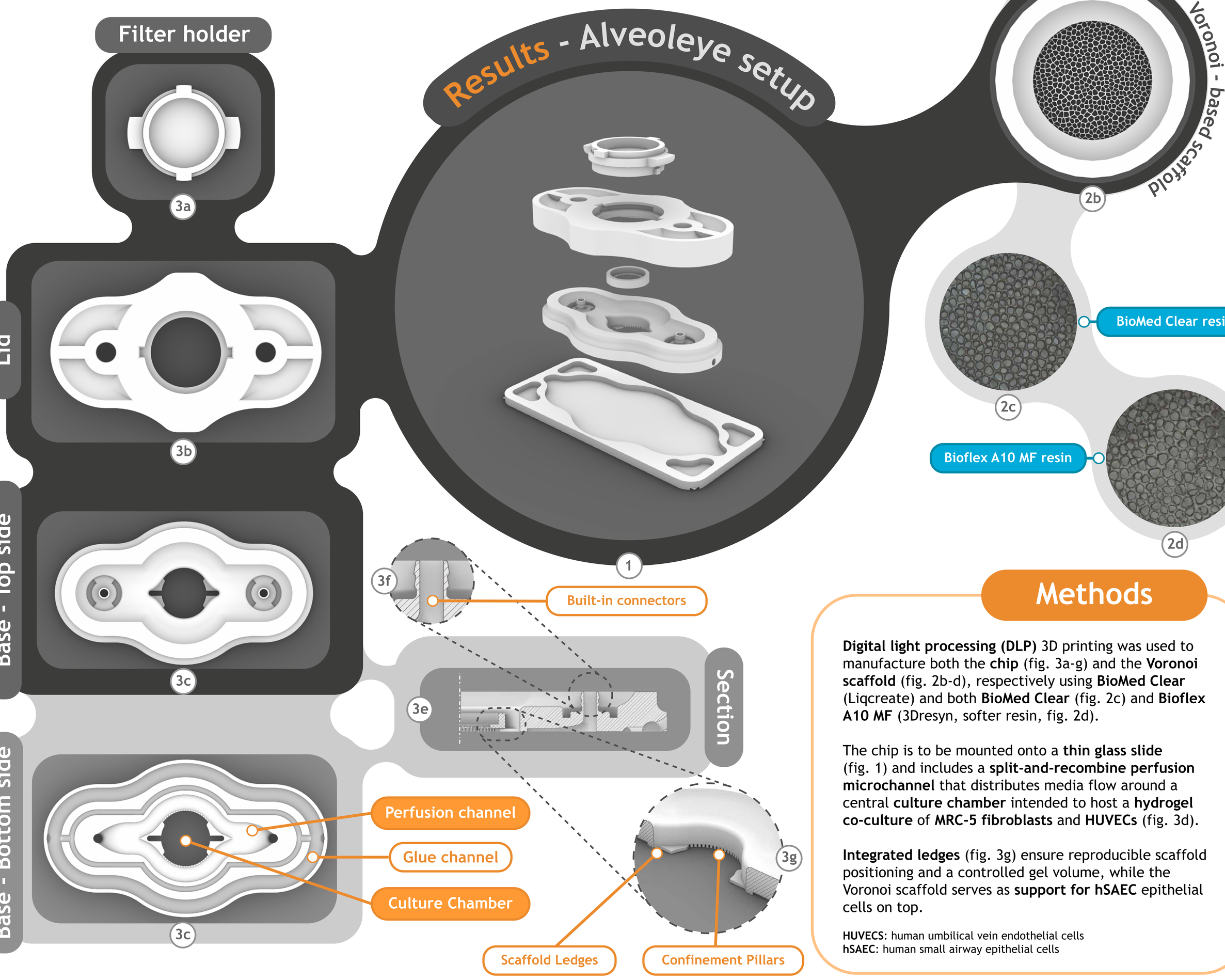
Among these, **microfluidic platforms** enable dynamic culture conditions and controlled flow stimulation, representing a promising strategy to reproduce key features of **complex tissues** such as the lung alveolar region. However, achieving a high level of **biomimetic complexity**, particularly in terms of tissue morphology and vascularization, remains a **major challenge**[1].

In this work, we present Alveoleye, a **custom-designed microfluidic chip** developed to support the formation of **capillary-like networks** and deliver controlled **flow stimulation**. To enhance structural biomimicry, an additively manufactured **scaffold based** on a **Voronoi pattern**[3], reflecting the spatial organization of alveoli, was implemented to mimic alveolar morphology.

Physiological morphology



Results - Alveoleye setup



Methods

Digital light processing (DLP) 3D printing was used to manufacture both the **chip** (fig. 3a-g) and the **Voronoi scaffold** (fig. 2b-d), respectively using **BioMed Clear** (Liqcreate) and both **BioMed Clear** (fig. 2c) and **Bioflex A10 MF** (3Dresyn, softer resin, fig. 2d).

The chip is to be mounted onto a **thin glass slide** (fig. 1) and includes a **split-and-recombine perfusion microchannel** that distributes media flow around a central **culture chamber** intended to host a **hydrogel co-culture** of **MRC-5 fibroblasts** and **HUVECs** (fig. 3d).

Integrated ledges (fig. 3g) ensure reproducible scaffold positioning and a controlled gel volume, while the Voronoi scaffold serves as **support for hSAEC** epithelial cells on top.

HUVECS: human umbilical vein endothelial cells
hSAEC: human small airway epithelial cells

Conclusion

An **alveoli-on-a-chip platform** was developed to enable controlled **flow stimulation** and support the formation of a **perfusable capillary network** interfacing with an epithelial monolayer organized by a **Voronoi-based scaffold** into a 3D alveolar array, mimicking the **alveolar-capillary barrier**.

This approach enhances **biomimicry** by targeting both **flow stimulation** and **mesoscale morphology**.

References

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*Created in https://BioRender.com

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