Non-invasive monitoring of 3D conjunctiva models using optical coherence tomography

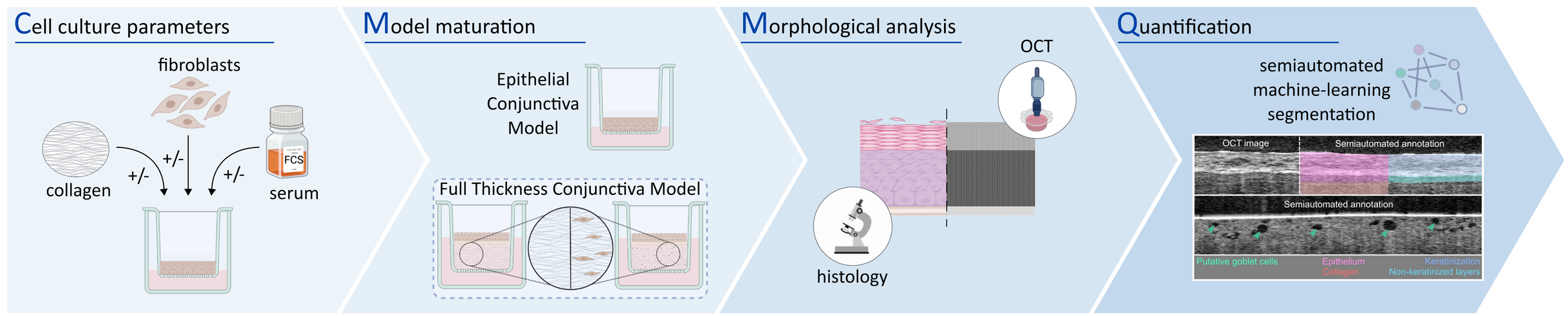
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Background: Conjunctival in vitro models need a **non-keratinized, stratified epithelium** with **mucus-producing goblet cells** to be physiologically relevant

Objective: **1.** Investigate the effects of serum concentration, collagen matrix, and fibroblast co-culture to optimize culture conditions. **2.** Establish OCT as a non-invasive tool to monitor differentiation.

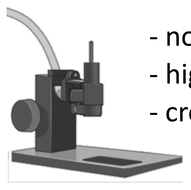
Methods: Human conjunctival epithelial cells were cultured on inserts (rhConE) or on a collagen matrix (FTConM), with or without fibroblasts, using 0–5% serum. Models were analyzed by optical coherence tomography (OCT) during culture (d7, d12, d15) and histology after 15 days. Epithelial thickness, keratinization, and goblet cell density were quantified from OCT images using semi-automated image segmentation.



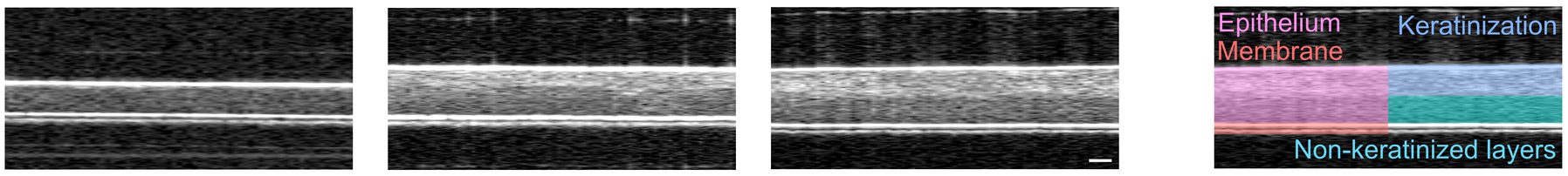
Results

Longitudinal monitoring: Optical coherence tomography enables non-invasive, repeated measurements and quantitative analysis of tissue parameters

Optical coherence tomography

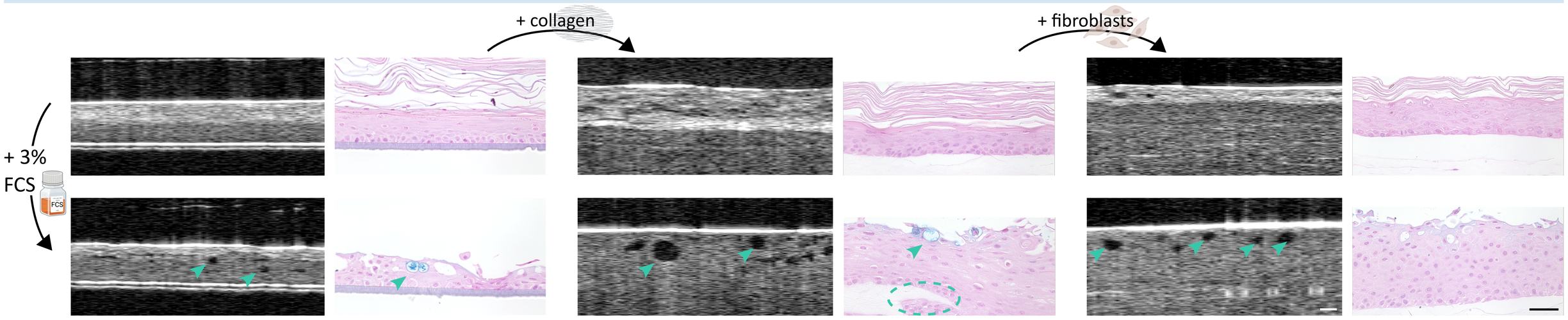


- non-invasive imaging
- high-resolution
- cross-sectional & 3D



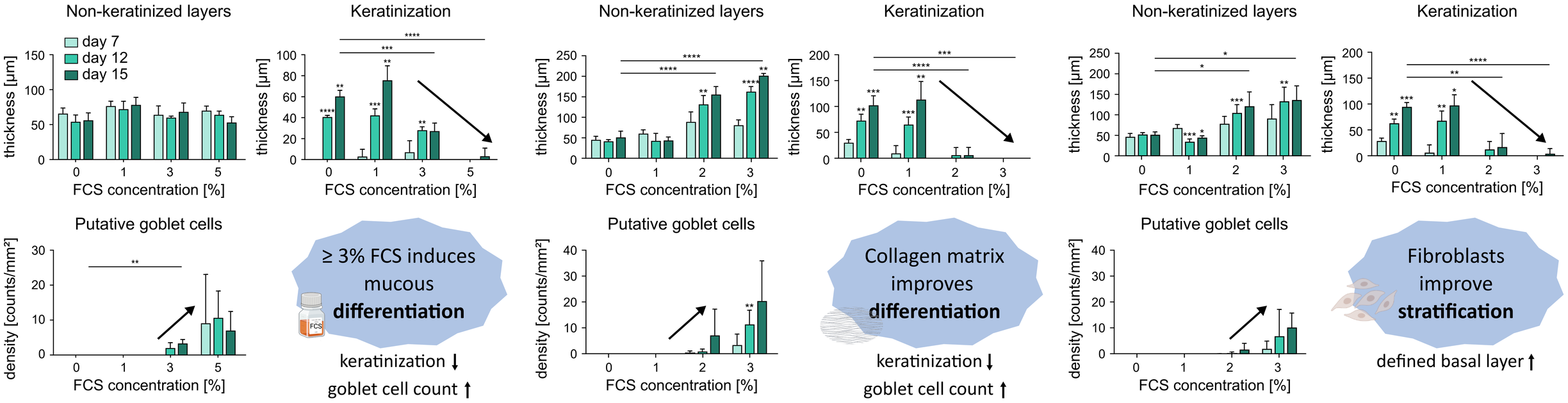
Cross-sectional OCT images of rhConE, cultured with 0% FCS. Conjunctiva models were cultured and monitored using OCT for 15 days, enabling the visualization of structural changes over time. Image segmentation was performed on 3D OCT scans using IMARIS software to allow quantification of structural tissue characteristics. Scale bar = 50 µm.

Morphological analysis: Structural characteristics, observed in OCT images and confirmed with histological alcian blue staining, reveal distinct effects of culture conditions



Cross-sectional OCT images and histological alcian blue staining of models at day 15. Arrowheads indicate putative goblet cells. Circle indicates epithelial invasion into the matrix. Scale bars = 50 µm.

Quantitative analysis: FCS reduces keratinization and induces goblet cell differentiation in epithelial and full thickness models



- OCT-enabled non-invasive, longitudinal monitoring
- quantitative analysis of tissue characteristics
- valuable insights into conjunctival development
- pathway analysis
- improve automation
- apply to other tissue models (e.g. cartilage)

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