

Stromal Scaffold

3D synthetic fibrous membrane for stromal or stromal-based *in vitro* tissue models

Background

The stromal part is a key element of current tissue equivalents as an alternative for animal experimentation. Due to the lack of synthetic alternatives, most researchers rely on animal derived and mostly modified materials based on collagens or decellularized tissue as main building block for the respective tissue equivalents. However, besides ethical concerns, biological scaffolds are prone to batch-to-batch variability, increased costs and often result in a reduction of physiological properties due to chemical modifications. The challenge within the development of suitable 3D scaffold materials is to meet and combine requirements such as a biomimetic structure, high porosity and bioactivity.

Membrane Fabrication

The synthetic scaffold is fabricated by a modified electrospinning process: an alternating process, electrospinning and incorporating defined NaCl particles, allows a controlled formation of the resulting 3D open porosity combined with structural stability. While specific spinning times in the step-

by-step process enable thin layers of movable fibers and high mesh openings, the size of the porogens and resulting pores determines structural long-term stability of porosity and cellular accessibility during application in an aqueous surrounding.

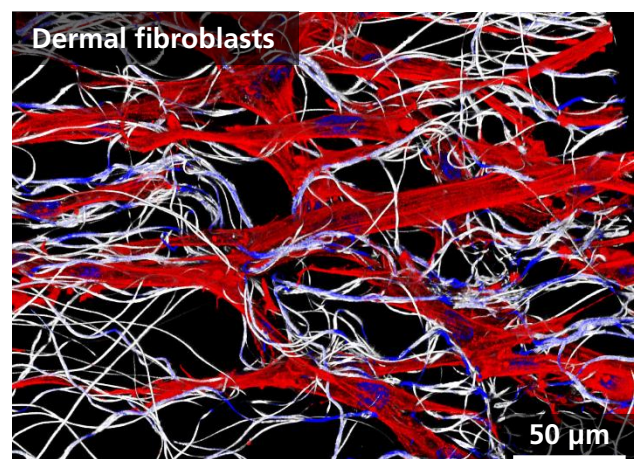
Materials

For the standard product, polyamide 6 is applied as the fiber material. High resistance of PA6 against most organic solvents gives the product the sufficient stability for all harsh analytical processes, like paraffin embedding and sectioning. As the superior biological suitability originates mainly in the structure of the membrane, fiber material can be easily adapted to any other spinnable biomaterial to meet customer requirements, like achieving biodegradability through resorbable materials.

Structural properties

Standard membrane (individual adjustable)

- Fiber diameter: 300 – 700 nm
- Pore size: 40 – 50 μm
- Resulting porosity after leaching: 97 – 99 %
- Scaffold thickness: \sim 200 μm



Biological Properties

The unique and stable structure of the 3D membrane allows stromal cells to migrate and populate the whole tissue. Due to the loose network of moveable fibers, cells are able to rearrange the network as a structural remodeling process. Additionally, cells are stimulated to produce their own matrix and transform the synthetic scaffold into a human tissue. The application of tissue specific fibroblast or the differentiation of stromal stem cells enables the formation of tissue specific stromal binding tissues or the shift towards other stromal binding tissues such as adipogenic/osteogenic lineages.

With this biologization step, the synthetic 3D membrane acts as a fully human tissue and is ready for the application in any stromal or stromal-based 3D tissue model. Until this step, all culture supplements can be applied as animal free supplements providing the basis for completely animal free tissue models.

Application – 3D Tissue Models

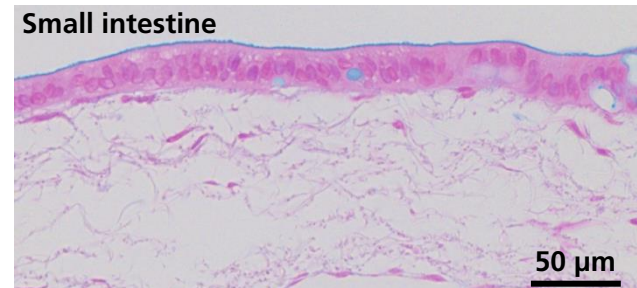
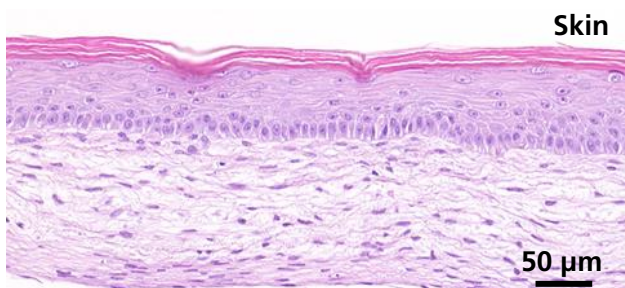
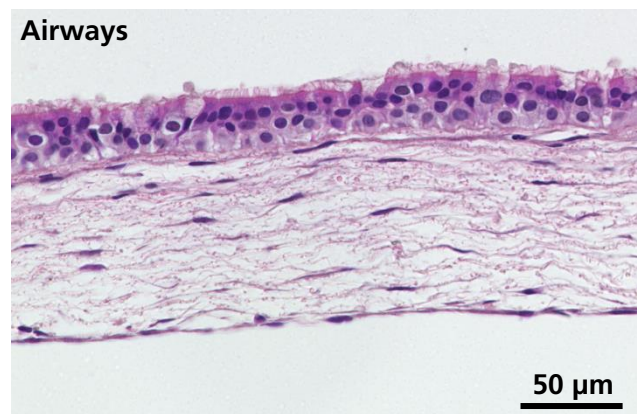
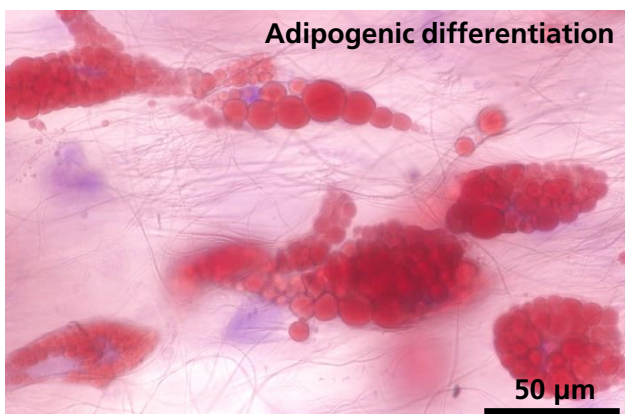
Equipped in a transwell system, biologized stromal tissues can be applied in a variety of barrier tissue types. Defined as full-thickness tissue equivalent, all stromal based epithelia are applicable (in either a healthy or diseased state). Most prominent examples are:

- Skin (subcutis optional)
- Small intestine
- Colon
- Airways
- Cornea
- Mucous membranes

Furthermore, a variety of tumors can be applied either together with the listed epithelia or on stromal-only tissue.

Literature for more information

- *Advanced Materials* 10.1002/adma.202106780
- *Materialia* 10.1016/j.mtla.2025.102440
- *Tissue Engineering Part C* 10.1089/ten.tec.2025.0087



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