A Novel Pro-Angiogenic Fibrin-Alginate Technology for Repair and Regeneration of Multiple Tissues

Vaibhav Sharma¹, Stuart Brown¹, Nupur Kohli², Lilian Hook², Elena García-Gareta¹

¹Regenerative Biomaterials Group, RAFT Institute, Mount Vernon Hospital, Northwood, HA6 2RN, United Kingdom.
²Smart Matrix Ltd, Leopold Muller Building, Mount Vernon Hospital, Northwood, HA6 2RN, United Kingdom.

Introduction: We describe a novel patented technology developed in our laboratory based on a fibrin-alginate mesh that is pro-angiogenic and shows excellent cell attachment and infiltration properties, making it an ideal platform technology for repair and regeneration of multiple tissues.

The first product developed using this technology is a dermal replacement scaffold called Smart Matrix®. Extensive in vitro and in vivo analysis has shown that Smart Matrix® allows a rapid initial infiltration of cells and blood vessels. Advantageously, this fibrin-alginate technology can be combined with synthetic polymers, either inert (i.e. silicones) or bioactive (i.e. polycaprolactone, PCL) in various shapes (sheets, 3D structures), or osteogenic components for repair and regeneration of various tissues.

Aim: to introduce a novel fibrin-alginate technology for repair and regeneration of multiple tissues

Method & Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Smart Matrix®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average porosity (%)</td>
<td>83.22</td>
</tr>
<tr>
<td>Pore interconnectivity (%)</td>
<td>100</td>
</tr>
<tr>
<td>Average pore size (μm)</td>
<td>132.26</td>
</tr>
<tr>
<td>Average roughness Sa (μm)</td>
<td>114.776</td>
</tr>
<tr>
<td>Average G' (kPa)</td>
<td>8.26</td>
</tr>
</tbody>
</table>


Cytoscopy (lased edge, bottom) and proliferation (shrink Blue crystal stain) of primary human dermal fibroblasts on the fibrin-alginate matrix showing significant growth over 7 days of culture under standard conditions. (García-Gareta et al. 2015, Sharma et al. 2016, 2017).

SEM images of fibrin/alginate + silicone composite scaffold seeded with primary human dermal fibroblasts at day 7 of culture. White arrow point at cells which are seen embedded in the matrix. (Sharma et al. 2017).

SEM images of fibrin/alginate + silicone composite scaffold showing similar % vascular area that the positive control (filter disc dipped in VGEF solution), showing similar % vascular area on the composites and SM, which have higher % vascular area that the positive control (fiber disc dipped in VGEF solution), showing the pro-angiogenic potential of the fibrin/alginate matrix. (Material patented; Manuscript in preparation).

Ex vivo CAM assay results (5 mm x 5mm scaffold size) showing significantly higher % vascular area on the composite and SM compared to PCL alone. (Material patented; Manuscript in preparation).

Ex vivo CAM assay results (5 mm x 5mm scaffold size) showing similar % vascular area on the composite and SM, which have higher % vascular area that the positive control (fiber disc dipped in VGEF solution), showing the pro-angiogenic potential of the fibrin/alginate technology. (Material patented; Manuscript in preparation).

References:

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Conclusions

- We present a fibrin-alginate platform technology which is pro-angiogenic and promotes a rapid initial cellular infiltration.
- The first product out of this platform technology is a dermal replacement scaffold (Smart Matrix®) which is under clinical development at the spin-out Smart Matrix Ltd.
- Future development of this platform technology will see its combination with 3D printing for development of custom-made implants.