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8:00 PM - SB02.11.11

Bacterial Cellulose-Based Microfluidic Device for 3D Skin Modelling (Skin-on-Chip)

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Paper fluidics is based on patterning hydrophilic paper with channels bounded by hydrophobic barriers. Fluids move along channels by capillarity. Several methods are available for patterning paper, with different costs/resolutions. Paper patterning for microfluidics also used the embossing technique to design open-channel microfluidic devices, fabricated by compressing the sheet of paper with the help of 3D plastic printing moulds.
These approaches are adopted in this work to develop a multiwell-microplate paper-based microfluidic, aiming the creation of organs-on-chip, combining complexity and miniaturization. Bacterial Cellulose (BC) represents a source of highly pure and biocompatible cellulose, with huge technological potential in many fields - biomedical, composites, textiles, food and cosmetics textiles - but currently still rather underexploited [Gama et al, 2916; Klemm et al, 2018]. This work describes a novel approach towards the development of a nanostructured and multifunctional cellulose-based device for the continuous culture of animal cells and tissues. A multilayered system of modified BC (hydrophobized and electroconductive) was used to assemble the skin-on-chip, a microfluidic platform, using the lab-on-paper technology intended to mimic vascularization, with controlled flow, to introduce external stimuli, such as electrical or mechanical, and to support multicellular growth.
This chip serves a multifactorial purpose, aiming the control of each part that make up the overall complex 3D system, including dynamic control of physical, chemical and gaseous gradients, ensure mimetic vascularization, introduce favourable stimuli and co-culture of skin cells. This model sustains cell growth and allow real time and in a high throughput manner to assess cellular phenomena, such as cell-cell crosstalk, paracrine factor exchange, ECM production, as well as tissue homeostasis in the presence of chemical, mechanical, electrical and biological stimuli, and also kinetics of substance delivery on/through the skin.
BC hydrophobization was achieved using a new strategy for the surface modification of BC through the combination of oxygen plasma deposition and silanization with trichloromethyl silane. The combined use of the two techniques modifies both the surface roughness and energy and therefore maximizes the hydrophobic effect obtained. These modified membranes were characterized by SEM, water contact angle measurements, FTIR-ATR and XPS, and its cytotoxic potential was investigated using both indirect and direct contact studies with cells. Importantly, this surface modification revealed no short-term cytotoxic effects on L929 and hDNFs cells. This material was used for the construction of a BC-based well plate for cell culture, which can be supplied continuously with culture medium in long term studies (ranging from days to weeks), using a two-layered 3D full-thickness skin equivalent consisting of an epidermal and a dermal tissue layer, cultivated in alginate scaffolds, that can be maintained

and studied as a skin surrogate on the SkinChip [Maia et al, 2014].

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REFERENCES

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