PhD Open Days

3D bioprinting of a vascularized, innervated and functional skin tissue

PHD IN BIOENGINEERING

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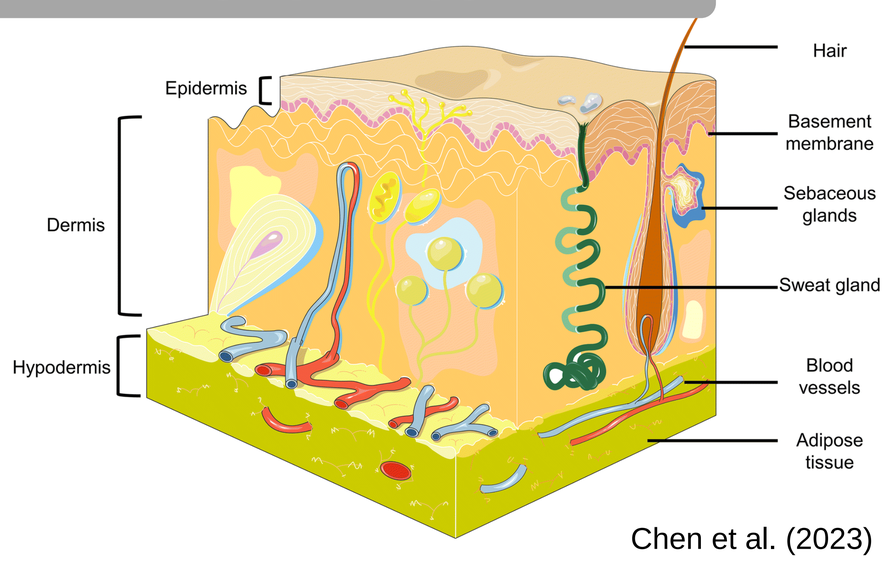
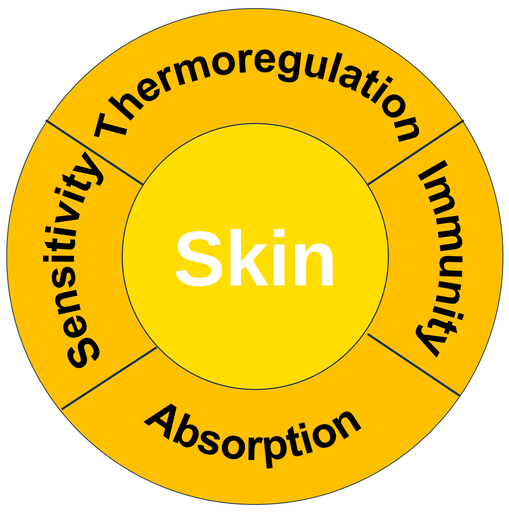
MOTIVATION

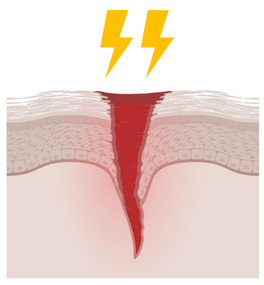


Chen et al. (2023)



Skin is a very complex tissue, with a multitude of functions. It harbors a great variety of cell types – such as keratinocytes, melanocytes, endothelial cells, sensory neurons, among others – and possesses an intricate microarchitecture, namely in the dermal-epidermal junction (DEJ), important for the maintenance of the structural integrity of skin.

Wound healing



Formation of scar tissue

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Loss of biomechanical properties
Loss of skin appendages
Loss of sensitivity

Autologous tissue transplantation

Gold standard

however…

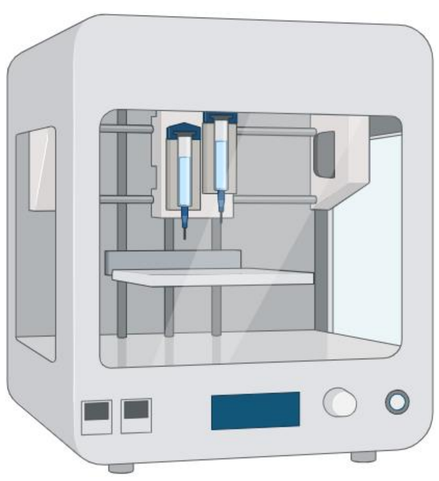
:(

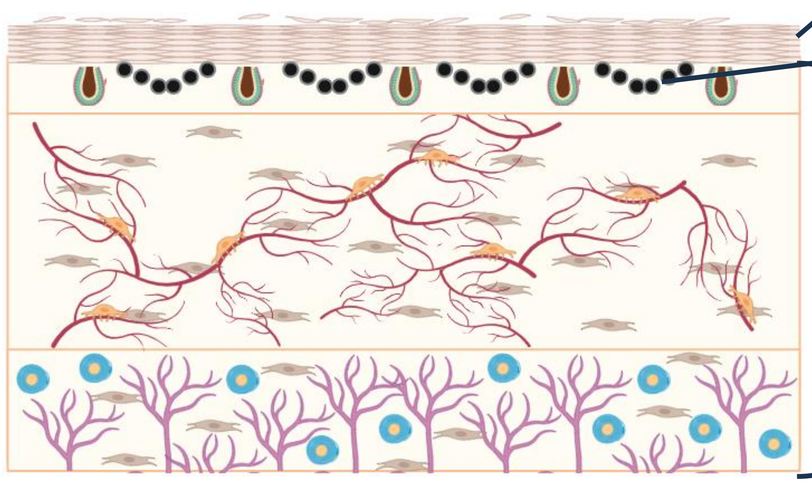
Lack of donor sites
Potential secondary injury
Infection risks

3D bioprinting has been extensively used for the fabrication of vascularized skin models, and it has also been used to introduce hair follicles into these models; nevertheless, there have not been reports of the use of this technique to fabricate **innervated skin tissues.**

The recapitulation of the DEJ has not been very explored, and can be tackled by the **remote controllability of magnetic nanoparticles (MNPs).**

PROPOSED SOLUTION





"Epidermal" bioink: keratinocytes in hyaluronic acid

Magnetic ink: collagen and MNPs; will be exposed to an external magnetic field to induce collagen fiber alignment

"Dermal" bioink: collagen and multiple cell types, divided in 3 sublayers:

- *Top layer:* will include the hair follicle spheroids
- *Middle layer:* will include human umbilical vein endothelial cells (HUVECs), fibroblasts and pericytes and is intended to promote **vascularization** of the construct
- *Bottom layer:* will include fibroblasts, Schwann cells and iPSC-derived sensory neurons and is supposed to be the **innervation**-promotor part of the construct

MAIN TASKS

Optimization of cell culture conditions: given the multiple cell types involved, it is crucial to find a suitable culture medium to guarantee viability and function

Development and characterization of bioinks: biomaterials' ability to elicit and maintain appropriate cell viability and function must be verified

3D bioprinted skin's functionality *in vitro*: proper stratification and layer formation will be assessed; sensory neuron function will be analysed as well, besides transepidermal resistance and wound healing behavior.

3D bioprinted skin's functionality *in vivo*: using mice models, the integration of the construct with the native tissue, in terms of reepithelialization, vascularization and innervation will be assessed

TÉCNICO LISBOA

Rensselaer

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