Potential use of skin bioprinting on cosmetics

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Juliana Lago, PhD

Natura does not

ANIMAL TESTING

In 2006 we eliminated all animal tests from research & development of raw materials and final products, without exclude demanding criteria of safety and efficacy of our products

TIMELINE BRAZILIAN CENARIO

2007

Arouca Law (11.794/08) Federal Legislation on animal experimentation;

Creates **CONCEA**

(National Council to Control Animal Experimentation)

2012-13

Ministry of Science and Technology creates **RENAMA**

ANVISA recognizes the Brazilian Center on Validation of Alternative Methods – **BRACVAM**

Royal Institute Laboratory closes after activist raid

PLC 70/2014

2014

São Paulo and Mato Grosso States test bans

CONCEA recognized **17 alternative methods** (3Rs) to be implemented up to **2019**

2016

Pará State test ban

CONCEA recognized more **7 alternative methods** to be implemented up to **2021**

2017

Senate CCT endorses **PLC 70/2014**

No animal testing for products and ingredients for cosmetic products

natura
bem estar bem

Living tissues and organs are manufactured and sold in markets

There is a huge demand for alternative methodologies in the cosmetics and skin care industry for product testing.

Cells growing into 3D structures, such as miniature human organs, can provide a more realistic way to test new ingredients.

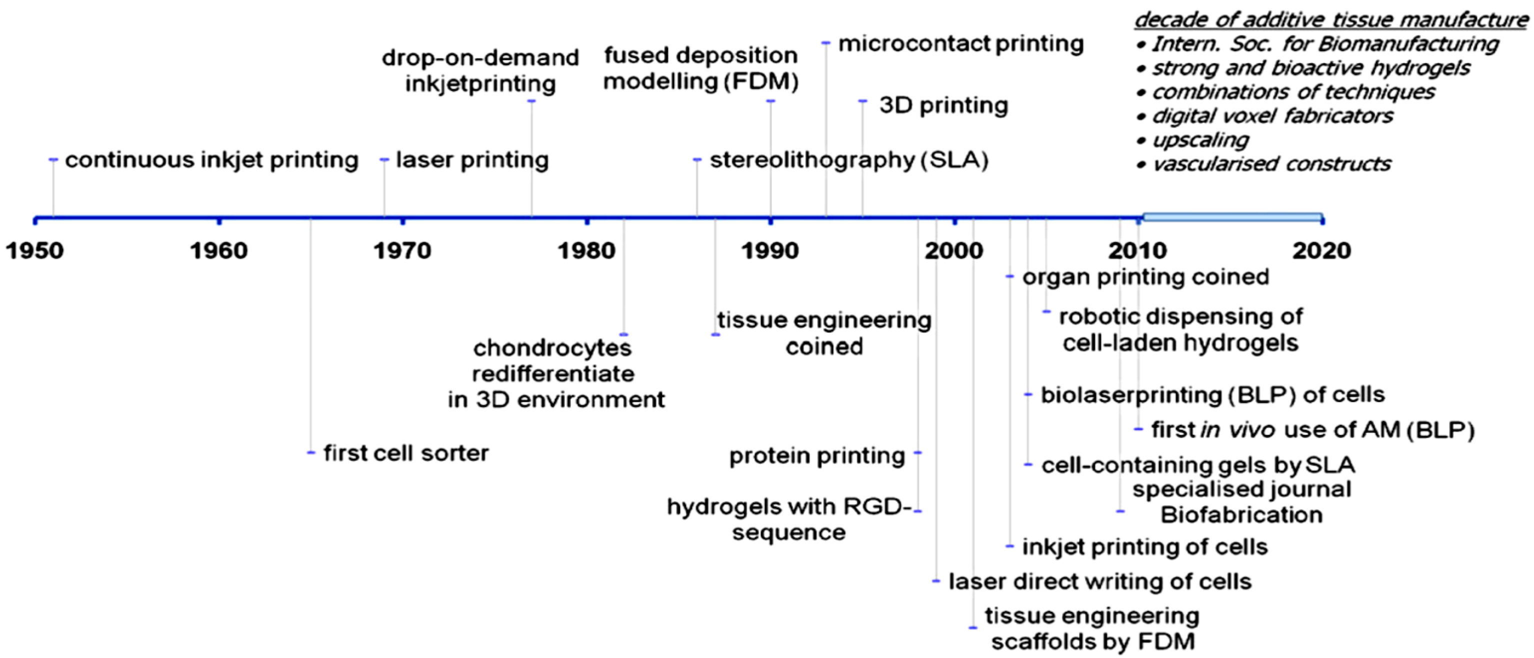
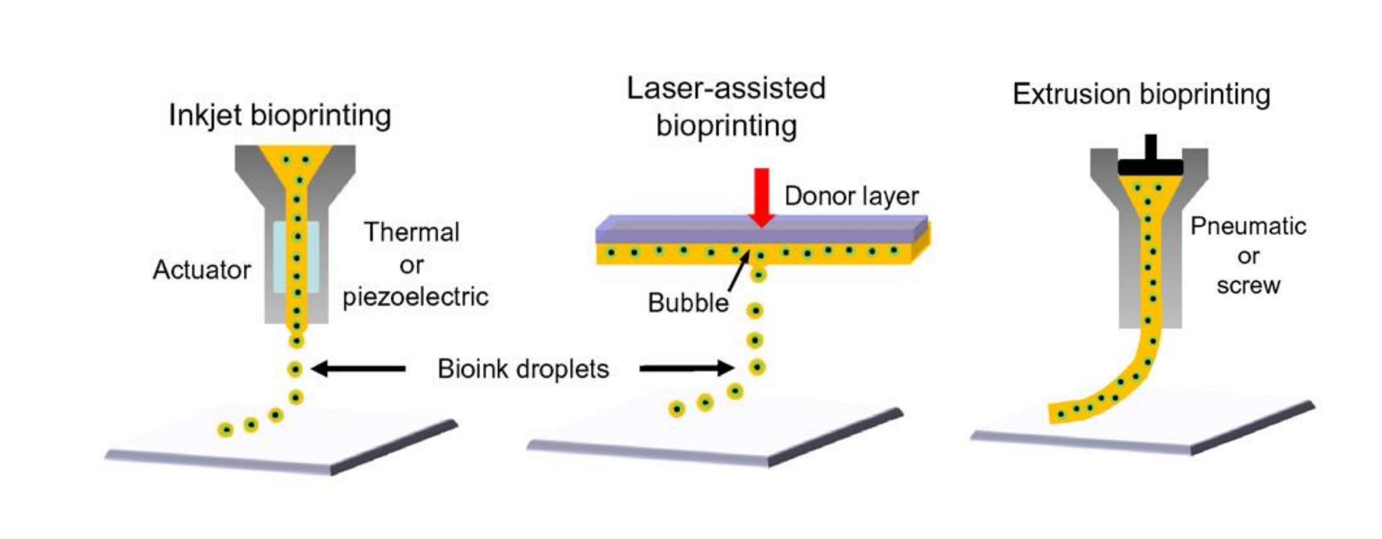


Figure: Woodfield T, et al.(2017)

The structure of skin is easy to print compared with other complex organs such as a heart or kidney

Three types of bioprinting processes, namely **inkjet bioprinting, laser-assisted bioprinting** and **extrusion bioprinting.**



C. Mandrycky et al. (2016)

Hydrogel bioink characteristics

Hydrogels play an essential role in bioprinting. They not only have direct contact with cells to provide structural support, but they also dominate the chemical and physical properties of bioinks *(Williams, 2008).*

Hydrogels used for bioprinting should be characterized by:

- Printability and crosslinkability
- Mechanical properties
- Biocompatibility

Two types of hydrogels:

- Natural hydrogels
- Synthetic polymers

Inkjet bioprinting

Inkjet bioprinting (also known as drop-on-demand printing) is a non-contact technique which refers to the spatially controlled dispensing of a jet of small droplets of liquid material through a small orifice on to a substrate (*Pati et al., 2016*).

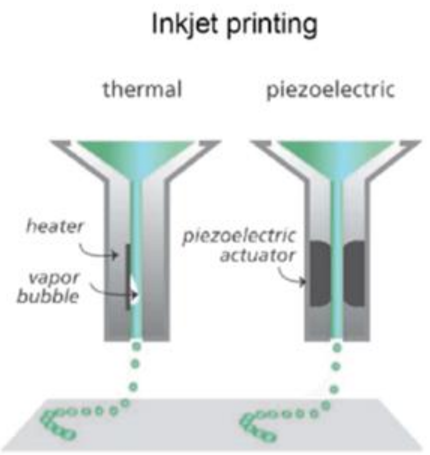


Figure: Avci, Huseyin et.al (2017)

Inkjet bioprinting offers an inexpensive, high-throughput capability, with the benefits of high resolution, reproducibility, and friendly use.

One of the main limitations of this technology is the relatively low threshold for the viscosity of inkjet printing fluids.

Cell settling effects in inkjet printers, which are highly related to clogging and viscosity, change during printing.

Laser-assisted bioprinting

For laser printing, the effects of laser energy, substrate film thickness, and hydrogel viscosity on the viability of cells as well as droplet size, cell differentiation and proliferation have been investigated.

Three layers of different componentes:

- a donor slide covered with
- a second laser energy absorbing layer
- a layer of cell-bioink components

The focused laser pulses cause local evaporation of the absorbing layer that generates a high gas pressure propelling the bioink compound towards the collector slide (*Malda et al., 2013*).

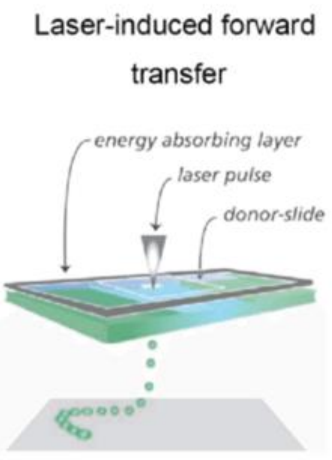


Figure: Avci, Huseyin et.al (2017)

Extrusion bioprinting

Robotically controlled extrusion of a material in a continuous manner rather than liquid droplets. These technologies allow the printing of hydrogels in specific target positions, turning out to be the most promising approach for producing 3D organ constructs.

Extrusion bioprinting provides good compatibility with hydrogels of very different viscosities at a reasonable cost.

For extrusion printing, relationships between dispensing pressure, printing time, and nozzle diameter are importante *(Yu et al., 2013)*.

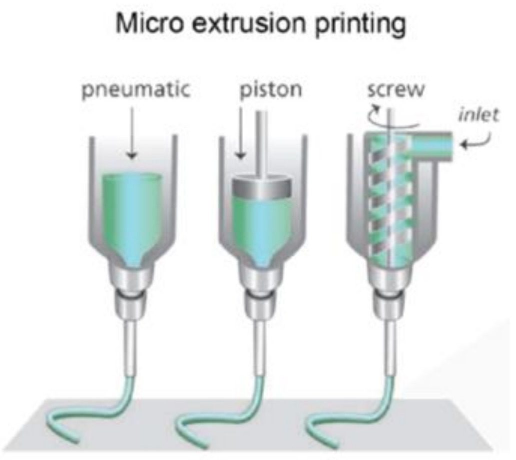


Figure: Avci, Huseyin et.al (2017)

Skin bioprinting

Bioprinting of skin involves five main process steps:

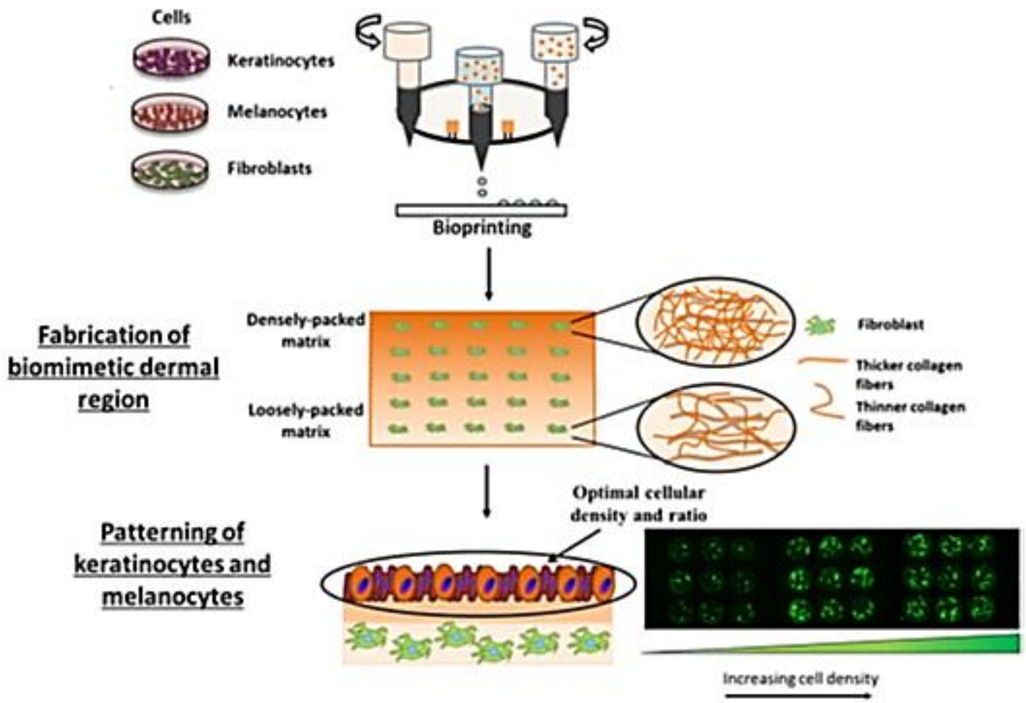
1. Design approach and modeling,
2. Selection of materials,
3. Selection of cells,
4. Bioprinting,
5. Maturation before transplantation/cosmetics or drug testing.

More than one type of cells (fibroblasts, keratinocytes and melanocytes) is preferred to fabricate a multilayered biomimetic skin model.

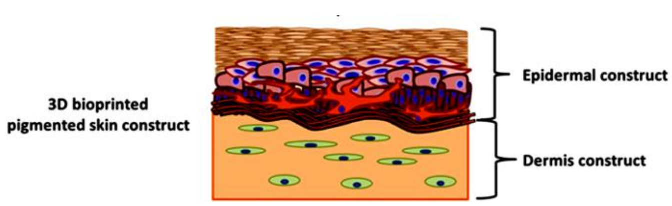
Skin bioprinting

The 3D pigmented human skin constructs are obtained from using three different types of skin cells:

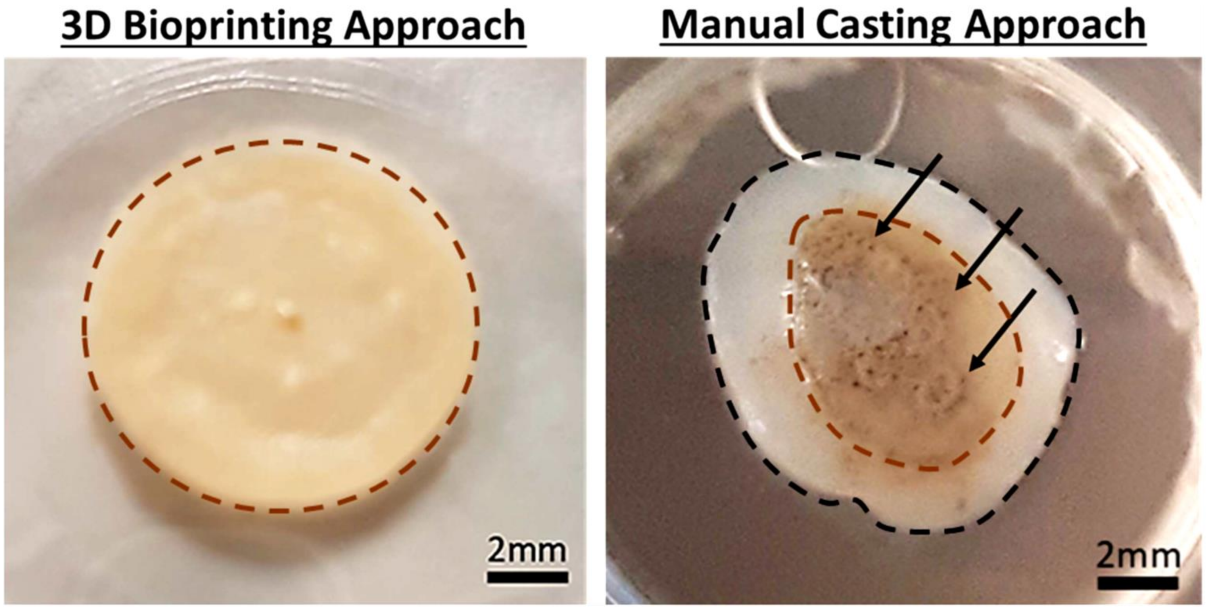
- keratinocytes, fibroblasts and melanocytes.



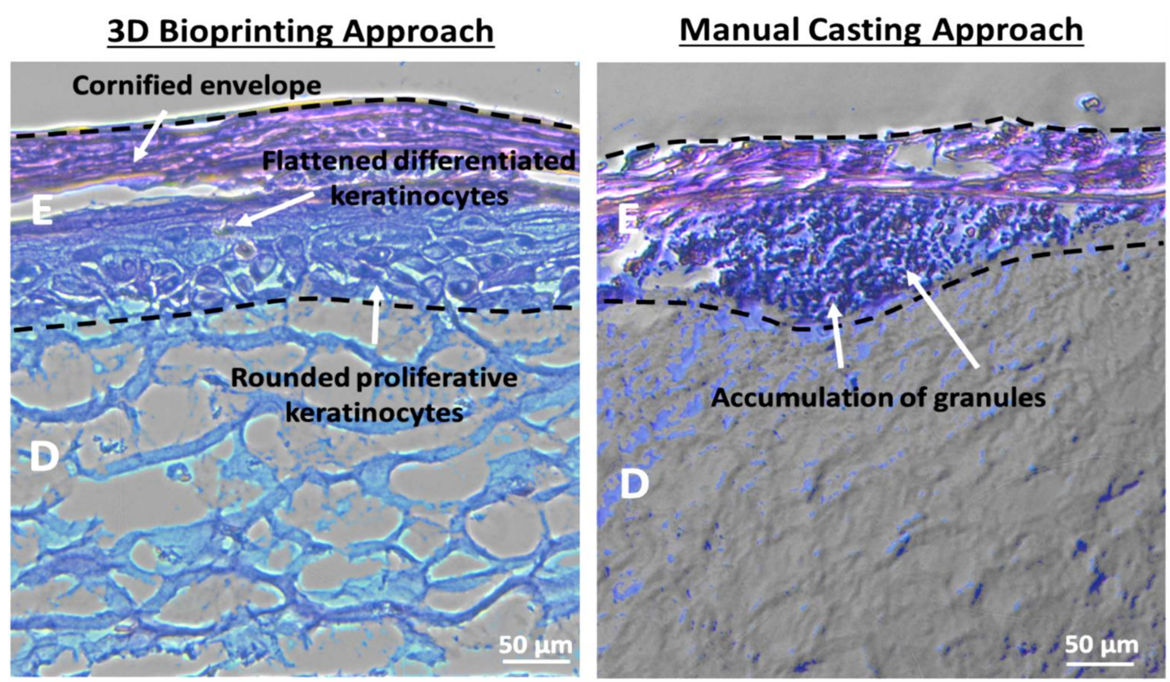
A critical aspect to achieving skin pigmentation is associated with the transfer of melanosomes from the melanocytes to the surrounding keratinocytes in the epidermal region.



Wei Long Ng, et al. (2018)



Bioprinting: 3D skin with excellent accuracy, high reproducibility and easy handling



Wei Long Ng, et al. (2018)

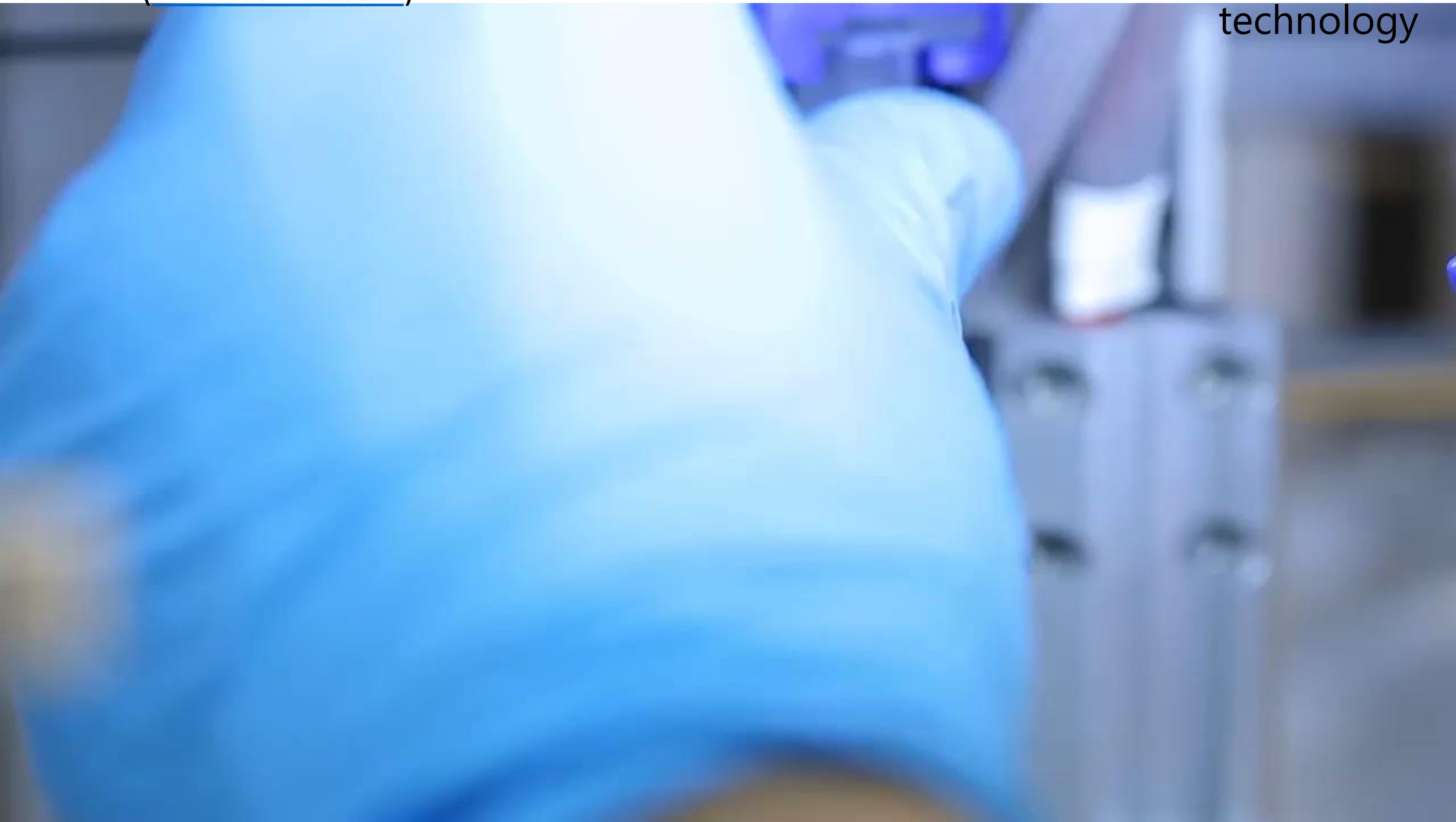
Natura develop a 3D Skin bioprinted

Natura is the 1st Brazilian cosmetic company having a 3D skin bioprinting

Natura develop a 3D Skin bioprinted

CELLINK (www.cellink.com)

Natura and USP signed an exclusive research and development partnership on 3D skin bioprinting technology




obrigada
natura
Juliana Lago
julianalago@natura.net