Centro de Tecnologia da Informação Renato Archer

Bioimpressão de tecidos e órgãos: o avanço de novas tecnologias visando a Medicina 4.0

Janaina Dernowsek, PhD

janaina.dernowsek@cti.gov.br
www.biofabricação.com

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

BRASIL GOVERNO FEDERAL

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Tópicos:

- Conceitos da bioimpressão e biofabricação de tecidos;
- Tecnologias envolvidas;
- O papel da tecnologia da informação na bioimpressão de tecidos;
- Projetos desenvolvidos no Brasil e no mundo sobre bioimpressão de tecidos.
- Medicina 4.0 → contribuição significativa da bioimpressão

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Núcleo de Tecnologias Tridimensionais (NT3D) 1997

Mission

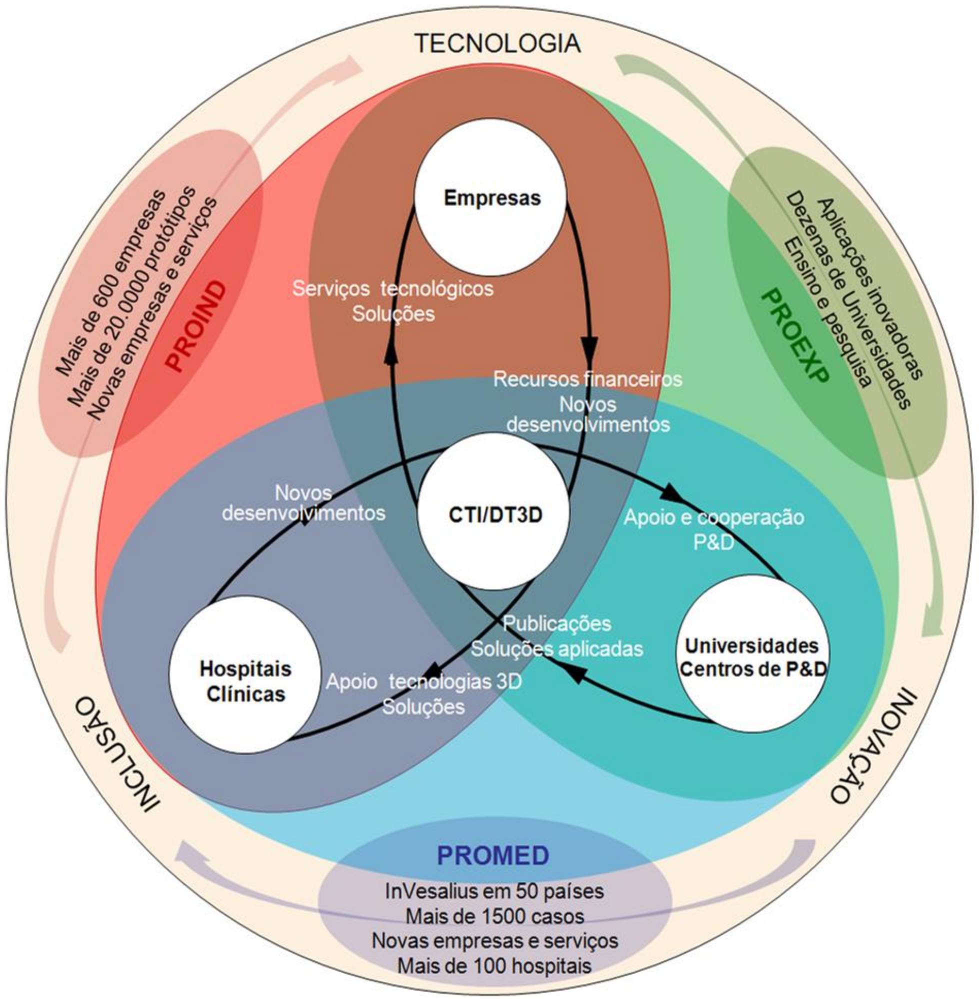
To research, develop, utilize, and diffuse three dimensional technologies (virtual and physical) focusing in innovation and multidisciplinary applications driven by society

Partnership

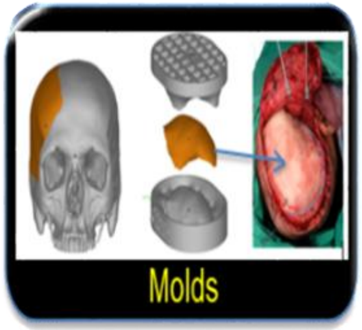
Companies (ProIND)

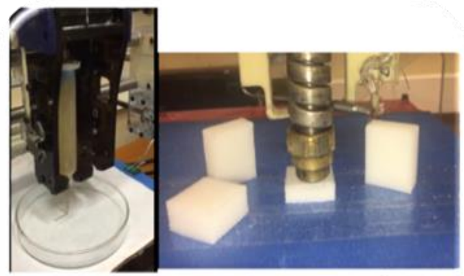
Hospitals (ProMED)

Universities (ProEXP)

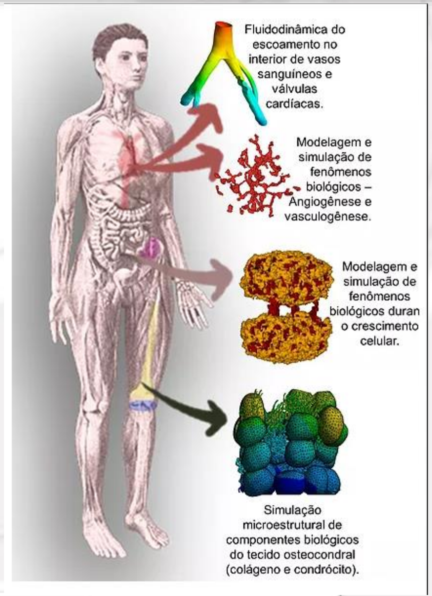


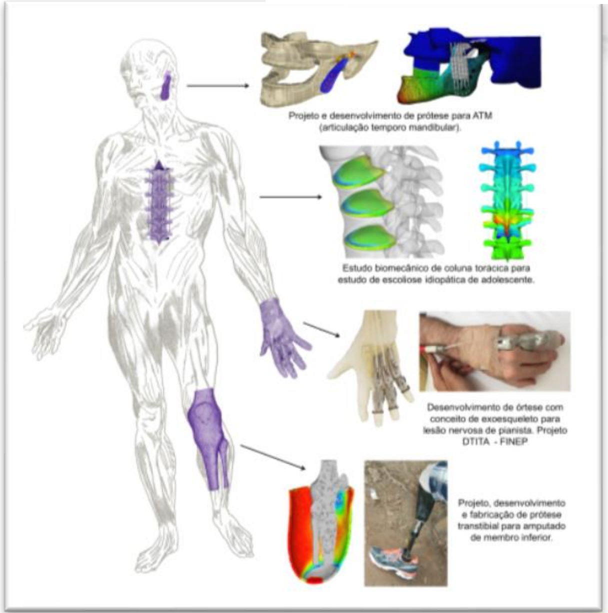
CTI Renato Archer - Aplicações





Scaffolds e Bioimpressão



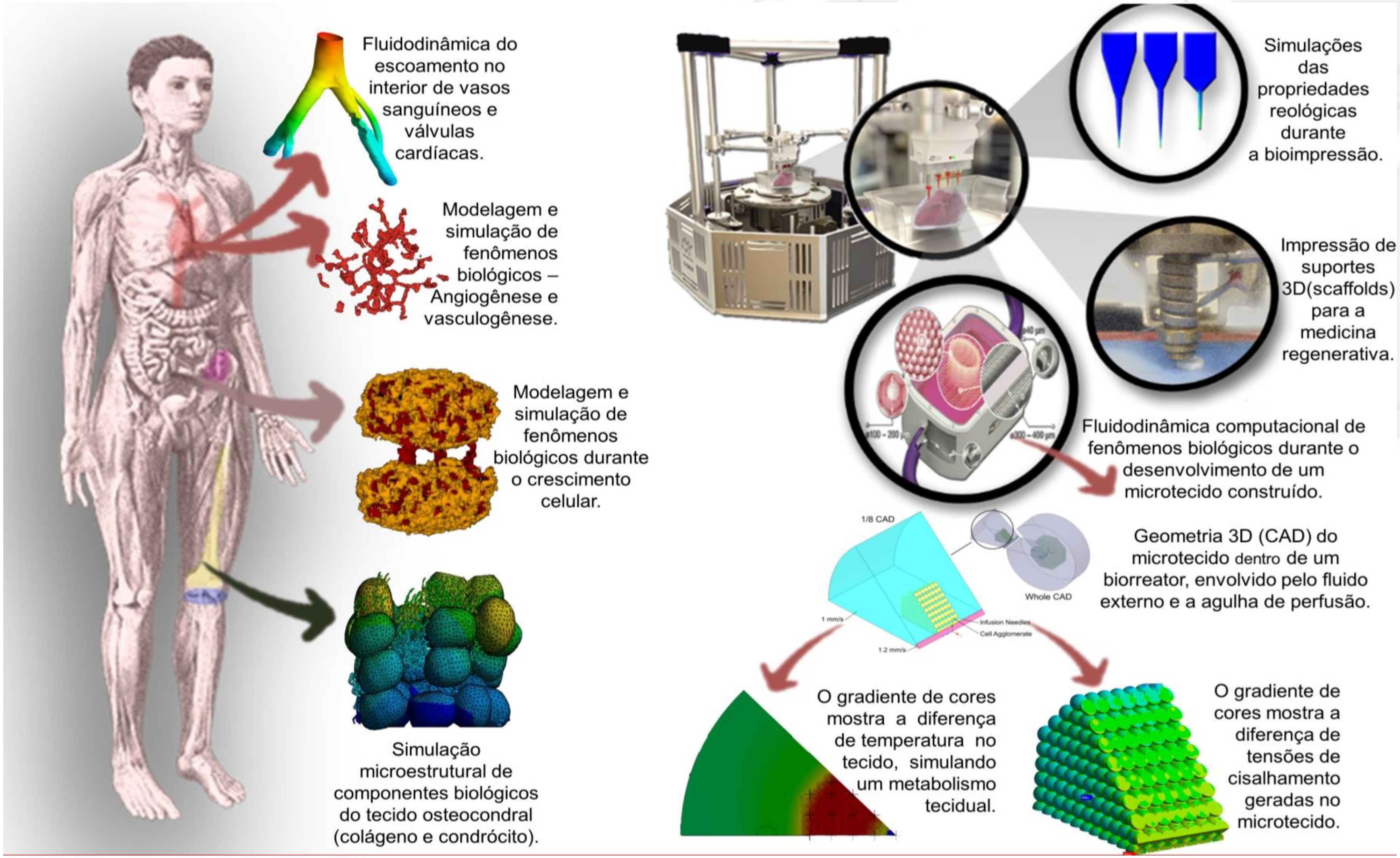


No Brasil - CTI Renato Archer

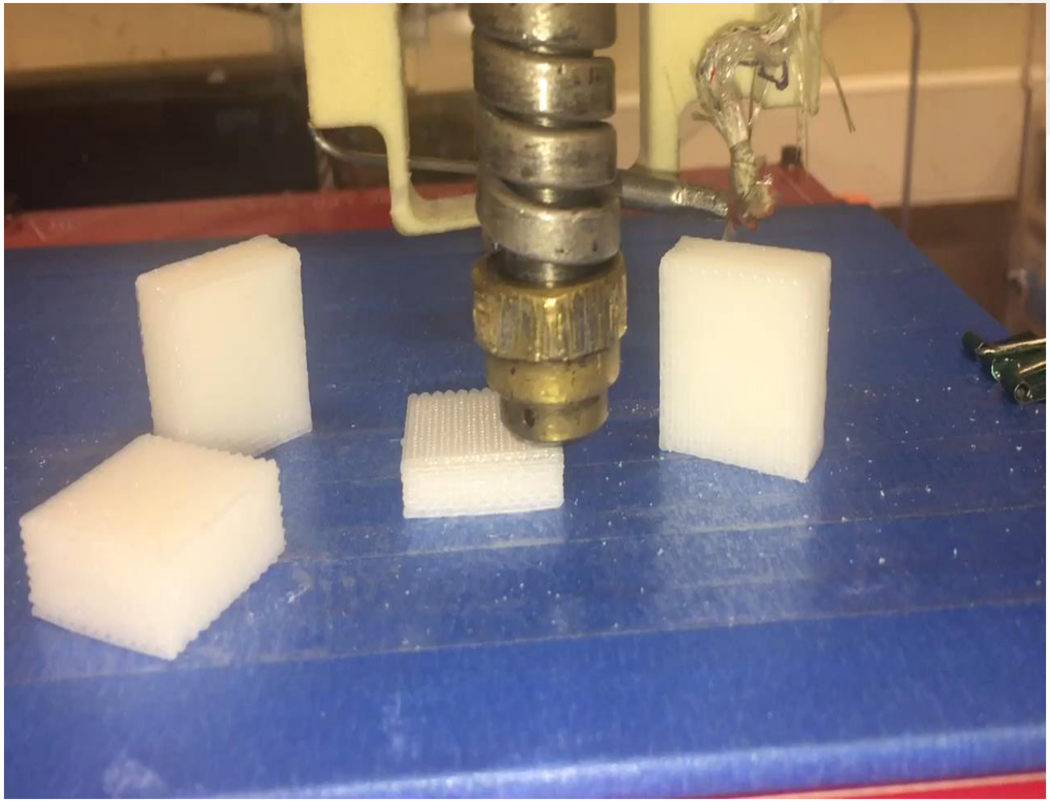
Software livre para reconstrução de imagens provindas de equipamentos de tomografia computadorizada ou ressonância magnética

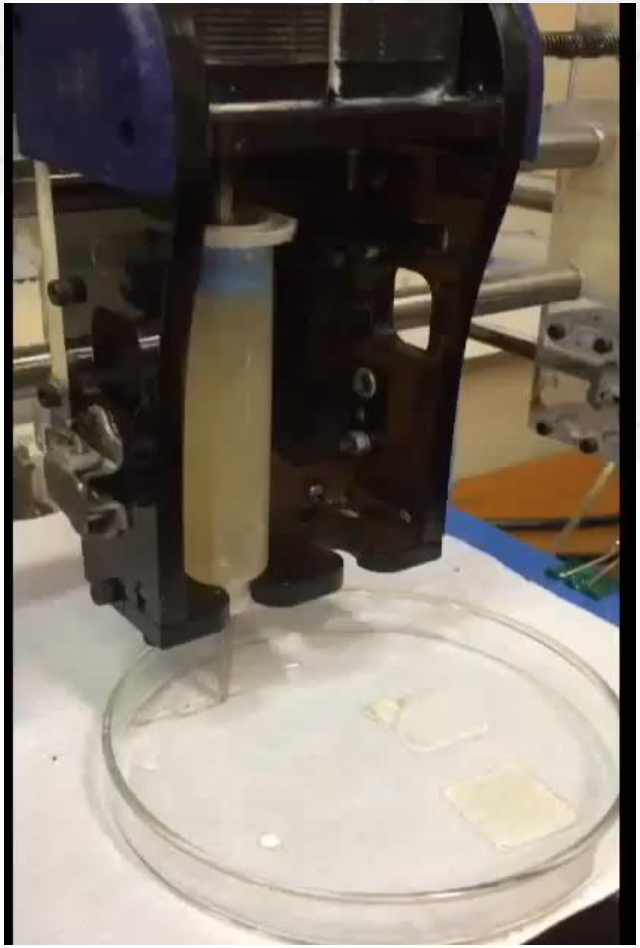
https://www.cti.gov.br/pt-br/invesalius

CTI Renato Archer - Aplicações

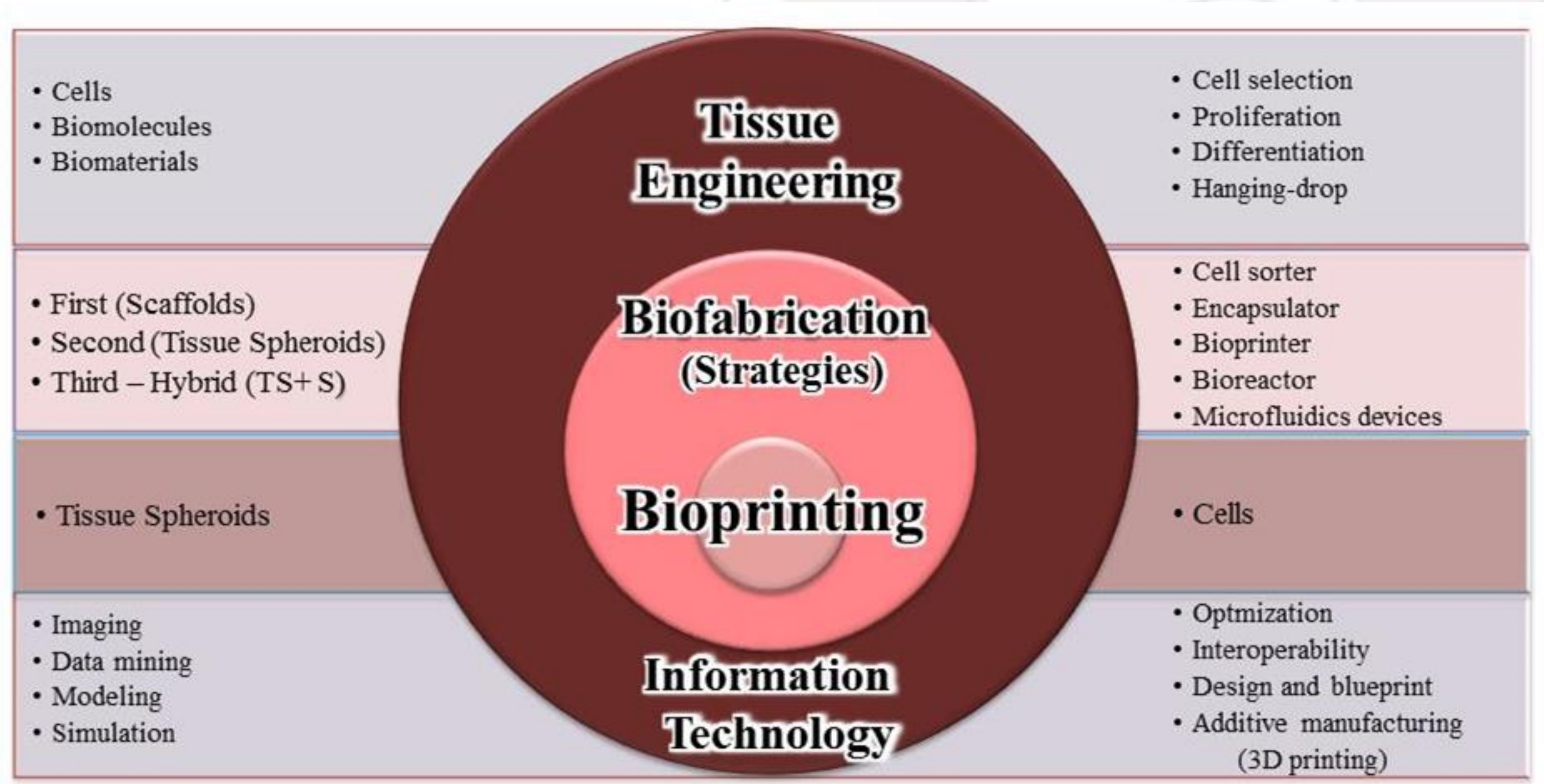


Impressão 3D na Engenharia de Tecidos



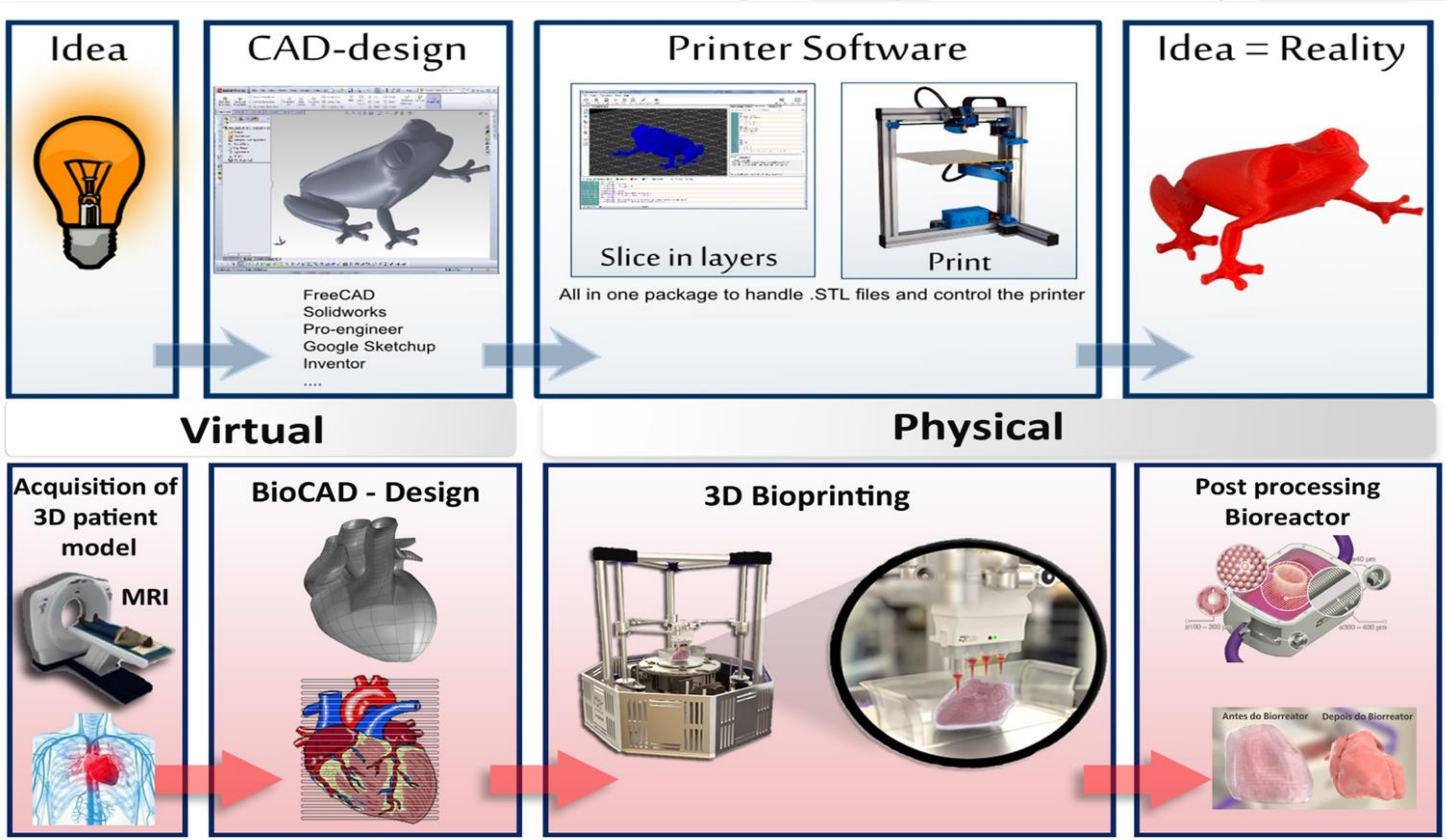


Engenharia Tecidual, Biofabricação, Bioimpressão e Tecnologia da Informação



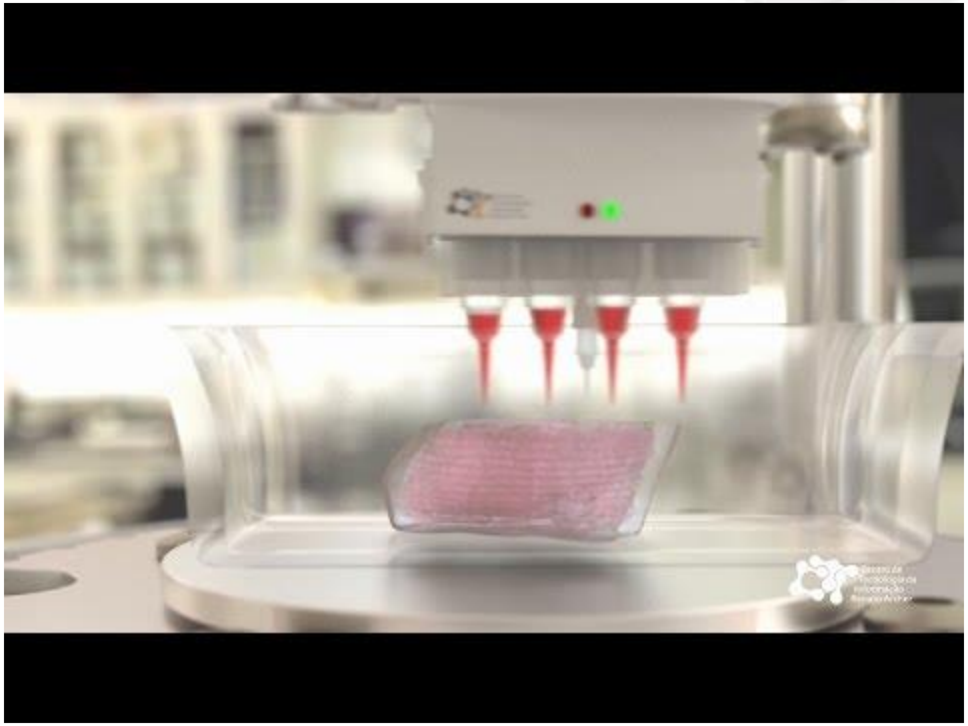
Dernowsek *et al.*, 2017

Tecnologias 3D, Tecnologia da Informação e Biofabricação



Bioimpressão

Bioprinting is a computer-aided robotic layer by layer
additive biofabrication of functional living
human organ constructs



The bio-ink:
cell aggregates
The cartridge:
TS container
The bio-paper:
gel
The printer:
bio-printer

Motivações

Uso de animais para teste de drogas e cosméticos

GAPMINDER

1800 1900 2000 2010

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Potencial de Mercado

A IDTechEx prevê que o mercado global de bioimpressão atinja um valor de US $ 1,9 bilhão até o ano de 2028.

INSIDE 3D PRINTING
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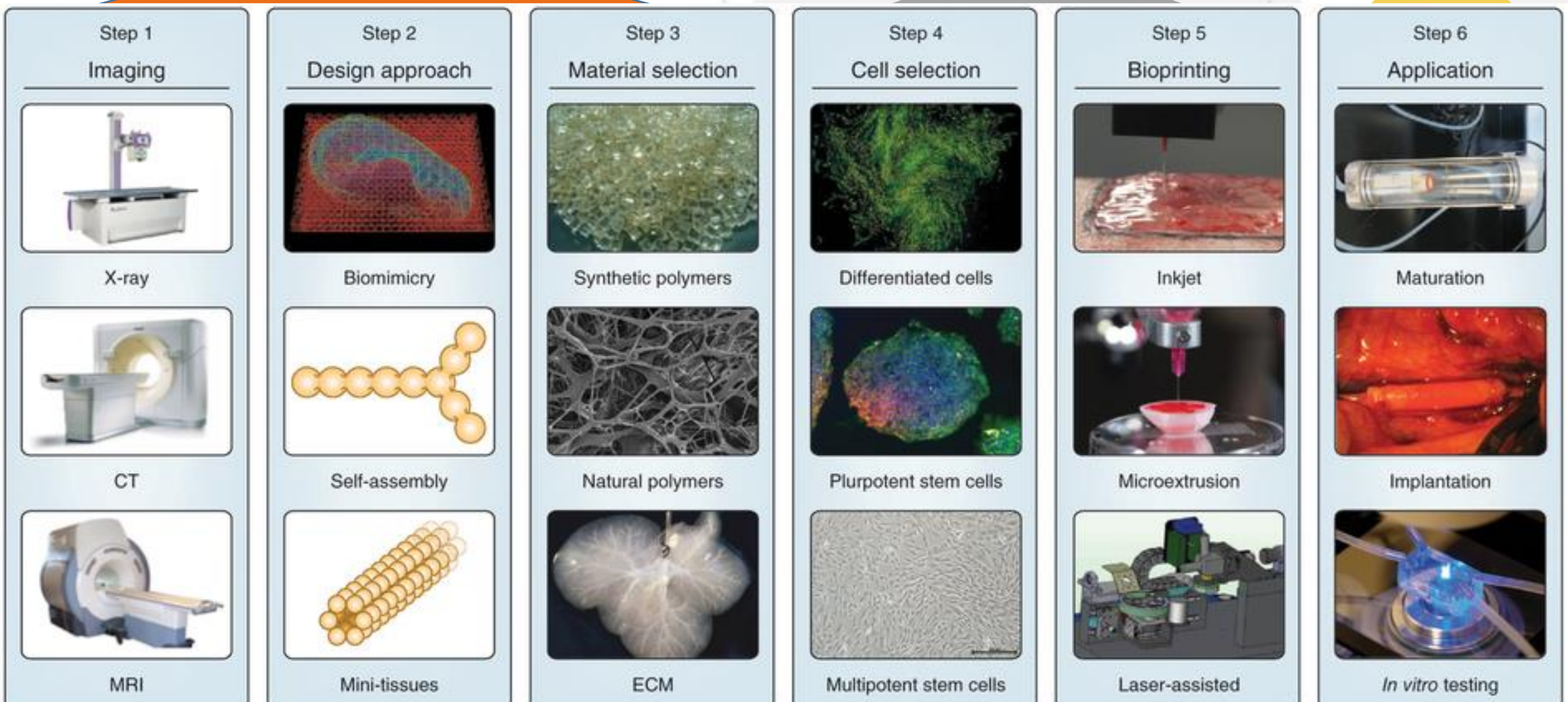
Etapas da bioimpressão

Pre-Processing
(CAD, Blueprints), Pre-conditioning

Processing
3D Tissue Printing

Post-processing
Bioreactor → Tissue maturation



Murphy & Atala, 2014

Etapas da Bioimpressão

Outlook

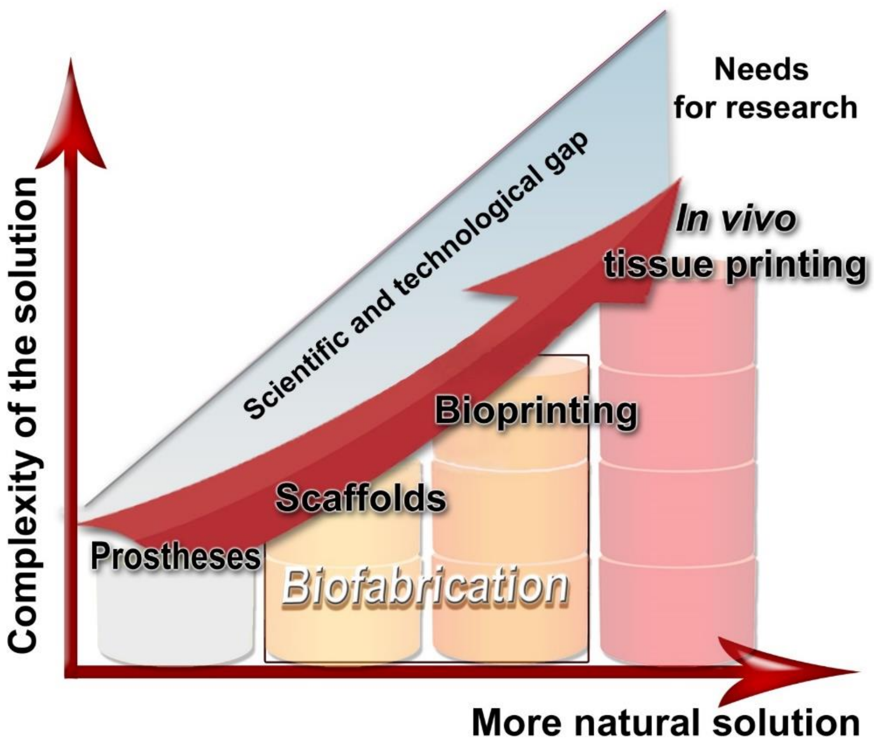
Today
- Small scale tissues
- Drug Discovery
- Toxicity testing

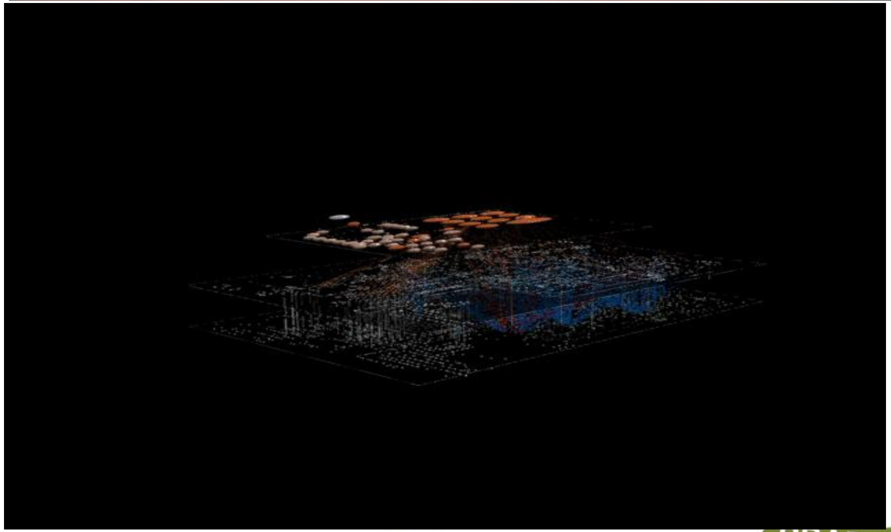
Tomorrow
- Microtissues
- Implants

Future
- Lobes
- Pieces of organs

Uncertain future
Full organs

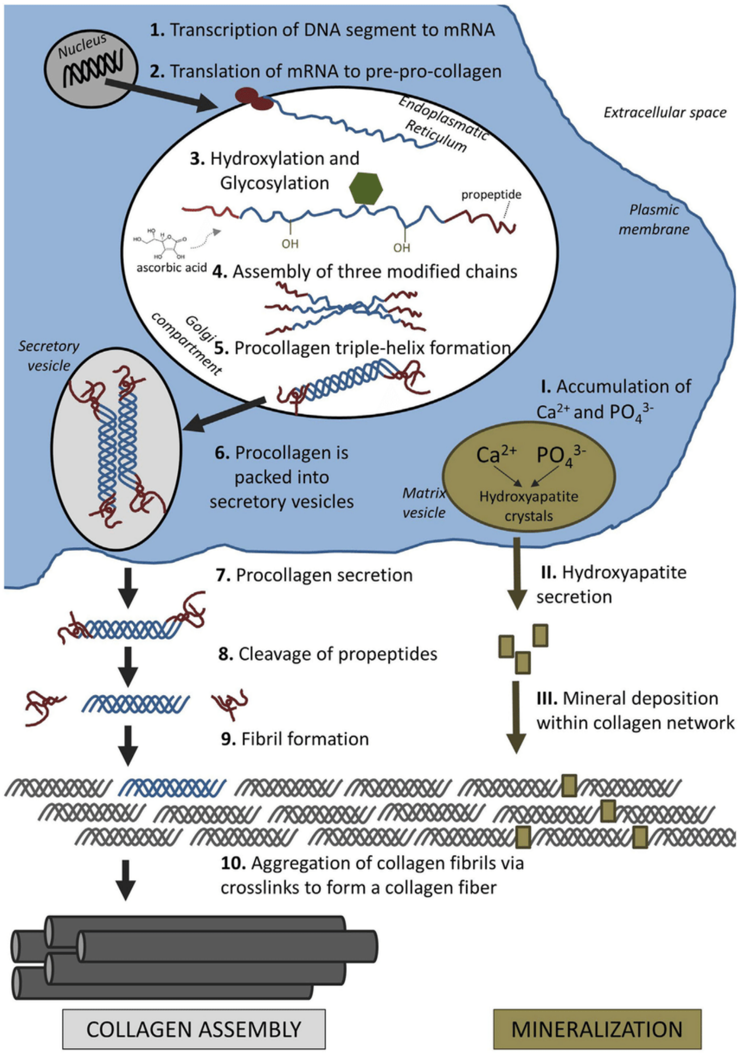
Biofabrication and the relationship between complexity and nature of the solution

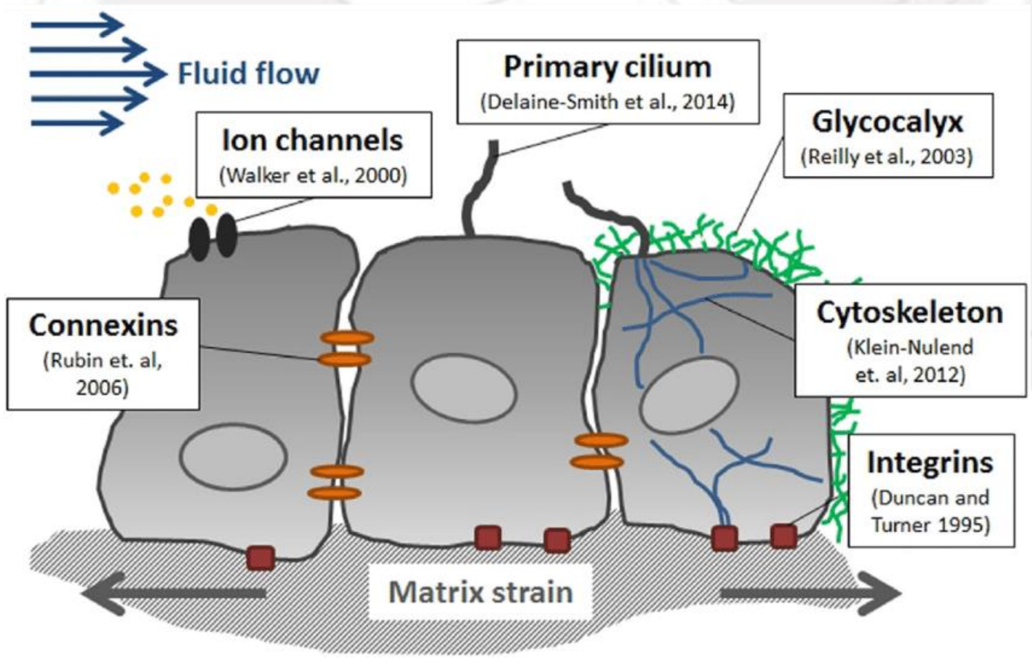




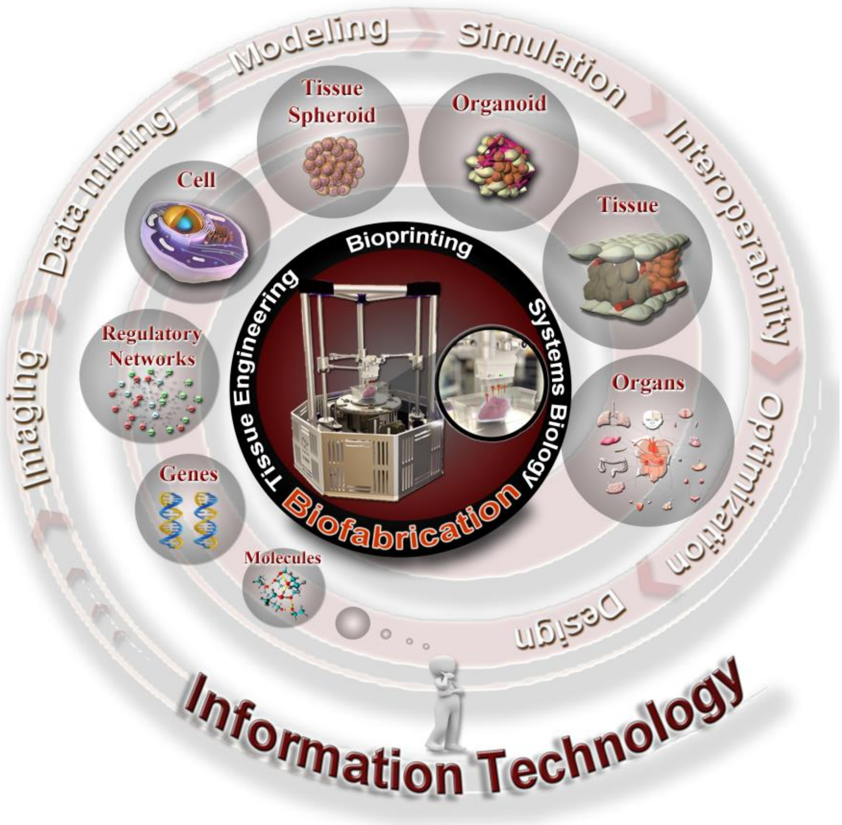
Dernowsek et al. 2017

"BioFerramentas"

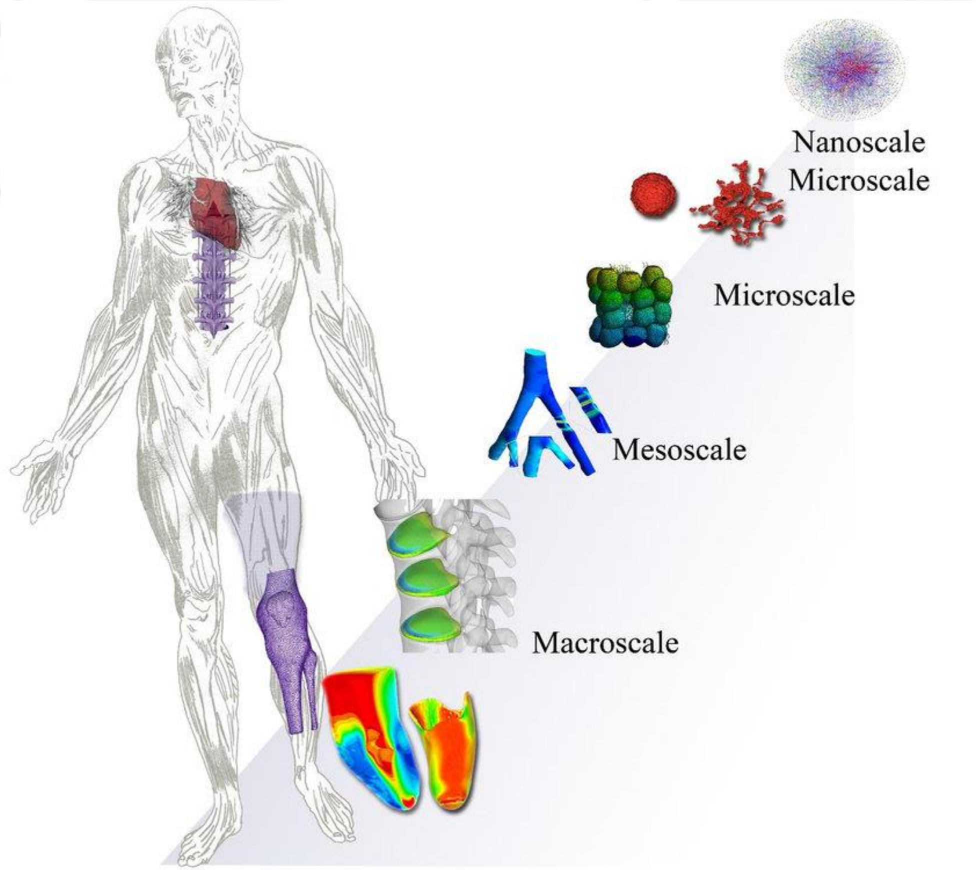




Conhecimento multiescalar



Dernowsek et al., 2017



Dernowsek et al., 2018

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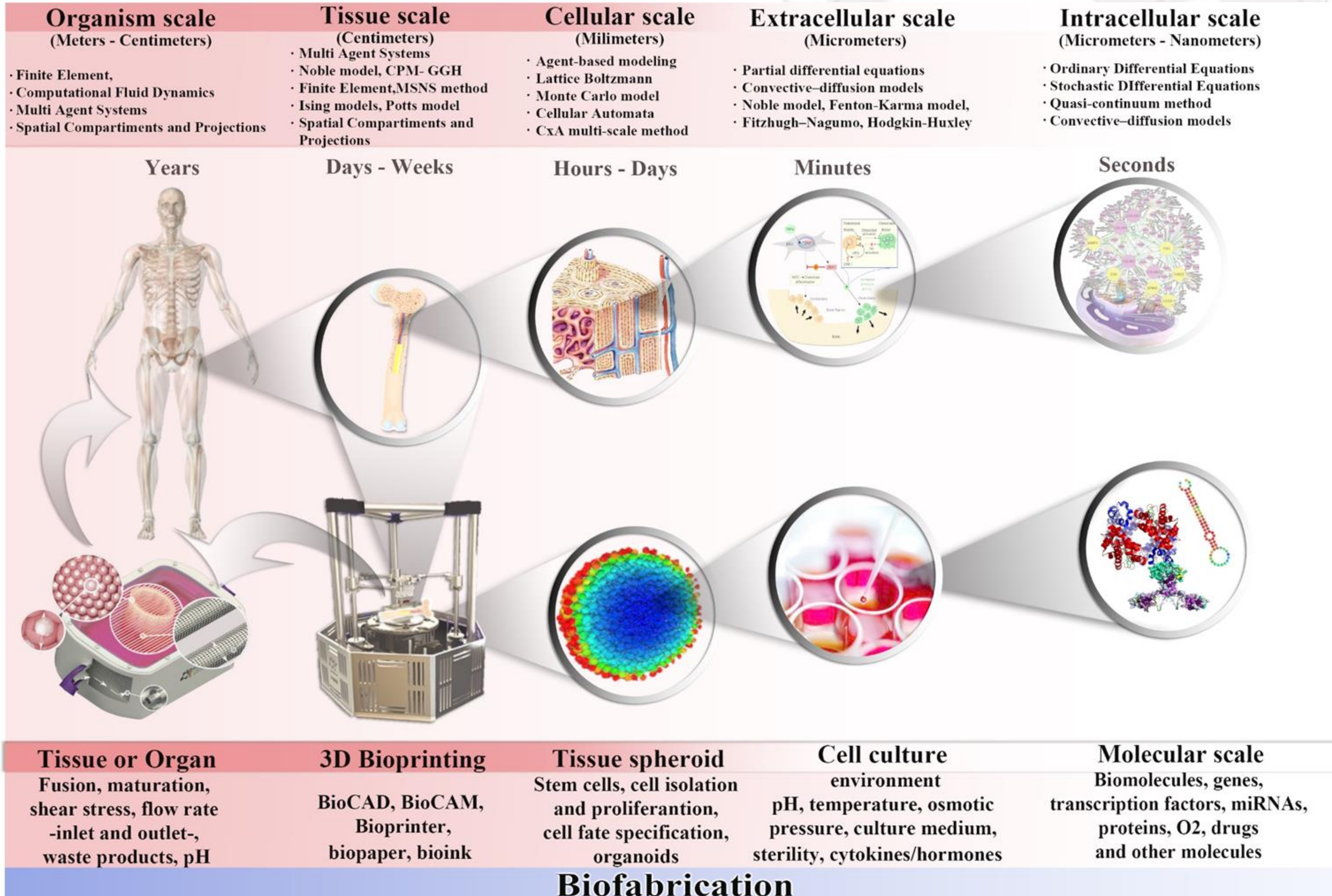

Dernowsek *et al.*, 2016

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Bioimpressoras

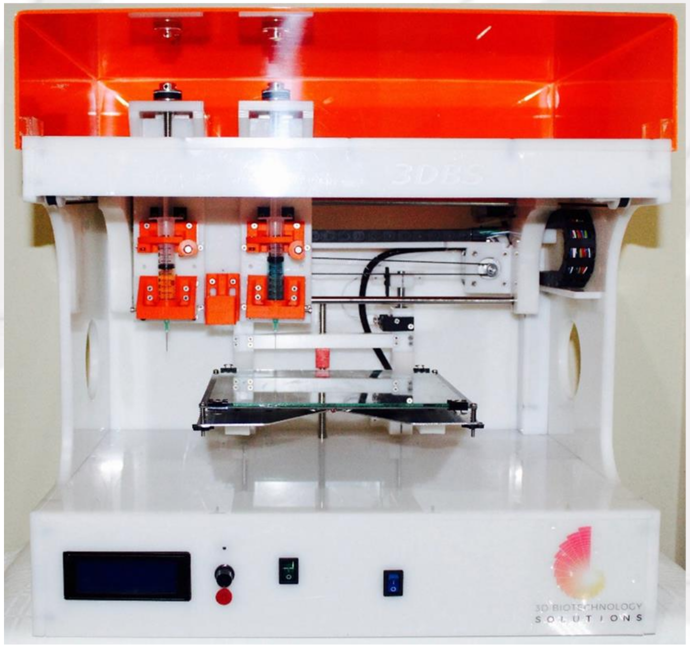
Bioimpressoras

3D Biotechnologies Solutions

__**Resolution**__:

Brasil

- 50µm Layer thickness (z)
- 100µm (x,y)
- **R$ 13.000**
- **OPEN-SOURCE PROGRAMS**



3D Biotechnologies Solutions

__**Resolution**__:

- 5µm Layer thickness (z)
- 10 µm (x,y)
- **R$ 30.000**
- Pronterface e Slic3R/Cura

OPEN-SOURCE PROGRAMS

Bioimpressoras

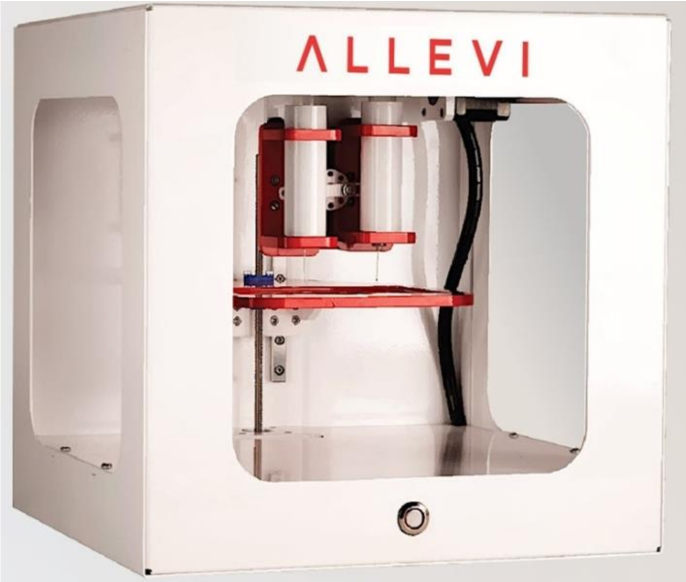
BIO X 3D BIOPRINTER
CELLINK
Suécia
<u>Resolution</u> :
- 1µm Layer thickness (z)
- 1µm (x,y)
- **11,840 - 21,840 USD**

reddot award 2018
winner

BIO X 3D BIOPRINTER
CELLINK
Suécia
<u>Resolution</u> :
- 50µm Layer thickness (z)
- 1µm (x,y)
- **40,840 USD**

INSIDE 3D PRINTING BRAZIL
CONFERENCE & EXPO

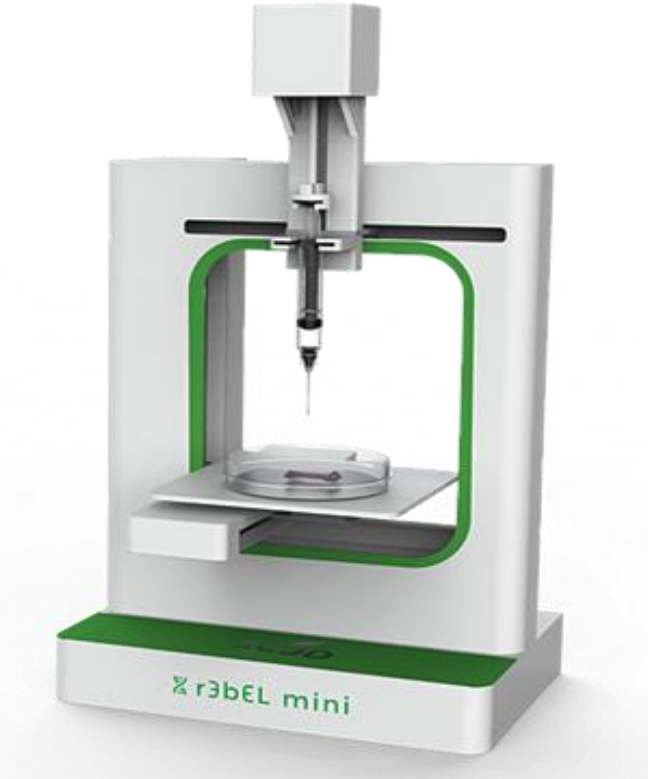
Bioimpressoras



Allevi 2 Bioprinter
Resolution:
EUA
- 5µm Layer Thickness (z)
- 5.5µm (x,y) 150
- 150µm Print Resolution
- **~ 5,000 USD**

Allevi 2 Bioprinter
EUA
Resolution :
- 1 µm (x, y, z)
- ? µm Print Resolution

Bioimpressoras

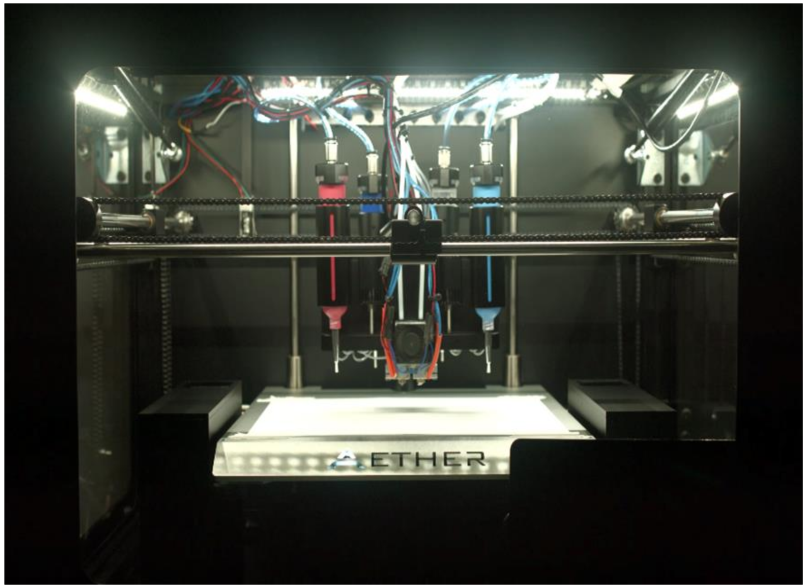


r3bEL MINI BIOPRINTER
SE3D
EUA
Resolution:
• 150 µm Layer thickness (z)

r3bEL X BIOPRINTER
SE3D
EUA
Resolution:
• 150 µm Layer thickness (z)
OPEN-SOURCE PROGRAMS

INSIDE 3D PRINTING BRAZIL
CONFERENCE & EXPO

Bioimpressoras



Aether Biopirnter
Aether
EUA
Resolution:
- 1 µm (x, y)
- 0.43 nm (z)

Tissue Scribe Gen. 3
3DCULTURES
EUA
Resolution:
- 0.1mm (x, y)
- 0.04375mm (z)
- 0.1-0.2mm
- 1,099 USD

Bioimpressoras

3D-Bioplotter
EnvisionTec
Alemanha
<u>Resolution</u>:
- 1µm (x,y,z)
- ? µm Print Resolution

BIOASSEMBLYBOT
Alemanha
<u>Resolution</u>:
- 1µm (x,y,z)
- ? µm Print Resolution

Bioimpressoras

3DDiscovery™ platform
REGENHU LTD
Suiça
Resolution: +-5µm
Melt Electrospinning & Bioprinting technology convergence

INVIVO Standard
ROKIT
Koreia
Resolution:
- Extruder 200 µm / Dispenser 80 µm

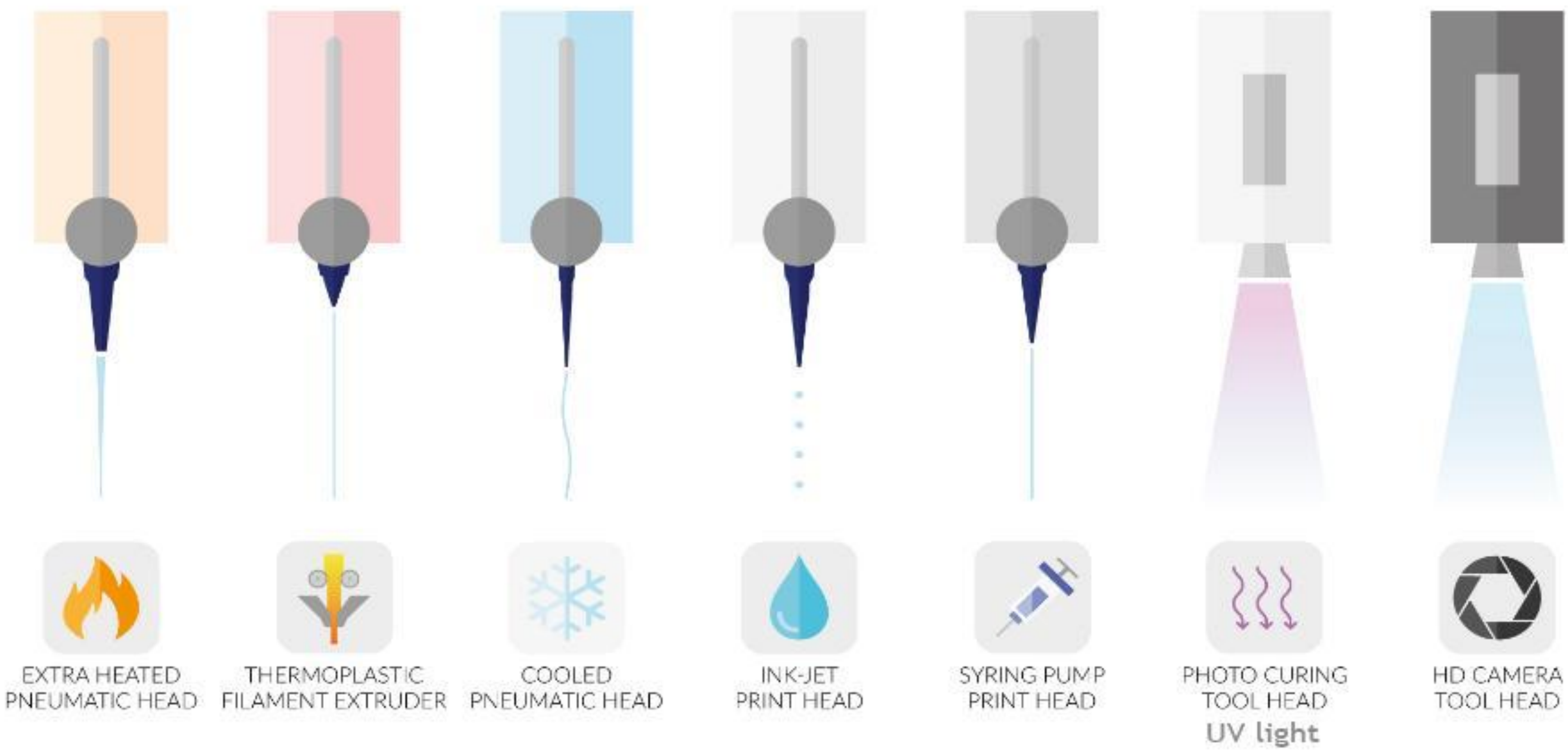
Bioimpressoras

RX1 Biopirnter
Aspect Biosystems Ltd
Canadá

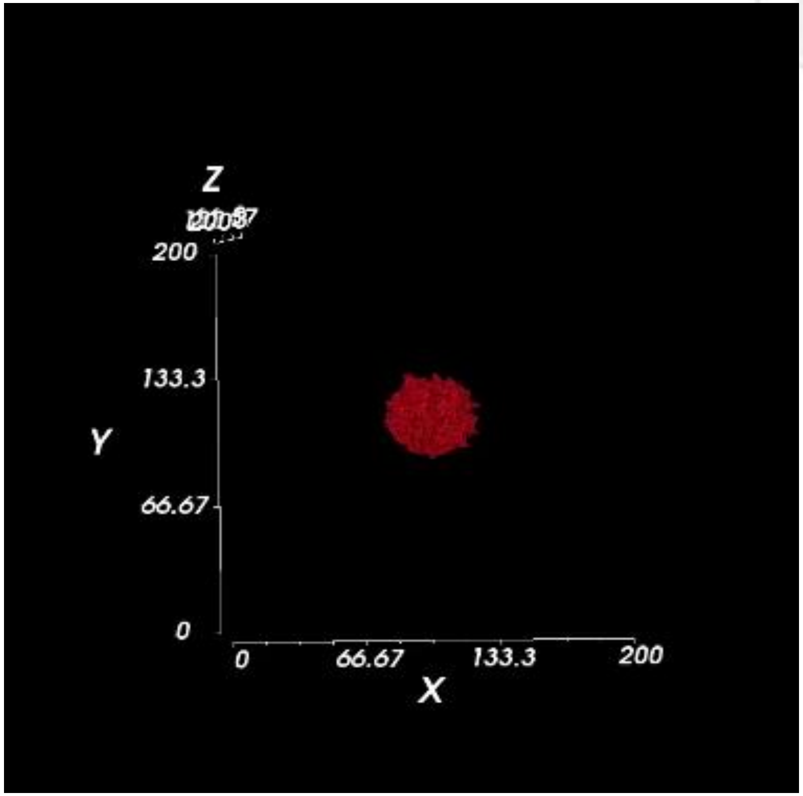
Resolution:

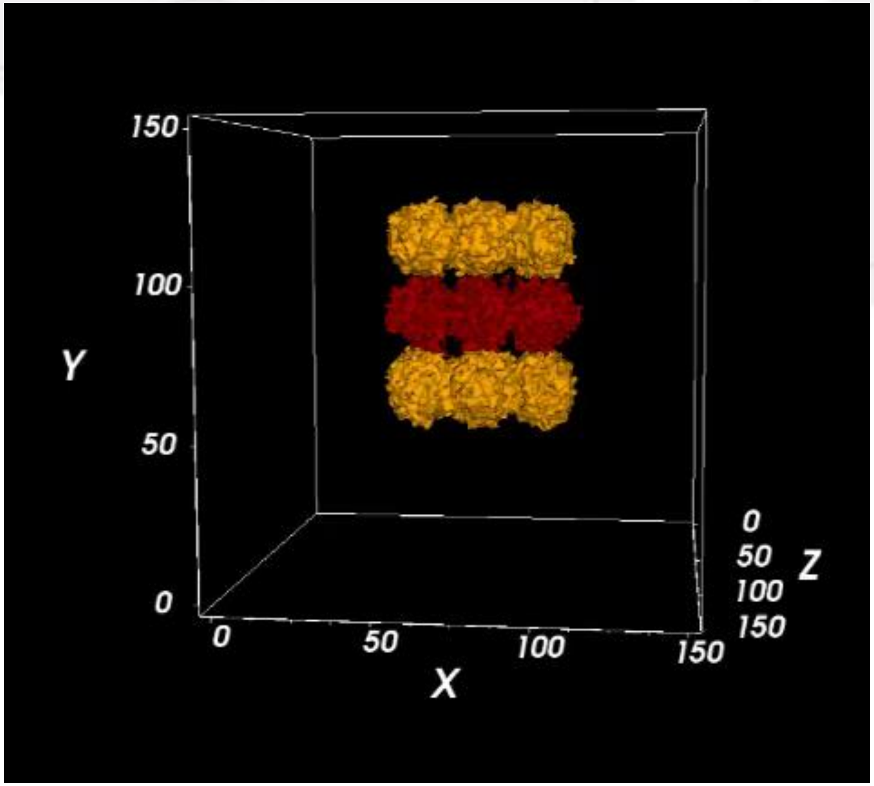
- 0.1mm (x, y)
- 0.04375mm (z)
- 0.1-0.2mm
- **1,099 USD**

Parâmetros presentes nas Bioimpressoras



Computational approaches for biofabrication of tissues → Angiogenesis + Proliferating cells

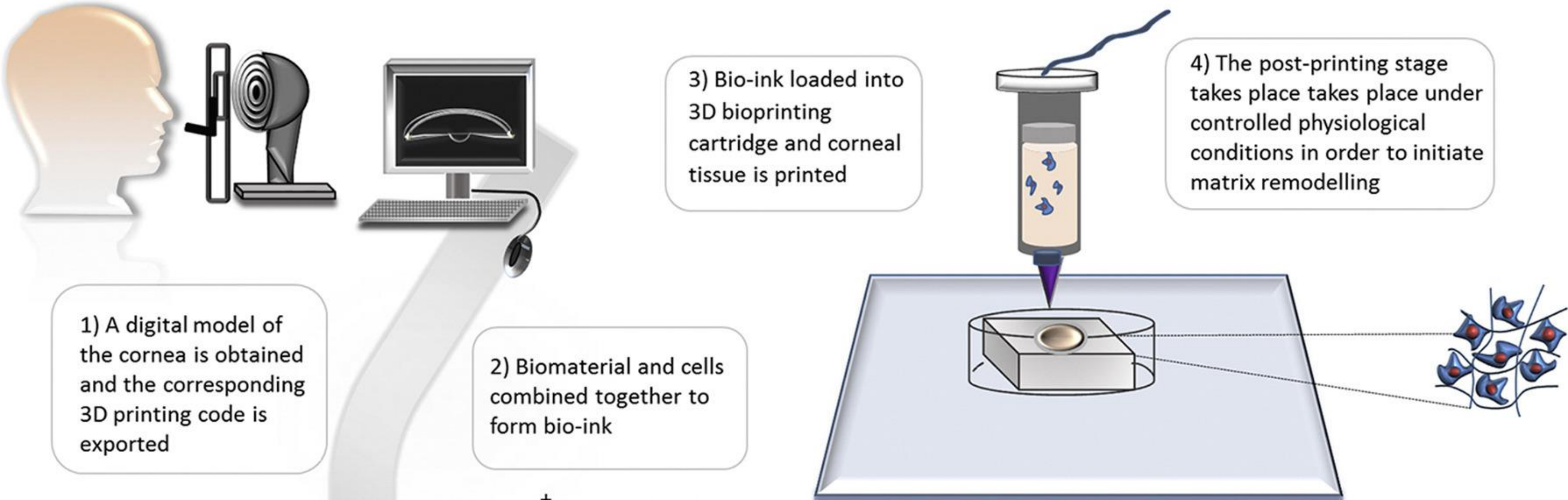




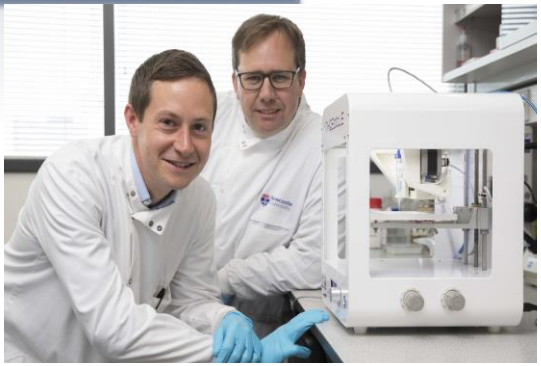
Projetos desenvolvidos no mundo sobre bioimpressão de tecidos

Cientistas BRITÂNICOS imprimem as primeiras córneas humanas

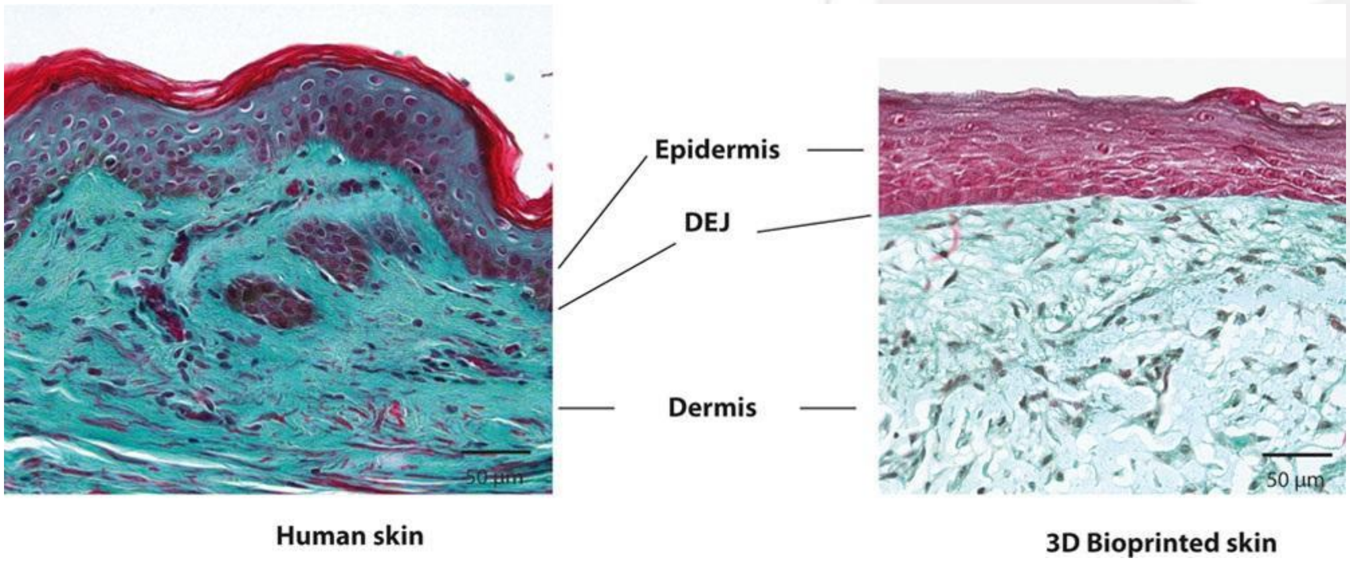
Abigail Isaacson, StephenSwioklo, Che J.Connon, 2018



Collagen-based bio-ink containing encapsulated corneal keratocytes

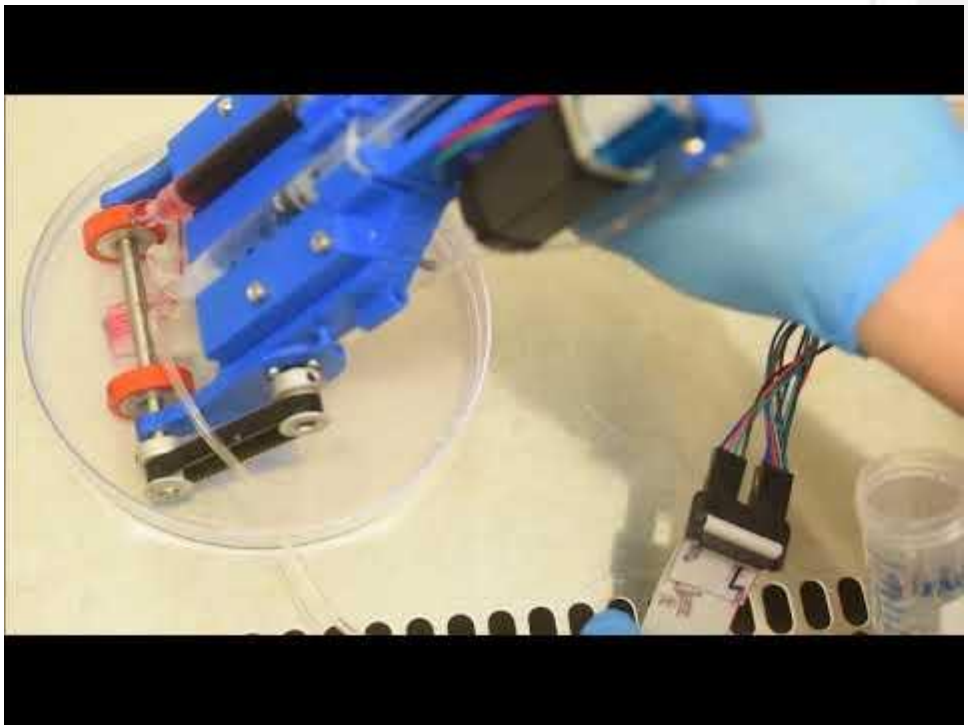


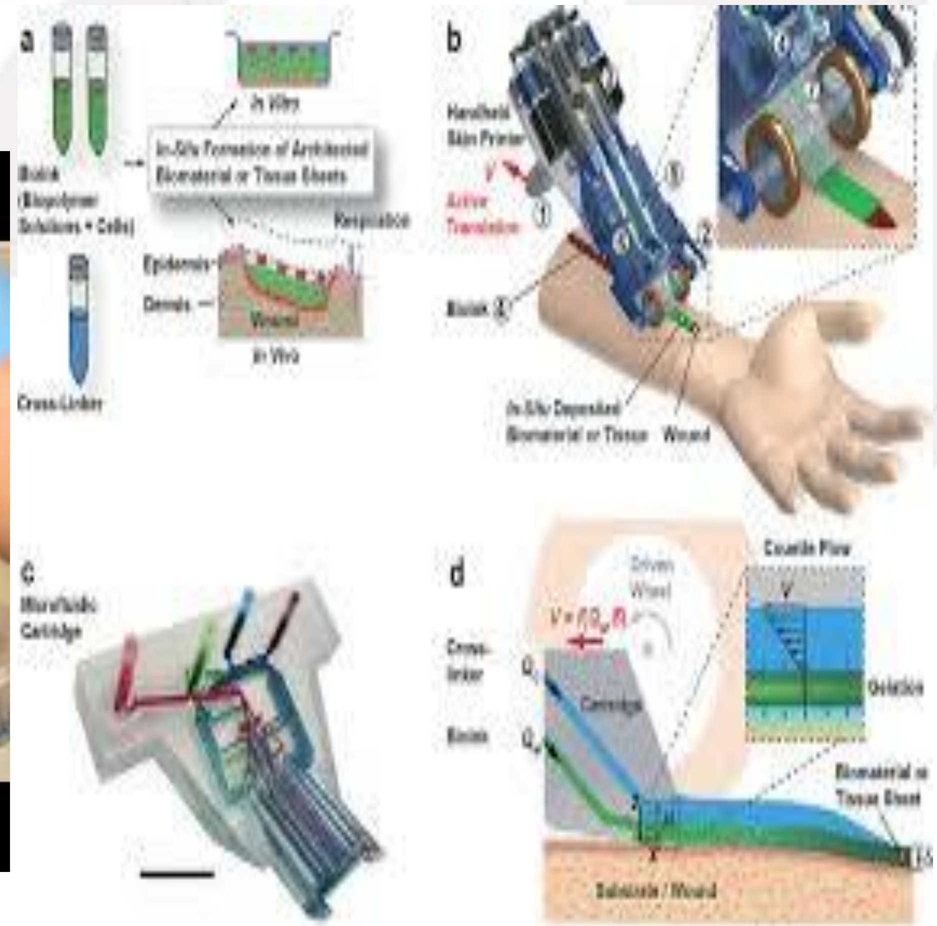
3D printing: Human skin is now being printed in labs



Comparison of optical microscopy images of equivalent slices of normal human skin and printed skin after 26 days of culture. The tissues were stained with Masson's trichrome. DEJ, dermoepidermal junction.

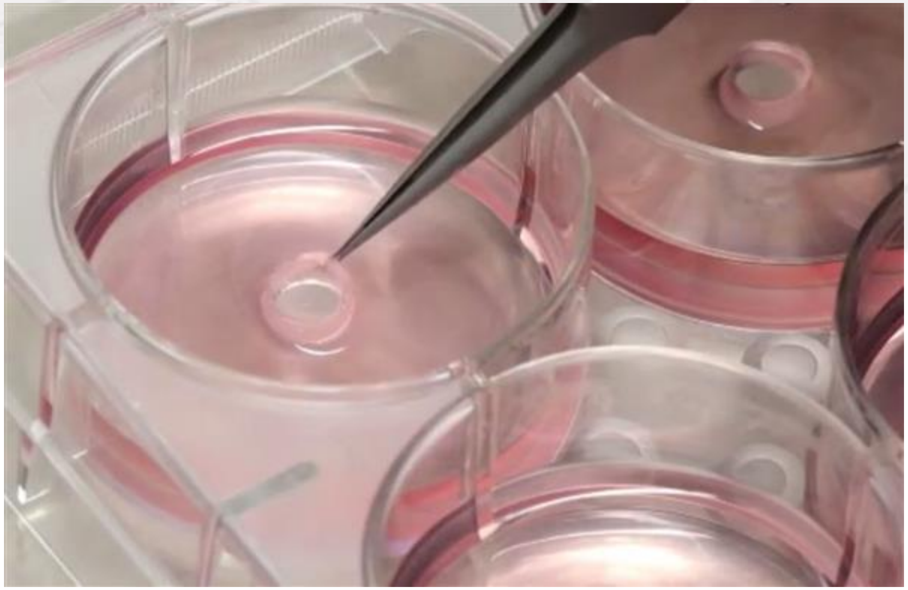
Handheld 3D printer





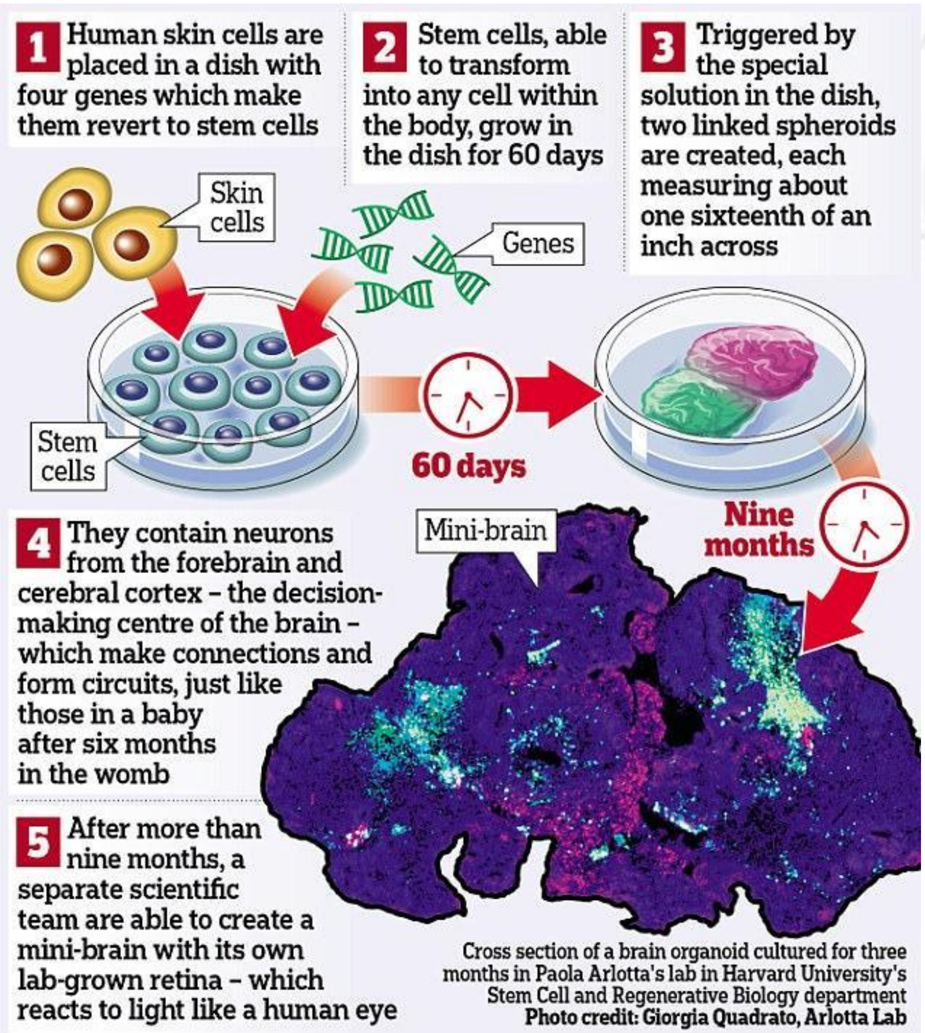
3D Printing Blood Vessels

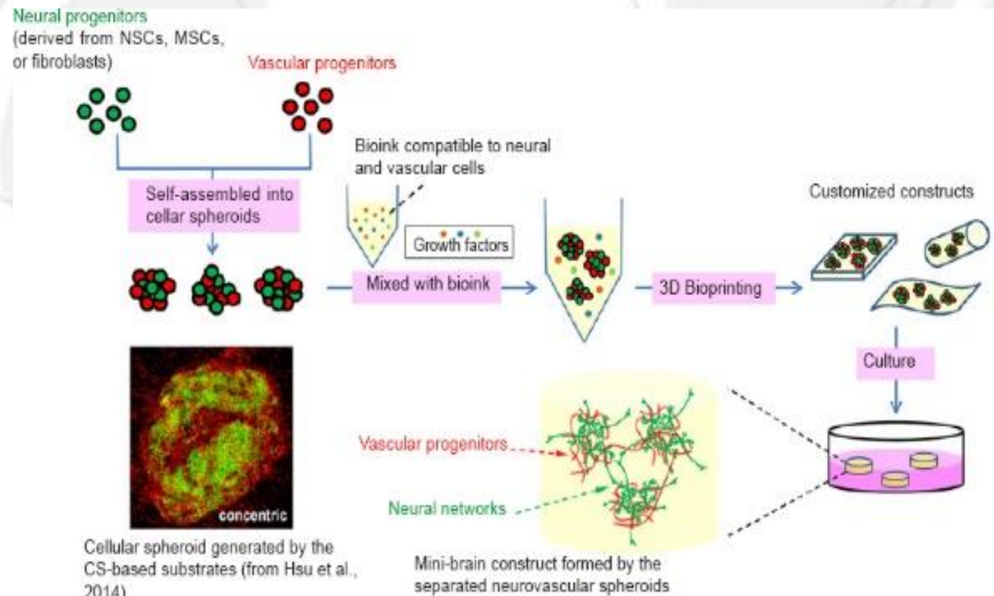
- Scientists are developing flexible materials to 3D print blood vessels

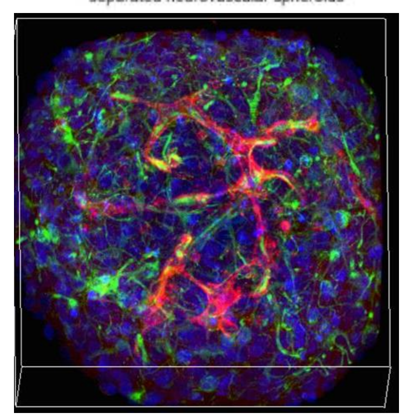


Using 3D bioprinting to produce mini-brain

Han and Hsu, Neural Regen Res, 2017







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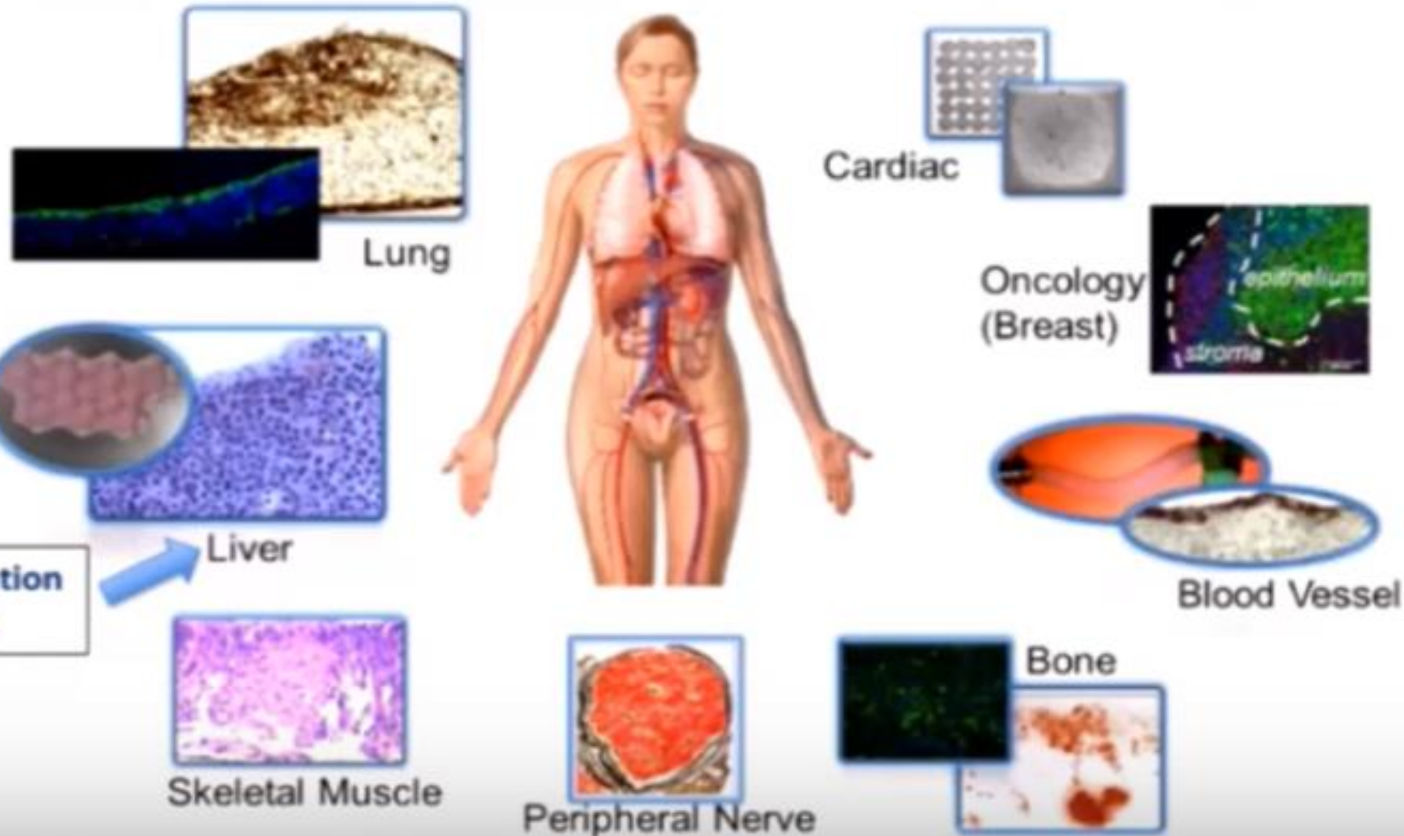
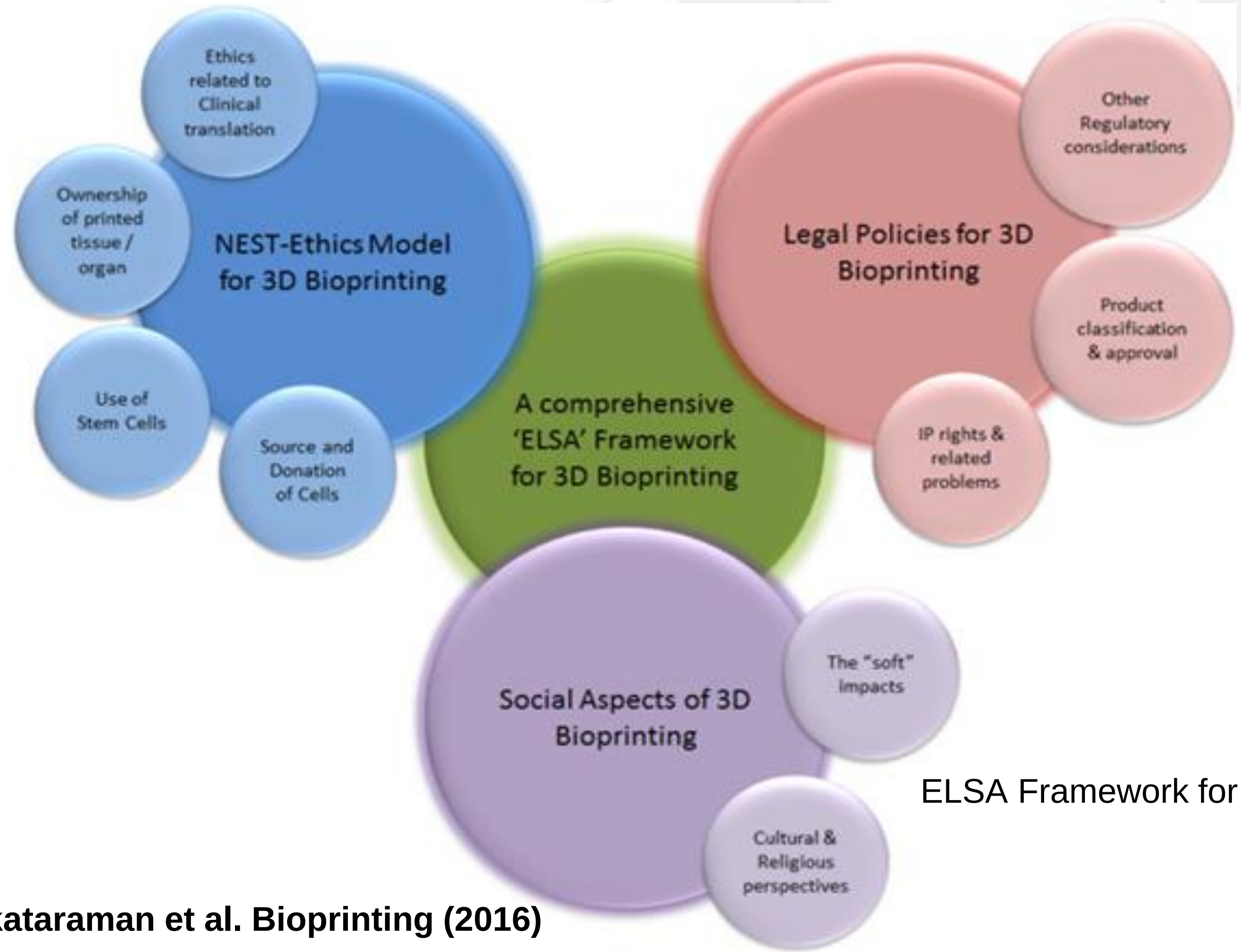
Tissues from throughout the body

Organovo technology has bioprinted successfully



Commercialization
Late 2014

Aspectos legais, éticos e sociais ??



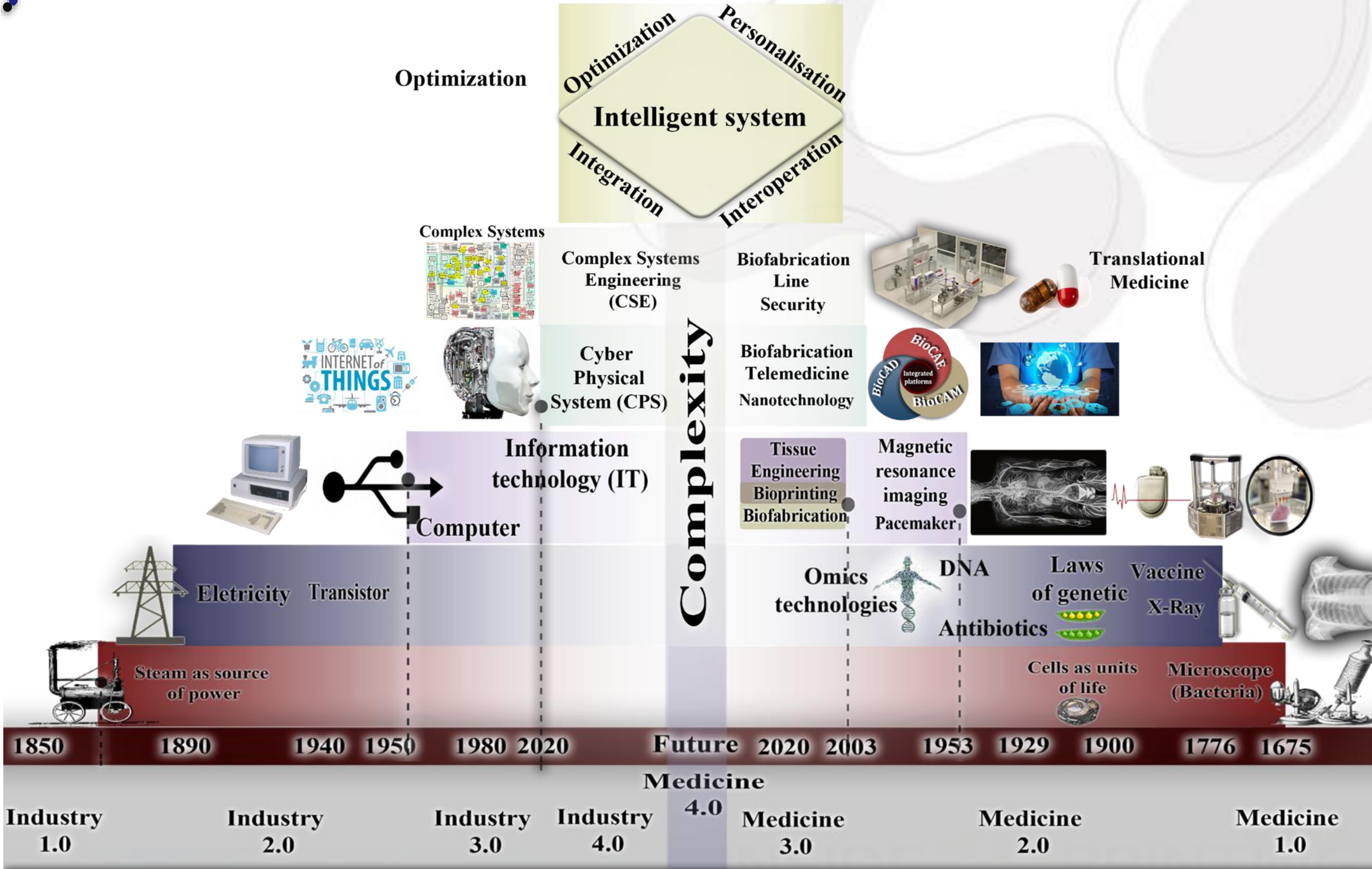
ELSA Framework for 3D bioprinting

S. Vijayavenkataraman et al. Bioprinting (2016)

Por que ainda não temos órgãos funcionais "bioimpressos"?

- ✓ Integration Engineering x Life Sciences;
- ✓ Development of new bioreactor for 3D bioprinted tissues;
- ✓ Development of bioprintable biomaterials;
- ✓ Development of "blueprint" for bioprinting of 3D human tissue and organs;
- ✓ Development of new STL file-free function representation based CAD software for digital bioprinting;
- ✓ Development of scalable technology for biofabrication millions uniform tissue spheroids.
- ✓ Development of integrated operational system integration of robotic bioprinters (special software);
- ✓ Laws and regulations.

Industry 4.0 *e* Medicine 4.0



Dernowsek *et al*., 2017

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Thank you for your kind attention!

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