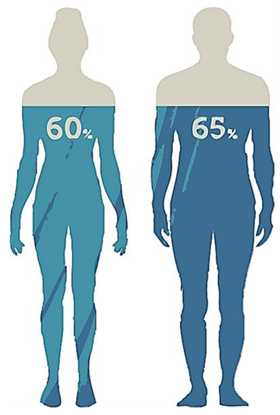
3d.FAB

Hydrogel design towards clinical translations (through extrusion bioprinting!!)

Christophe A. Marquette, Laura Chastagnier, Lucas Lemarié, Benjamin Da Sousa, Carlos Chocarro-Wrona, Edwin-Joffrey Courtial, Elea Rae, Céline Thomann, Albane Carre, Lucie Essayan, Ana J. Pasuch, Aliée Mosnier, Chloé Devillard, Emma Petiot, Eva-Laure Matera, Meigge Simoes, Charles Dumontet, Cristina Cuella Martin, Léa Pechtimaldjian, Eve-Isabelle Pécheur, Véronique Maguer-Satta, Maude Michelet, Marie-Laure Plissonnier, Fabienne Archer, Karen Moreau, Marjorie Dufaud, Cécile Zaupa, Jean-Marc Balloul, Quentin Pruvost, Thibaud Dauphin, Mathilde Mosser, Sarah Pragnère

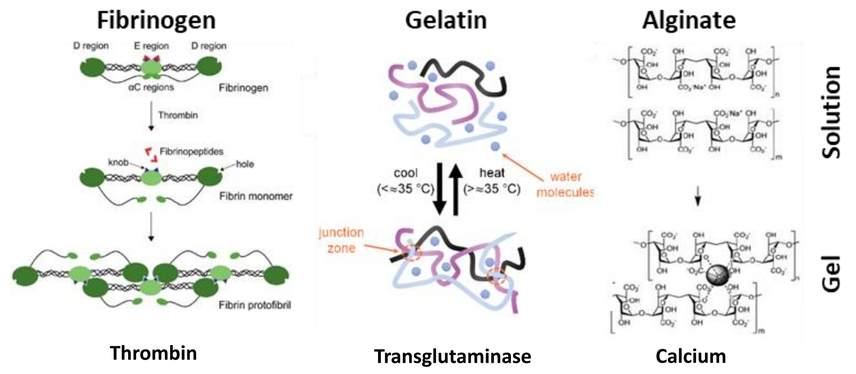
Which composition for human soft tissues?



~ 60-65% of water
~ 16% of protein (collagen and other ECM)
~ 16% of fat
~ 1% of carbohydrate

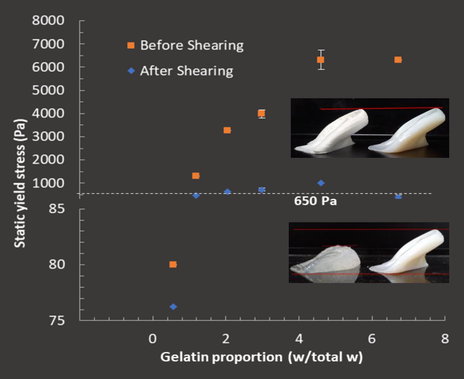
Trillion of cells

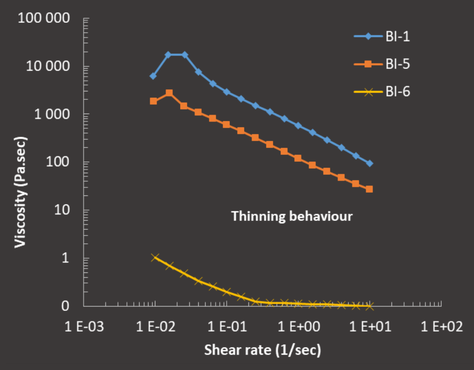
The bioinspired HYDROGEL



5-10% Gelatin
2% Fibrinogen
1-4% Alginate
92-84% Water
0.3-6M cells /mL

Formulations for viability and printability



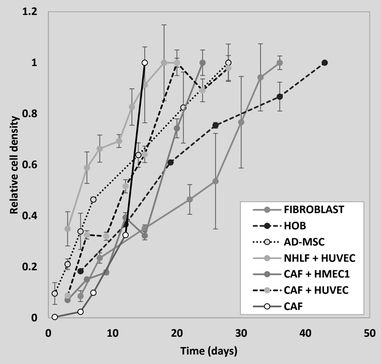


PRINTABILITY Additive Manufacturing 28, 50-57

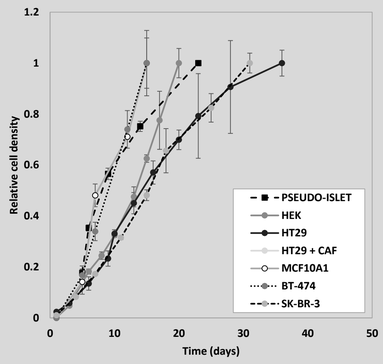
VIABILITY Bioprinting 21, e00119

Growth in hydrogels

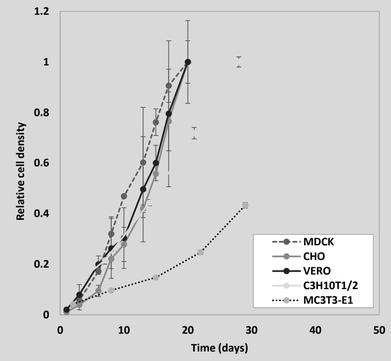
Human primary cells



Human cell lines

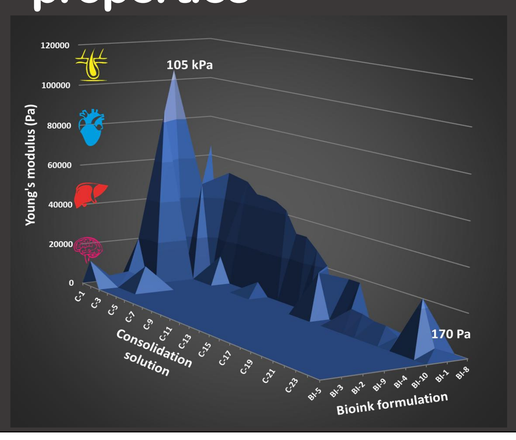


Animal cell lines



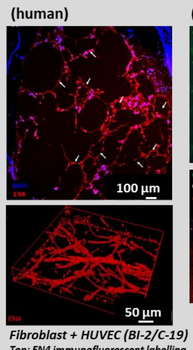
Bioprinting 2024, *41*, e00351.

Tuned mechanical properties



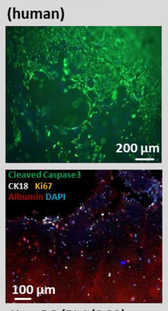
Tissue organization in hydrogels

A. Microvascularization (human)



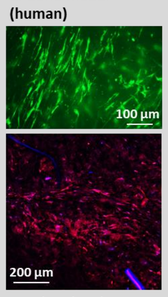
Fibroblast + HUVEC (BI-2/C-19)
Top: EN4 immunofluorescent labelling
Bottom: confocal 3D reconstruction
D7 after bioprinting

B. Liver model (human)



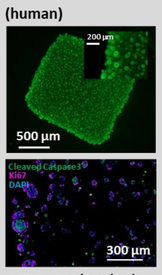
HepaRG (BI-1/C-20)
Top: calcein labelling
Bottom: multiplexed immunofluorescent labelling
D28 after bioprinting

C. Bone model (human)



HOB (BI-1/C-18)
Top: calcein labelling
Bottom: actin labelling using phalloidin + nucleus using DAPI
D12 after bioprinting

I. Colon tumour (human)



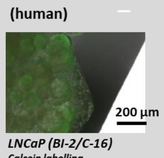
HT29 + CAF (BI-1/C-4)
Top: calcein labelling
Bottom: multiplexed immunofluorescent labelling
D35 after bioprinting

J. Breast tumour (human)



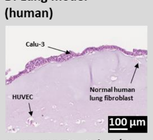
BT474 + CAF (BI-11/C-23)
Fluorescent microscopy of transformed cells
D10 after bioprinting

K. Prostate tumour (human)



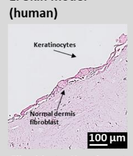
LNCaP (BI-2/C-16)
Calcein labelling
D21 after bioprinting

D. Lung model (human)



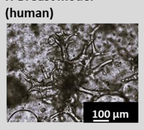
NHLF+ HUVEC + Calu-3 (BI-1/C-24)
H&E histology
Day 30 after bioprinting

E. Skin model (human)



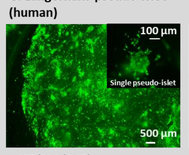
Fibroblast + Keratinocytes (BI-2/C-19)
H&E histology
Day 20 after bioprinting

F. Breast model (human)



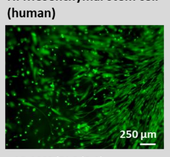
MCF10A (BI-2/C-4)
Phase contrast
Day 23 after bioprinting

G. Langerhans pseudo-Islet (human)



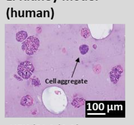
1.4E7 (BI-2/C-17)
Calcein labelling
D5 after bioprinting

H. Mesenchymal stem cell (human)



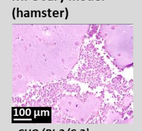
AD-MCS (BI-2/C-4)
Calcein labelling
D21 after bioprinting

L. Kidney model (human)



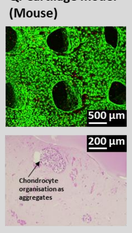
HEK (BI-2/C-2)
H&E histology
D20 after bioprinting

M. Ovary model (hamster)



CHO (BI-2/C-2)
H&E histology
D20 after bioprinting

Q. Cartilage model (Mouse)



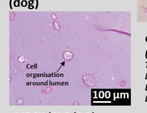
C3H10T1/2 (BI-1/C-18)
Top: Live dead labelling at D28 of proliferation
Bottom: H&E histology at D28 of differentiation

O. Kidney model (monkey)



VERO (BI-2/C-2)
H&E histology
D20 after bioprinting

P. Kidney model (dog)



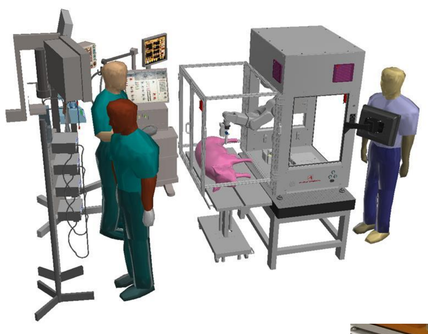
MDCK (BI-2/C-2)
H&E histology
D20 after bioprinting

Bioprinting 2024, *41*, e00351.

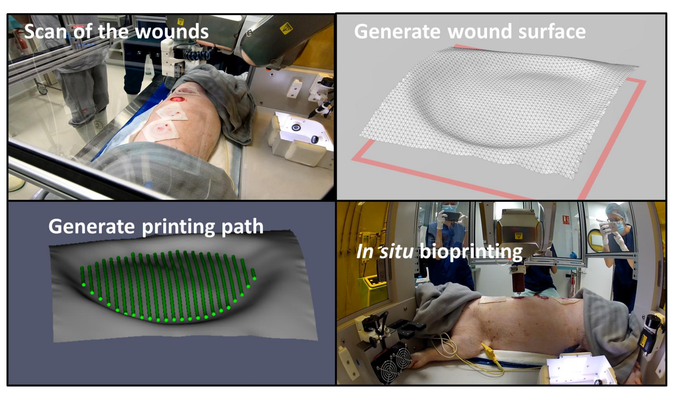
Translation #1/ Bioprinting in situ or *in vivo*

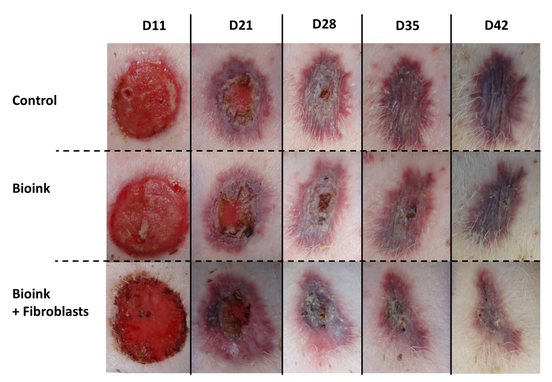
J Tissue Eng Regen Med. 2021;15:37–48.

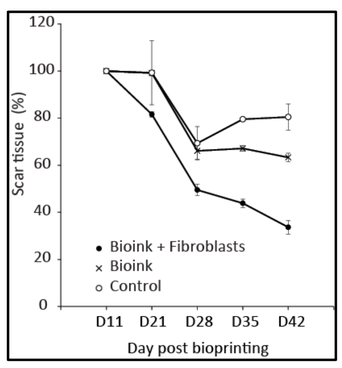
Plastic and ***Reconstructive Surgery – Global Open*** **2022,** *10* (1), e4056.





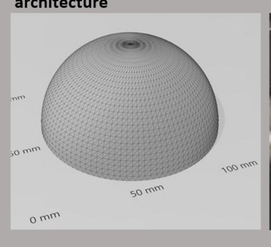






Translation #2/ Printing hydrogel for *in vivo* tissue development

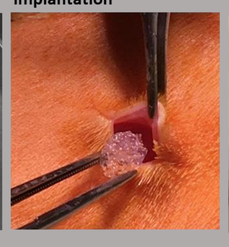
Optimized miniaturized architecture



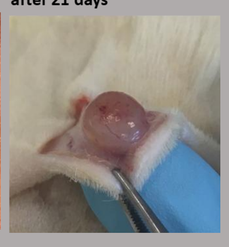
Bioprinted miniaturized implant



Subcutaneous implantation



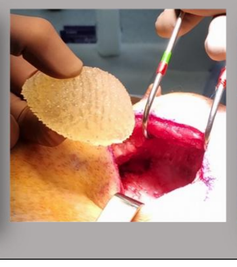
Implant integration after 21 days



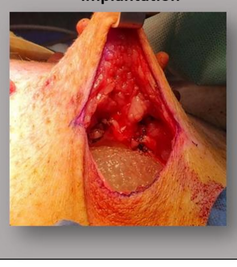
Optimized architecture



3D printed implant



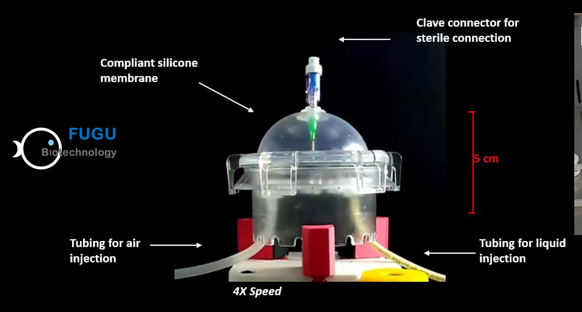
Subcutaneous/RM implantation

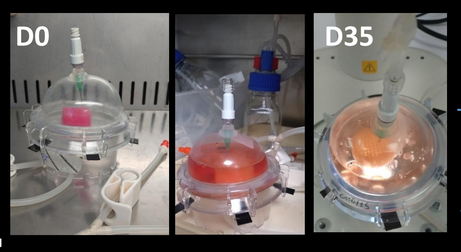


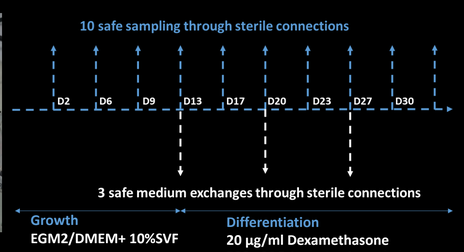
Lipofilling after 30 days



Translation #3/ 17cm³ bioprinted adipose tissue + microvascularization







Scientific Reports volume 14, Article number: 11003 (2024)