Mechanical property of bioinks for 3D bio-printer “INKREDIBLE”

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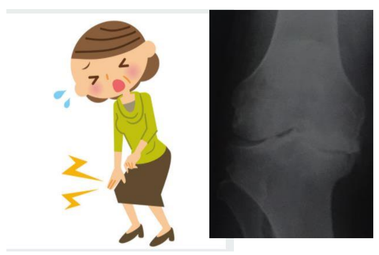
Background

Tissue engineering in Orthopaedics

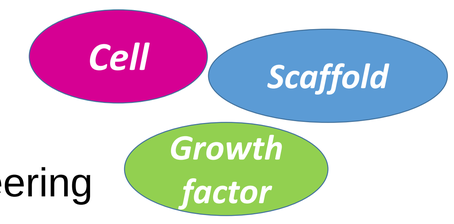
Soft tissue in joints such as cartilage is thought as a target tissue for replacement in the tissue engineering.



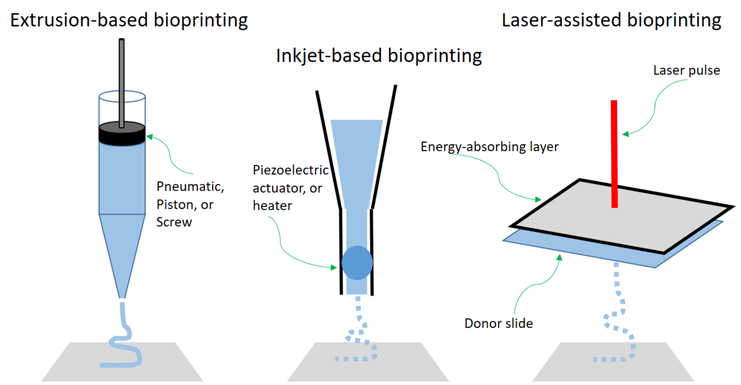
3D Bio-printer

3D bio-printer has become popular recently to make scaffold, which is one of the most important factors in the tissue engineering.

Three factors in tissue engineering

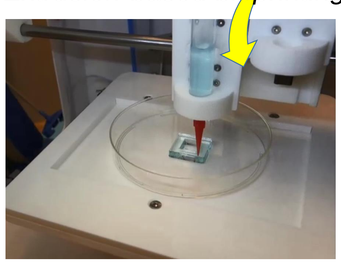


Types of the bio-printer



The bio-printer in this study

Extrusion-based bioprinting



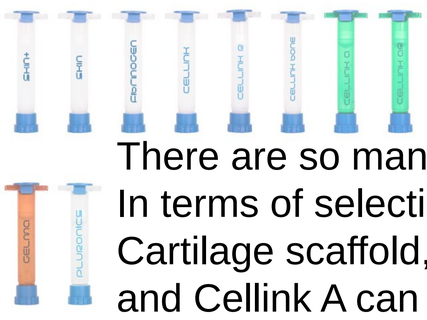
Alginate-based bio-ink Is used.

(Inkredible, Cellink)

Specification of Inkredible

- 2 printer heads
- Automatic calibration
- Build volume 130 x 80x 50 mm
- UV crosslinking system (365 nm)
- Xyz resolutions; 10 micron

Bioinks for Inkredible



There are so many options. In terms of selection for Cartilage scaffold, Cellink Bioink and Cellink A can be applied. In addition, RGD is recommended by A person in the company.

The purpose of this study

Scaffold by this bio-printer with some bioinks requires resistance to mechanical loading because original tissue does so. Therefore, we investigated the mechanical property of the alginate based bio-inks for a 3D-bioprinter (Inkredible).

Materials

Three bio-inks were tested:
Cellink Bioink (Alginate with nano-cellulose) ,
Cellink A (Alginate), and
Cellink RGD (Alginate with nano-cellulose and RGD peptide).

Cellink Bioink

Quick facts
As a polysaccharide hydrogel (non-animal derived), CELLINK is ideal for 3D bioprinting and cell culturing. The biologically relevant 3D environment of CELLINK Bioink, composed of alginate and highly hydrated cellulose nanofibrils with morphological similarity to collagen, provides mammalian cells with a milieu that resembles their natural matrix.

Cellink A

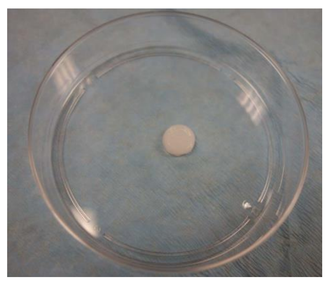
Quick facts
CELLINK A is a biodegradable bioink specifically developed for advanced 3D Bioprinting researchers. CELLINK A offers excellent biocompatibility, easy handling, and works with a wide range of human cells. CELLINK A is composed of highly purified sodium alginate and crosslinks with divalent cations.

Cellink RGD

Quick facts
CELLINK RGD bioink offers the same good printability properties and biologically relevant 3D environment as CELLINK bioink, with an additional biofunctionalization of RGD motifs to improve cell attachment. CELLINK RGD bioink can be mixed with a high concentration of cells.

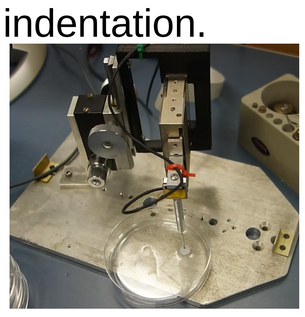
Sample by the 3D bio-printer

Size; Cylindrical construct (10mm diameter and 3mm height)
Crosslinking: with calcium chloride.

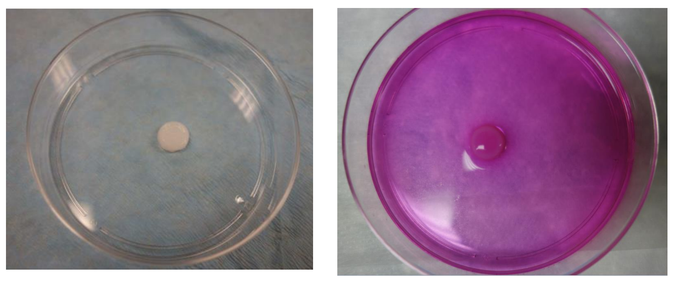


Compression Test

The elastic modulus of each printed construct was measured by a custom made micro indentation.



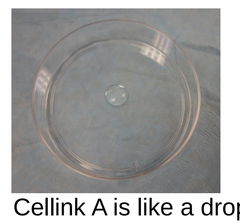
Effect of Culture



Each printed construct was measured after cross-linking and after 48 hours in DMEM culture.

Result

Does the 3D bio-printer make model with each bioink?



Cellink A is like a droplet (Cellink A could not be printed as a cylindrical constructed due to low viscosity).

Cellink	Cellink RGD	Cellink A
○	○	X

Result

Elastic Modulus (kPa)	Cellink	Cellink RGD	Cellink A
Post-Crosslinked	22.4	26.9	38.4
After 48 hours in culture	20.1	20.5	34.6

Discussion

One of the most interesting point was that Cellink A was the stiffest of the three printed constructs in spite of its very low viscosity. However, none of the three bioinks were sufficiently strong. Furthermore, scientists should be aware of weakening of the printed constructs after the culture.

Conclusion

In the current study, we investigated a stiffness of bioinks of “INKREDIBLE” (CELLINK) which are already commercialized.In terms of the initial stiffness, none of the three bioinks were sufficiently strong.
In general, for soft tissue orthopaedic regenerative medicine applications, a support material is necessary while bio-printing.

Acknowledgement: The first author would appreciate Mr. Yuki Nishikawa (Filgen, Japan) ‘s technical and knowledge supports for this study.