Case Study: Nipple-Areola Skin Grafts for breast cancer survivors

3D Printing Workshop
Sarah Van Belleghem

Clinical Need

Breast Cancer Stages

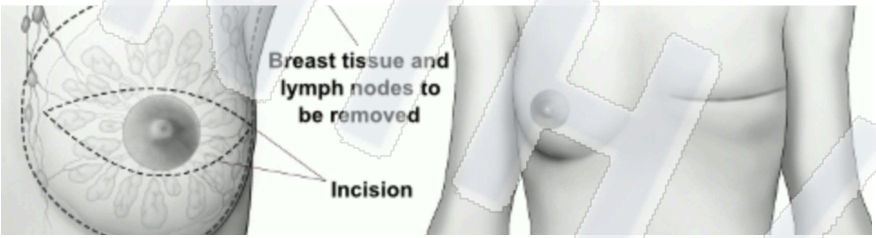
25%	35%	58%
Stage 0	Stage I and II	Stage III

40%

Undergo Breast Reconstruction

~70,000 Breast Reconstruction Cases per Year

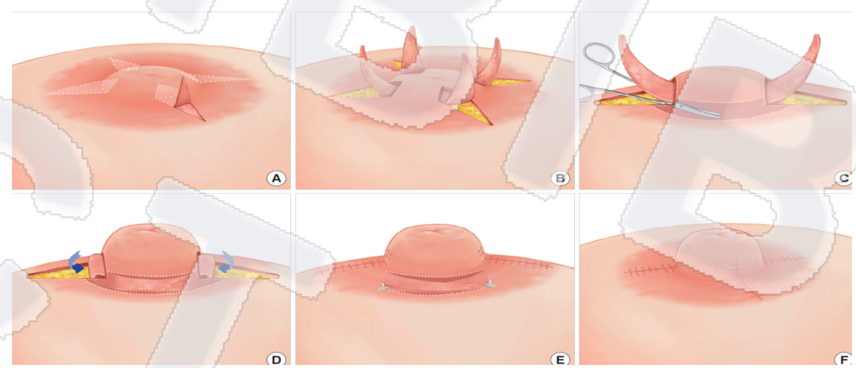
Current Treatment



- Invasive procedure resects all breast tissue
- *Central scar* across chest
- Silicone implant produces mirage of natural tissue

Cancer Society. Mastectomy. 2017. www.cancer.org

- Star configuration of cut skin is knotted onto itself with sutures
- High rates of *infection and multidirectional scarring*
- Repeated multiple times due to *nipple flattening*

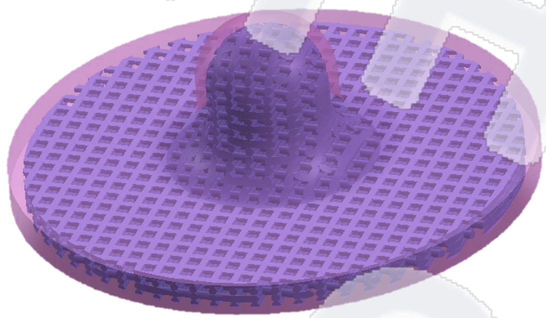


Kim, J, Ahn, H. Archives of Plastic Surgery, 43(4): 339-343. 2016.

Project: Nipple-Areola Skin Graft

The **goal** of this work is to create a nipple prosthetic implant that exceeds preexisting nipple restorative attempts due to its *reinforced mechanical structure* with medical grade epoxy and *presence of native tissue*.

Project: Nipple-Areola Skin Graft



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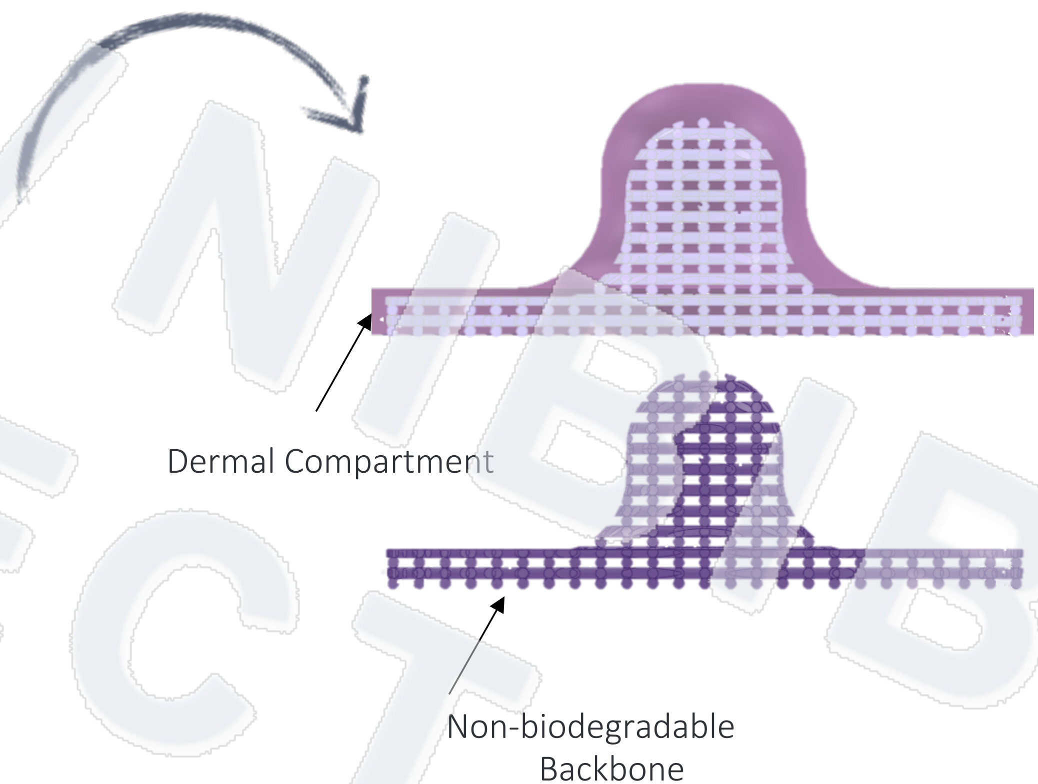
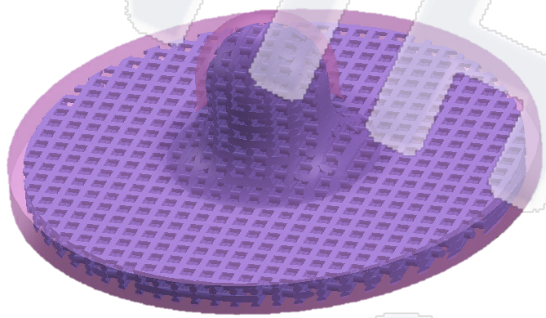


Project: Nipple-Areola Skin Graft



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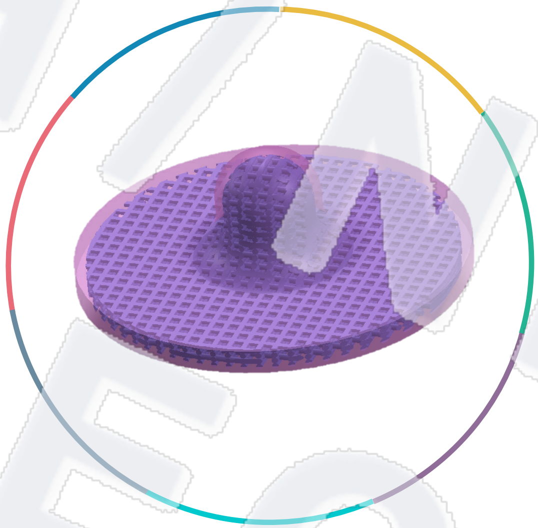
Design Criteria

Non-degradable backbone

Optimization of degradable portion for tissue regeneration

Precise printing application of both bioink and synthetic materials

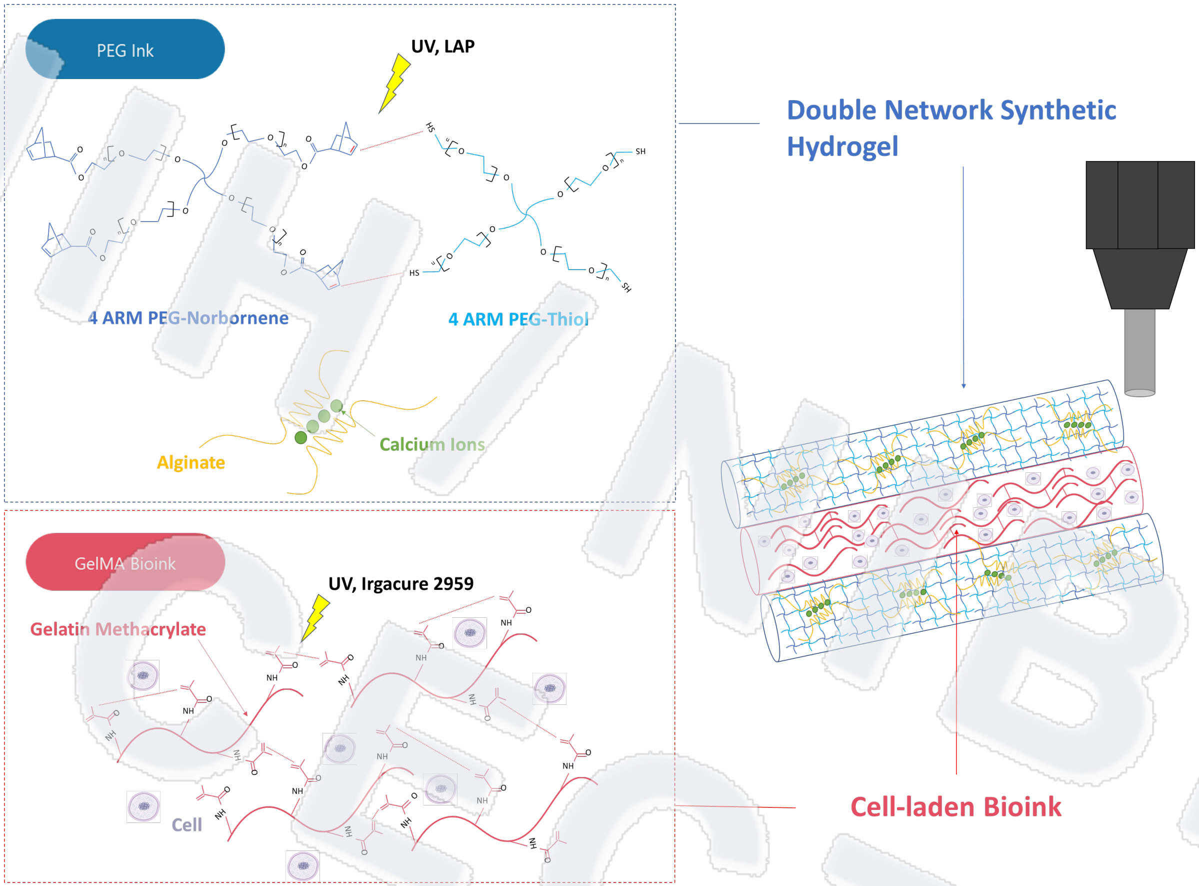


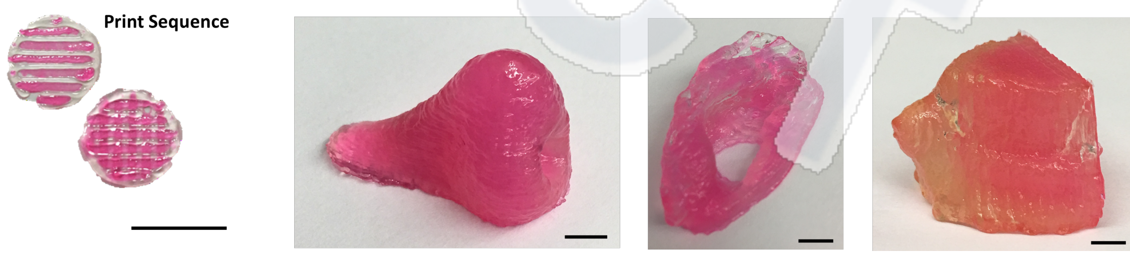
Single-step fabrication

In vivo-like mechanical properties

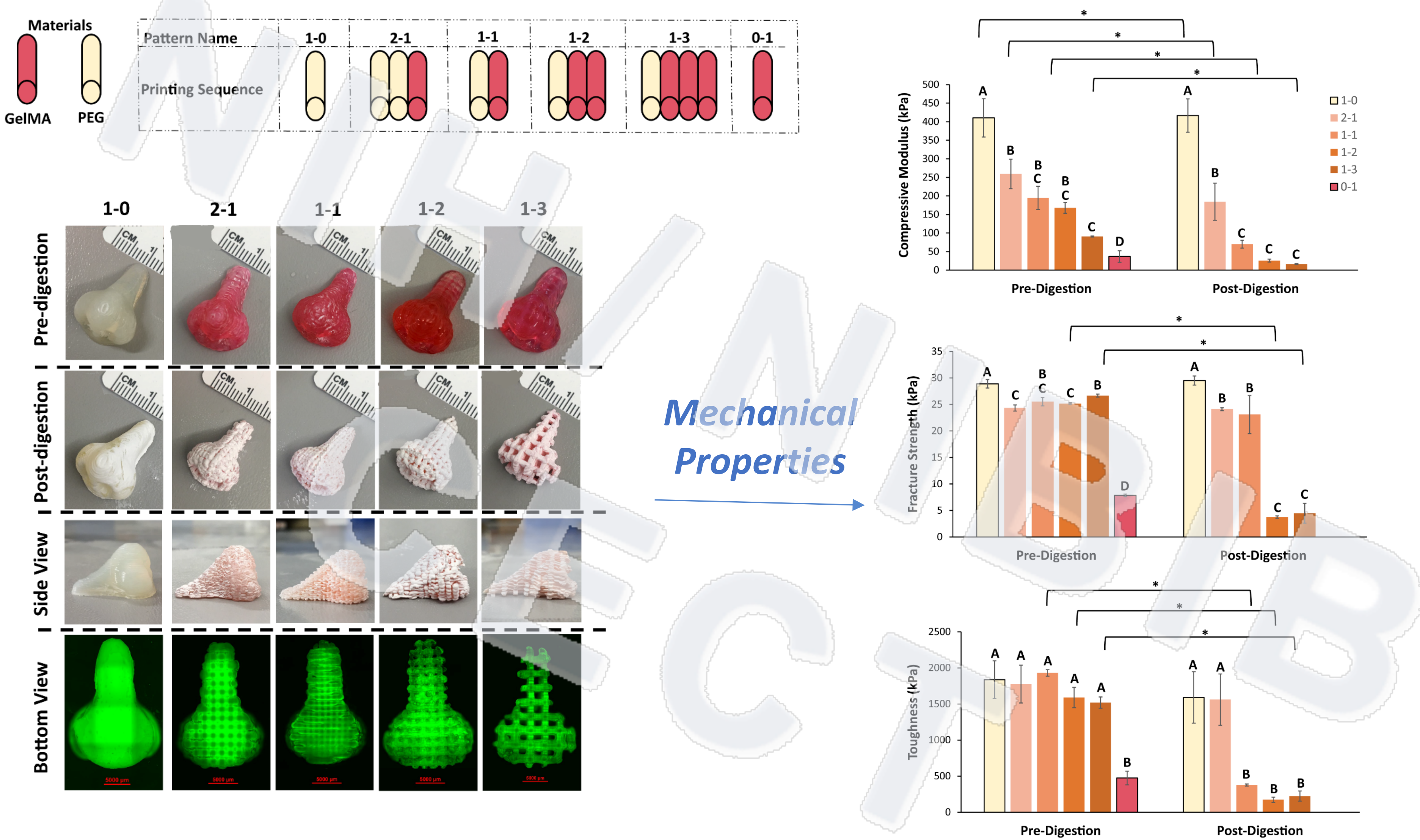
Material Compatibility

Printing Strategy and ink development



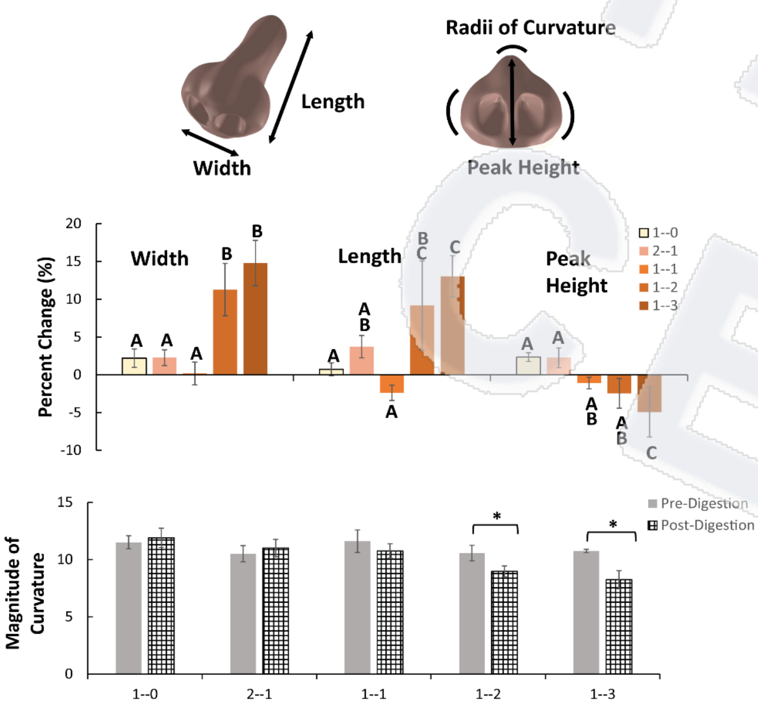


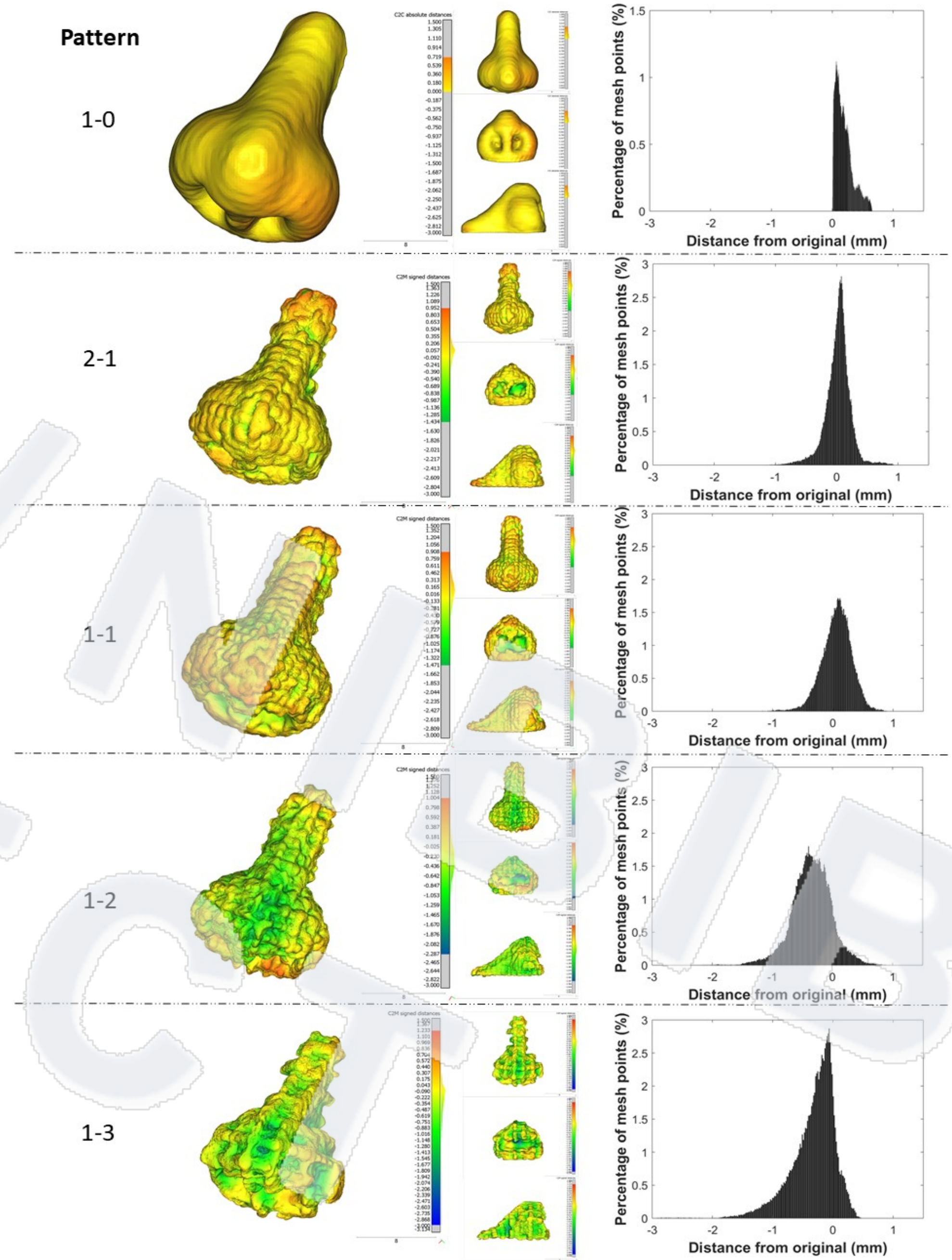
Pattern Printing



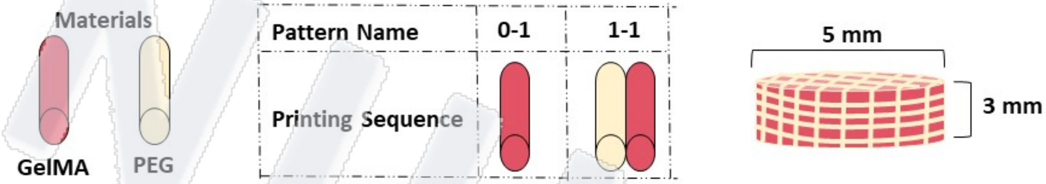
Shape Retention

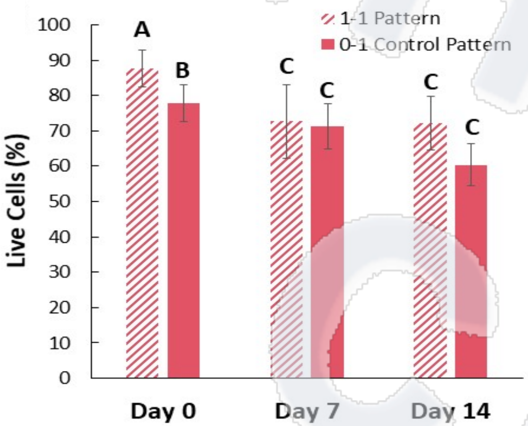
3D scanning and Point Cloud Comparison

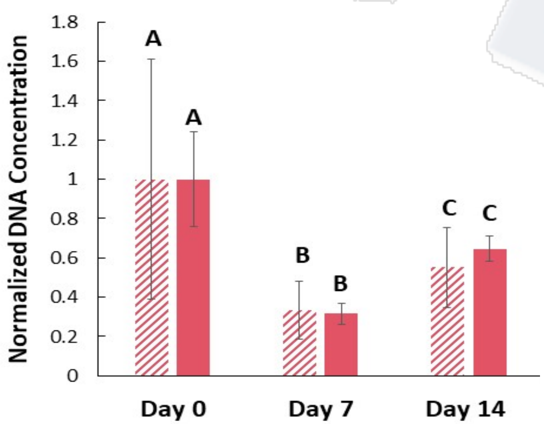


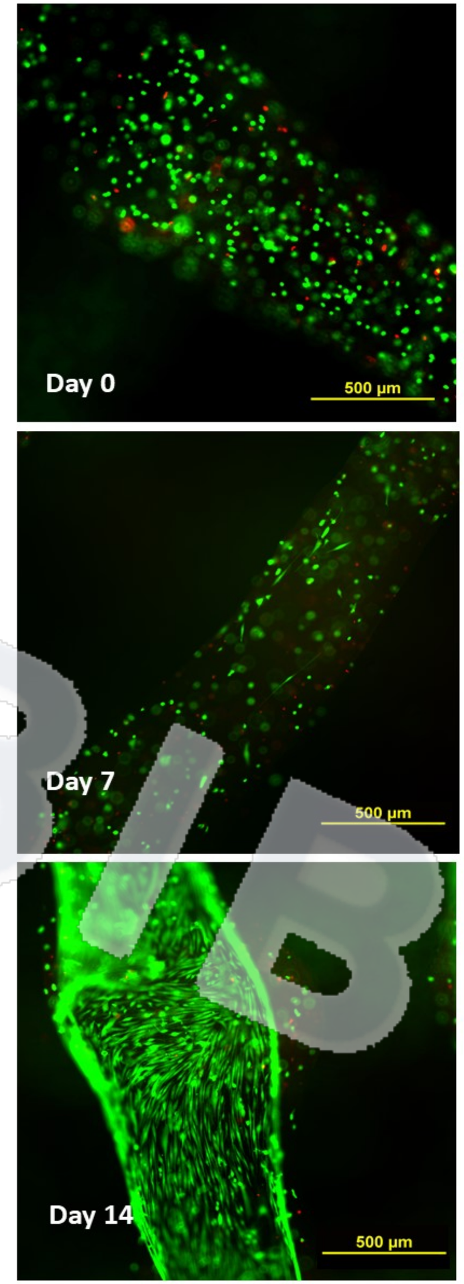


Cytotoxicity Testing

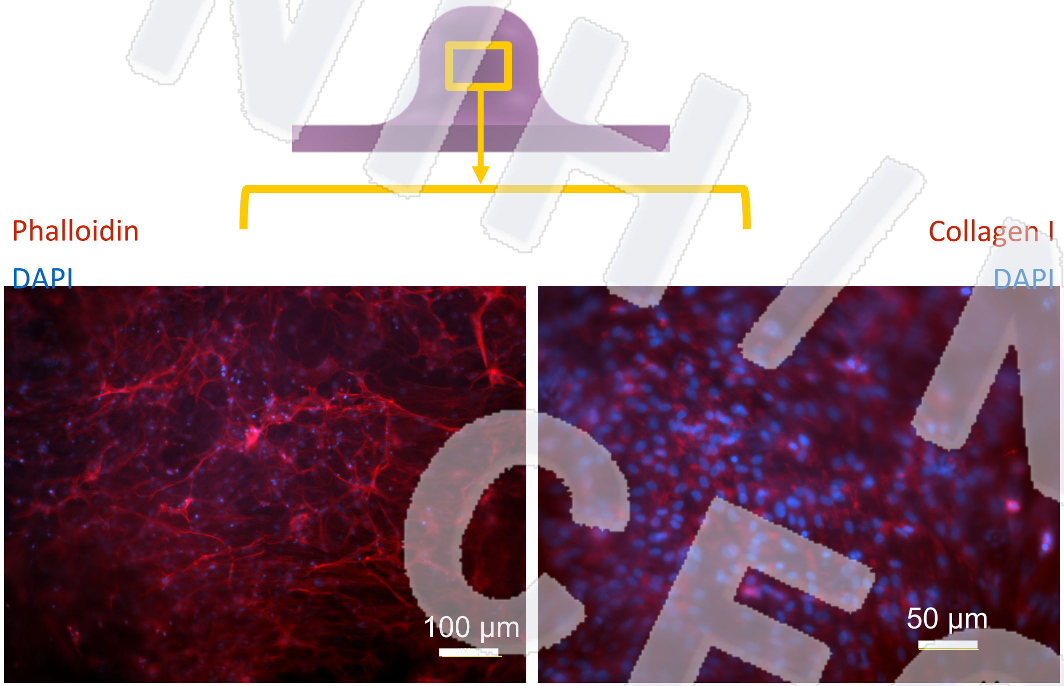






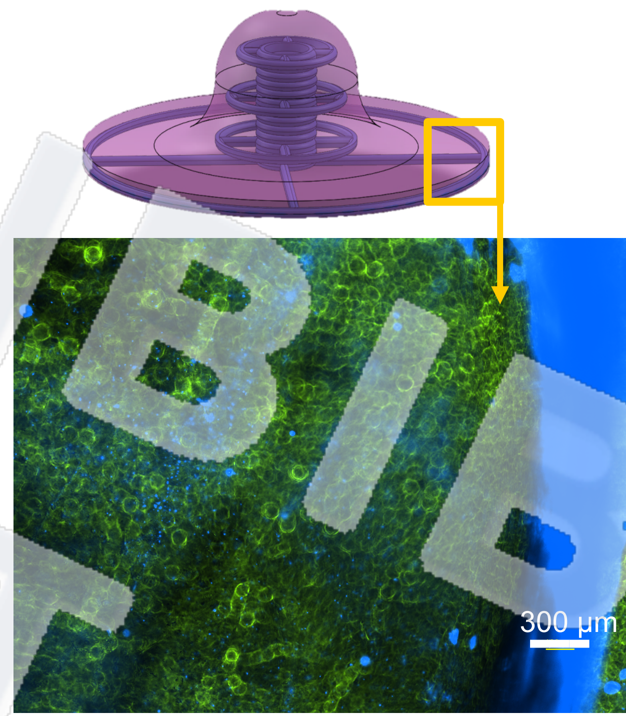


Skin Graft Development



Functional dermis develops in printed scaffolds, with ***FB healthy spindle-like morphological development*** *and* ***collagen I expression***

Epidermal growth is shown to develop through positive ***cytokeratin 10 expression*** in co-printed scaffolds.



Future Direction

A co-printed ***nipple areola skin graft*** construct composed of biodegradable cell-laden bioink and synthetic poly(ethylene) glycol

Material compatibility with human dermal fibroblasts for ***sustained cell proliferation and physiological skin protein expression***

Robust mechanical properties ***comparable to those seen in vivo***

Thank you for your attention!