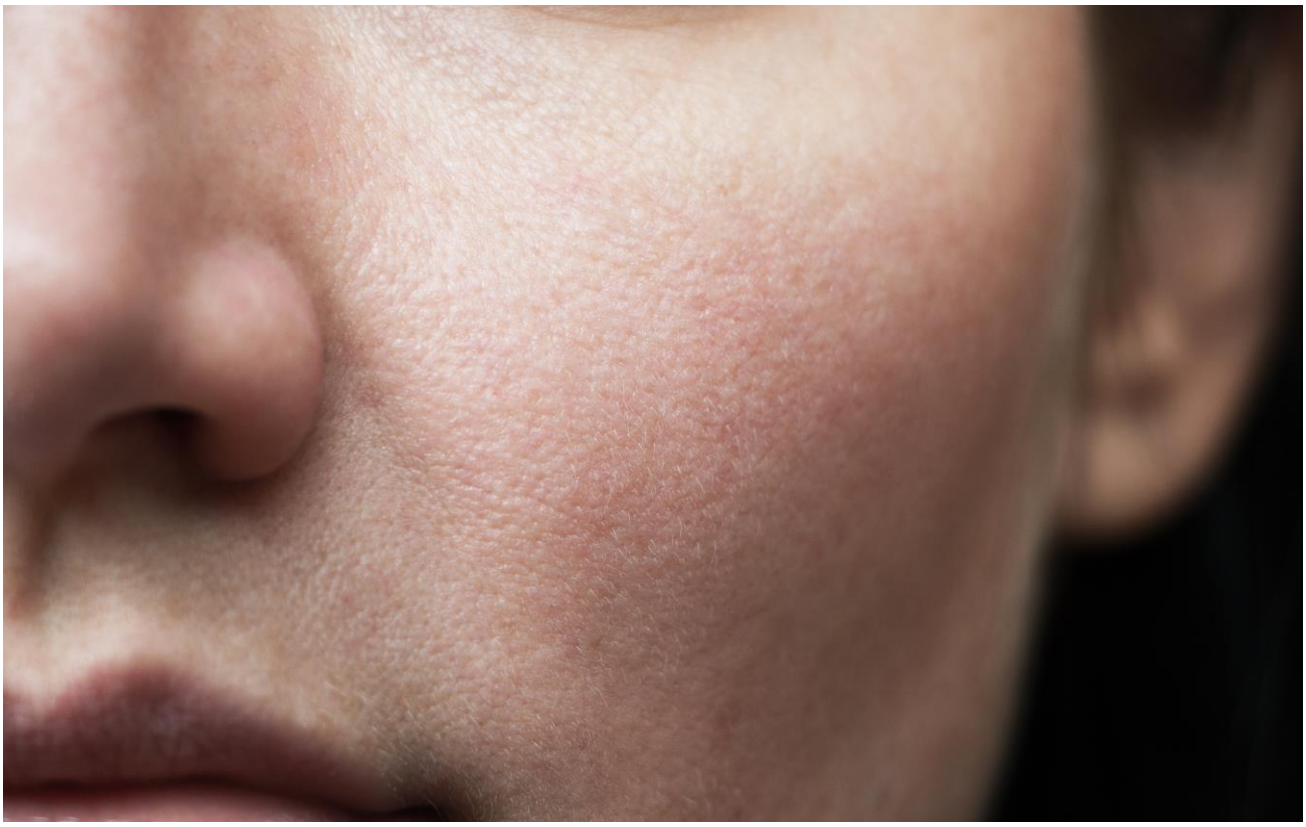
THE FUTURE OF SKIN



BIOPRINTING SKIN MODELS FOR DRUG DISCOVERY, COSMETIC RESEARCH AND CLINICAL APPLICATIONS

REGENHU

CONTENTS

LEARNING POINTS

Skin is a complex organ which provides mechanical protection, immune defense, sensory functions, and homeostasis. Native skin is a highly ordered and complex tissue, consisting of various cell types and Cellular Matrix components, which provides numerous functions such as: mechanical protection, immune defense, sensory functions, and homeostasis. It consists of three specialized layers: epidermis, dermis and hypodermis

3D bioprinting is the precise spatial placing of cells and biomaterials to produce complex structures mimicking properties and functions of natural tissues

Microextrusion, laser based bioprinting, and inkjet printing are the bioprinting methods commonly utilized in skin construct production

The development of skin constructs in commercial research applications has largely been driven by the EU's animal testing ban, and the large unmet clinical need for therapies for extensive and chronic wounds

3D bioprinted skin constructs have improved microstructure and increased reproducabilty compared to manually fabricated constructs, enabling the standardization of fabricated products

Protocols using 3D bioprinting can yield mature skin constructs within 15 days, half the time of traditional casting methods. Less time in culture leads to a higher output production of skin models, whilst reducing the risk of failure through culture contamination

Further development in skin construction will incorporate vasculature and other key components of skin for increased physiological relevance for therapeutic use

There is currently no specific regulatory framework for 3D printed constructs and their widespread application and commercialization will be complex

INTRODUCTION TO 3D BIOPRINTING

3D bioprinting is an additive manufacturing process that incorporates viable living cells with biomaterials to fabricate sophisticated tissue/organ substitutes. This fully automated process deposits cells and biomaterials according to pre-defined patterns generated by computer aided design (CAD), allowing for more complex structures to be generated than traditional manual processes.

The 3D bioprinting market is projected to reach $4.2 billion in 2027 with a 17.4% growth rate from 2020 [1]. This growth has been driven by advancements in bioprinting technology and an increase in interest and funding for 3D bioprinting research. The demand for 3D bioprinted skin not only comes from the unmet clinical need (where skin printing applications are forecasted to grow at a rate of 19.8% between 2019 and 2024 [2]), but from the pharmaceutical and cosmetic industries in the generation of physiologically relevant human *in vitro* models. Cosmetics giant L'Oréal has dominated the skin model market to date with its Episkin™ product range and is investing in 3D bioprinting technology to further develop their skin models [3].

The aim of this whitepaper is to understand the complexities of skin tissue and the need for artificial equivalents, highlight the current approaches to 3D bioprinting skin and the benefits over other methods of fabrication, and identify the barriers to market for the widespread manufacture and application of bioprinted skin.

SKIN: THE BARRIER TO THE BODY

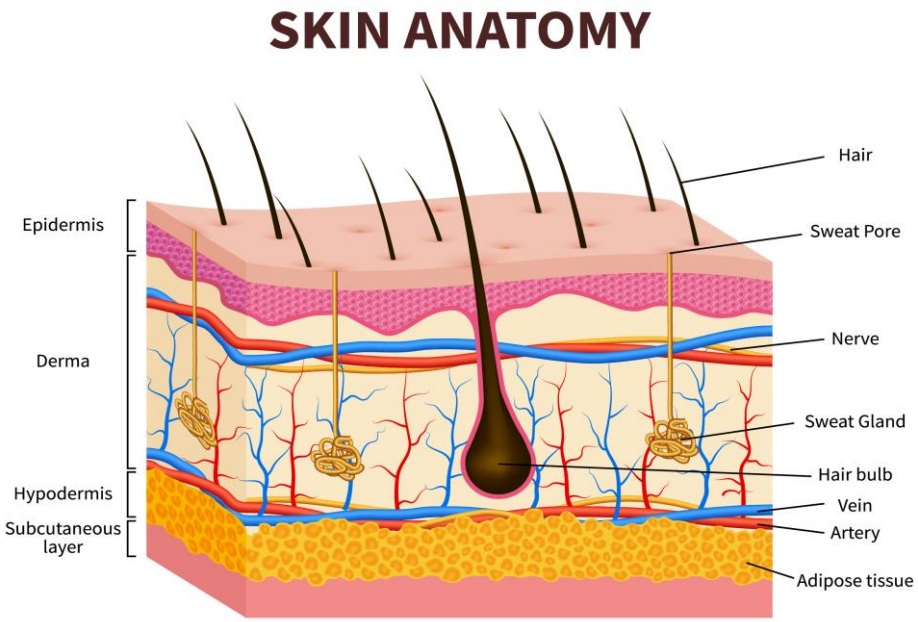
The skin is the largest organ of the body and ranges in thickness between 0.1mm-2mm depending on the anatomical location. It is typically described as having three main layers: the epidermis, dermis and hypodermis.

The epidermis is the outermost region of skin and acts as a physical and biological barrier. It is primarily composed of keratinocytes in progressive stages of differentiation, which terminally differentiate to form a stratified squamous epithelium. This epithelium is renewed every two-three weeks to account for the shedding of differentiated cells from enzymatic action and abrasion. The epidermis also contains pigment producing, sensory and immune cells which contribute to mechanical protection, immune defense and sensory properties of the skin. These cells, alongside keratinocyte stem cells are anchored or adjacent to the basement membrane (dermal-epidermal junction), a complex multi-molecular structure that anchors the epidermis to the dermis.

The dermis has a relatively low number of cells compared to the epidermis and predominantly consists of extracellular matrix (ECM), a complex network made up of proteins, proteoglycans, lipoproteins, glycolipids and glycosaminoglycans. These components are secreted by dermal fibroblasts which are relatively plastic and able to transform into various phenotypes. The dermis provides the mechanical strength and elasticity which allows the skin to extend 10-50%. It is also key in homeostasis and delivering nutrients/ excreting waste from cells in the non-vascular epidermis. Most skin appendages such as hair follicles and sweat, apocrine and sebaceous glands are located in the dermis.

The hypodermis (subcutis) is the thickest component of the skin consisting of subcutaneous fat populated with adipocytes and extensive networks of blood vessels and nerve tissues. The hypodermis has traditionally been characterized by its insulator and shock absorbing properties. However, it also provides essential signaling molecules which regulate many essential body functions.

FIGURE 1: Cross section of Human Skin



THE KEY COMPONENTS OF SKIN

Native skin is a highly ordered and complex tissue. The various cell types, ECM components, signaling molecules and niches allow the skin to carry out numerous functions and protect the body from external threats.

Layer	Cell types	Protein makeup	Functions
Epidermis	Keratinocytes Melanocytes *(pigment producing cells)* Merkel cells *(neurosensory receptors)* Langerhan's cells *(antigen presenting cells)* Innate Lymphoid cells *(immune cell)*	Keratin Laminin 332 Laminin 311 Laminin 321 Collagen IV Collagen VII Perlecan Fibrillin	Moisture regulation Thermal, photo and chemical-energy protection Mechanical protection Mechanical and hydro-dynamic articulation Sensory function Immune surveillance and defense Communication Homeostasis
Dermis	Dermal fibroblast *(mesenchymal stem cell)* Dermal dendritic cells *(resident leukocytes)* Mast cells Endothelial cells *(lining of blood and lymphatic vessels)*	Collagen I Collagen III Collagen IV Collagen VII Proteoglycans Elastin	Moisture regulation Thermoregulation Mechanical and hydro-dynamic articulation Immune surveillance and defense Homeostasis
Hypodermis	Adipocytes Fibroblasts Endothelial cells *(lining of blood and lymphatic vessels)*	Collagen I Elastin	Energy store Insulation Shock absorption Homeostasis

WOUND HEALING

After injury, the cutaneous healing response is deployed by the body to reinstate the integrity and functionality of the skin. This response first temporarily shields the wound and provides the cellular and signaling components required for healing (inflammation), which is then followed by matrix deposition, vascularization (proliferation), ECM reorganization and re-epithelialization of the wound site (maturation). However, in cases of extensive damage (chronic or acute non-healing wounds), this response is inadequate, and interventions are required to provide a temporary physical barrier and aid the wound healing process.

THE NEED FOR TISSUE ENGINEERED SKIN CONSTRUCTS

Traditionally skin grafts have been performed to treat deep or extensive skin wounds that cannot heal naturally. The clinical “gold standard” treatment is split-thickness autologous skin grafts, where skin is removed from a healthy part of the body to act as a physical barrier, promote angiogenesis, and provide growth factors and essential cytokines to enable wound healing. However, in cases of extensive injury this approach is not feasible due to the lack of donor sites and the creation of new injury sites on the patient. In these cases, allogeneic grafts may be applied with donor skin from cadavers. However, the limited availability of cadaveric donor skin and the risk of immune rejection has led to the development of new approaches to skin substitutes for healthcare. These skin substitutes range from acellular wound dressings to prevent fluid loss and infection to cell laden scaffolds with dermal and epidermal cells to promote wound healing.

Advances in skin tissue engineering have been heavily led by the cosmetic and pharmaceutical industries in the development of *in vitro* models to assess the effects of topical agents, skin care products and cosmetics. This was largely driven by the introduction of the EU’s 7th Amendment to the Cosmetics Directive in 2003 which prohibited animal testing of finished products and cosmetics ingredients, and a marketing ban on products tested on animals within the EU. Large companies like L’Oréal have invested heavily in the development of skin equivalent models to assess the genotoxicity, penetration, and other effects of test products. These models are effective at demonstrating some skin functionality *in vivo*, however, they still lack the complexity of native skin.

Application	Product (example)	Company	Components	Anatomical structure
Wound healing	Integra®DRT	Integra Life Sciences	Silicone polymer polysiloxane (“Epidermis”) Bovine collagen and chondrotim-6-sulfate GAG (“Dermis”)	Epidermis + Dermis
	Epicel®	Vericel	Autologous keratinocytes on petrolatum gauze scaffold	Epidermis
	Dermagraft®	Organogenesis	Polygalactin mesh matrix with human neonatal fibroblasts	Dermis
	Apligraf®	Organogenesis	Bovine collagen matrix with neonatal foreskin fibroblasts (“Dermis”) and keratinocytes (“Epidermis”)	Epidermis + Dermis
In vitro model	EpiDerm™	MatTek Life Sciences	Normal human epidermal keratinocytes on culture inserts	Epidermis
	T-Skin™	L’Oréal	Dermal equivalent with human fibroblasts (“Dermis”) and keratinocytes on polycarbonate filter (“Epidermis”)	Epidermis + Dermis

3D BIOPRINTING METHODS FOR CREATING SKIN CONSTRUCTS

To obtain artificial substitutes able to mimic native skin properties and functions it is required to mimic the high-complexity, hierarchical structure of the tissue itself. To this purpose, manufacture processes need to provide an accurate spatial localization on multiple cell types and biomaterials, as well as retaining cell viability and desired function throughout all the process. 3D Bioprinting technologies represents the most suitable solution to address these needs, through its ability to combine multiple printheads to deposit cell-laden biomaterials in an highly controlled, accurate, automated fashion in an high-throughput, repeatable process.

Microextrusion, laser-based, and inkjet bioprinting are the main methods used to generate skin constructs through this technique. These processes are briefly described below.

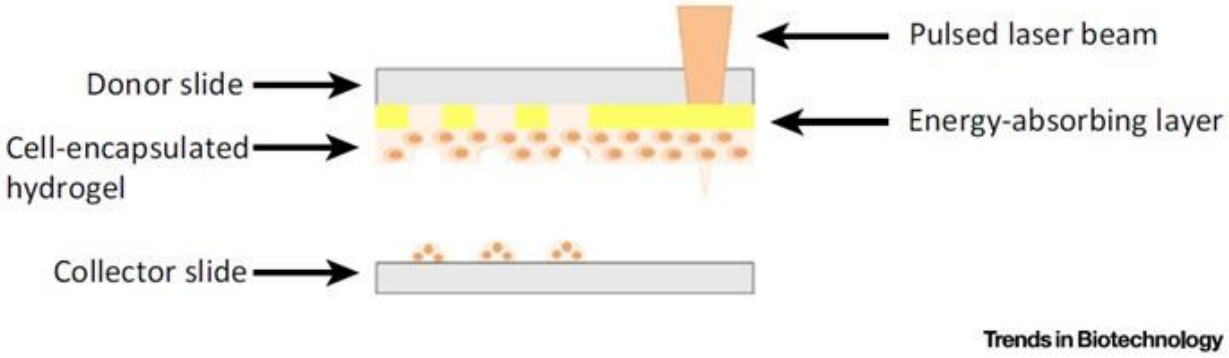
LASER- BASED BIOPRINTING

Laser-based bioprinting also known as Laser Induced Forward Transfer (LIFT), uses a laser beam to displace cells from a cell loaded donor slide to a target collector slide in a pre-defined pattern. Cells are encapsulated in a hydrogel or protein matrix and homogenously applied to a donor slide pre-coated with an energy absorbing layer. The donor slide is suspended above the collector slide with a gap of 350-500µm. When a pulsed laser beam is applied to the donor slide the energy is absorbed by the energy absorbing layer. This leads to local evaporation creating a high gas pressure, which propels droplets of cell laden hydrogels towards the collector plate and results in precise cellular deposition at specific points. As this is a nozzle free technique, issues of clogging, cell sedimentation and negative effects from shear stress are avoided. However, the technique present limitations in achievable thickness of the fabricated constructs. And due to the printing process, particles of the energy absorbing layer are also deposited onto the target collector slide, with the possibility to affect cellular signaling interactions and cell proliferation, essential for full functionality of the construct

This method has been used to generate fibroblast and keratinocyte laden constructs showing the presence of cell-cell channels [4], and implanted into the dorsal skin fold chamber of nude mice which showed good graft take and partial vascularization after 11 days [5].

Benefits	Challenges
Nozzle free	Possible thermal damage due to laser irradiation[6]
”Single-cell” printing resolution (~10µm)	Limited range of printing viscosities (1-300 mPa/s)
	Limited achievable construct thickness
High cell viability (>95%)	Fast drying of thin encapsulated cell layer
	Potential to transfer thermal layer material to the cellular construct

FIGURE 2: Laser Induced Forward Transfer Bioprinting



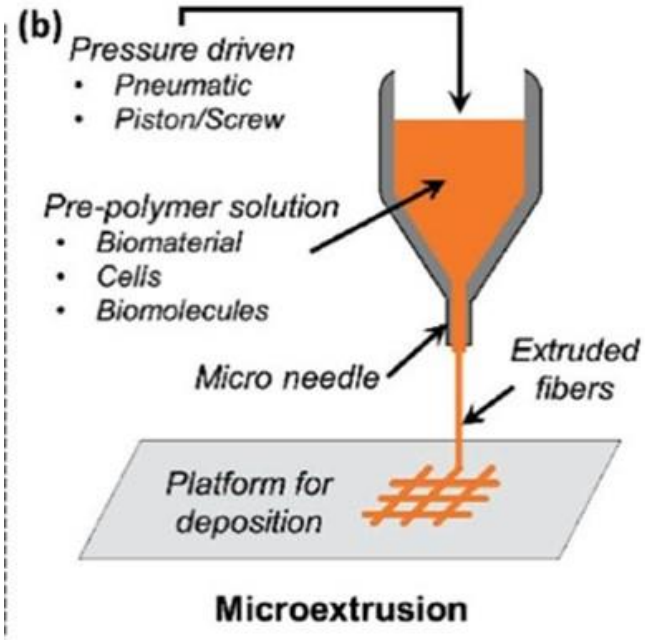
MICROEXTRUSION BIOPRINTING

Microextrusion bioprinters use an array of cartridges and a movable build platform. Cells suspended in hydrogels or other matrices are deposited onto the build platform via continuous pneumatic or piston driven pressure. Multiple cartridges can be utilized in the system meaning that separate layers of cells and ECM can be deposited simultaneously using different techniques. However, as this method uses nozzles, optimal process conditions need to be identified in order to avoid clogging phenomena and at the same time minimize the shear stress applied to cells during the extrusion. Extrusion printing can generate both strands and droplets of deposited material, in part reducing shear stress on cells.

Constructs consisting of epidermal, basement membrane and dermal regions with validated morphology, barrier function and minimal lateral contraction have been assembled using microextrusion bioprinting [7]. Full thickness vascularized constructs incorporating fibroblasts, keratinocytes, pericytes and iPSC derived endothelial cells have also been produced using this method and have elicited pharmacological responses that correlate with clinical data [8].

Benefits	Challenges
Ability to print wide range of biomaterials and high embedded cell densities	Moderate material viscosities help to avoid excess shear stress through the nozzle
Good cell viability (>86%)	Limited fabrication time to ensure cell viability during the process
Simultaneous independent printing of multiple cell types and ECM	Possible cell sedimentation phenomena in cartridge (depending on biomaterial viscosity)

FIGURE 3: MicroExtrusion Bioprinting



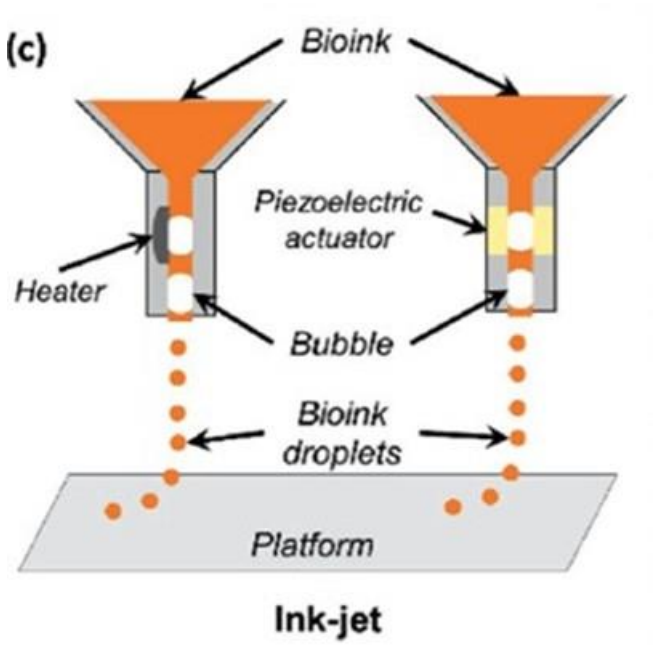
INKJET PRINTING

Inkjet bioprinters are based on traditional inkjet technology used in desktop printers. In thermal inkjet printers the nozzle is electrically heated to produce air pressure pulses that force droplets onto the build platform. Piezoelectric inkjet printers create the same pressure pulses via deformation of a piezoelectric actuator. Droplets can be stacked to create a 3D structure. Multiple cartridges can be used in the same system allowing for the simultaneous printing of ECM and cells. As with microextrusion printing, cell clogging can occur from high cell density suspensions. Cell aggregation can also affect the droplet formation and trajectory in the case of inkjet printing, reducing print quality.

Using this method pigmented human skin constructs have been generated and have demonstrated stratified epidermal layers and a continuous basement membrane [9].

Benefits	Challenges
High throughput printing (~1500 droplets per second)	Only prints hydrogels with moderate viscosities <10 mPa/s) [10, 11]
Good cell viability (80-90%)	Limited achievable construct thickness
Simultaneous independent printing of cells and ECM	Cell suspension density limited to 10^6 cells/mL [11]

FIGURE 4: Ink Jet Bioprinting



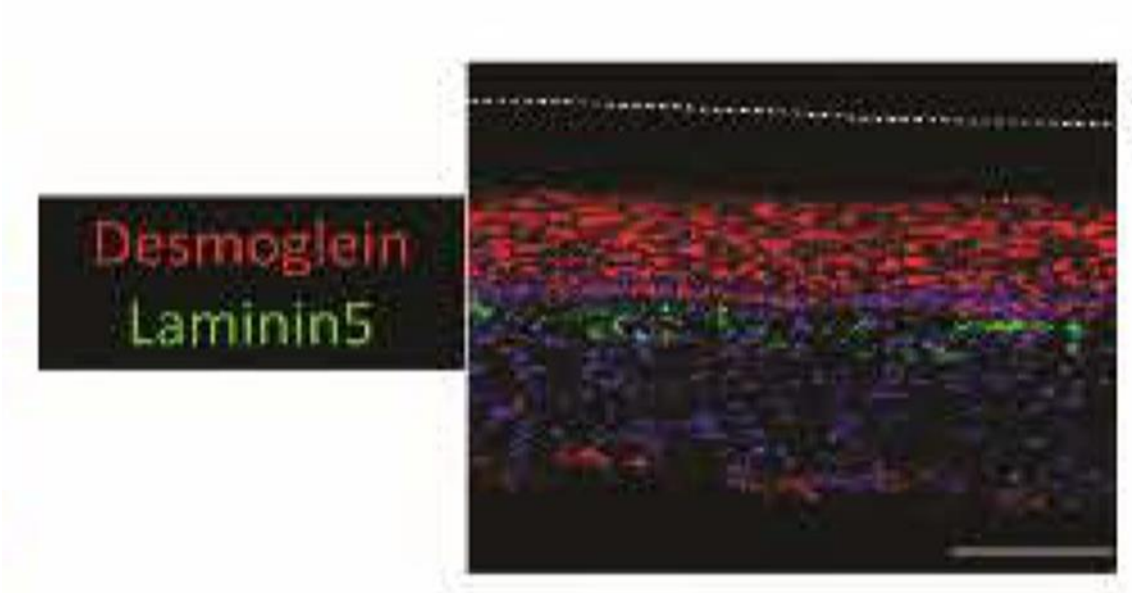
BENEFITS OF 3D BIOPRINTING FOR SKIN TISSUE ENGINEERING

Most commercially available skin constructs are produced using manual methods of fabrication. The production of bilayered scaffolds (such as Epiderm™ and Apligraf®) usually involves cultivating fibroblasts within a hydrogel or ECM and seeding a layer of keratinocytes on top. Scaffolds are cultured in submerged conditions until the populations are mature, and then exposed to an Air Liquid Interface (ALI) to stratify the epidermal layer. Manually created constructs have been relatively effective in their respective applications. However, 3D bioprinting offers many crucial benefits for the development and widespread application of skin constructs.

TUNABLE MICROSTRUCTURE FROM PRECISE SUBSTRATE DEPOSITION

As 3D bioprinting is an additive manufacturing process, substrates are deposited according to a digital design. These designs can be simple or complex, allowing for geometries that aren't achievable through manual fabrication techniques. For intricate components like vasculature, fibroblasts, pericytes and endothelial cells loaded hydrogels can be printed onto a scaffold in strips and overlayed with a protein matrix. Once keratinocytes are added to the opposing side of the scaffold and the construct is cultured in submerged and ALI conditions, the construct demonstrates micro vessel formation within the 'dermis' alongside a stratified epidermis with barrier function. This model has been applied in preclinical studies for Atopic Dermatitis demonstrating pharmacological responses to drug treatments which correlate to clinical therapeutic data [8].

FIGURE 5: Stained cross section of human skin constructs from (Liu et al 2020 [8]). Epidermis fluorescently labelled red and dermis labelled green

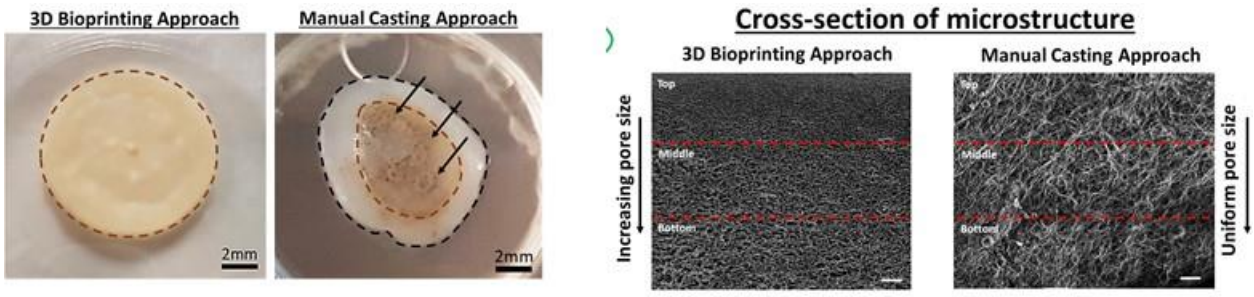


A more conventional layered approach can be printed to produce bilayer scaffolds (epidermal/dermal) with the inclusion of a basement membrane layer. Layers of neonatal human dermal fibroblasts in a dermal base hydrogel have been printed onto a scaffold with 1 layer of basement membrane on top. Keratinocytes are then deposited in the center of the construct and cultured in submerged and ALI conditions. This process results in constructs with minimal lateral contraction, which is a common occurrence in traditional raft cultures and usually requires an incubation period of seven days to allow the contraction to subside before the application epidermal cells [7].

CELL PATTERNING TO CREATE BIOMIMETIC STRUCTURES

The precise deposition of substrates in 3D bioprinting allows cells to be patterned in optimal configurations to create biomimetic structures found in native skin tissue. Many existing bilayer constructs use keratinocytes in the epidermal layer and fibroblasts in the dermal layer to elicit the main functions of the skin. However, other important features of the skin such as pigment are not present in these models. Using 3D bioprinting, skin constructs containing keratinocytes and melanocytes in the epidermal layer have been assembled. Each melanocyte droplet is surrounded by eight keratinocytes droplets, and droplets are overlapped to emulate functional epidermal melanin units. These constructs show a uniform skin pigmentation and hierarchical porous dermal region within the 3D printed construct compared to uneven pigmentation and uniform porosity in the manually fabricated construct [9].

FIGURE 6: Comparison between Manual Skin Construct production and 3D Bioprinting Skin Construction (Ng et al 2018 [9]).



CONSISTENCY, REPRODUCIBILITY AND PERSONALIZATION

Using a high-precision liquid dispensing robotic 3D bioprinter results in a high degree of consistency and less batch to batch variation and reduces one of the quality variables of non-automated methods. Additionally, protocols using 3D bioprinting can yield mature skin constructs within 15 days, half the time of traditional casting methods. Less time in culture leads to a higher output production of skin models, whilst reducing the risk of failure through culture contamination.

This degree of consistency is required for standardized, reproducible toxicology studies and ensuring quality across products. As skin constructs for clinical applications advance, 3D bioprinting will allow the personalization of constructs to meet patient needs, such as the use of the patients own cells through iPSC utilization, correct skin pigmentation and the addition of dermal appendages.

ADOPTING 3D BIOPRINTING IN INDUSTRY FOR SKIN CONSTRUCT MANUFACTURE

Although 3D bioprinting has been primarily used in research for the advancement of skin constructs, BASF and CTIBiotech announced that they were developing the first 3D bioprinted human reconstructed skin including immune macrophages in 2019. The development of these constructs for use as *in vitro* models allow analysis more similar to human physiology and the immune role of macrophages than current *in vitro* methods [9]. L'Oréal and Procter & Gamble are also investing in this technology to produce 3D skin organotypic models [3].

LIMITATIONS OF 3D BIOPRINTING IN SKIN CONSTRUCT FABRICATION

There remain a number of technical challenges to the large scale manufacture of skin constructs using 3D bioprinting. For methods using nozzles (extrusion and inkjet processes), the composition of the printing material can lead to nozzle clogging, cell sedimentation, heterogenous cell distribution in the construct, and mechanical stress on the cells. Whilst simple solutions such as agitating the cartridge can help reduce cell sedimentation, other factors like the effects of mechanical stress cannot be remedied as easily. Using lower viscosity solutions reduces the amount of mechanical stress cellular components are exposed to but leads to a decrease in print resolution. In these cases, developments in bioinks and computational modelling will be beneficial to optimize the materials to the printing method.

In the advancement of 3D bioprinting for skin constructs, manufacture process controls need to be regulated to ensure quality and efficacy across products. Some of these are listed below:

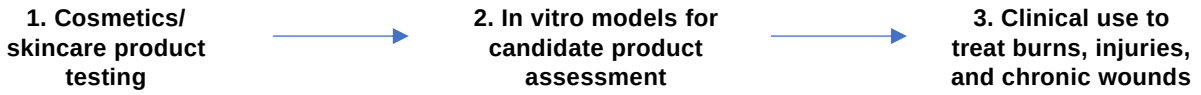
Bioink controls	*Cell sources, cell expansion, cell functionality, bioink composition and consistency, ECM composition*
In-process controls	*Design, product orientation, layer thickness, printer height, printing speed, printing pattern*
Environmental controls	*Temperature, humidity, cartridge agitation, time cells remain in cartridge, sterility*
Quality controls	*Cell functionality, construct maturation, sterility, construct maintenance post printing and through transport, immunogenicity*

CHALLENGES OF BRINGING 3D BIOPRINTED SKIN CONSTRUCTS TO THE MARKET

APPLICATION IN HEALTHCARE AND COMMERCIAL RESEARCH

Currently there are no 3D bioprinted skin constructs available on the market. However, the potential for bioprinted skin to enter the market primarily relies on its application. As there are less regulatory requirements around the production of *in vitro* models it is likely that the implementation of bioprinted skin constructs will have the following trajectory:

FIGURE 7: There are still technical and regulatory challenges to achieving Clinical grade Skin Constructs



VASCULARIZATION

One of the fundamental challenges in tissue engineering is the lack of functional vasculature to deliver nutrients and remove waste from cells. In the development of 3D bioprinted constructs there have been small steps forward in this area such as: patterning cells to promote microvasculature, using sacrificial inks to print synthetic microvascular networks which are then lined with endothelial cells [11], and direct printing of a perfusable vascular network using a coaxial nozzle [12]. Further development of 3D bioprinting technologies and materials may open new avenues to solving this fundamental challenge and enable the manufacture of vascularized skin constructs.

PERSONALIZATION

Key components of the skin such as pigment, innervation, appendages and texture are not currently available in commercial constructs, but are vital in both personalization for patients, and investigating the effects of test compounds in research and development. 3D bioprinting has already provided a route to generating pigmented constructs [9] and may enable the incorporation of other key skin components into bioprinted constructs.

SCALABILITY

3D printing allows the automation and standardization of generating skin constructs with increased efficiency and complexity. However, one major challenge in this process is the culture and preparation of sufficient starting materials (cells and biomaterials) which remains a time-consuming process. Products incorporating cells are also currently limited by the cell source and the retention of functional characteristics through cell expansion. These issues can restrict the scalability of skin construct generation, although advancements in automated cell culture platforms and iPSC production processes are providing options to solve these problems.

REGULATORY CHALLENGES

The application of 3D bioprinted skin constructs into healthcare requires the support of a robust regulatory framework consisting of quality control standards for each process step. These steps include:

- Cell expansion and characterization
- Model design
- Bioink selection
- The bioprinting process
- Validation of the printing
- Construct maturation
- Construct quality assessment before transplantation

There is currently no framework in place to regulate 3D bioprinted constructs, so approval of these products will most likely be on a case by case basis following routes established for tissue-engineered products.

In the US tissue-engineered constructs are categorized as combination products by the FDA, and their classification is based on their primary mode of action (PMOA) or therapeutic action. Where the cellular components of the construct elicit the therapeutic effect, these products are designated biologic-led combination products. These products are licensed through biological license applications (BLAs) submitted under section 351 of the Public Health Service Act (PHS Act) and are usually assigned to the Center for Biologics Evaluation and Research (CBER) for premarket review and regulatory oversight. This application is a standalone application, so all applicant, product, manufacturing information and safety data must be submitted. In products where the PMOA is dependent on the non-cellular components of the construct, they can be classified as device-led combination products and are regulated by either CBER or the Center for Devices and Radiological Health (CDRH). These products usually require premarket approval (PMA) with submission of sufficient data to demonstrate the safety and effectiveness of the product. Commercially available bilayer skin constructs such as Apligraf® and Dermagraft® have gained FDA approval under the PMA process [13] [14] [15].

In Europe, the EMA classes tissue engineered products as Advanced Therapy Medicinal Products (ATMPs). The ATMP regulation involves a centralized marketing authorization route in which an application dossier with the product safety, efficacy and quality data is submitted and reviewed by the Committee for Advanced Therapies (CAT). The ATMP regulation also contains the hospital exemption route for individual therapies that are not produced regularly and are prescribed by a medical practitioner. Pre-market approval is waived for these therapies as quality standards are specific to the product. Due to the current experimental nature of 3D bioprinted tissues, the hospital exemption pathway is the most applicable route to approval in Europe. However, for the commercialization of 3D bioprinted constructs pre-market approval for ATMPs and combined ATMPs (products incorporating a medical device and viable cells/tissues) from the EMA will be required [16] [17].

With the inevitable commercialization of 3D bioprinting technology, a comprehensive framework and clear route to market is imperative to bring therapeutic benefit of tissue-engineered constructs to patients.

GLOSSARY

ATMPs- Advanced Therapy Medicinal Products

ALI- Air Liquid Interface

BLA- Biological License Application

CAD- Compute Aided Design

CAT- Committee for Advanced Therapies

CBER- Center for Biologics Evaluation and Research

CDRH- Center for Devices and Radiological Health

ECM- Extracellular Matrix

EMA- European Medicines Agency

EU- European Union

FDA- Food and Drug Administration

GAG- Glycosaminoglycans

GMP- Good Manufacturing Practice

iPSCs- Induced pluripotent Stem Cells

LIFT- Laser Induced Forward Transfer

PHS Act- Public Health Service Act

PMA- Premarket Approval

PMOA- Primary Mode of Action

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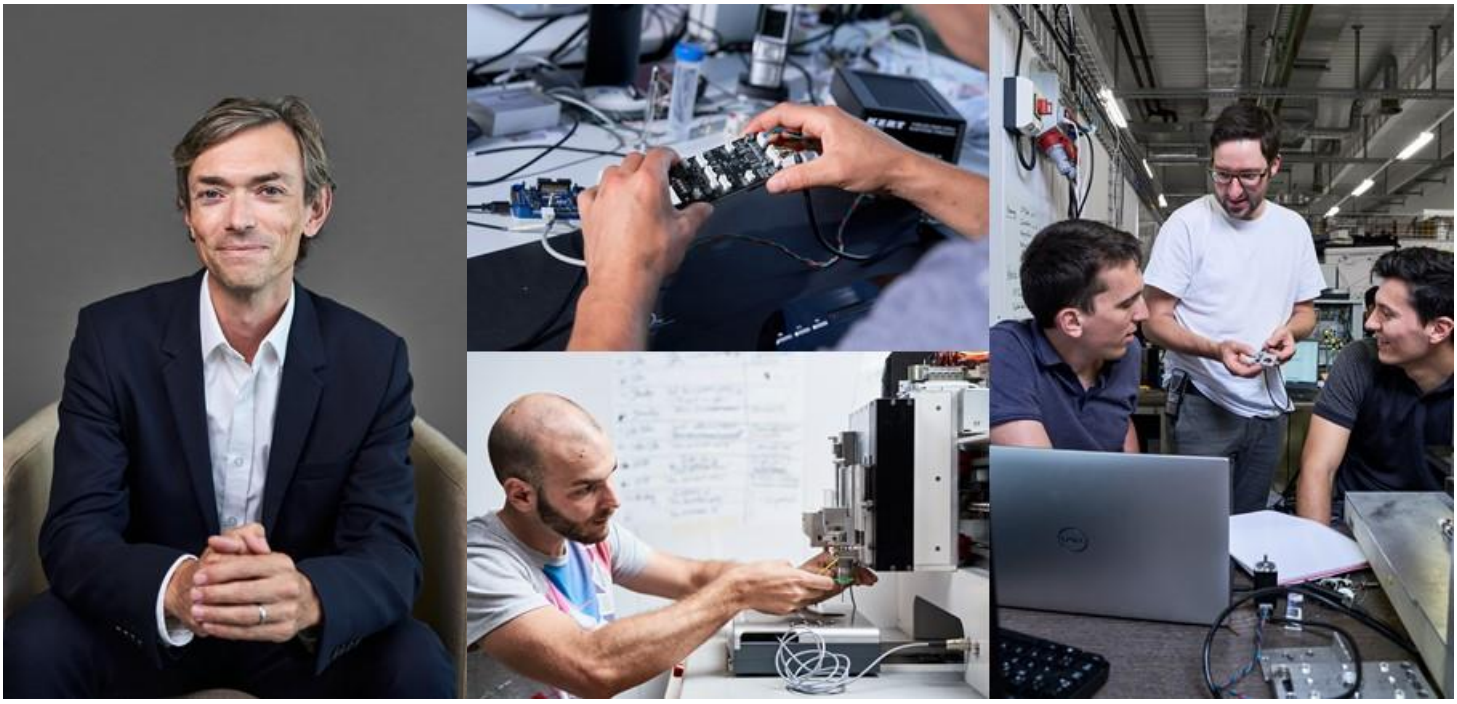

ABOUT REGENHU

As a Swiss Med Tech company, REGENHU's mission since its formation in 2007 is to enable our users to reach the next level in their work, goals and ambitions. This is why we are focusing on creating bioprinting instruments to help them do just that.

We personalize each instrument to the specific project needs of our users, and provide multiple bioprinting technologies in one instrument, enabling true multi-material printing for our global customer portfolio comprising key players in biotech, pharma, cosmetics, and medtech industries in addition to leading universities in 38 countries.

The success of our user network, the REGENHU family, is incredibly important to us, which is why we are investing so much time to help them and will continue to do so. We guide and support them in their research journey, from their initial interest in bioprinting, selecting the perfect instrument to achieve their goals, through to continuing to help until those goals are achieved.

Benefiting from this unique network of global partnerships with leading scientific innovators and industrial players, we are constantly at the forefront of innovation. Our technology evolves alongside our partners' research needs and continues to expand into new and exciting application areas.

Our customer-focused approach, visionary outlook, advanced instruments, and user-friendly software that helps them perform tasks with accuracy and repeatability, are at the heart of everything we do.

We are an ambitious, passionate, and driven team that is building research instruments for our customers today, with a view to creating systems that will provide their manufacturing needs of the future. We are already engaged in building these future generation bioprinting instruments alongside our new SHAPER software, which is specifically configured for biofabrication and for manufacturing the future of medicine.

REGENHU was formed to build bioprinters that will clearly impact the world of medicine. Today, we remain strong believers in this vision and are driven to accomplishing this.

REGENHU

E *sales@regenhu.com*

W regenhu.com