***Evaluation and Licensing Opportunities***

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***Patent Literature***

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# 3D Bioprinting Platform using Bacterial Cellulose Biofilms

## Bacterial Cellulose-Derived Biofabrication System for Biomedical and Biotechnological Applications

Bacterial cellulose, the most abundant biopolymer on Earth, is an extracellular polysaccharide produced and secreted by certain bacteria, including the Gram-negative *Acetobacter xylinum*. To date, bacterial cellulose has predominately been applied as composite scaffolds for biomedical applications, such as in wound healing, cartilage growth and vascular grafts owing to its proficient biocompatibility, cytocompatibility and ability to support tissue regeneration. Bacterial cellulose is also fully biodegradable and offers superior mechanical strength compared to synthetic polymers, making it the optimal choice for many biomedical and industrial biotechnology applications.

A team led by Estaban Ponguillo Betancourt at the Universidad San Francisco de Quito (USFQ), Ecuador, have developed a Three-Dimensional (3D) Cellulose Biofilm Synthesizer Bioreactor System. This next-generation bioprinting platform creates complex, high-resolution scaffolds directly from bacterial biofilms – without relying on expensive and mechanically weak bioinks. Instead, the system leverages the natural self-assembly properties of bacterial cellulose to fabricate custom 3D structures sustainably, and reproducibly.

The programmable bioreactor system directs layer-by-layer formation of bacterial cellulose to assemble predefined geometries using a mobile negative mold. Oxygen-blocking floaters ensure growth is restricted only to designated areas of the mold to create the desired structure, see Figure 1 and 2 for overview of the bioreactor's design and exemplar geometries. The bioprinter's movement synchronizes with the bacterial culture medium surface to facilitate continuous biofilm formation. Environmental settings, including temperature, humidity, airflow, and nutrients, are precisely regulated to optimize synthesis. Together, the bioreactor system provides a platform for controlled, 3D bioprinting from bacterial cellulose.

Key components

- **Mobile negative mold:** Guides 3D formation by exposing successive cross-sections layer-by-layer
- **Floating device:** Prevents undesired biofilm growth outside the specified reaction zone
- **Environmental control sensors:** Regulate optimal temperature (28-31°C), humidity (70–80%), and airflow (to minimise contamination risk)

**The USFQ Three-Dimensional Cellulose Biofilm Synthesizer Bioreactor System is the subject of patent applications filed by USFQ. For more information or licensing interest, please contact PBL.**

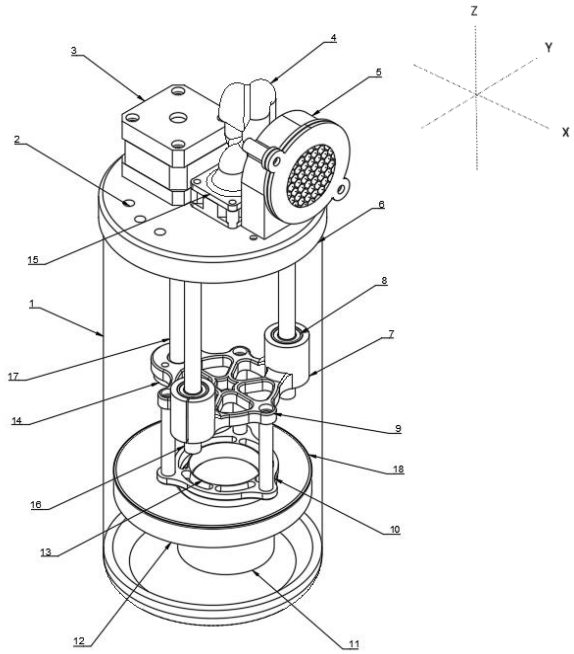


**Figure 1. Isometric upper view of the 3D cellulose bioreactor system.** The system is designed to be scalable and adaptable to many requirements based on printing volume, type of bacteria/consortia used, and the selected culture media.

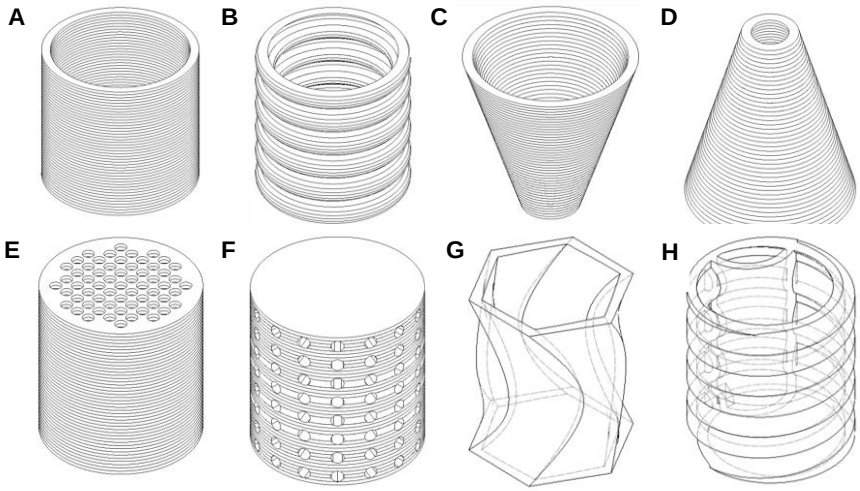


**Figure 2. Example forms of the 3D molds generated by the system. (A)** Cylindrical (**B)** Spiral (**C, D)** Frustoconical shapes (**E, F)** Hollow geometries with venting **(G)** Spiralular form **(H)** Asymmetrical shapes with compound geometries.

Key features

- **Fully programmable** bioprinting platform using bacterial cellulose biofilms
- **Layered growth system** using negative molds for precise 3D geometry
- **Customizable and scalable,** accommodating diverse shapes and applications
- **Oxygen-restrictive floaters** enable selective scaffold formation
- **Sterility** maintained through filtered airflow and unidirectional valve systems

Advantages

- **Natural and biodegradable:** Derived from bacterial cellulose – sustainable and non-toxic
- **Superior mechanical properties:** Outperforms many synthetic biomaterials in strength and flexibility
- **Bioink-free:** Reduces costs and complexity associated with traditional 3D bioprinting
- **High resolution & reproducibility:** Fine structure control through environmental and spatial regulation
- **Versatile and scalable:** Adaptable for lab-scale or industrial-scale applications

Applications

The bioreactor system offers a wide range of applications across biomedicine and industrial biotechnology.

**Biomedical Engineering**

- Tissue scaffolds for regenerative medicine
- Organoids and artificial organs
- Medical implants (e.g. cartilage, bone)

**Industrial Biotechnology**

- Biocatalysts
- Biofilters
- Custom bioreactors
- Biomimicry
- Synthetic biology
- Nutrition i.e., edible foods

In the biomedical field, the system serves as a platform to generate scaffolds supporting cell growth and differentiation in tissue and organoid-based systems. This also opens the possibility to generate artificial organs for human transplantation. The ability to generate precise and biocompatible structures is additionally suited for medical implants including bone and cartilage scaffolds, owing to its strong mechanical properties.

Applications in industrial biotechnology are also highly versatile, with use in the production of biocatalysts and biofilters possible, along as serving as specialized bioreactors for numerous microbial processes. The system can support synthetic biology approaches i.e., creating engineered microbial consortia for bioenergy, biomaterials or in precision medicine, and extends to nutritional innovation including the development of novel foods.

***References:***

Not yet published in the scientific literature.