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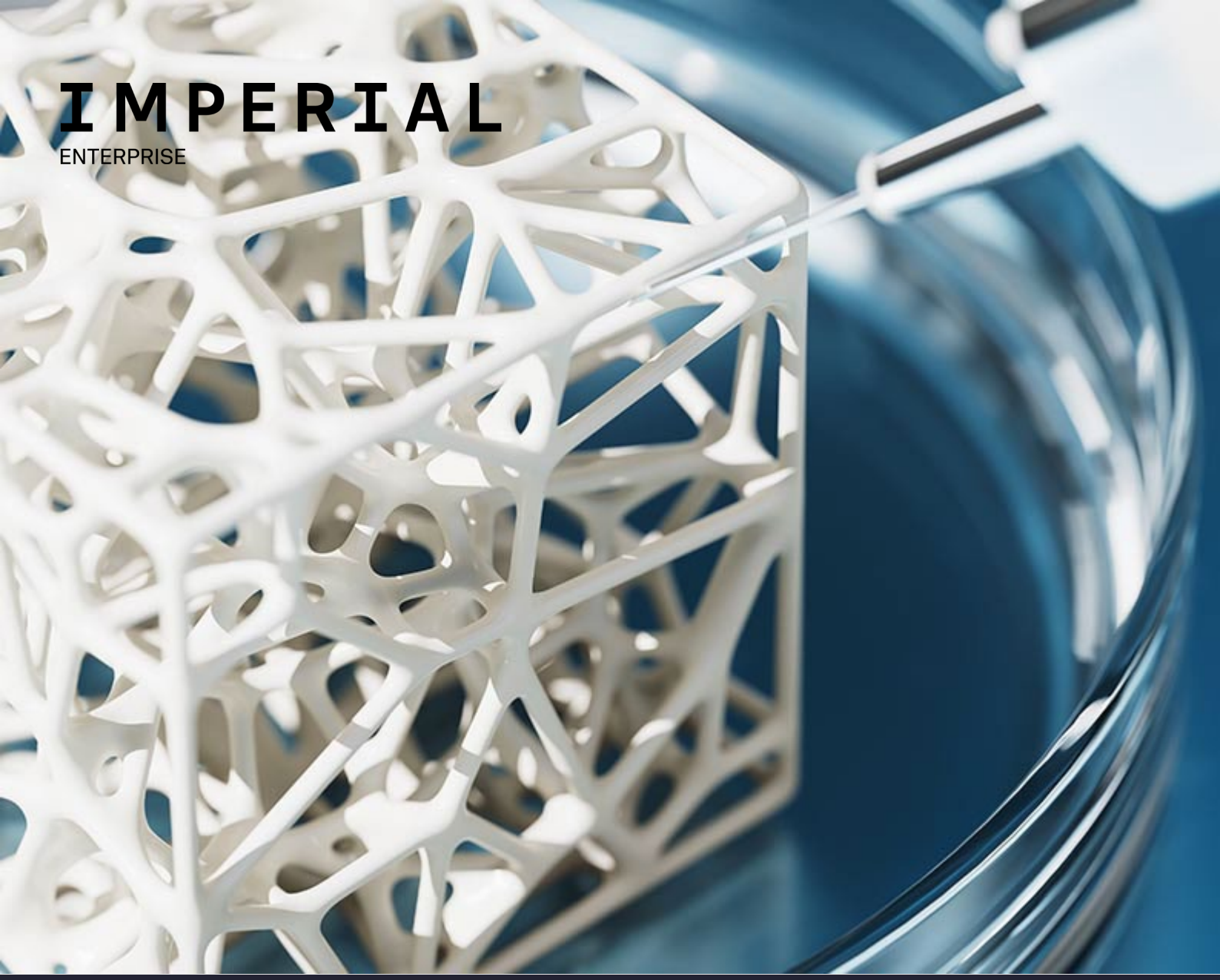

Patterned 3D-printed Hydrogel for Plant Growth

A 3D-printed, biocompatible hydrogel matrix with internal air channels that can deliver water, nutrients, and gases directly to plant roots, enabling robust, soil-free cultivation with reduced land, water, and environmental impact.

Edmond Yau

Commercialisation Executive

– Faculty of Natural Sciences

h.yau@imperial.ac.uk

Technology reference: 11822

Intellectual property information
UK Priority Application filed May 2025 – GB2508005.2 – Growth Medium

Inventor information
Dr Giovanni Sena
Dr Connor Myant

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Proposed Use

The hydrogel matrix is designed as a growth medium for vertical farming and other soilless cultivation systems. Seeds germinate on its surface and roots extend into an internal channel network to access water and nutrients from the gel and exchange oxygen and CO_2 from the air in the tubules.

Problem addressed

The major costs of traditional soilless cultivation are water circulation and illumination, with current systems such as hydroponics, aquaponics, and aeroponics relying on constant oxygenation of liquid media to sustain root health. These setups are often complex, energy-intensive, and difficult to scale. There is a growing need for simpler, more resource-efficient solutions that can support resilient food production with reduced environmental impact and water consumption. This technology responds to that need by improving root access to air and nutrients through its structured design.

Technology Overview

This invention introduces a 3D-printed, biocompatible hydrogel matrix incorporating a tubular network optimised for surface-to-volume ratio, ensuring the right balance of air and water to simulate natural soil conditions. The hydrogel matrix can be hydrated with a desired liquid medium containing the optimal amounts of nutrients, pH, and minerals. Unlike state-of-the-art hydroponics, the design eliminates the need for the liquid to be oxygenated, providing a simplified, robust, and easily handled platform that supports healthy plant growth in compact, soil-free environments.

We are currently exploring opportunities to collaborate with partners interested in advancing this technology through further research, development and real-world testing.

Inventor information

Dr. Giovanni Sena – Department of Life Sciences

Dr Connor Myant – Dyson School of Engineering

Link to preprint

Mohammed, A, Salvalaio, M, Li, Y, Myant, C and Sena, G (2025). Patterned 3D-printed hydrogel as a novel soilless substrate for plant cultivation, bioRxiv. DOI: 10.1101/2025.08.06.668759

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Benefits

Higher Yields and Plant Health

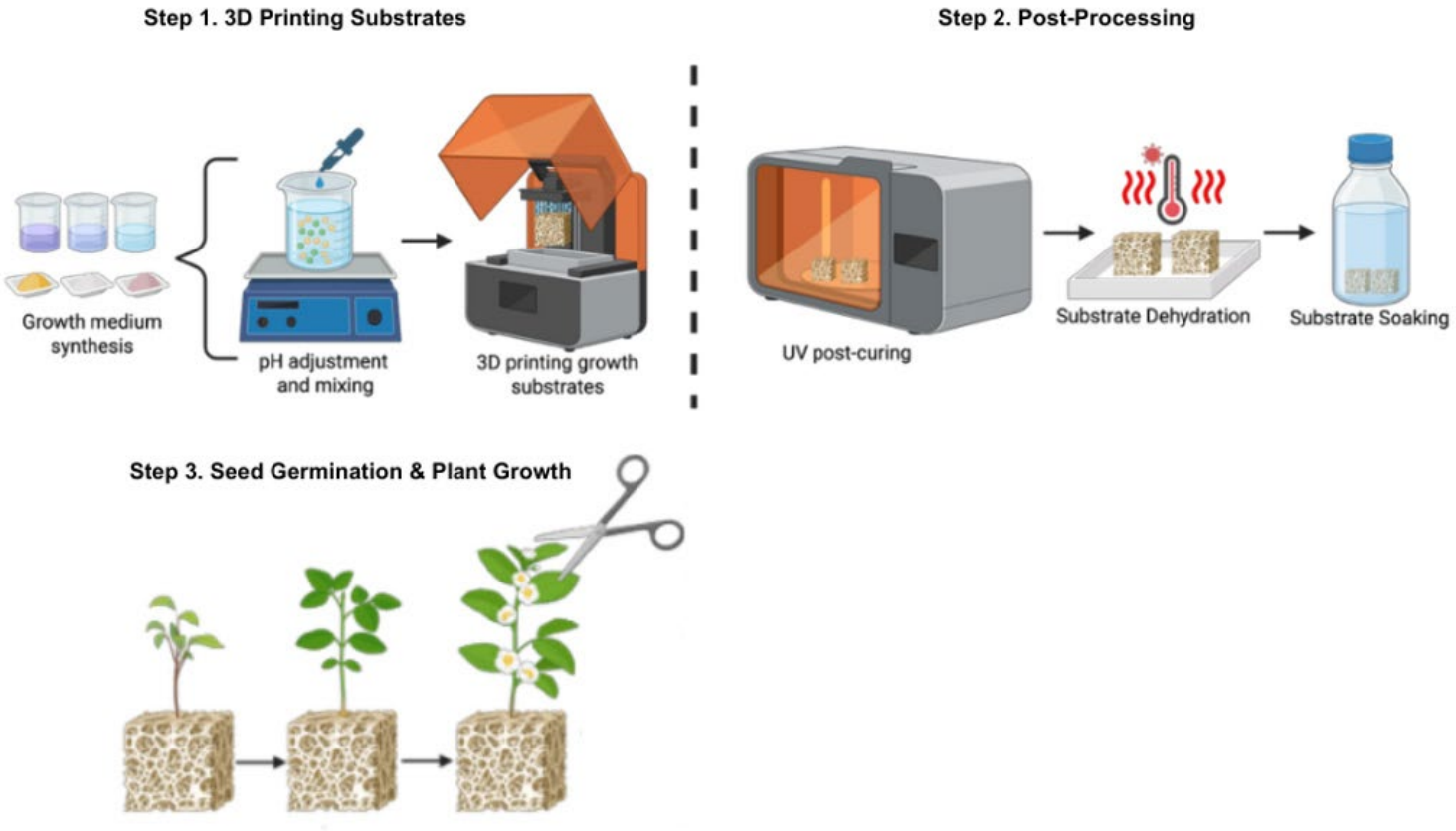
- Increases root growth dramatically compared to aerated hydroponics (industry benchmark)
- Optimised tubular network balances air and water, simulating natural soil conditions
- Allows controlled delivery of nutrients, pH, and minerals through the hydrogel

Lower cost and resource efficiency

- Removes the need for oxygenated nutrient solutions, cutting circulation costs
- Reduces irrigation demand and overall water consumption

Scalable, sustainable cultivation

- Enables soil-free cultivation, reducing land use
- Supports vertical farming and urban agriculture applications
- Provides a robust, mechanically stable matrix that is easy to handle
- Scalable and adaptable for different plant types and growing environments


Step 1. 3D Printing Substrates
Growth medium synthesis
pH adjustment and mixing
3D printing growth substrates
Step 2. Post-Processing
UV post-curing
Substrate Dehydration
Substrate Soaking
Step 3. Seed Germination & Plant Growth