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From mushrooms to new architecture: the rise of living, self-healing buildings

EU-funded researchers are cultivating fungi on agricultural waste to create smarter and greener construction materials able to adapt and react to their environment, and even repair themselves.

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In his office in the Netherlands, Professor Han Wösten holds up a hard sponge-like block for show. It is a material he made in 2012 using the intricate rooting network of fungi. He has bold predictions about the potential of this stuff.

“Ten years from now, we should have the first fungal buildings,” said Wösten, a professor of molecular biology at Utrecht University.

He is not talking about mouldy walls, but something far more exciting – materials that are alive, sustainable, and full of potential.

Wösten studies how different fungi operate within a mycelium – nature’s internet, a living network of threads that nourishes fungi and connects plants by sharing resources and information.

He is now engineering fungal “threads” into sustainable, biodegradable alternatives to plastic, wood and leather – materials already sparking new uses in fashion, furniture and construction.

Future-proof “living” buildings

Wösten is part of a team of researchers from Belgium, Denmark, Greece, the Netherlands, Norway and the UK who are exploring a radical idea: what if the materials we build with could grow, repair themselves, and even sense their environment?

This EU-funded research initiative, called Fungateria, is developing engineered living materials (ELMs) by fusing fungal mycelia with bacteria – creating adaptable, self-healing materials that do what conventional products

cannot.

Unlike traditional materials like concrete or plastic, ELMs can grow, repair themselves, sense changes in their environment, and sometimes even adapt over time.

The researchers aim to design these materials so that they combine the strength of natural growth with the functionality of engineering. For example, walls that fix their own cracks, building blocks that absorb CO_2, or surfaces that can clean the air.

The goal is to create sustainable, low-waste materials that work with nature instead of against it, opening the door to smarter, greener architecture and products.

“Already we can make leather-like materials or insulation panels from these extended fungal networks,” said Wösten. “Now we want to go to the next stage and grow buildings, but in a controlled way.”

Low waste, high efficiency

There are considerable savings to be made. The construction sector generates more than one third of the EU’s total waste.

Greenhouse gas emissions from material extraction and manufacturing construction products, as well as construction and renovation of buildings, contribute an estimated 5% to 12% of the total national emissions of EU Member States. Greater material efficiency could save 80% of those emissions.

Crucially, while manufacturing concrete emits very large quantities of CO_2 into the atmosphere, contributing to climate change, fungal-composite buildings could upcycle agricultural waste into building material while reducing carbon emissions.

The idea of living organisms in buildings may unsettle some people. But for Professor Phil Ayres, a pioneer in the field of biohybrid architecture at the Royal Danish Academy of Architecture, Design and Conservation in Copenhagen, this is a social adaptation that will happen over time.

“We’ve eaten foods with living organisms for hundreds of years. We have only been looking at the potential applications of these organisms in the building sector for the last 20 years.”

Ayres, who coordinates the work of the Fungateria research team, wants to overturn the dogma of his fellow architects that materials are controllable and have fixed properties.

“All constructions change over time in quite dramatic ways. If we began to think about buildings more like organisms in a continuous state, we might create architecture that is more ecologically connected,” he said.

Bridging fields from microbiology to architecture and ethics, the researchers are also engaging the public through exhibitions like the Venice Biennale and workshops that challenge traditional ideas of what buildings can be.

Growth control

A mushroom in the forest is just the tip – hidden below it is a massive mycelium network, sometimes weighing tonnes.

For construction, the fungal hyphae – the thread-like filaments – can be encouraged to feed on agricultural waste to form a strong, lightweight and insulating composite. But controlling this growth is key to making safe, durable structures.

The fungal species being used by the researchers is the splitgill mushroom, or *Schizophyllum commune*. It primarily grows on dead wood, which poses a potential risk. The growth of the mycelium needs to be stopped when the structure is completed so that it does not begin eating through wood supports.

One method uses nature's own signals: light and temperature can cue the fungus to grow or stop. Another involves bacteria genetically engineered at the University of Ghent in Belgium.

These bacteria feed the fungus essential nutrients. Therefore, killing the bacteria halts fungal growth. The same bacteria can even be programmed to release antifungal compounds on command, providing an extra safety layer.

Future proof

Already, the Fungateria researchers, who will continue their collaboration until late-2026, have shown that the fungus can grow and survive under stressful conditions such as drought and high temperatures. That means it is resilient to the possible impact of changing climatic conditions.

The research team is already envisioning a time when buildings are made from wood and fungus matter grown on agricultural waste in a living process of construction.

"In the future, I can imagine that we will grow complete buildings where the wood will be the supporting structure and the fungus grows along and between the wood frames," said Wösten.

As global demand for sustainable solutions intensifies, this research points to a future where architecture is not just inspired by nature, but made of it – alive, adaptive and intertwined with the ecosystems around it.

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More info

- Fungateria
- Fungateria project website
- EU policy on buildings and construction
- EU chemicals and advanced materials research and innovation