EINPRESSWIRE

Researchers Achieve Long-lasting And Renewable Chemical Production with Photosynthetic Microorganisms

TURKU, FINLAND, August 10, 2026 /EINPresswire.com/ -- Finnish researchers have taken an important step toward long-lasting production of renewable chemicals and fuels using photosynthetic microorganisms. By entrapping cyanobacteria engineered for ethylene production in thin nanocellulose films, the researchers enabled sustained ethylene production for more than four months and generated approximately twice as much ethylene as comparable suspension cultures.

> Our next challenge is to translate the performance of small laboratory films into larger, reliable production systems. ”
>
> *Professor Yagut Allahverdiyeva-Rinne*

Photosynthetic microorganisms can use light energy to convert carbon dioxide into useful compounds under mild, environmentally compatible conditions. However, many current photosynthetic production systems rely on cells growing freely in large volumes of liquid. This creates a substantial demand for water and requires extensive mixing to keep the cells evenly distributed and exposed to light, increasing the resource and energy requirements of the process.

“For practical chemical production, photosynthetic microorganisms need to function not only as growing cultures, but as stable and long-lived biocatalysts,” says Senior Research Fellow Sergey Kosourov from the University of Turku in Finland. “One major limitation of suspension cultures is self-shading: cells near the light source block light from reaching cells deeper in the culture. This reduces the efficiency of light use and creates challenges when scaling the technology toward industrial applications.”

To address these limitations, the researchers entrapped the engineered cyanobacteria within specifically designed nanocellulose films. The nanocellulose scaffold, developed by researchers at VTT Technical Research Centre of Finland, provides a supportive environment for the living cells. These films act as living biohybrid catalysts in which the cells perform photosynthesis and produce the target chemical from atmospheric carbon dioxide, while the surrounding material maintains hydration, supports cell fitness, and facilitates light penetration.

“The important advance is that we are combining engineered photosynthetic cells with supporting materials to create functional living systems for chemical production. This biohybrid approach combines the natural abilities of the cells with the controllable properties of the surrounding material. Entrapping the cells within the matrix restricts cell division and excessive biomass accumulation, allowing more of the captured carbon and energy to be directed toward the desired product," says Professor Yagut Allahverdiyeva-Rinne, leader of the Photosynthetic Microbes research group at the University of Turku.

Living Films Sustained Photosynthetic Production for More Than Four Months

The nanocellulose films containing ethylene-producing cyanobacteria were tested in a continuous-flow biofilm reactor, where they remained moist while exposed to the reactor headspace. This configuration facilitated the release and collection of ethylene from the films. Under these conditions, the cyanobacterial films remained productive for more than four months and generated up to approximately twice as much ethylene as comparable suspension cultures.

"Most studies of photosynthetic bioproduction focus on the highest production rate achieved over a relatively short period," says Sergey Kosourov. "For practical applications, however, it is equally important to know whether the cells can remain productive for weeks or months and function as long-lived biocatalysts."

The researchers also evaluated the biodegradability of the nanocellulose formulations and confirmed that the matrices could be broken down after the production phase. This finding supports the further development of biodegradable and potentially recyclable materials for photosynthetic production.

Engineering Biocatalytic Architecture to Improve Light Use

The ethylene study focuses on long-term operation, but it forms part of a broader research programme at the University of Turku to develop effective living photosynthetic catalysts. In an earlier study, the team demonstrated that engineered living materials can be organized in innovative ways to improve light utilization. By layering cells with smaller light-harvesting "antennae" above cells with larger antennae, the researchers distributed light more evenly throughout the biocatalyst, substantially increasing light-to-product conversion efficiency.

"Together, these studies show that the biocatalysts can be designed for both long-term operation and more efficient light use. By engineering the photosynthetic cells and controlling their spatial organization within the biocatalytic architecture, we can improve light management and address limitations that are difficult to overcome in suspension cultures," Kosourov explains.

The technology is still at the laboratory stage, and further work is needed to increase productivity, improve product recovery, and scale the platform to larger reactors suitable for pilot-scale operation.

“Our next challenge is to translate the performance of small laboratory films into larger, reliable production systems. This requires us to engineer the cells, materials, and reactors together so that light, water, and carbon dioxide are distributed efficiently at larger scales. If successful, this platform could support a new generation of low energy biohybrid technologies for the production of renewable chemicals and fuels,” says Professor Yagut Allahverdiyeva-Rinne.

Together, these efforts aim to move biohybrid photosynthetic materials from laboratory demonstrations toward practical solar-driven biomanufacturing.

The new study was published in Trends in Biotechnology on 2 July 2026.

Sergey Kosourov
University of Turku
communications@utu.fi
