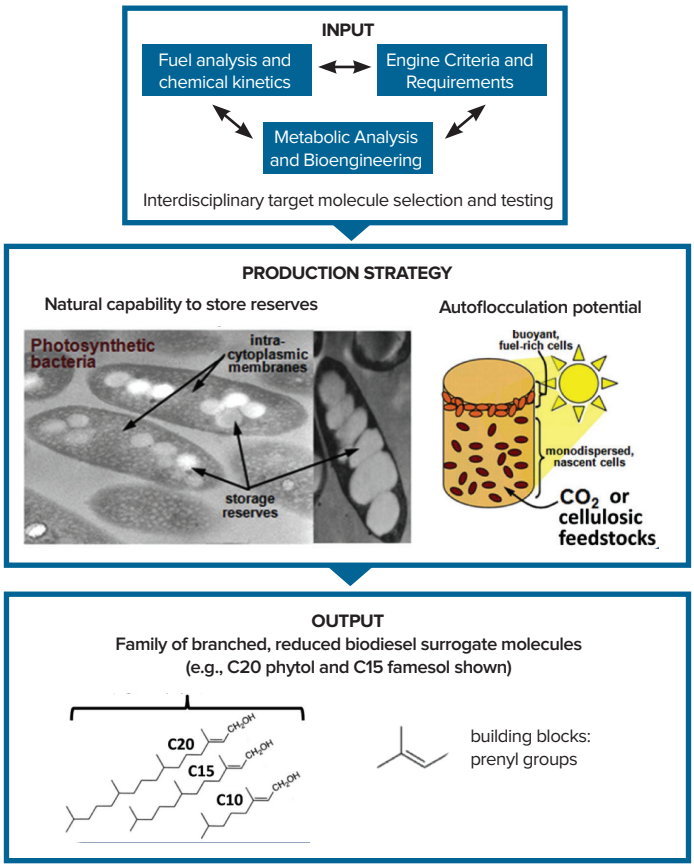
BIOFUELS FROM PHOTOSYNTHETIC BACTERIA (IN-09-001)

Efficient Biofuels for the Next Generation



Schematic of the overall approach including the method for production of biofuels

Developmental Stage

- Experimental-scale production of biofuel achieved; ready for scale up.

Availability/ Commercial Readiness

- Available for licensing and scale up or further development to focus on production of specialized fuels or chemicals.

THE INNOVATION

Production of fuels from renewable energy sources can address many important national and global issues. Rising energy costs and the uncertainty in supply of crude oil have the ability to affect national security. Rising CO_2 levels resulting from the world's thirst for liquid fuels pose substantial climate and ecosystem threats.

Photosynthetic bacteria can be a renewable source of fuel molecules. The photosynthetic machinery in these highly pigmented bacteria includes cofactors (chlorophyll, carotenoids, quinones, etc.) that are anchored in the proteins by long hydrocarbon tails. These anchors can be used directly as fuel substitutes once they are separated from the bacteria that produced them. They are more compatible with modern engines than are molecules that comprise current-day biodiesel formulations (sourced from plant fatty acids). In this alternative approach to efficient production of next-generation biofuels, Argonne researchers have engineered photosynthetic bacteria and developed specific Rhodobacter strains and processes that mass produce the fuel molecules (such as phytol, shorter isoprenols, and other atypical alcohols) and export them from the cell to be separated and used directly as fuel in compression-ignited (diesel) engines. The molecules require no further chemical upgrading for use.

The Rhodobacter species of photosynthetic bacteria are facultative and are frequently known to bloom in animal waste lagoons in the summer in the Midwest. This versatility, as such, can be exploited for adaptation of their growth to whatever feedstocks are prevalent in local areas. More than 115 engineered Rhodobacter strains are under evaluation at Argonne, and a variety of screening methodologies has allowed selection of strains that are relatively omnivorous with respect to the nutrient and energy requirements used for conversion processes (e.g., the use of light). Depending upon the type of separations process used downstream for recovery, fuel molecules can be secreted into the fermentation broth or internalized as storage reserves for later harvest and extraction from bacterial cell pellets.

Argonne is pursuing industrial partnerships to scale and commercialize this technology.

THE BENEFITS

The Rhodobacter strains developed at Argonne have the following benefits over traditional approaches:

- Flexibility: the engineered bacteria produce biofuels using a variety of growth modes (including photosynthetic) and can thrive on carbon sources available in most areas.
- Versatility: the bacteria can grow on waste materials (carbon and water) not currently used for food or as feedstocks for other processes.
- Simplicity: Direct production is realized by single-celled organisms exporting product into the culture medium.
- Compatibility: the biofuels produced can be consumed “as is” or mixed with other fuels without the need for refining (cracking) or distillation.
- Transportability: Rhodobacter fuel bioreactors can be set up at any (including those seemingly most remote) location(s) for production of liquid fuel or for conversion in diesel generators to produce electricity on demand.
- Sustainability: 30–70% of waste from the new process consists of lipids, which can be modified to produce conventional biodiesel.

APPLICATION AND INDUSTRIES

- Transportation sector
- Waste-to-energy facilities
- Remote operations requiring liquid fuels or electricity

PATENT AND PUBLICATION INFORMATION

US Patent Application Publication Number US2011/0302830

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