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Photosynthetic Production of 3-Hydroxybutyrate from Carbon Dioxide

The market interest in bioproduction of chemicals and polymers is steadily growing, driven by sustainability concerns and increashttp://azte.technologypublisher.com/files/sites/ncs-m12-182,-m14-208l,-m14-232l.pdfed environmental awareness. However, most production technologies rely on petroleum or food crops as feedstocks. In the coming decades, materials made from renewable sources will gradually replace non-renewable petrochemical-based materials, and microbial biocatalysts such as cyanobacteria will lead this shift with their potential ability to convert solar energy and CO2 into useful chemical and polymer products.

Researchers at the Biodesign Institute of Arizona State University have constructed and expressed synthetic pathways to photosynthetically produce both (S)- and (R)-3-hydroxybutyrate (3HB) as enantiomerically-pure products using the cyanobacterium Synechocystis. 3HB is the monomer precursor for synthesizing biodegradable plastics such as poly-ß-hydroxybutyrate (PHB), and also serves as a chiral building-block for many chiral fine chemicals. Titers of over 500 mg/l 3HB have been demonstrated at the flask scale. The synthetic pathways have been modified and optimized such that efficiency in 3HB production can be achieved.

This technology has demonstrated the feasibility and high efficiency of producing 3HB directly from CO2 using engineered cyanobacteria, and expands the diversity of useful chemicals that can be produced photosynthetically. Moreover, this allows for biopolymer production by utilizing renewable resources that do not compete with feedstocks.

Potential Applications

- Biopolymers/Bioplastics Industry - Monomer feedstock for the production of polymers, including biodegradable polymers for packaging applications
- Medical Industry - Medical devices requiring biodegradable plastics including sutures, bone plates, surgical mesh, pins, stents, etc.
- Fine Chemical Industry - through production of enantiomerically-pure (S) or (R)-3HB and production of chiral fine chemicals regulated by these pathways

Benefits and Advantages

- Cost effective - Cells continuously produce and secret 3HB using only CO2, water, and sunlight. Biosynthesis and secretion of 3HB monomer instead of traditional biosynthesis of PHB polymer simplifies the downstream product-recovery process, and allows cell reuse to reduce the overall production cost.
- Green - Sustainable. Removes CO2 from environment and emits oxygen as a by product, replaces non-renewable petroleum-based plastics, biodegradable.

Low reliance on petroleum for production. Biopolymers can serve as raw materials in a wide variety of applications.

- Compact production - Current technologies require vast quantities of farmland to produce feedstocks. Cyanobacterial aquaculture has low space and energy requirements and does not compete with food production.

For more information about the inventor(s) and their research, please see Dr. Meldrum's directory webpagebr>Dr. Nielsen's laboratory webpage