# ADVANCES IN ENGINEERING OF CHEMOLITHOAUTOTROPHIC BACTERIA FOR CARBON DIOXIDE FIXATION

Tasawar Abbas[1,2,3], Naglis Malys[1,2,3]

[1]Kaunas University of Technology, Faculty of Chemical Technology, Bioprocess Research Centre, Radvilėnų street 19, Kaunas, LT-50254, Lithuania
[2]Kaunas University of Technology, Faculty of Chemical Technology, Department of Organic Chemistry, Radvilėnų street 19, Kaunas, LT-50254, Lithuania
[3]Kaunas University of Technology, Faculty of Chemical Technology, Synthetic Biology and Biotechnology Research Group, Radvilėnų street 19, Kaunas, LT-50254, Lithuania
tasawar.abbas@ktu.edu

Chemolithoautotrophic bacteria utilize a hydrogen and other reduced compounds as electron donors for carbon dioxide (CO2) fixation offering an attractive alternative to light dependent photosynthetic systems. Seven natural metabolic pathways of CO2 fixation have been reported in chemolithoautotrophic bacteria including reductive pentose phosphate or Calvin-Benson-Bassham (CBB) pathway, reductive tricarboxylic acid (rTCA) or Arnon-Buchanan pathway, reductive acetyl Co-A or Wood-Ljungdahl (WL) pathway, 3-hydroxypropionate (3HP) bicycle or Fuchs-Holo pathway, 3-hydroxypropionate/4-hydroxybutyrate (3HP/4HB) pathway, dicarboxylate/4-hydroxybutyrate (DC/4HB) pathway and reductive glycine (rGly) pathway. Metabolic diversity in CO2 fixation by chemolithoautotrophic bacteria indicates their inherent potential for mitigation of climate change. Present work has investigated available literature on developments in detailed mapping and engineering of CO2 fixation metabolic pathways of chemolithoautotrophic bacteria through advanced strategies of metabolic engineering, systems biology, synthetic biology, genome sequencing and comparative genomics. Improvements in catalytic efficiencies of involved enzymes, energy supplies, redox cofactors, metabolic flux, heterologous expression of pathway genes, and systems level optimization of pathways are reviewed here. Special attention is dedicated to several synthetic pathways for CO2 fixation developed recently. Challenges of engineering the CO2-fixing organisms to reduce product toxicity, inhibition of competing pathways, and genetic stability are highlighted. Our findings highlight potential of chemolithoautotrophic bacteria for utilization in the sustainable carbon capture and circular bioeconomy.

**Keywords:** Chemolithoautotrophic bacteria, CO2 fixation, Metabolic engineering, Metabolic pathways, Biosynthesis, Synthetic Biology