The reversible TCA cycle in thermophilic chemolithotrophs

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The tricarboxylic acid (TCA) cycle is essential to ensure the biosynthesis of the five universal precursors of anabolism; acetyl-CoA, pyruvate, phosphoenolpyruvate, oxaloacetate and 2-oxoglutarate, and complete or incomplete TCA cycles are conserved in most of the life on Earth. Among the major variants of the complete TCA cycles, the reductive TCA (rTCA) cycle has been recognized as one of the most ancient carbon fixation metabolism. The major difference between the rTCA and other TCA cycles is the presence of ATP citrate lyase or its alternate pathway of citryl-CoA synthetase and citryl-CoA lyase instead of citrate synthase in the rTCA cycle because reverse reaction of citrate synthase was believed to be infeasible under physiological conditions.

A deeply-branching, chemolithotrophic and thermophilic bacterium, *Thermosulfidibacter takaii* grows with hydrogen oxidation coupled with sulfur reduction under both autotrophic and mixotrophic growth conditions. We identified the reversible TCA cycle with citrate synthase in *T. takaii* that functioned reductively for carbon fixation under autotrophic condition and as bifurcatated pathways under mixotrophic conditions (Nunoura et al. 2018). Similar reversible TCA cycle was also found in a facultatively chemolithoautotrophic deltaproteobacterium *Desulfurella acetivorans* (Mall et al. 2018). I will introduce the previously unseen reversible TCA cycle and its impacts on the environmental microbiology and the discussions related to the origin of life.

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