【Grant-in-Aid for Scientific Research (S)】

Biological Sciences (Agricultural Sciences)

Title of Project : Comprehensive, Spatiotemporal Study and Applied Research of Carboxydotrophs

Yoshihiko Sako
(Kyoto University, Graduate School of Agriculture, Professor)

Research Project Number : 16H06381 Researcher Number : 60153970
Research Area : Marine microbiology
Keyword : Carboxydotroph, CO metabolism, genomics, marine core, methane hydrate

【Purpose and Background of the Research】

Carboxydotrophic microorganisms can grow on poisonous CO because they possess CO dehydrogenases (CODH), which catalyze the interconversion of CO_2 and CO. CODHs are involved in several metabolic activities such as energy conservation and carbon fixation. Hydrogenogenic carboxydotrophs (CO trophs) possess a CODH gene clustered with hydrogenase genes, and can acquire energy via CO oxidation and H_2 generation. Therefore, hydrogenogenic CO trophs can be considered candidate biocatalysts for improving the efficiency of H_2 production from syngas. Furthermore, CO is the most important precursor for C1-chemistry. CODHs can be new sustainable catalysts for generating CO from CO_2. However, knowledge on diverse CO trophs is limited, and this creates a bottleneck for the development of efficient biocatalysts and catalysts.

Previously, we successfully isolated various thermophilic hydrogenogenic CO trophs from oceanic and terrestrial hydrothermal environments. Of these, one particular bacterium of novel genera, isolated from a core sample of a submerged caldera, harbors six CODH genes. This bacterium appears to be an "ancient-type" CO troph that had been dormant in the core as spores, and is a powerful CO utilizer. Therefore, the aim of this study is to comprehensively understand the CO trophs, particularly "ancient-types", towards construction of a next-generation platform for CO_2 reduction and carbon cycle.

【Research Methods】

(1)We will isolate various CO trophs from water and core samples of oceanic and terrestrial hydrothermal environments and investigate their genetic diversity by metagenomic analysis.
(2)We will unveil CO metabolism of the unique carboxydotrophic isolates by genomic, metabolomic, and transcriptomic analysis.
(3)We plan to characterize recombinants carrying efficient CODH, and construct a large expression system for the CODH.

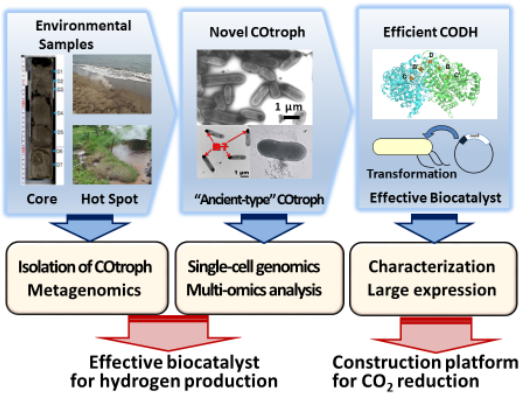

Figure 1 Overall strategy of this study

【Expected Research Achievements and Scientific Significance】

Understanding CO trophs and their CO metabolism will help establish effective heat-resistant biocatalysts for hydrogen production from synthesis gas. Further, we will construct a next-generation platform for CO_2 reduction through development of a sustainable catalyst for conversion of CO_2 to CO.

【Publications Relevant to the Project】

・Yoneda *et al.* (2015) Detection of anaerobic carbon monoxide-oxidizing thermophiles in hydrothermal environments. *FEMS Microbiol. Ecol.* 91: 1-9.
・Yoneda *et al.* (2013) A novel thermophilic, hydrogenogenic, and carboxydotrophic bacterium *Calderohabitans maritimus* gen. nov., sp. nov. from a marine sediment core of an undersea caldera. *Int. J. Syst. Evol. Microbiol.* 63: 3602-3608.

【Term of Project】

FY2016-2020

【Budget Allocation】

133,100 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.microbiology.marine.kais.kyoto-u.ac.jp/