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Abstract
The role of tetraheme cytochrome c₅₅ (CycA) in the metabolism of the sulfate-reducing bacterium *Desulfovibrio vulgaris* Hildenborough (DvH) was investigated by deletion of the cycA gene using a marker-exchange deletion strategy. A highly abundant periplasmic cytochrome, CycA, has an important function of transferring electrons from periplasmic hydrogenases (Hyd, Hyn, Hys) to transmembrane complexes which transport the electrons to the cytoplasm where sulfate is reduced. Previous studies have indicated that during its interaction with periplasmic hydrogenases, CycA is also involved in the reduction of toxic metals.

Growth of the cycA mutant strain on lactate as the electron donor and sulfate as the terminal electron acceptor showed that, despite its abundance, CycA is not essential for DvH growth. However, the rate of growth of the mutant strain was significantly lower, and the extent of growth less, than rates and extents of growth of the wild-type and complement strains on lactate/sulfate medium. This indicates that a portion of the electrons generated from periplasmic lactate oxidation are transported by CycA for energy production, possibly in a hydrogen cycling mechanism employed to generate ATP. Failure of the mutant strain to grow on either formate or H₂ with sulfate or sulfate as electron acceptors, further indicated that CycA may be the only redox partner of periplasmic hydrogenases.

The cycA mutant strain also did not grow as well as either the wild type or complement strains on medium supplemented with pyruvate/sulfate. Final growth on pyruvate/sulfate was comparable, but the mutant grew more slowly than the wild type and complement strains. Interestingly, the mutant grew better than the wild type or complement strains on pyruvate, possibly due to the release of H₂ or CO₂ in concentrations which may be somewhat inhibitory to wild type growth.

CycA transports a portion of electrons generated by lactate oxidation but, because the CycA mutant strain does not appear to grow on H₂ or formate, CycA may be the only redox partner for periplasmic hydrogenases.

CycA probably operates as a hydrogenase reductase in the electron transport chain, possibly Hmc (65kDa), a transmembrane complex.

For confirmation of CycA deletion in the mutant strain, total proteins of whole cell extracts were separated using SDS-PAGE, and heme-containing proteins were stained. When grown on lactate and sulfate, the CycA mutant appears to express a high molecular weight cytochrome – possibly Hmc (ε550Da), a transmembrane complex.

Conclusions
- CycA is important, but not essential, for DvH growth
- CycA can be circumvented in sulfate reduction when organic acids supply electrons
- Hmc transmembrane complex may be expressed to compensate for the loss of CycA
- CycA may be the only redox partner of periplasmic hydrogenases
- CycA participates in uranium reduction but can also be bypassed when organic acids supply electrons

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