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H.D. Peck: SULFATE-REDUCING BACTERIA: MICROBIOLOGY AND PHYSIOLOGY

Recent discoveries have changed our concept of the sulfate-reducing bacteria: formerly considered a small group of anaerobes with limited metabolic capabilities we now recognize that they are a large group of bacteria with diverse metabolic capabilities. The sulfate bacteria are essential members of the microbial food chain in anaerobic high sulfate marine water but they also flourish in low sulfate fresh water as hydrogen-producing bacteria (they produce hydrogen for interspecies hydrogen transfer). The sulfate-reducing bacteria vary greatly in their modes of growth: dissimilatory sulfate reducers can grow heterotrophically using a large number of organic substrates including acetate and long-chain fatty acids up to C_{18}, aromatic compounds, alcohols, and hydroxy acids; they can grow autotrophically with hydrogen or formate plus sulfate; they can ferment the simple organic compounds pyruvate, fumarate, lactate, choline; they can utilize inorganic pyrophosphate as a source of energy for growth; they can reduce nitrate rather than sulfate as a terminal electron acceptor, growing in association with photosynthetic bacteria; and they can grow using hyurogen derived from other bacteria. All sulfate-reducing bacteria are strict anaerobes. Thydrogenases are important in the bioenergetics and biochemistry of dissimilatory sulfate reduction. The sulfate reducing bacteria contain two types of periplasmic hydrogenase, a nickel-non-heme iron hydrogenase with four redox centers and a (non-nickel) non-heme iron hydrogenase with three redox centers. Both hydrogenases utilize periplasmic cytochrome c_3 (MW = 13,000) as their cofactor for the reduction of low molecular weight electron transfer proteins.

The sulfate reducing bacteria, the first non-photosynthetic anaerobic bacteria demonstrated to contain c-type cytochromes, perform electron transfer coupled to phosphorylation. A new bioenergetic scheme for the formation of a proton gradient for growth of *Desulfovibrio* on organic substrates and sulfate involving vectors/electron transfer and consistent with the cellular localization of enzymes and electron transfer components has been proposed. Hydrogen is produced in the cytoplasm from organic substrates and, as a permease molecule diffuses rapidly across the cytoplasmic membrane, it is oxidized to protons and electrons by the periplasmic hydrogenase. The electrons only are transferred across the cytoplasmic membrane to the cytoplasm where they are used to reduce sulfate to sulfide. The protons are used for transport or to drive a reversible ATPase. The net effect is the transfer of protons across the cytoplasmic membrane with the intervention of a proton pump. This type of H_2 cycling is relevant to the bioenergetics of other types of anaerobic microorganisms.

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