

Molybdenum and tungsten-dependent formate dehydrogenases

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Abstract The prokaryotic formate metabolism is considerably diversified. Prokaryotes use formate in the C1 metabolism, but also evolved to exploit the low reduction potential of formate to derive energy, by coupling its oxidation to the reduction of numerous electron acceptors. To fulfil these varied physiological roles, different types of formate dehydrogenase (FDH) enzymes have evolved to catalyse the reversible 2-electron oxidation of formate to carbon dioxide. This review will highlight our present knowledge about the diverse physiological roles of FDH in prokaryotes, their modular structural organisation and active site structures and the mechanistic strategies followed to accomplish the formate oxidation. In addition, the ability of FDH to catalyse the reverse reaction of carbon dioxide reduction, a potentially relevant reaction for carbon dioxide sequestration, will also be addressed.

Keywords Molybdenum · Tungsten · Formate oxidation · Carbon dioxide reduction · Formate-dependent energy metabolism · Sulfur-shift

Abbreviations

DMSOR Dimethylsulfoxide reductase
EPR Electron paramagnetic resonance spectroscopy
FDH Formate dehydrogenase

FDH-H	<i>E. coli</i> formate dehydrogenase H, from the formate-hydrogen lyase system
FDH-N	<i>E. coli</i> formate dehydrogenase N, from the anaerobic nitrate–formate respiratory pathway
FDH-O	<i>E. coli</i> formate dehydrogenase O, from the aerobic respiratory pathways
Fe/S	Iron–sulfur centre
Mo-FDH	Molybdenum-dependent formate dehydrogenase
Mo/W-FDH	Formate dehydrogenase that incorporates either molybdenum or tungsten
Mo/NAD-FDH	Molybdenum-dependent/NAD-dependent formate dehydrogenase
Mo/W-bis PGD	Molybdenum/tungsten-bis pyranopterin guanosine dinucleotide-containing enzymes
NAD-FDH	NAD-dependent formate dehydrogenase
NarGHI	Respiratory nitrate reductase, after the name of the encoding genes, <i>narG</i> , <i>H</i> , and <i>I</i>
PGD	Pyranopterin guanosine dinucleotide cofactor
W/NAD-FDH	Tungsten-dependent/NAD-dependent formate dehydrogenase
W-FDH	Tungsten-dependent formate dehydrogenase