A composite system for bacterial nitrate and nitrite assimilation as exemplified by *Paracoccus denitrificans*

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*Paracoccus denitrificans* can grow aerobically or anaerobically using nitrate as sole N-source. Central to this growth physiology is a gene cluster that encodes a cytoplasmic nitrate and nitrite reduction system (Nas) that comprises a nitrate and nitrite transporter (NasA), a possible nitrite transporter (NasH), a nitrite reductase (NasB), a Rieske-type ferredoxin (NasG) and a nitrate reductase (NasC). NADH serves as an electron donor for nitrate and nitrite reduction, but only NasB is predicted to contain an FAD-dependent NADH oxidising domain. NasB and NasG are both essential for growth with either nitrate or nitrite as sole N-source under aerobic and anaerobic conditions. A composite cytoplasmic redox system is proposed in which electrons are extracted from NADH at the FAD-binding site of NasB and then transferred via NasG to the sites of nitrate and nitrite reduction present in NasC and NasB, respectively. Delivery of extracellular nitrate to this composite NasBGC system is mediated by the NasA transporter. The roles of NasA and NasC in nitrate import and reduction can be substituted by the respiratory Nar system during anaerobic growth, demonstrating functional overlap between two physiologically distinct systems. The *nasG* gene is highly conserved in bacterial nitrate and nitrite assimilation gene clusters, which suggests a key role for this putative ferredoxin, as exemplified here by *P. denitrificans*, as part of a phylogenetically widespread composite nitrate and nitrite reductase system.