Molecular Oxygen Controls Nitrate Transport of *Escherichia coli* Nitrate-respiring Cells*

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*Escherichia coli* cells grown anaerobically in the presence of nitrate reduce the nitrate as a terminal electron acceptor in place of molecular oxygen by an induced respiratory-type electron transferring system residing in the inner membrane structure. When oxygen is introduced to a suspension of nitrate-respiring cells, the oxygen is immediately reduced preferentially and the cellular uptake of nitrate ceases abruptly. In contrast, we found that the cells exhibited no oxygen control on uptake of chlorate, a competitive substrate analogue, indicating operation of an oxygen-sensitive transport system specific to nitrate. This was further evidenced by the fact that chlorate inhibition of reduction of nitrate was brought about only when the transport of both chlorate and nitrate was facilitated by the aid of carrier-type chlorate (or nitrate) ionophore. We demonstrated that oxygen inhibition on reduction of nitrate was abolished within the cells treated by octyl glucoside resulting in a removal of permeability barrier specific to nitrate. We conclude that the transient control by molecular oxygen is primarily due to the inhibition of nitrate transport into the cytoplasmic side. Since nitrate induces the nitrate-respiring system, the repression of the nitrate reductase operon by molecular oxygen is consistently interpreted on the basis of the "inducer exclusion mechanism."
be incorporated into the membrane bilayer structure, thus rate of nitrate reduction, further indicating that nitrate trans-ionophore-aided nitrate transport into the cells increases by addition of dithionite and stopped by vigorous aeration after 5 min. The rates of reduction given alongside traces are expressed in µg atom of oxygen/min/mg of protein (••••) and nmol of nitrate/min/mg of protein (—). The rate of nitrite disappearance was confirmed to be negligible under the present conditions.

The disulfide form in the presence of oxygen (11). The detailed molecular mechanism of how oxygen inhibits nitrate transport remains to be further explored.

It is known that the inducer of the lactose operon (e.g. lactose) is excluded when glucose enters the cell (12). Our results support such an inducer exclusion mechanism in which the oxygen control of nitrate respiration is analogous to the glucose inhibition of lactose transport. Oxygen not only transiently inhibits nitrate respiration, but also represses the
induction of the system by nitrate by inhibiting specifically the nitrate transport system.

After submission of the present paper, we realized that Hernandez and Rowe (13) reported that inhibition of nitrate utilization by oxygen appeared to be at the level of nitrate uptake in denitrifying Pseudomonas aeruginosa. It is likely that a common mechanism exists for oxygen control of nitrate uptake in nitrate-respiring microorganisms.

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