

Regulation of nitrogenase by combined nitrogen sources

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*** In general, N_2 fixation is greatly decreased or inhibited completely, when alternative sources of nitrogen are available.**

*** When added to N_2 fixing organisms, ammonium (NH_4^+) usually inhibits nitrogenase activity markedly whereas nitrate (NO_3^-) and nitrite (NO_2^-) is often less effective in inhibiting N_2 fixation.**

Nitrogenase enzyme synthesis is regulated at transcriptional level by presence of other sources of nitrogen.

- Nif genes are the genes encode for nitrogenase enzyme.
- Regulation of nif genes transcription is done by the nitrogen sensitive NifA protein.
- When there isn't enough fixed nitrogen available NtrC protein triggers NifA expression.
- If there is a sufficient amount of reduced nitrogen or oxygen is present, another protein NifL is activated.
- NifL inhibits NifA activity resulting in the inhibition of nitrogenase formation.

Post-translational regulation

- During energy limiting or nitrogen sufficient condition, the nitrogenase complex is rapidly, reversibly inactivated by ADP-ribosylation of Fe protein.
- It occurs at a specific arginine residue, i.e. Arg₁₀₁.
- The presence of ADP ribose group prevents association of Fe protein with Mo-Fe protein.
- Thus it results in regulating the nitrogen fixation.

Effect of ammonia or ammonium salts

- **Ammonia or ammonium salts can inhibit nitrogenase activity:**
- by interfering with the supply of reductant to nitrogenase.
- through covalent modification of the Fe-protein of nitrogenase.
- a more general effect of NH_4^+ on N_2 fixation is exerted through inhibition of nitrogenase synthesis. The true inhibitor is either NH_4^+ itself or an assimilatory product derived from NH_4^+ .

Effect of nitrate and nitrite

Nitrate (NO_3^-)

- The reduction of nitrate by the enzyme nitrate reductase produces nitrite.
- Subsequently nitrite is converted to NH_4^+ by the enzyme nitrite reductase.
- If nitrates are present in plentiful amount, diazotrophs prefer the second pathway for the synthesis of amino acids.
- In through this way NO_3^- inhibits nitrogenase synthesis.

Nitrite (NO_2^-)

- In *Anabaena variabilis*, for example, nitrite (NO_2^-) inactivated nitrogenase directly, whereas in *Azotobacter chroococcum*, inhibition of N_2 fixation by NO_2^- was indirect, caused by one or more assimilatory product(s) of NH_4^+ which, in turn, arose as a result of the action of nitrite reductase on NO_2^- .

Questions

- Explain regulation of nitrogenase by combined nitrogen sources.
- Explain how availability of ammonium salts, nitrate and nitrites regulates nitrogenase enzyme activity?