Nitrification & Denitrification

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Nitrification

- **Nitrification** is the aerobic process of ammonium ion (NH_4^+) oxidation to nitrite (NO_2^-) and subsequent nitrite oxidation to nitrate (NO_3^-).
- **Nitrifying bacteria** are chemolithotrophic, gram-negative bacteria that are members of the family nitrobacteriaceae convert ammonia to nitrite and nitrite to nitrate. They derive energy from the oxidation of ammonia.
- These are soil and aquatic bacteria of considerable ecological significance.
- Ammonia oxidation to nitrate depends on the activity of at least two different genera. For example, *Nitrosomonas* and *Nitrosospira* oxidize ammonia to nitrite.

$$NH_4^+ + 1\frac{1}{2}\,O_2 \longrightarrow NO_2^- + H_2O + 2H^+$$

- The nitrite can then be further oxidized by *Nitrobacter* and *Nitrococcus* to yield nitrate.

$$NO_2^- + \frac{1}{2}\,O_2 \longrightarrow NO_3^-$$

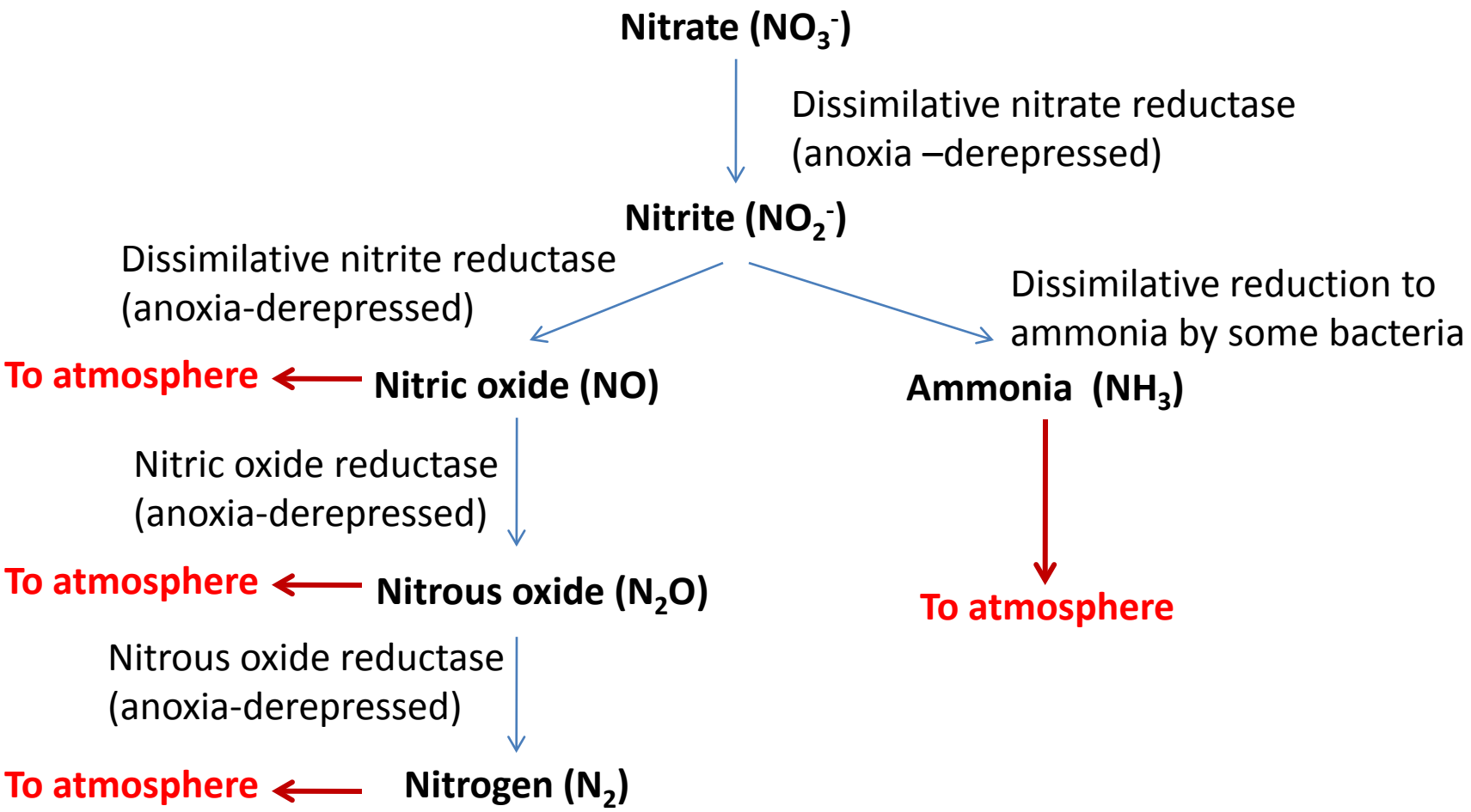
- When two genera work together, ammonia in the soil is oxidized to nitrate in a process called **nitrification.**
- Energy released upon the oxidation of both ammonia and nitrite is used to make ATP by oxidative phosphorylation. ***Explained during N oxidizing chemolithotrophs (second unit of syllabus).**

Ecological importance of nitrification

- Nitrifying bacteria are very important ecologically and can be isolated from soil, sewage disposal systems, and freshwater and marine habitats.
- Nitrification occurs rapidly in soils treated with fertilizers containing ammonium salts.
- Nitrate nitrogen is readily used by plants, but it is also rapidly lost through leaching of the water soluble nitrate and by denitrification to nitrogen gas.
- **Thus nitrification is a mixed blessing.**

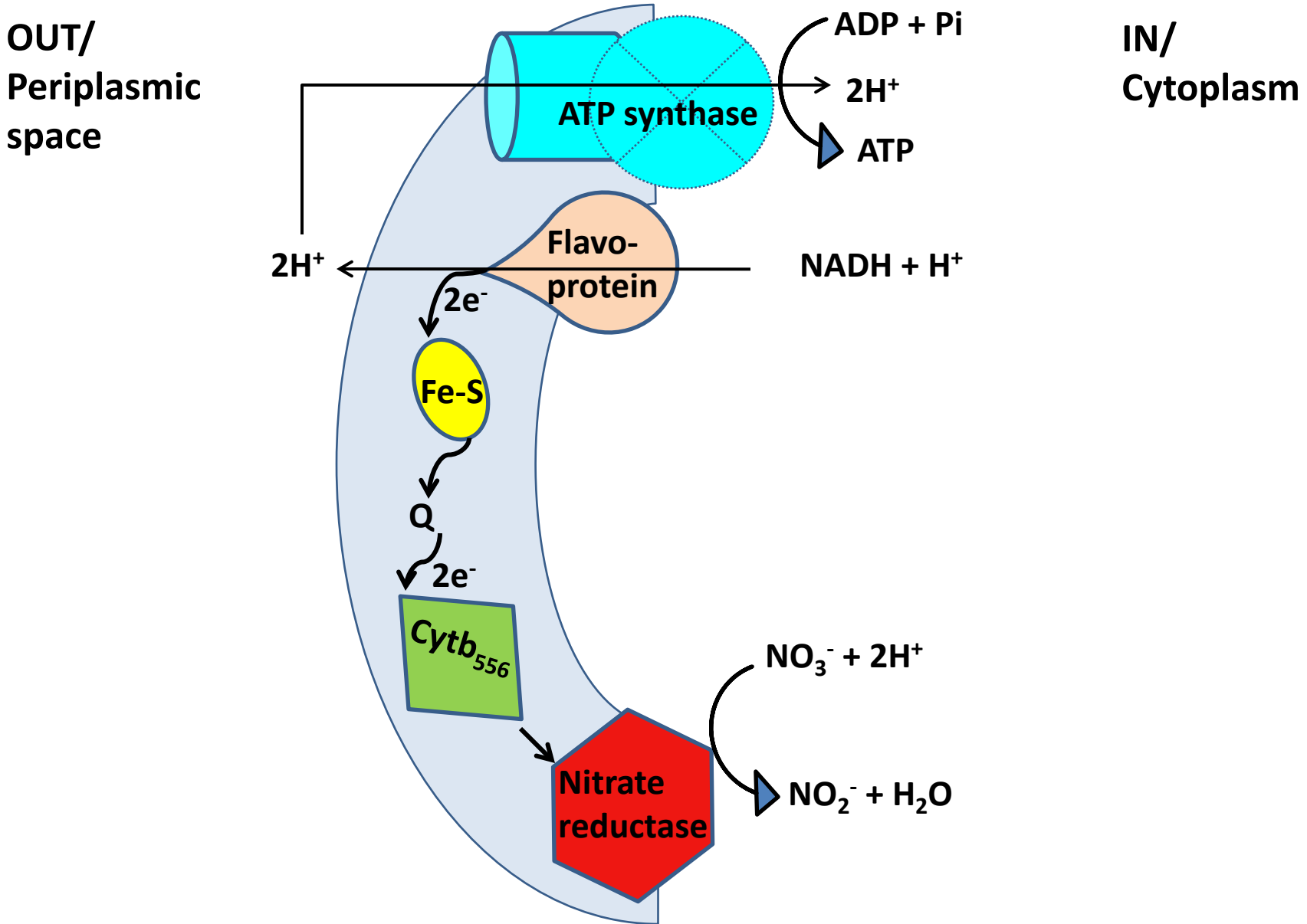
Denitrification

- **Denitrification** is the reduction of nitrate to gas products, primarily nitrogen gas, during anaerobic respiration.
- NO_3^- is converted to more reduced forms of nitrogen, N_2O, NO, and N_2. Because these products of nitrate reduction are all gaseous, they can easily be lost from the environment, and because of this the process is called **denitrification or dissimilative nitrate reduction.**
- Denitrification is carried out by some members of the genera *Pseudomonas, Paracoccus,* and *Bacillus.* They use this route as an alternative to normal aerobic respiration and may be considered facultative anaerobes.
- If O_2 is present, these bacteria use aerobic respiration (the synthesis of nitrate reductase is repressed by O_2).
- Denitrification in anaerobic soil results in the loss of soil nitrogen and adversely affects soil fertility, thus detrimental process for agricultural purpose.
- However, for sewage treatment denitrification is beneficial because it converts NO_3^- to N_2, effectively decreasing the amount of available nitrogen in the sewage treatment effluent that can stimulate algal bloom.



- Dissimilative nitrate reductase (Molybdenum containing) is a membrane bound enzyme.
- Denitrification is strictly an anoxic process.
- Pathway restricted to prokaryotes.

Biochemistry of denitrification or dissimilative nitrate reduction- studied in *E. coli*



Questions

- Write a short note on nitrification. Discuss the ecological importance of nitrification.
- Write a short note on denitrification.
- Write a short note on dissimilative nitrification reduction.
- Explain biochemistry of denitrification.