

# **Nitrate & Ammonia Assimilation**

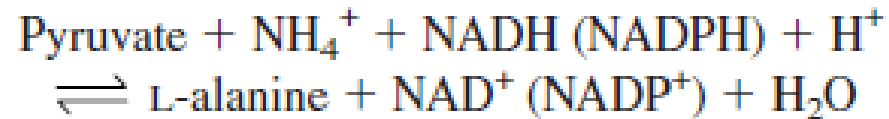
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# Nitrogen Assimilation

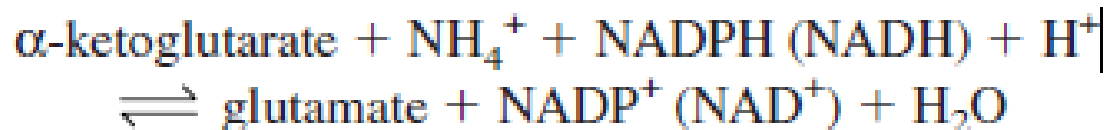
- Although nitrogen gas is abundant in the atmosphere, few microorganisms can reduce the gas and use it as a nitrogen source.
- Most must incorporate either ammonia or nitrate.

# Ammonia Incorporation

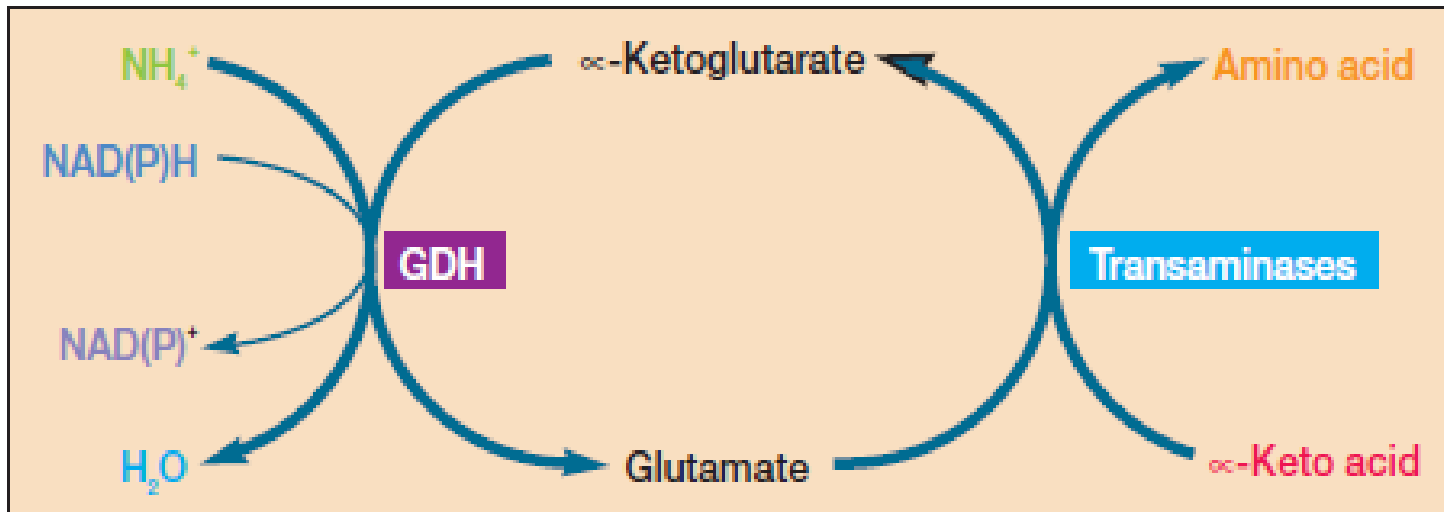
- Ammonia nitrogen can be incorporated into organic material relatively easily and directly because it is more reduced than other forms of inorganic nitrogen.
- Some microorganisms form the amino acid alanine in a reductive amination reaction catalyzed by **alanine dehydrogenase**.



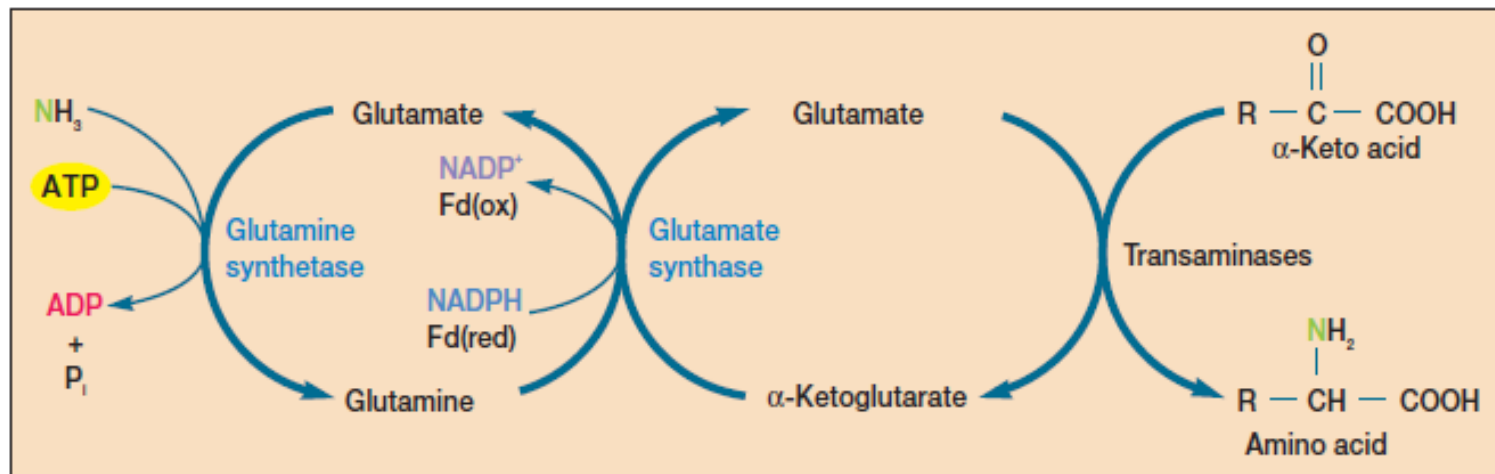
- The major route for ammonia incorporation often is the formation of glutamate from  $\alpha$ -ketoglutarate (a TCA cycle intermediate).
- Many bacteria and fungi employ **glutamate dehydrogenase**, at least when the ammonia concentration is high.



- Different species vary in their ability to use NADPH and NADH as the reducing agent in glutamate synthesis.
- Once either alanine or glutamate has been synthesized, the newly formed  $\alpha$ -amino group can be transferred to other carbon skeletons by transamination reactions to form amino acids.
- Microorganisms have a number of transaminases, each of which catalyzes the formation of several amino acids using the same amino acid as an amino group donor.
- When glutamate dehydrogenase works in cooperation with transaminases, ammonia can be incorporated into a variety of amino acids.

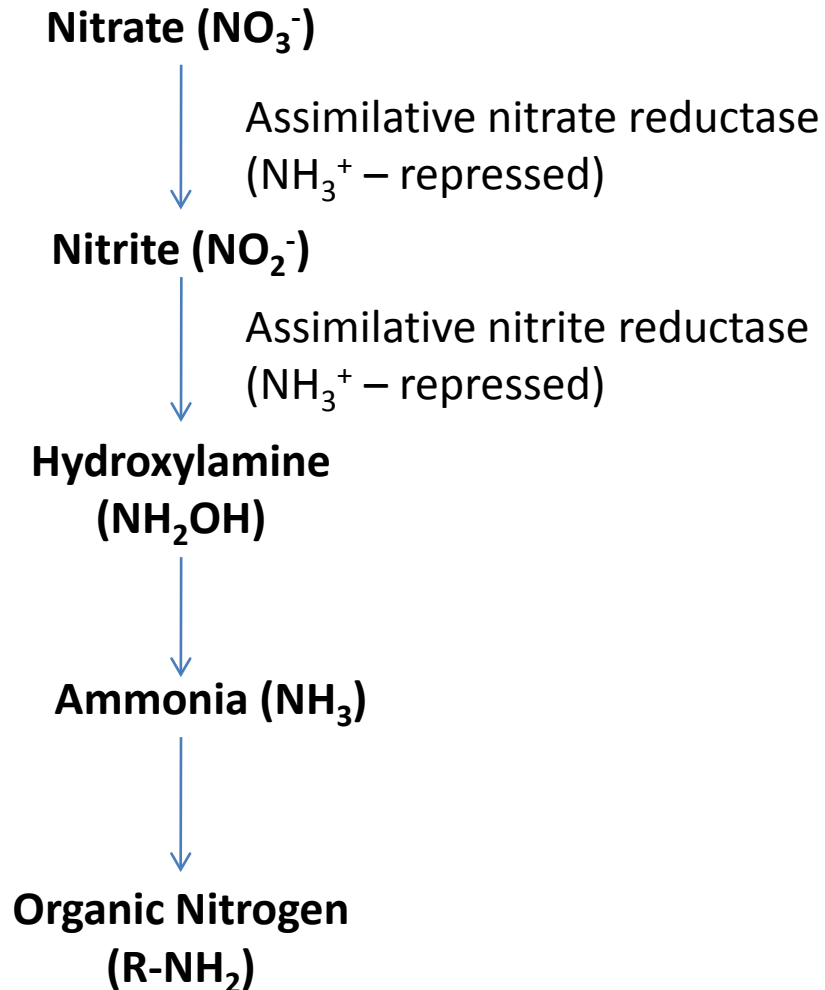


- **A second route** of ammonia incorporation involves two enzymes acting in sequence, **glutamine synthetase** and **glutamate synthase**.
- Ammonia is used to synthesize glutamine from glutamate, then the amide nitrogen of glutamine is transferred to  $\alpha$ -ketoglutarate to generate a new glutamate molecule.
- Because glutamate acts as an amino donor in transaminase reactions, ammonia may be used to synthesize all common amino acids when suitable transaminases are present .
- Both ATP and a source of electrons, such as NADPH or reduced ferredoxin, are required.
- This route is present in *Escherichia coli*, *Bacillus megaterium*, and other bacteria.
- The two enzymes acting in sequence operate very effectively at low ammonia concentrations, unlike the glutamate dehydrogenase pathway.



# Nitrate Assimilation

- The nitrogen in nitrate ( $\text{NO}_3^-$ ) is much more oxidized than that in ammonia.
- Nitrate must first be reduced to ammonia before the nitrogen can be converted to an organic form.
- This reduction of nitrate is called **assimilatory nitrate reduction**, which is not the same as that occurring during anaerobic respiration and dissimilatory nitrate reduction
- In assimilatory nitrate reduction, nitrate is incorporated into organic material and does not participate in energy generation.
- However, in dissimilative nitrate reduction nitrate is used as an alternative electron acceptor in energy generation.
- Assimilatory nitrate reduction takes place in the cytoplasm in bacteria.
- The first step in nitrate assimilation is its reduction to nitrite by nitrate reductase, an enzyme that contains both FAD and molybdenum .
- Nitrite is next reduced to ammonia with a series of two electron additions catalyzed by nitrite reductase and possibly other enzymes. Hydroxylamine may be an intermediate.
- The ammonia is then incorporated into amino acids by the routes already described.



- Assimilative nitrate reductase (Molybdenum containing) is a cytoplasmic enzyme.
- Assimilative nitrate reduction can occur quite well under fully aerobic condition.
- Pathway found in plants, fungi, bacteria.

# Questions

- Write an essay on assimilation of nitrogen

Ans. Write both ammonia and nitrate assimilation

- Explain ammonia assimilation.

- Write a note on nitrate assimilation.

Ans. Write conversion of nitrate to ammonia, then ammonia assimilation

- Differentiate between assimilative and dissimilative nitrate reduction.