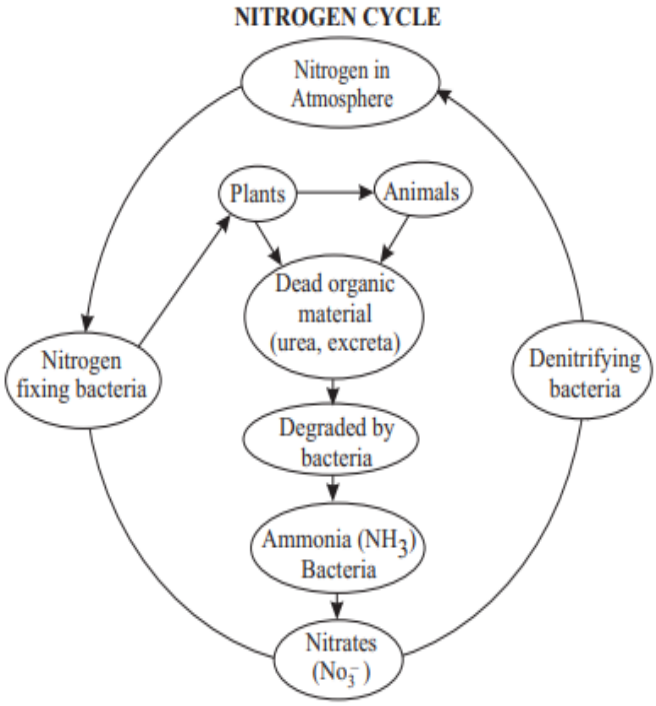
LESSON- 10
NITROGEN METABOLISM

In a living cell, nitrogen is an important constituent of amino acids, proteins, enzymes, vitamins, alkaloids and some growth hormones. Therefore, study of nitrogen metabolism is absolutely essential because the entire life process is dependent on these nitrogen-containing molecules



- Nitrogen is an important constituent of several bio molecules such as amino acids, proteins and enzymes.
- Molecules such as vitamins, alkaloids, nucleic acids, pigments and some growth hormones also contain nitrogen.
- Molecular nitrogen is triple bonded and stable.

NITROGEN FIXATION

- Nitrogen fixation is the reduction of nitrogen to ammonia.
- In abiological nitrogen fixation the nitrogen is reduced to ammonia without involving any living cell. This is industrial fixation wherein nitrogen gets reduced to ammonia. (Haber's process).

$$N_2 + 3H_2 \xrightarrow[1000\ \text{atmosphere}]{500^\circ C} 2NH_3$$

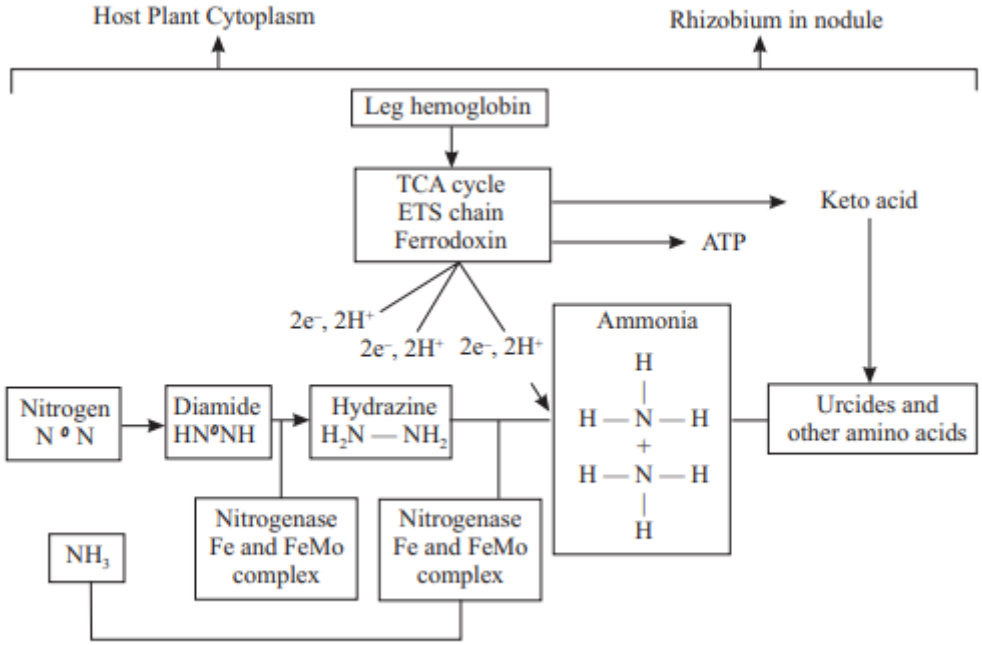
- Biological nitrogen fixation takes place in a living cell.
  N 16ATP + 8H + 8e 2NH 16ADP + 16Pi
- The enzyme that catalyzes nitrogen fixation is **Nitrogenase**.
- Nitrogen fixation may take place in free living organisms or in symbiotic systems. There are many symbiotic nitrogen fixation systems such as Lichens, Pteridophytes, Bryophytes, Gymnosperms and Legumes.

- A cyanobacterium is the symbiotic component in Lichens, Bryophytes, Pteridophytes andGymnosperms.
- In Legumes, the symbiont is a species of bacterium *Rhizobium*.

- The process of nitrogen fixation is primarily confined to microbial cells like bacteria and cyanobacteria. These microorganisms may be independent and free living

ORGANISM	STATUS
Clostridium	Anaerobic bacteria (Non-photosynthetic)
Klebsiella	Facultative bacteria (Non-photosynthetic)
Azotobacter	Aerobic bacteria (Non-photosynthetic)
Rhodospirillum	Purple, non-sulphur bacteria (Photosynthetic)
Anabaena	Cyanobacteria (Photosynthetic)

- Leghemoglobin is produced as a result of interaction between the bacterium and legume roots.
- During N2-fixaion, function of Leghemoglobin is to act as Oxygen-scavenger so that the enzymes, Nitrogenase then, convert N_2 to NH_3 under anaerobic condition.
- Source of electrons and energy for nitrogen fixation is generally pyruvic acid after it enters Krebs' cycle during cell-respiration.



Simplified flowsheet of biochemical steps for nitrogen fixation

NITRATE AND AMMONIA ASSIMILATION BY PLANTS

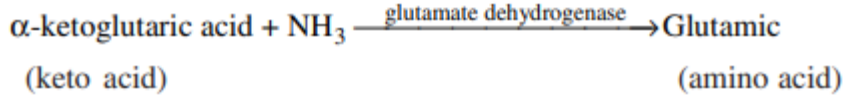
Nitrate is absorbed by most plants and reduced to ammonia with the help of two different enzymes. The first step conversion of nitrate to nitrite is catalyzed by an enzyme called nitrate reductase.

$$NO_3^- + NADH + H^+ \xrightarrow{\text{Nitrate reductase}} NO_2^- + NAD^+ + H_2O$$

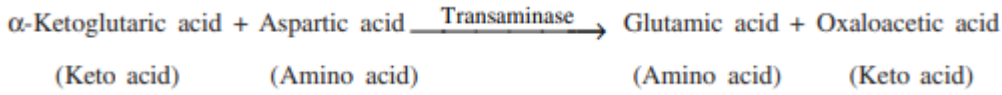
In the second step the nitrite so formed is further reduced to ammonia and this is catalyzed by the enzyme nitrite reductase. Nitrite present in the cytosol is transported into chloroplast or plastids where it is reduced to ammonia.

$$NO_2^- + 3NADPH + 3H^+ \xrightarrow{\text{Nitrite reductase}} NH_3 + 3NADP^+$$

- Amino acids have two functional groups, namely, amino group and carboxyl group.
- Amino acids may be produced by reductive amination of keto acids.



- Reductive amination reactions are catalyzed by dehydrogenases.
- Amino acids may be produced by transamination reaction.



- A large number of amino acids are synthesized by this transamination reaction.
- Transamination reactions are catalyzed by transaminases.

TEST YOURSELF

1. Write the function of Enzyme Nitrate Reductase.
2. Mention the difference between nitrogen fixation and nitrogen assimilation? Describe in brief the process of abiological nitrogen fixation.
3. Explain in brief the reductive amination reactions for synthesis of amino acids in plants.