

CONTAIN

- » **Introduction**
- » **Role of nitrogen in plant**
- » **Nitrogen source**
- » **mechanism of Nitrogen fixation**
- » **Type of nitrogen fixation**
- » **Reference**

Introduction

- ✘ N_2 gas are found 78.084% on atmosphere of earth.
- ✘ N_2 are found in molecular N_2 ($N \equiv N$) form in soil.
- ✘ Dinitrogen are don't more active in chemically form.
- ✘ Dinitrogen is more stable, so we need of nitrogen fixation.
- ✘ Nitrogen fixation is a process by which nitrogen of the Earth's atmosphere is converted into ammonia (NH_3), nitrogen salts or other molecules available to living organisms.

Role of nitrogen in plant

- » Major substance in plants next to water
- » Building blocks
- » Constituent element of
 - » Chlorophyll
 - » Cytochromes
 - » Alkaloids
 - » Many vitamins
- » Plays important role in metabolism, growth, reproduction and heredity

Sources of nitrogen

- Atmospheric Nitrogen
 - 78.084 % of atmosphere.
 - Plants cannot utilize this form.
 - Some Bacteria, Blue Green Algae, leguminous plants.
- Nitrates, Nitrites and Ammonia
 - Nitrate is chief form.
- Amino acids in the soil
 - Many soil organisms use this form.
 - Higher plants can also taken by higher plants.
- Organic Nitrogenous compounds in insects
 - Insectivorous plants.

Mechanism of nitrogen fixation

- Nitrogen fixation, natural and synthetic, is essential for all forms of life because nitrogen is required to biosynthesize basic building blocks of plants, animals and other life forms, e.g., nucleotides for DNA and RNA and amino acids for proteins.
- Nitrogen fixation is a process by which nitrogen in the Earth's atmosphere is converted into ammonia (NH_3) or other molecules available to living organisms. Atmospheric nitrogen or molecular dinitrogen (N_2) is relatively inert, it does not easily react with other chemicals to form new compounds.

➤ Basic requirement of nitrogen fixation –

- Nitrogenase and hydrogenase enzyme.
- Constant supply of ATP.
- Hydrogen releasing system or electron doner [pyruvic acid or glucose /sucrose.]
- Co-enzyme and cofactors TPP , CoA , Inorganic phosphate and mg^{+2} .
- Cobalt and molybdenum.

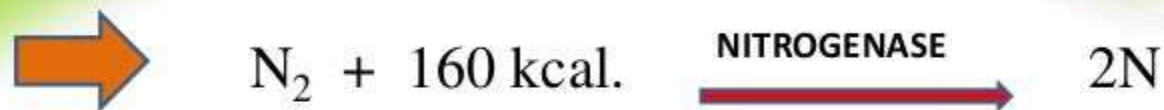
Cont...

➤ Biochemistry of nitrogen fixation –

- ✓ Nitrogen fixation process is given by **Burris** 1966.
- ✓ Nitrogen fixation in atmosphere N_2 is convert into ammonia or nitrates presence of nitrogenase enzyme.
- ✓ Nitrogen fixation in first stable compound is ammonia.
- ✓ Nitrogen convert into ammonia is a reduction.
- ✓ In this process , N_2 is spilt up into free N_2 atoms by breaking the triple bond with the help of enzyme nitrogenase.

Cont...

- This reaction is endergonic [energy consuming] it requires an input of nearly 160kcal energy.

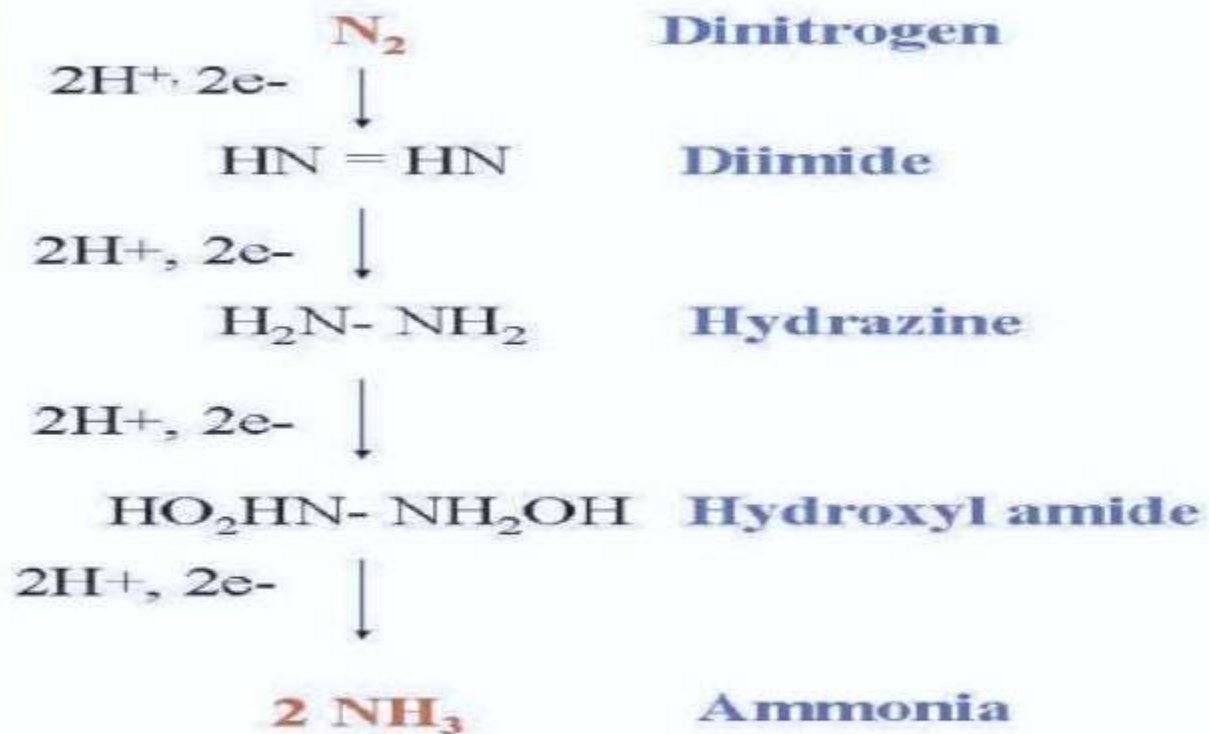


- Free nitrogen combines with hydrogen forming NH_3 presence of hydrogenase enzyme.
- The reaction is exergonic [energy releasing].[13kcal. Energy]



Cont...

Reduction process

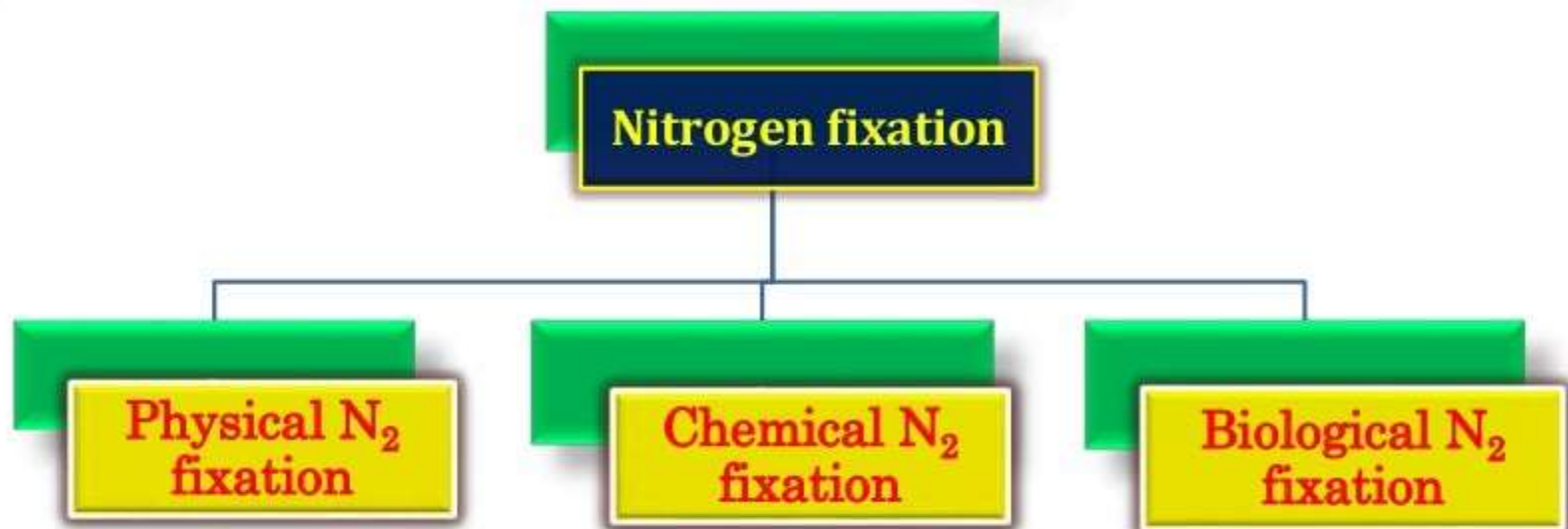


According By :-
Burris [1962]

BIOLOGICAL NITROGEN FIXATION MECHANISM



Types of Nitrogen fixation



Physical N₂ fixation

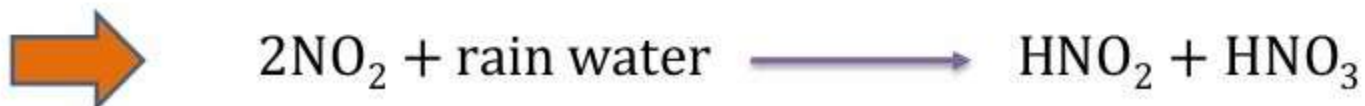
- Physical N₂ fixation are occurs by the natural factor such as :- lightening , thunder.
- It occurs in several steps and starts with combination atmospheric nitrogen with oxygen under the influence of electric discharge and thunder to produce nitric oxide.



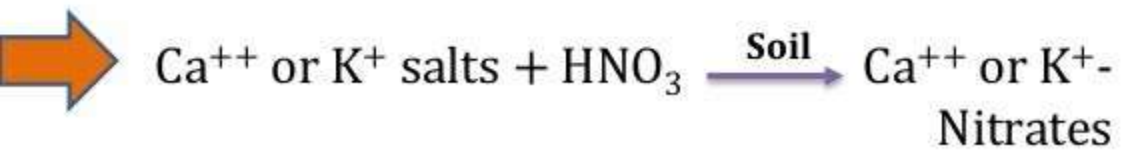
- The nitric oxide is then oxidized to nitrogen peroxide in presence of oxygen.



- During rains, the nitrogen peroxide combines with rain water to form nitrous acid and nitric acid which come to ground along with rains.



➤ On ground the alkali radicals of the soil react with nitric acid to produce nitrites and nitrates which are soluble in water and which can be absorbed by the plant through roots.



Chemical Nitrogen fixation

- Reduction of N_2 into NH_3 by the chemical process is called chemical nitrogen fixation.
- In the use of Haber's process.
- Haber's process in use of high pressure [$\sim 200\text{Atm}$] and high temperature [$\sim 200\text{A}^\circ\text{C}$].



- The method is used in agriculture and industry.

Biological nitrogen fixation

- Fixation of atmospheric Nitrogen into nitrogenous salts with the help of micro-organisms.
- Biological nitrogen fixation (**BNF**) occurs when atmospheric nitrogen is converted to ammonia by an enzyme called nitrogenase.
- Biological Nitrogen fixation in all micro-organism are prokaryotes.
- They micro-organism are called is diazotrophs.

Types of biological nitrogen fixers

- Biological nitrogen fixers are classified based on fixing micro-organism.
- Per year 60% part of total nitrogen fixing by biological nitrogen fixing on earth.
- Two types
 - Symbiotic
 - Non-symbiotic

Non-symbiotic

- They are free living nitrogen fixers.
- They inhabit both terrestrial & aquatic habitats.
- Aerobic, anaerobic and blue green algae
- Bacteria: special type (nitrogen fixing bacteria) types -
 - Free living aerobic : *Azotobacter, Beijerenckia*
 - Free living anaerobic : *Clostridium*
 - Free living photosynthetic : *Chlorobium, Rhodopseudomonas*

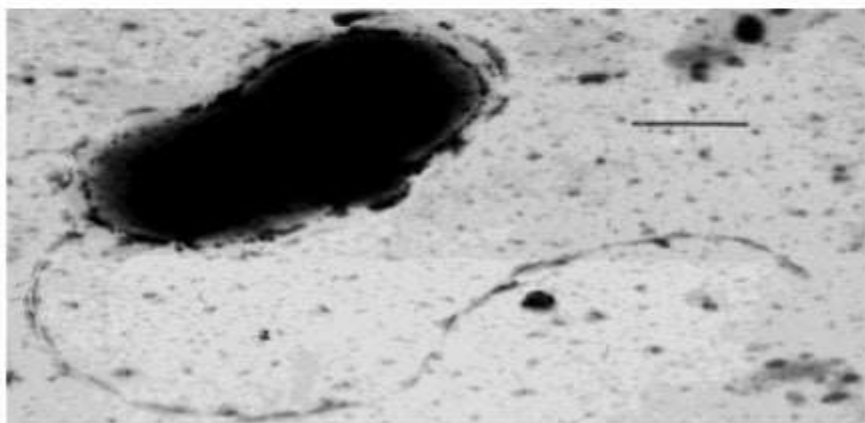
- Free living chemosynthetic : *Desulfovibro, Thiobacillus*
- Free living fungi: *Yeasts and Frankia.*
- Blue green algae:
 - unicellular – *Gloeothece, Synechococcus*
 - Filamentous (non heterocystous) – *Oscillatoria, Plectonema.*
 - Filamentous (heterocystous) – *Anabaena, Nostoc*



Nostoc



Oscillatoria



Desulfovibro



synechococcus

Symbiotic

- Fixation of free nitrogen by micro-organisms in soil living symbiotically inside the plants
- 'Symbiosis' – coined by **De Bary**
- There are two type
 - ✓ Nodulated symbiosis -
 - **Nodule formation in leguminous plants-** *Rhizobium + Cicer aritetinum, Pisum sativum, Glycine max.*
 - **Nodule formation in non-leguminous plants-** *Frankia + Casuarina, Alnus.*
 - ✓ Non nodulation- *Cycas+Anabaena/Nostoc, Anthoceros + Nostoc*



Glycine max on rhizobium



Nodule formation in leguminous plants
Cicer arietinum with "*Rhizobium*"



Nodule formation in non-leguminous plants
Alnus with "*Frankia*"

Factors affecting N₂ fixation

- Presence of nitrate or ammonium.
- Presence of certain inorganic substances
- Ca, Co, Mo – influence N₂ fixation along with P
- *pH:- Neutral- Azotobacter – Acidic- Beijerinckia*
- Soil moisture :- Adequate is good for fixation
- Temperature:- Mesophilic – 30°C.

Reference

- Agrawal. K and Sharma. J (2008), **Plant physiology & Biochemistry**, 1st edition, CBH publication, Jaipur.
- Panday, S N and Sinha, BK. (1994), **Plant physiology**, 2nd edition, Vikas publication house, New Delhi.
- Singh V, Panday PC, Jain DK. (2009-10), **Plant physiology & Biochemistry**, 3rd edition Rastogi publication, Meerut, New Delhi.



**Any
questions ?**



Your questions is...

- Q.1. which form of nitrogen present in atmosphere ?
- Q.2. which enzyme is responsible for splitting $\text{N}\equiv\text{N}$ bond in N_2 Fixation.
- Q.3. Which process are used in chemical nitrogen fixation ?
- Q.4. Give a name of a nodulated symbiosis ?

Thank you



Don't forget
to...
Smile :)♥