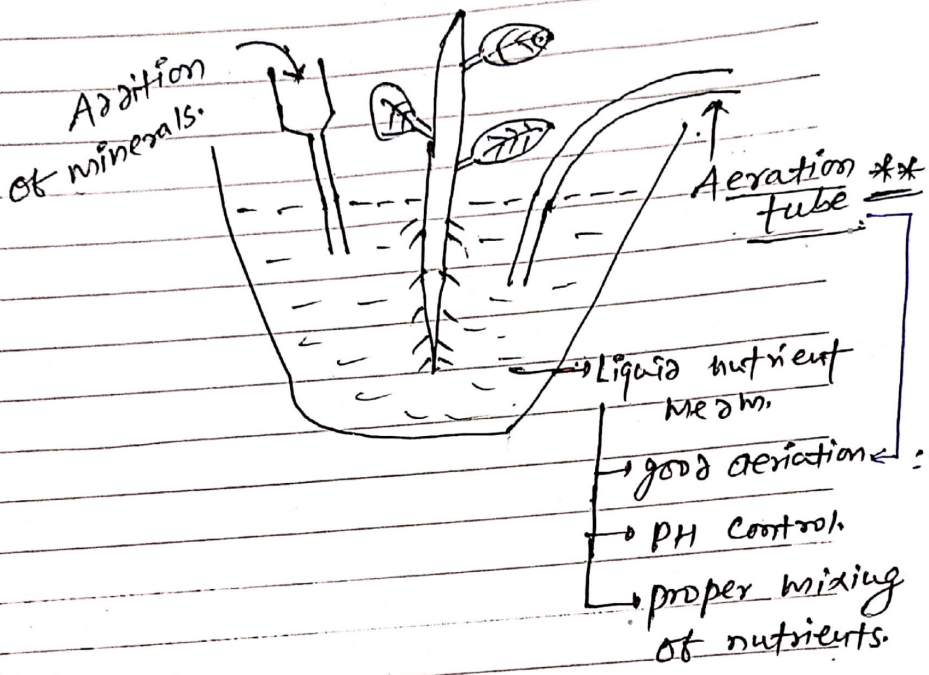
Date. 16/oct/2019.

MINERAL NUTRITION

Hydroponics :- By J.v sachs.

It is the technique of growing plants in soil-Less Culture medm or Liquid nutrient medm.



* Na-EDTA [Disodium-Ethylene Diamine Tetra Acetate]

Is used as a chelating agent to prevent precipitation of Fe^{++} & SO_4^{--} ions as $FeSO_4$.

* This technique has played important role in identification of essential minerals and their deficiency symptoms.

* This technique can also be used for inhouse or terrace growth of small plants like tomato & Lettuce.

Essential Elements :-

Criteria :- (i.) Element having direct role in plant metabolism.

(ii.) Elements necessary for plant growth and development.

(iii.) Element necessary for completing sexual reproduction cycle of plants.

(iv.) Requirement of element must not be replaceable.

(v.) Difficiency of element must result in " symptoms.

Essential Elements (17 elements)

Macro-nutrients.

* $\geq$ 10 mmole/kg of dry wt. of plants.
* C, H, O, N, P, S, Ca, K, Mg
* Most of them play structural role and thus more amount is required.

micro-nutrients.

* < 10 mmole/kg of dry wt. of plants.
* Fe, Cu, Zn, Mo, B, Mn, Ni, Cl
  - Fe → Maxm amount in micronutrients.
* Most of them are enzyme activators and thus Less amount is required.

Main roles :→

(i.) Main structural element कौन है ?
↳ C, H, O, N (कोन)

* Protoplasmic elements.
↳ C, H, O, N + P, S. (कोन P, S)

* Main Elements in plant body.
↳ C, H, O, N + P, Ca. (कोन पि का)

ii.) Energy metabolism :→
↳ Mg → in chl.
↳ P → in ATP.

(iii.) Enzyme activators :→
↳ Mg^{++} → Hexokinase, PFK, Pepcase, Rubisco.
↳ Zn^{++} → Carbonic anhydrase, Alcohol dehydrogenase.
Mo → Nitrogenase
↳ Cu^{++} → Tyrosinase.

(iv.) Ionic balance
↳ K^+ & Cl^-
↳ Most common free ion.

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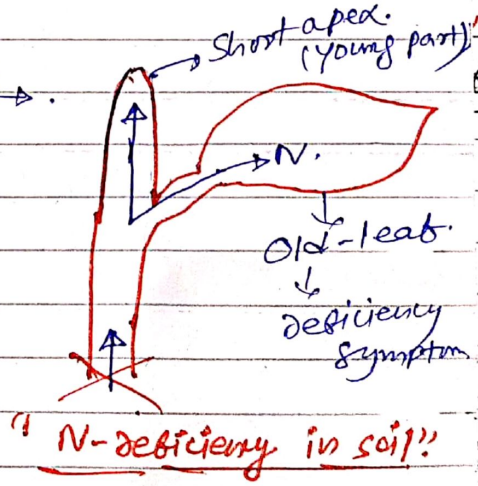
NOTE:→ Beneficial elements
- → useful for some plants.
- → Na, Se, Co, Si.
  - Si → grasses.
  - Na → baloplytes
- → Not essential.

* Deficiency Symptoms:→
  - → the conc^n below which any Element shows diffeciency symptoms is referred as critical conc^n, gt's value is variable for different Elements.

  - → Some elements can be remobilised even after becoming the part of plant body, and they are called mobile Elements, their deficiency symptoms 1st appeared on older plant parts.

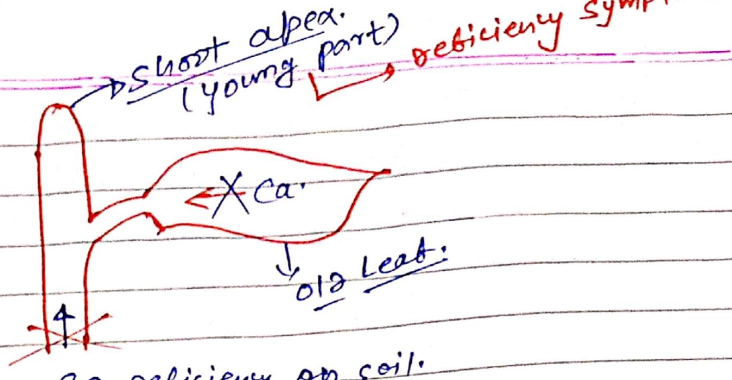
  - → Remobilised mobile elements.
    eg:→ N, P, K, Mg



"N-deficiency in soil"

* Elements which can not be remobilised after becoming the part of plant body are called immobile elements, and their deficiency symptoms 1st appear on younger parts of plants.
  eg:→ Ca, Fe, B.

Solpher.
↳ NCERT Transport से mobile लिखा है।
hormone से immobile.



Note :→ 'S' partially mobile.
↳ more nature of immobile.

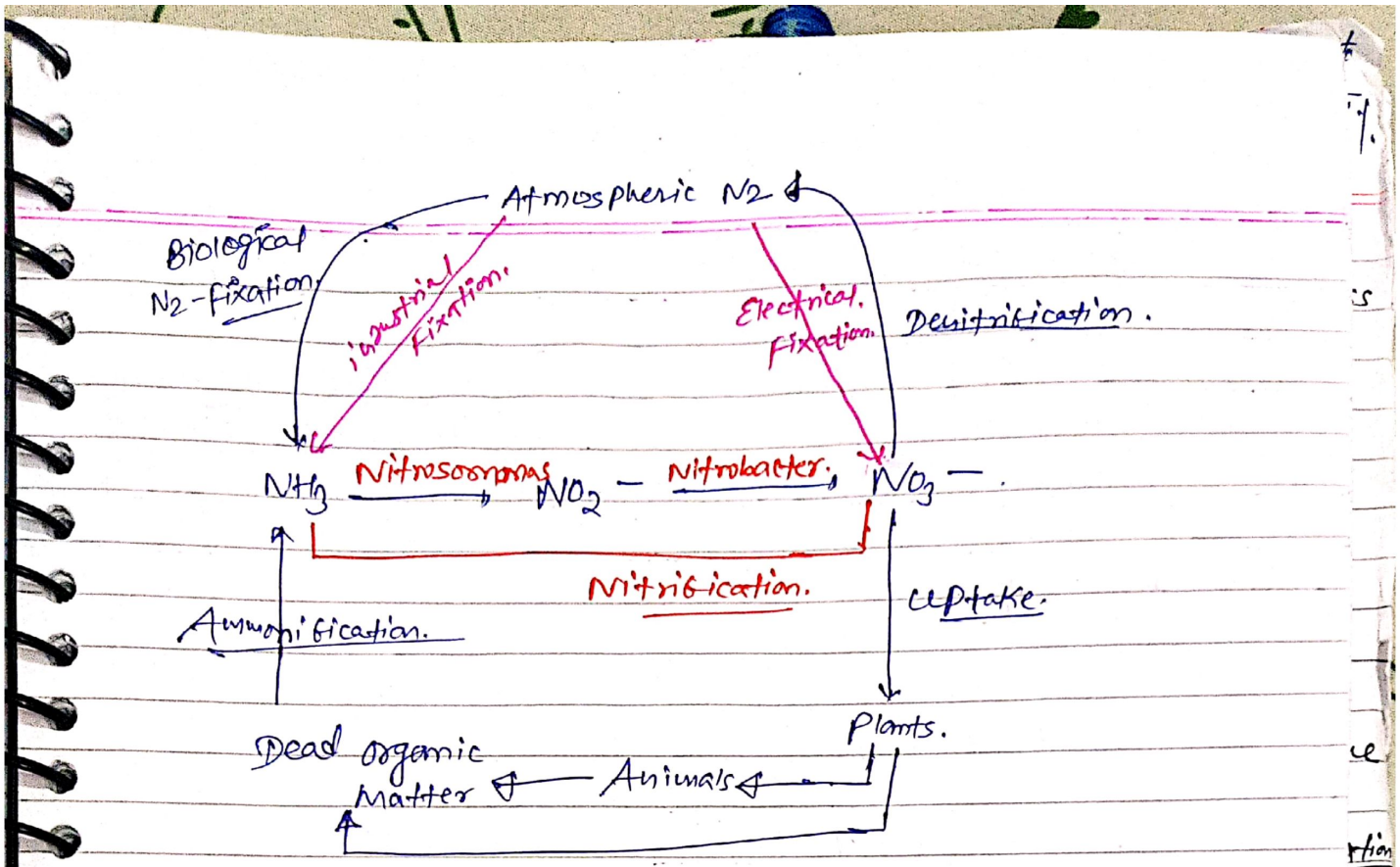
Note :→ C, H & O → from CO_2 (C), from H_2O (H), from CO_2 (O)
↳ essential Elements but not minerals.

Note :→ Minerals are those which are absorbed from Soil in forms of ions.

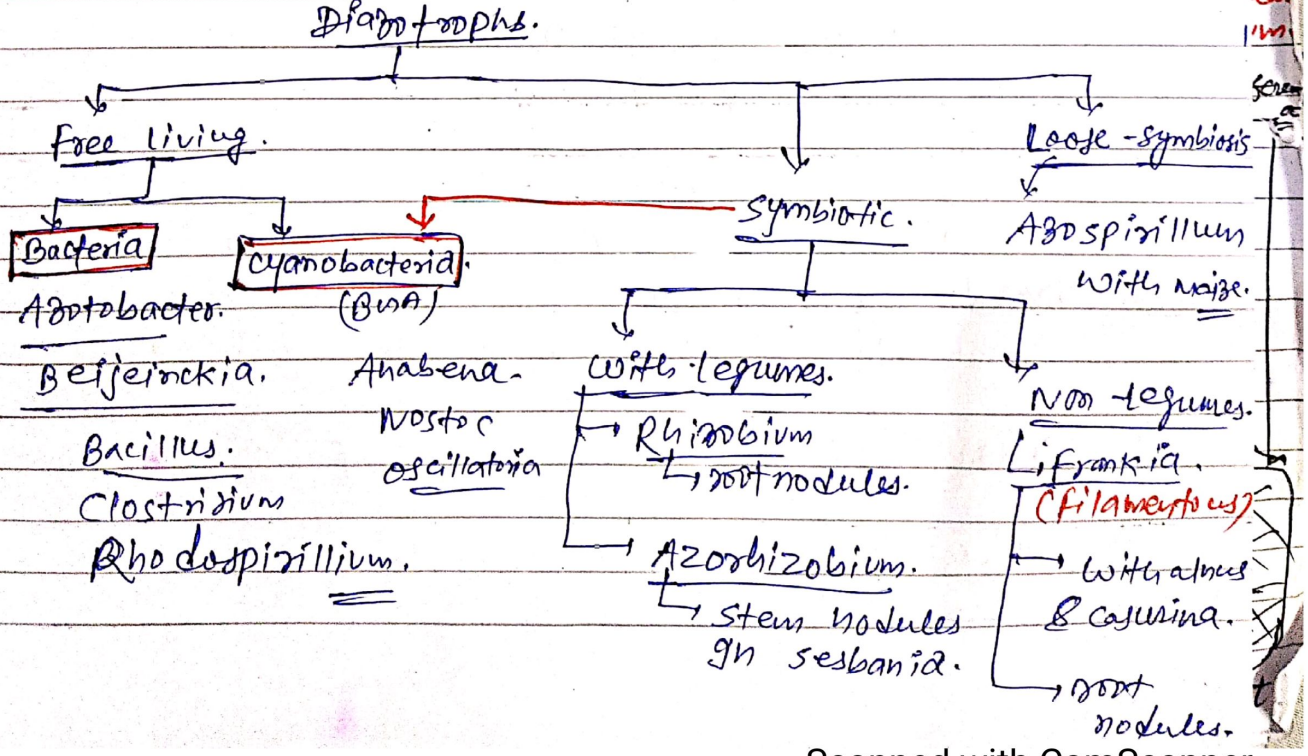
Nitrogen metabolism

* Plant's are not able to directly utilise atmospheric N_2 b/z it is very stable due to its triple covalent bond.

* Plants uptake oxidise or reduce form of Nitrogen. (NO_3^-, NO_2^- & NH_3).
↳ mostly



* **Biological N2 – Fixation :→**
  - reduction of N_2.
  - by some prokaryotes.
    - they are called Diazotrophs.



Animal body में protein ज्यादा
↳ ज्यादा Ammonia बनता।
(Foul Smell).

* Nitrification.
  - ↳ Oxidation.
  - Nitrifying bacteria are chemo autotrophs and they carry out oxidation of Nitrogen Compds to obtain energy.

* Denitrification.
  - By pseudomonas denitrificans and thiobacillus denitrificans
    - ↓
    - are denitrifying bacteria.
  - → Loss of N compounds from soil.
  - promoted by anaerobic condition.

* Ammonification.
  - Organic source → NH_3.
  - part of decomposition.
  - By Bacillus mycoids.
    Bacillus vulgaris.
    Bacillus ramosus.

* Animal body is reach in protein and thus dead organic matter of animals produce more ammonia. which result in more foul smell.

* Industrial fixation involves fertilizer production

* Electrical fixation is due to lightning

** Azolla - Anabaena has symbiotic association. Azolla is an aquatic fern. and Anabena is found associated in it's leaves. thus. azolla leaves are used in paddy field. to increase productivity.

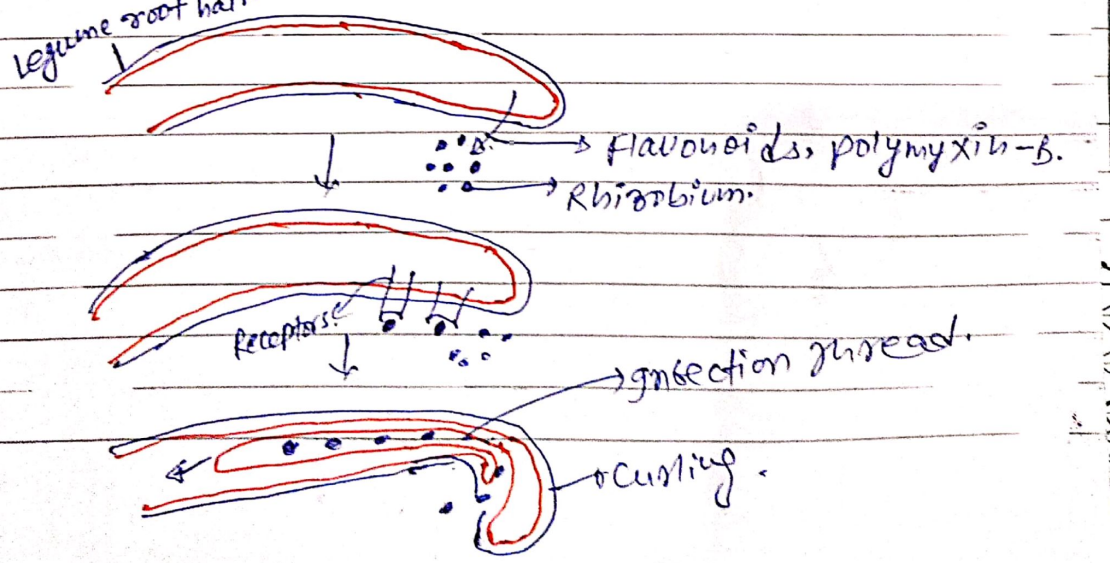
* Oscillatoria is also be used in paddy field.

@ Heterocyst are special cell on DNA which provide suitable environment for N_2 fixation.

* N_2 - fixation by Rhizobium :-

Rhizobium bacteria can be independently found in soil but under such condition they don't carry out N_2 fixation and they behave as saprotrophs.

* When these bacteria come in contact of legume root hair then nodule formation process has started.



⇒ Certain chemical released by legume root hair are identified by bacteria with the help of receptors, present on Bacteria.

→ * Thereafter bacteria bind at receptors present on root hairs.

→ * Bacteria released cytokinine. which makes root hair c.w soft and also causes curling. Bacteria enter into root hair through such soft point and plant responds by infolding cell-membrane to form infection thread.

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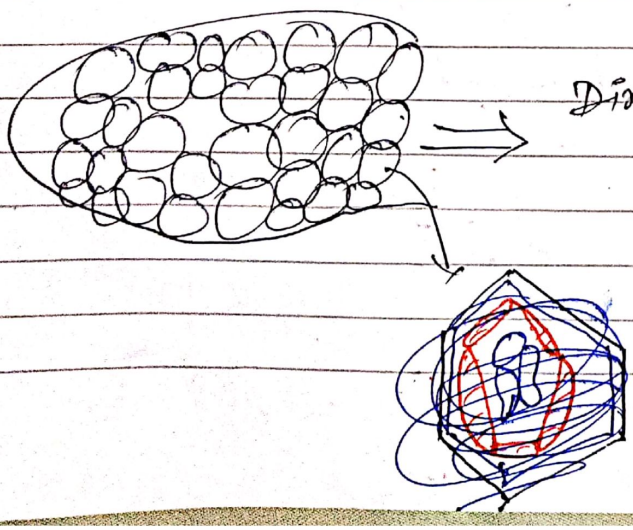
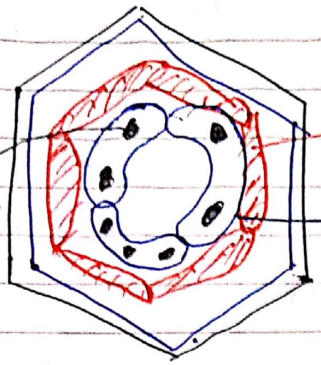
⇒ Some bacteria penetrate the memb. of infection thread and they enter into cortex cell, these bacteria are now called bacteroids.

→ Bacteroids (Bacteria) + plant → Auxin. → cytokinin → cells of cortex and pericycle divide → Bunch of cells. → Nodule.



Direct Connectivity with vascular bundles.

O_2 के प्रति sensitive
↳ अतः O_2 नहीं होना चाहिए।



leghaemoglobin.
↳ pink
- Haeme.
  ↳ By bacteria.
- Legume globin.
  ↳ plant.

Role:→ Act as O_2 scavanger.
↳ prevents diffusion of O_2 towards inner side.

Bacteroids.
↳ Synthesis of nitrogenase enzyme
↳ N_2 fixation.

* Sensitive to O_2.
* requires anaerobic condition.
↳ because damaged / oxidised By O_2.

Subunit → I
* MO-fe protein.
* Larger.
* Main role in reduction of N_2.

Subunit → II
Fe-S protein
Smaller.

$N_2 + 8e^- + 8H^+ + 16ATP \xrightarrow{\text{Nitrogenase}} 2NH_3 + 16ADP + 16iP + H_2$

↑ From $NADPH_2$ (or) $NADH_2$

* In this process. 2 ATP are utilised for transfer of $1e^- + 1H^+$ (1H).
(e^-) (Protons)

Q:- If we consider that H_2 is not released. In this process then How many ATP must be utilised per N_2 fixation?

Soln:- Ans = 12 ATP. (Hypothetical Question)

* NH_3 formed from fixation process is ionised at cellular or physiological pH to form Ammonium ion.

$NH_3 + H^+ \longrightarrow NH_4^+$

↳ used as source of Nitrogen for organic compound synthesis like. AAs.

* Nitrogen assimilation:-
↳ inorganic compounds of Nitrogen are used for synthesis of organic compounds of Nitrogen. and Amino acid biosynthesis is the main process.

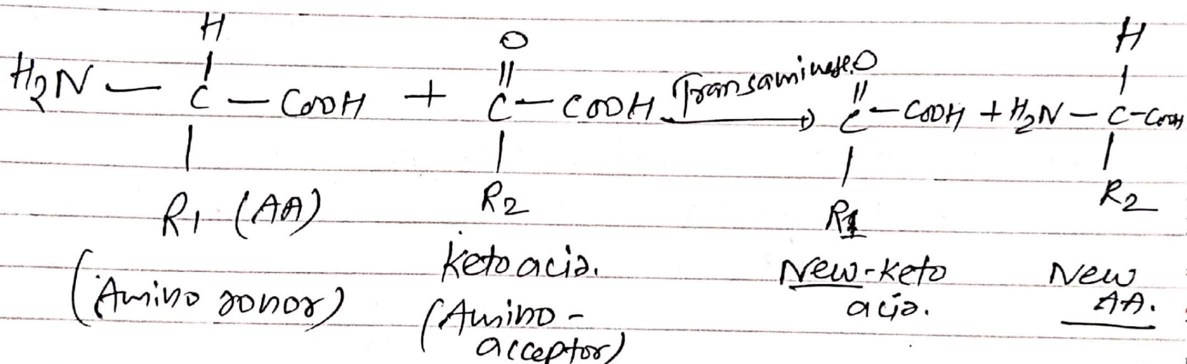
i) Reductive amination

$$\alpha\text{-Keto glutarate} + NH_4^+ \xrightarrow[\text{NADPH}_2 \rightarrow \text{NADP}^+]{\text{Glutamate dehydrogenase}} \text{Glutamic acid} + H_2O$$

(From Kreb cycle).

→ It is primary process of Amino Acid synthesis and it involves reduction as well as amination, of α-keto glutarate. and product is Glutamic acid.

ii) Transamination :→ In this process amino group is transferred from an amino-acid to a keto-acid. for synthesis of new Amino acid.



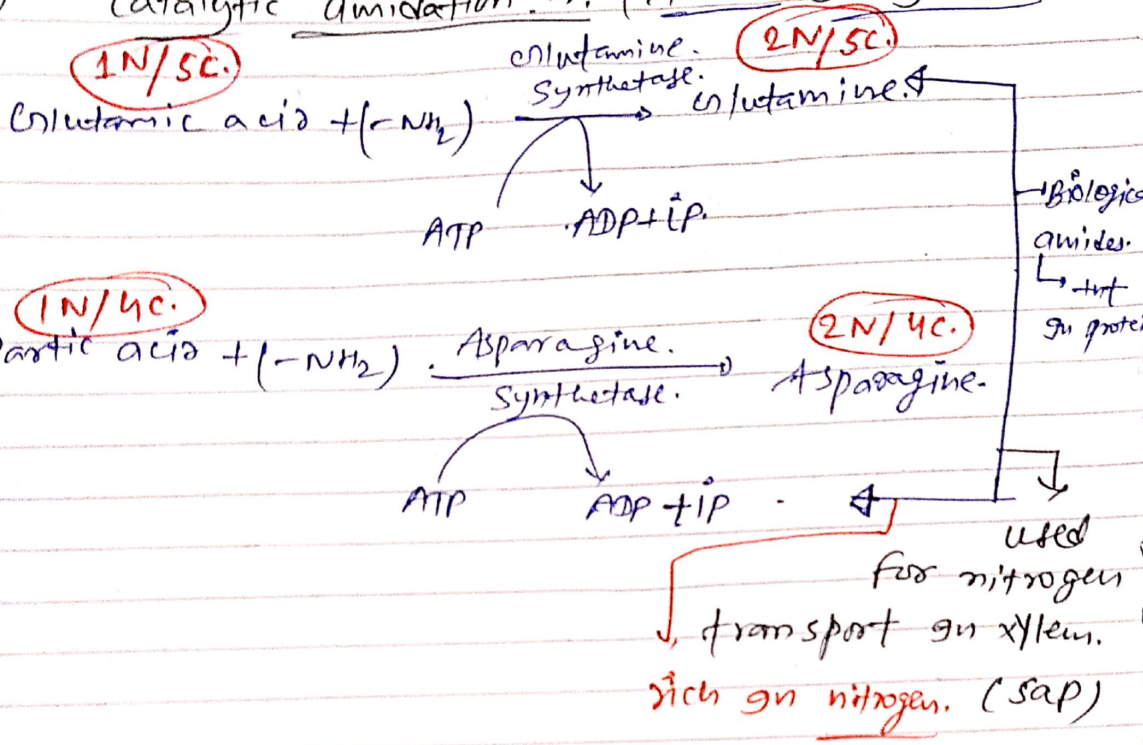
eg :→ Glutamic acid + pyruvic acid ⟶ α-keto glutarate + Alanine.

eg :→ 〃 + OAA ⟶ 〃 + Aspartic acid.

Transamination process can be used for synthesis of (17) different types of AA.

(जिनके बाद 18 AA = 17 + Glutamic acid) और 2 और बचे।

(iii) Catalytic amidation :→ (Amide Biosynthesis)



NOTE:→ In some tropical legume plants nitrogen is transported in the form of ureides. as in soyabeans.

Nitrate Reduction.

Nitrate absorb from soil is reduced to ss form ammonia. This process mainly occurs in leaves but small part of nitrate reduction also occurs in roots.

NO_3^- —(Nitrate reductase.)→ NO_2^-

NO_2^- —(Nitrite reductase)→ NH_3 —(ionisation. (H+))→ NH_4^+

NH_4^+ used for AA Synthesis.

* Only limited amount of NH_3 or NH_4^+ are formed, they are used for AA Synthesis and they are not stored b/z they are toxic.

Micronutrient toxicity

* decrease in dry weight of plant upto 10% or more due to excess micronutrients is called micronutrient toxicity.

* Adverse effect or metabolism is responsible for weight Loss.

Eg:→ Mn^{++} excess/toxicity → disturbs role of Mg^{++}, Ca^{++} and Fe^{++}.

→ Chlorotic veins & Brown spots.