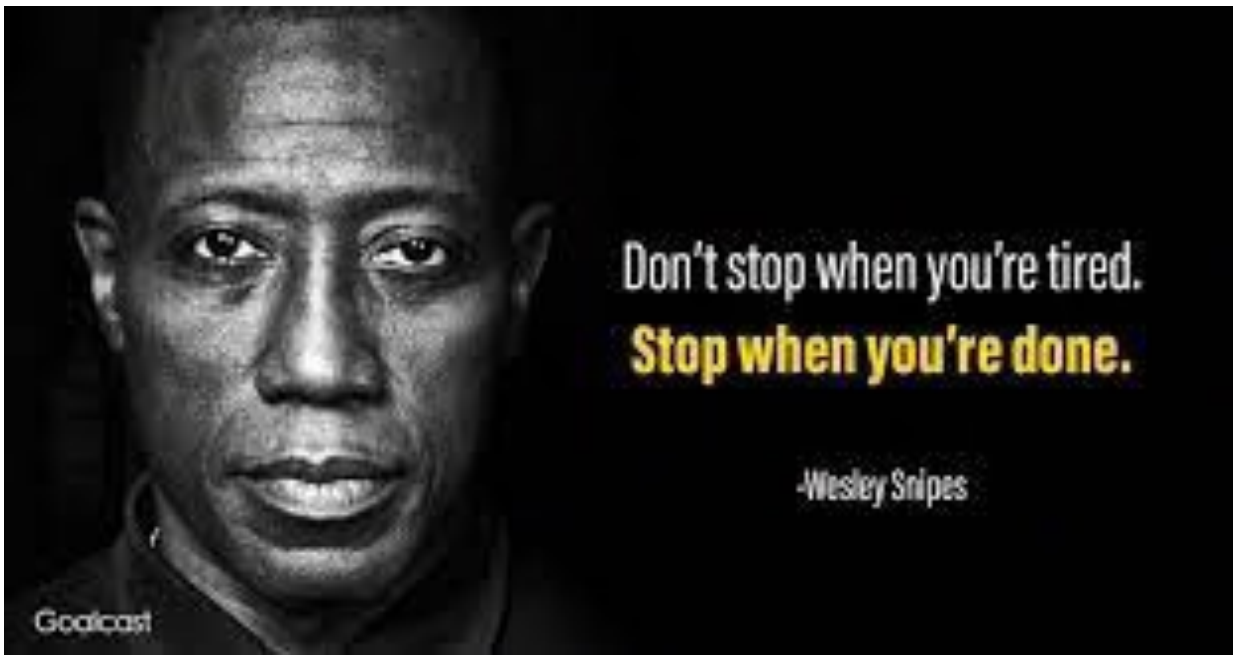
Mineral Nutrition !

@IshitaKhurana20

TELE Ishita 4 U



Mineral nutrition

① HISTORY

- 1860 Julius Von Sachs → German Botanist
  - HYDROPONICS: Complete absence of soil – Plant can be grown in "Defined Nutrient Sol"
  - By this method, essential elements were identified & deficiency symptoms discovered
- TLC → Tomato, Lettuce, Cucumber — successfully for commercial prod" of
- Aerated.

② ESSENTIAL MINERAL ELEMENTS →

- → >60 element / 105 found in plants.
- → Some plants have Se, Au, *, Sr (Radioactive).
- → Minerals can detected at low level. (10^{-8} g/ml).

Essential elements can also be grouped as →

Essential Elements.
1. → C, H, O, N. → Components of Biomolecules & Structural Components in cells.
2. → Energy Related → Mg^{2+} in chloro. / ATP.
3. → Alter osmotic potential → K^+ — open/closing of stom...

④ Activate / Inhibit certain enzymes.
- Mg^{2+} ⊕ → Rubisco.
- Mg^{2+} ⊕ → phospho enol pyruvate carboxylase (PEPCase)
- Zn^{2+} ⊕ → Alcohol dehydrogenase
- Mo ⊕ → Nitrogenase.

TELEGRAM: ISHITA4U
YOUTUBE: ISHITA KHURANA

③ CRITERIA for ESSENTIALITY

① Must be absolutely necessary for for growth / Reproduc"
② Must be specific not Replaceable.
③ Must be directly involved in Metabolism of Plant.

BASED on these criteria essential elements classified as.

Macronutrients	Micronutrients
> 10 mmole / kg of Dry Matter.	also k/a Trace elements. < 10 m mole / kg of dry matter.
C H O N P K Mg S Ca ~~Fe~~	Fe, Mn, Cu, Mo, Zn, B, Ce, Ni

BENEFICIAL ELEMENTS

Useful but not essential.

कोना सिरो → Beneficial elements*
Co Na si se → Higher plants *

Role of Macro - Micro Nutri

- Metabolic process.
- cell permeability.
- Osmotic conc.
- ETS, Buffers, enzymes, coenzyn

DEFICIENCY Symptoms

↳ conc" of essential element — Below which ↓ Plant growth Retarded.

↓ k/a Critical conc".

① Chlorosis :– M ✓ C ✗ (yellowing)
N, K, Mg, S, Fe, Mn, Zn, Mo

② Necrosis :– C M C K / Ca Mg Cu

③ Inhibition of cell Division
Narendra Modi ko Salaam
N ✓ Mo K S

④ Delay in flowering
N, Mo, S

MOBILE ELEMENTS.
↳ Older – Younger leaves. eg: N, K, Mg
↳ Deficiency first in older leaves.

IMMOBILE ELEMENTS.
↳ X transported eg: Ca.
↳ Deficiency first in young leaves.

TOXICITY

↳ Moderate ↑se.
↳ Mineral ion conc" — that reduces dry wt about 10%
↳ Many times, ↑ conc" of one → ises uptake of other

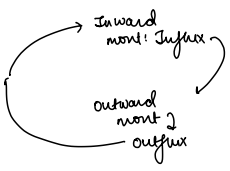
Mn ↑
- competes ∈ iron & Mg for uptake
- Mg for binding to enzym
- ⊖ Ca^{+2} transloc. to shoot Apex

Mn Toxicity → Brown spots chlorotic Surrounding by ~~chlorotic~~ veins.

TRANSLOCATION of Solutes.
↳ Mineral salts translocated through Xylem.

MECH" of Absorption of Elements.

- ⊙ Apoplast → Passive → Rapid uptake of Ions.
- ⊙ symplast → Active → Second phase: Requires energy

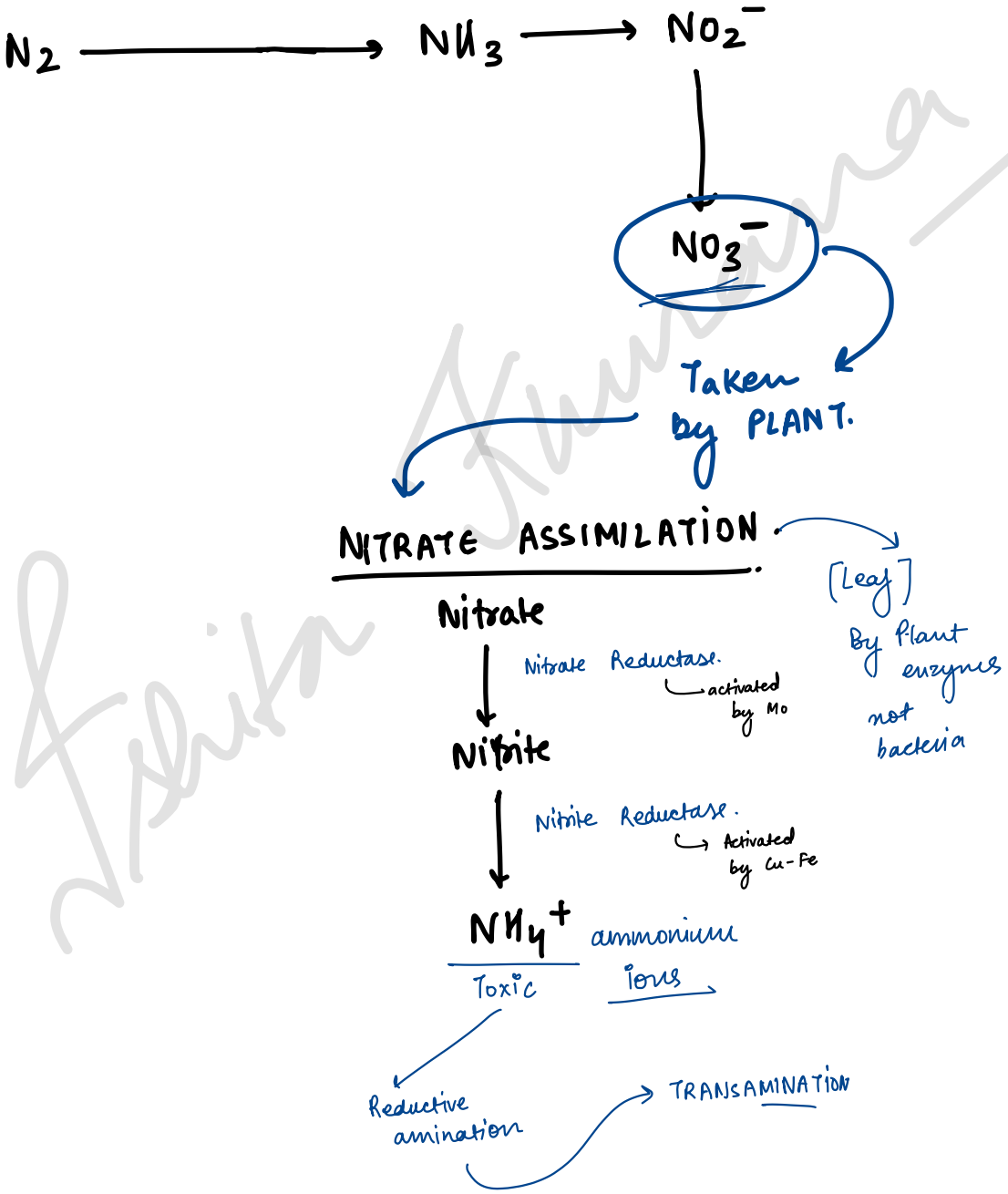


TELEGRAM: ISHITA4U
YOUTUBE: ISHITA KHURANA

MINERAL ELEMENTS	ABSORBED AS	REQUIRED IN	FUNCTIONS
① Nitrogen	NO_2^-, NO_3^- or NH_4^+	All parts of plant particularly: Meristems	Major constituents of Proteins, N.A, Vitamins, hormones. → ~~greatest~~ amt. greatest
② Phosphorous.	$H_2PO_4^-$ / HPO_4^{2-}	Developing fruits, seeds, storage organs, young Meristems.	• Cell Membrane. • Nucleotide, nucleic acid. • Phosphorylation • Some proteins
③ Potassium	K^+	Meristems, buds, leaves, Root tips.	★ Maintain turgidity of cells. ★ Opening / closing of Stomata. ★ Anion - Cation balance.
④ Calcium	Ca^{+2}	Meristems + Differentiating tissues.	★ Middle lamella ★ Mitotic Spindle. ★ Certain enzymes
Magnesium	Mg^{+2}	Seeds, leaves, growing areas of Root & Stem.	★ Constituent of Ring Structure of chlorophyll. ★ helps maintain Ribosome structure. Cell
Sulphur	SO_4^{2-}	Young leaves + Meristems.	AA, coenzyme, vit, ferredoxin → cysteine, Methionine. Biotine, Co-A, Thiamine
Iron	Fe^{+3}	All parts of plant	★ Constituent of → Ferredoxin, Cytochromes. ★ Activates → Catalase. ★ essential for formation: chlorophyll.
⑧ Manganese.	Mn^{+2}	Leaves + Seeds.	★ Best Defined func^n — Splitting water to liberate O_2 during photosy^n
⑨ Zinc	Zn^{+2}	All parts of plants.	• Activates enzymes - especially - carboxylases • Auxin Synthesis.
⑩ Copper	Cu^{+2}	All parts of plants.	Certain enzymes.
⑪ Boron.	BO_3^{2-} or $B_4O_7^{2-}$	Leaves & Seeds.	CAB Me (A) Padho C_3 cycle. → Ca^{2+} uptake + utilisn, Boron, Membrane Function, Pollen germn. C_3 → Cell elong, Cell Diff, Carbony Translocn
⑫ Molybdenum	MoO_2^{2+}	All parts of Plant + Commonly: Roots	Component of → Nitrogenase → Nitrate Reductase.
⑬ Chlorine	Cl^-	All parts of plants.	Essential for — Water Splitting Rxn in photosynthesis → Anion - Cation balance.

TELEGRAM: ISHITA4U
YOUTUBE: ISHITA KHURANA

SOME BASIC CONCEPTS



Ishita Kundra

TRANSLOCATION of SOLUTES

↳ Translocate via xylem pulled by Transpirational pull.

TELEGRAM: ISHITA 4U
YOUTUBE: ISHITA KHURANA

SOIL : RESERVOIR of ESSENTIAL ELEMENTS

↳ wide variety of substances

↳ Minerals + N_2 fixing bacteria.

NITROGEN CYCLE

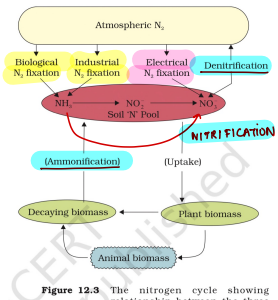


Figure 12.3 The nitrogen cycle showing relationship between the three main nitrogen pools – atmospheric soil, and biomass

→ N_2 is the constituent of Aminoacid, Protiens, Hormones, Chlorophyll, Vitamins.

→ N_2 is limiting nutrient in natural and agri.

* Denitrification.
↳ Nitrate (NO_3) → N_2.
↓ Psudomonas, Thiobacillus.

$NH_3 \xrightarrow{(a)} NO_2^- \xrightarrow{(b)} NO_3^-$ Nitrate

Nitrite

TRICK. [0-0-वाले.] ← Nitrosomonass, Nitrococcus. Nitrobactor

* Chemoautotrophs.

BIOLOGICAL NITROGEN METABOLISM

① Nitrogen Fixation → Nitrogenase → exclusively in prokaryotes.

$N \equiv N \xrightarrow{\text{Nitrogenase}} NH_3$

Nitrogen Fixing Microbes.

- Free Living — Single Log
  - AEROBIC [AB]. → Azetobactor → Bejernikia.
  - ANAEROBIC Rhodosprillum. [अनार].
- Symbiotic.
  - with legumes (Rhizobium).
  - NON Leguminous. [Frankia]. ↓ Alnus * Plant

Cyanobacteria → Anebena, Nostoc.

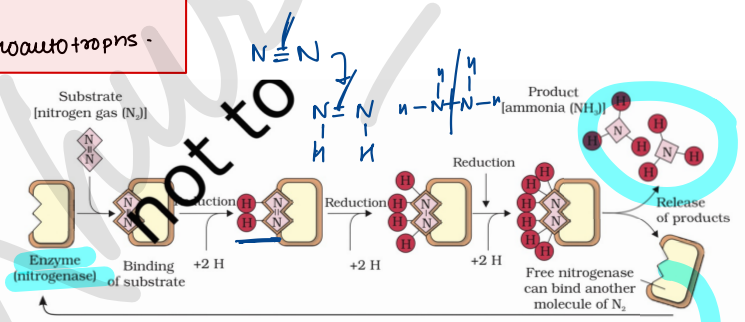


Figure 12.5 Steps of conversion of atmospheric nitrogen to ammonia by nitrogenase enzyme complex found in nitrogen-fixing bacteria

NODULE FORMATION

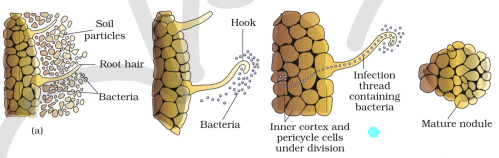


Figure 12.4 Development of root nodules in soyabean : (a) *Rhizobium* bacteria contact a susceptible root hair, divide near it, (b) Successful infection of the root hair causes it to curl, (c) Infected thread carries the bacteria to the inner cortex. The bacteria get modified into rod-shaped bacteroids and cause inner cortical and pericycle cells to divide. Division and growth of cortical and pericycle cells lead to nodule formation. (d) A mature nodule is complete with vascular tissues continuous with those of the root

NODULE

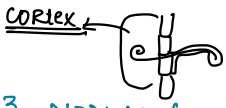
Contains Nitrogenase. Leghaemoglobin

Pinkish Colour like Hb.

- Mo - Fe protein
- highly sensitive to Molecular O_2 ⇒ Thus Requires Anaerobic Conditions.
- To protect Nitrogenase Nodule contains:— O_2 Scavenger ⇓ called Leghaemoglobin.

Nodule formation.

1. Rhizobium multiply AND Binds to epidermal and root
2. Root Hair curls



3. Nodule formation in cortex of root.
4. Bacteria Released. → Nitrogen fixan.
5. Direct vascular connection with host for exchange of gases.
6. MOFe catalysed rxn.

The reaction is as follows:

$$N_2 + 8e^- + 8H^+ + 16ATP \longrightarrow 2NH_3 + H_2 + 16ADP + 16P_i$$

($2NH_3$ → $1NH_3$)

TELEGRAM: ISHITA 4U
YOUTUBE: ISHITA KHURANA

FATE of AMMONIA

$NH_3 \xrightarrow{H^+} NH_4^+$ ion → Toxic → can't be accumulated. ∴ NH_4 → used to Synthesise Amino acids in 2 ways.

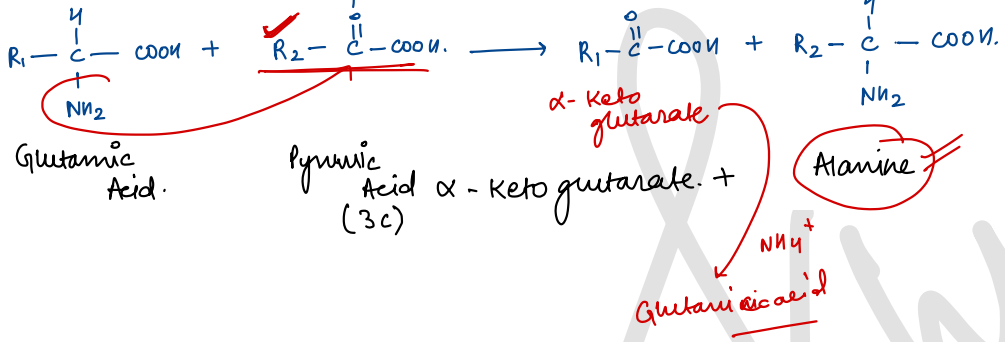
① Reductive amination

α-Keto glutaric acid + NH_4^+ + NADPH $\xrightarrow[\text{Dehydrogenase}]{\text{Glutamate}}$ Glutamic acid. + H_2O + NADP.

Glutamic Acid + Keto Acid

② TRANSAMINATION:

Transfer of $-NH_2$ group from a.a. to Keto group of Keto Acid.



Two Most imp Amides

③ Amide.

Asparctic acid → Asparagin
Glutamic acid → Glutamine

⇓

Have more N_2 Transport via Xylem.

② Ureides:

High N:C Ratio.

→ Nodules of some plants like Soyabean export as Ureides. Fixed N_2

The enzyme nitrogenase is highly sensitive to the molecular oxygen; it requires anaerobic conditions. The nodules have adaptations that ensure that the enzyme is protected from oxygen. To protect these enzymes, the nodule contains an oxygen scavenger called leg-haemoglobin. It is interesting to note that these microbes live as aerobes under free-living conditions (where nitrogenase is not operational), but during nitrogen-fixing events, they become anaerobic (thus protecting the nitrogenase enzyme). You must have noticed in the above reaction that the ammonia synthesis by nitrogenease requires a

TELEGRAM: ISHITA 4U
YOUTUBE: ISHITA KHURANA

Detailed explanation
15th July
10 pm.

• Live @ YT Channel - Ishita Khurana