FREE NOTES · NCERT + NEET LEVEL

Mineral Nutrition

Extra reading (old NCERT chapter): hydroponics, essential elements (macro and micro), their functions and deficiency symptoms with memory tricks, toxicity, the nitrogen cycle and biological nitrogen fixation.

01 Hydroponics and essential elements
02 Functions of elements
03 Deficiency symptoms and tricks
04 Nitrogen cycle
05 Biological nitrogen fixation
06 Important Q&A
07 Common mistakes
08 Practice (NEET style)
09 Quick revision

01 Hydroponics and essential elements

- **Julius von Sachs** (1860): grew plants in nutrient solution without soil = **hydroponics**; used for tomato, seedless cucumber, lettuce.
- Criteria of essentiality: (1) needed for normal growth and reproduction, (2) requirement is specific (cannot be replaced), (3) directly involved in metabolism.
- **Macronutrients** (>10 mmol/kg dry matter): C, H, O, N, P, K, S, Ca, Mg. Trick: "**C. HOPKiNS CaFe Mg**" (C, H, O, P, K, N, S, Ca, Fe*, Mg; *Fe is actually a micronutrient).
- **Micronutrients** (<10 mmol/kg): Fe, Mn, Cu, Mo, Zn, B, Cl, Ni. Trick: "**Moby Cl Fe Mn ZnCu Ni**" (Mo, B, Cl, Fe, Mn, Zn, Cu, Ni).
- Beneficial elements: Na, Si, Co, Se.

02 Functions of elements

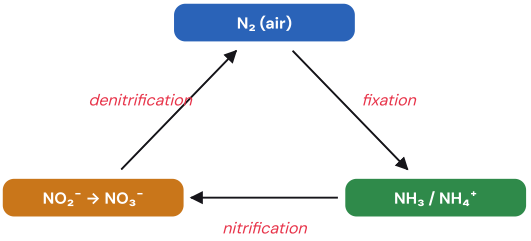
Element	Main role
N	Proteins, nucleic acids, chlorophyll, vitamins, hormones
P	ATP, nucleic acids, membranes (phospholipids)
K	Anion–cation balance, stomatal opening, turgidity
Ca	Middle lamella (calcium pectate), spindle, cell division
Mg	Chlorophyll ring; activates RuBisCO, PEP case; ribosome structure
S	Cysteine, methionine; coenzyme A, thiamine, biotin, ferredoxin
Fe	Ferredoxin, cytochromes; chlorophyll formation; activates catalase
Mn	Photolysis of water (O_2 evolution); activates many enzymes
Zn	Carboxylases; auxin synthesis
Cu	Enzymes of redox reactions
B	Ca uptake, pollen germination, cell elongation
Mo	Nitrogenase, nitrate reductase
Cl	Anion–cation balance, water splitting with Mn

03 Deficiency symptoms and tricks

Symptom	Elements	Trick
Chlorosis (yellowing)	N, K, Mg, S, Fe, Mn, Zn, Mo	"**MONKS with yellow flowers** Zn Mn Fe": Mo, N, K, S, Mg + Zn, Mn, Fe
Necrosis (tissue death)	Ca, Mg, Cu, K	"**Calcium Copper Killed Maggie**": Ca, Cu, K, Mg
Inhibition of cell division	N, K, S, Mo	"**MONKS**": Mo, N, K, S (also low B)
Delayed flowering	N, S, Mo	"**NSM**"

- Mobile elements (N, P, K, Mg) ⇒ symptoms first in **old** leaves; immobile (Ca, S, Fe, B) ⇒ in **young** leaves.
- **Toxicity**: excess reduces dry weight by ~10%. Mn toxicity shows brown spots surrounded by chlorotic veins; it competes with Fe and Mg uptake and inhibits Ca translocation ⇒ symptoms of Fe, Mg, Ca deficiency.

04 Nitrogen cycle

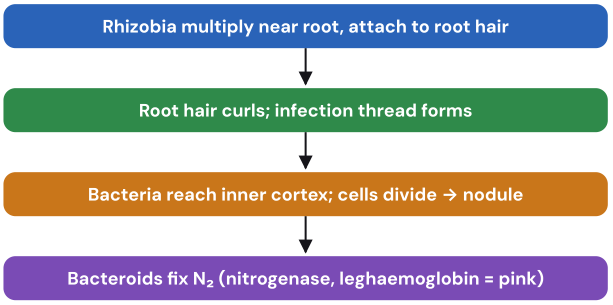


Nitrogen cycle (NO_3^- is absorbed by plants; dead matter returns NH_3 by ammonification)

- **Nitrogen fixation**: $N_2 \rightarrow NH_3$ (lightning, industrial Haber process, biological).
- **Ammonification**: decomposition of proteins → NH_3 (*Bacillus ramosus*, *B. vulgaris*).
- **Nitrification**: $NH_3 \rightarrow NO_2^-$ (*Nitrosomonas*, *Nitrococcus*) → NO_3^- (*Nitrobacter*). Plants absorb nitrate.
- **Denitrification**: $NO_3^- \rightarrow N_2$ (*Pseudomonas*, *Thiobacillus*).

05 Biological nitrogen fixation

- Only prokaryotes fix N_2 using **nitrogenase** (Mo-Fe protein), which is very sensitive to O_2.
- Free-living: aerobic *Azotobacter*, *Beijerinckia*; anaerobic *Rhodospirillum*; cyanobacteria *Anabaena*, *Nostoc*.
- Symbiotic: *Rhizobium* with legume roots; *Frankia* with non-legume *Alnus*.
- **Leghaemoglobin** (pink) in nodules scavenges O_2 to protect nitrogenase.
- Reaction: $N_2 + 8e^- + 8H^+ + 16\ ATP \rightarrow 2NH_3 + H_2 + 16\ ADP + 16\ Pi$.
- NH_3 assimilated by **reductive amination** (α-ketoglutarate + NH_4^+ → glutamate) and **transamination**; amides asparagine and glutamine carried in xylem; ureides in soybean.



Root nodule formation

06 Important Q&A

Q1. Why is leghaemoglobin pink and what is its role?

It is an oxygen-binding haem protein; it keeps O_2 low inside nodule so nitrogenase (O_2-sensitive) can work.

Q2. How many ATP are needed to fix one N_2?

16 ATP ($N_2 + 8e^- + 8H^+ + 16ATP \rightarrow 2NH_3 + H_2$).

Q3. Name the bacteria converting NH_3 to NO_2^- and NO_2^- to NO_3^-.

Nitrosomonas/*Nitrococcus*; *Nitrobacter*.

07 Common mistakes

- Calling Fe a macronutrient.
- Saying plants absorb N_2 directly.
- Mixing nitrification and denitrification bacteria.
- Thinking Ca deficiency shows in old leaves.

08 Practice (NEET style)

1. Element in chlorophyll ring?
2. Element for photolysis of water?
3. Enzyme fixing N_2?
4. Non-legume symbiont?
5. Father of hydroponics?

ANSWERS

1) Mg · 2) Mn (with Cl) · 3) Nitrogenase · 4) *Frankia* (in *Alnus*) · 5) Julius von Sachs

09 Quick revision: 5 minutes before the exam

ELEMENTS

- Macro >10 mmol/kg
- Micro: Fe Mn Cu Mo Zn B Cl Ni

TRICKS

- Necrosis: Ca Cu K Mg
- Cell division: MONKS
- Delayed flowering: N S Mo

N CYCLE

- Nitrosomonas → Nitrobacter
- Pseudomonas denitrifies

FIXATION

- Nitrogenase, 16 ATP
- Leghaemoglobin pink
- Rhizobium, Frankia

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.