

# AGRY 515 2008

- Classification by Function
- N Assimilation
- Ammonium Assimilation
- N Structural Roles
- Ammonium Vs Nitrate Nutrition

Table 1. Group 1: Structural components of biological compounds (carbohydrates, proteins, lipids, nucleic acids) and intermediates of metabolism.

Element	% DM	Major Functions
C	44	Components of organic compounds
H	6	Components of organic compounds
O	44	Components of organic compounds
N	2	Amino acids, proteins, coenzymes, nucleic acids
P	0.5	Sulfur amino acids, proteins, coenzyme A
S	0.4	ATP, NADP, intermediates of metabolism (e.g. sugar phosphates), membrane phospholipids and nucleic acids

Table 2. Group 2: Enzyme activators: elements required for the activation of specific enzymes.

Element	% DM	Major Functions
K	2.0	Activation of ~60 enzymes (e.g. pyruvate kinase). Essential for protein synthesis. Responsible for turgor in turgor-based movements in of guard cells in leaves
Ca	1.5	Enzyme activator (e.g. $\alpha$ -amylase, membrane ATPases). Essential for membrane permeability. Associated w/ pectins in cell walls.
Mg	0.4	Activates numerous enzymes (esp. ATP: phosphotransferases). Component of chlorophyll.
Mn	0.01	Activates IAA oxidase, malic enzyme, isocitrate dehydrogenase. Essential for photolysis of H <sub>2</sub> O (pos. via redox changes: $Mn^{2-} \rightarrow Mn^{3-} + e^{-}$ )

Table 3. Group 3: Redox reagents: elements that undergo reduction / oxidation (redox) reactions by virtue of multiple valence states

Element	% DM	Major Functions
Fe	0.015	Participant in cytochromes ( $\text{Fe}^{\text{III}} + \text{e}^- \leftrightarrow \text{Fe}^{\text{II}}$ )
Cu	0.002	Participant in cytochrome oxidase and plastocyanin ( $\text{Cu}^{\text{II}} + \text{e}^- \leftrightarrow \text{Cu}^{\text{I}}$ )
Mo	0.002	Reduction of $\text{NO}_3^-$ by nitrate reductase, reduction of $\text{N}_2$ by nitrogenase of free living and nodule bacteria ( $\text{Mo}^{\text{VI}} + \text{e}^- \leftrightarrow \text{Mo}^{\text{V}}$ )

Table 4. Group 4: Elements of uncertain function.

Element	% DM	Major Functions
B	0.003	Thought to be important for membrane activity. Root growth very susceptible to deficiency
Cl	0.01 – 2.0	Osmosis, charge balance, photolysis of water
Si	< 20	May serve as a strengthening agent in <i>Equisetum</i> and the grasses. Also thought to reduce transpiration.
Na	0.5 – 10.0	Requirement for plants using C <sub>4</sub> photosynthesis (including CAM plants). Source of turgor for halophytes.

# Fig. 1. Uptake and Compartmentalization of Nitrate and Nitrite in Leaf Tissues

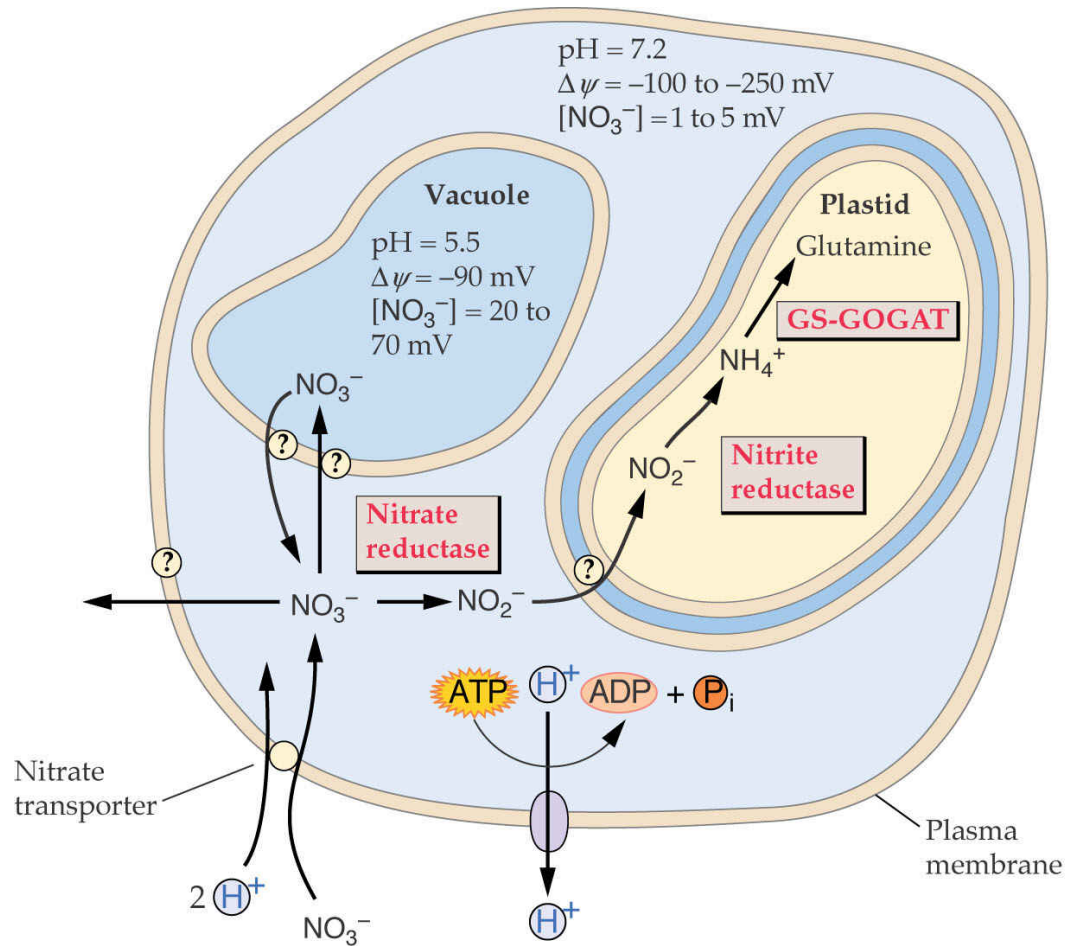
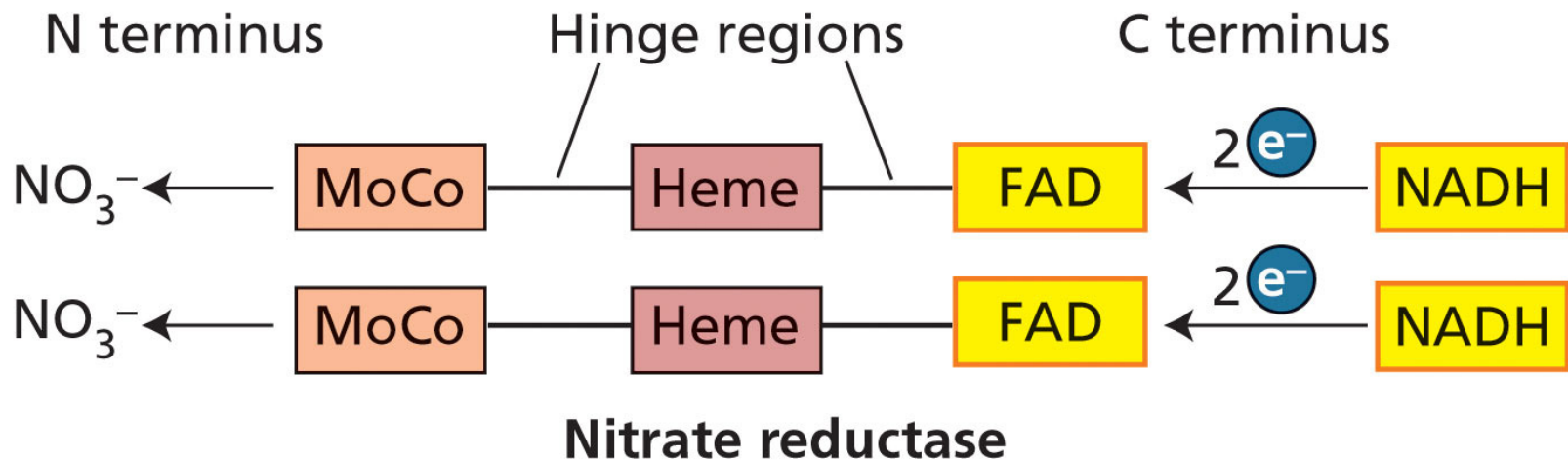
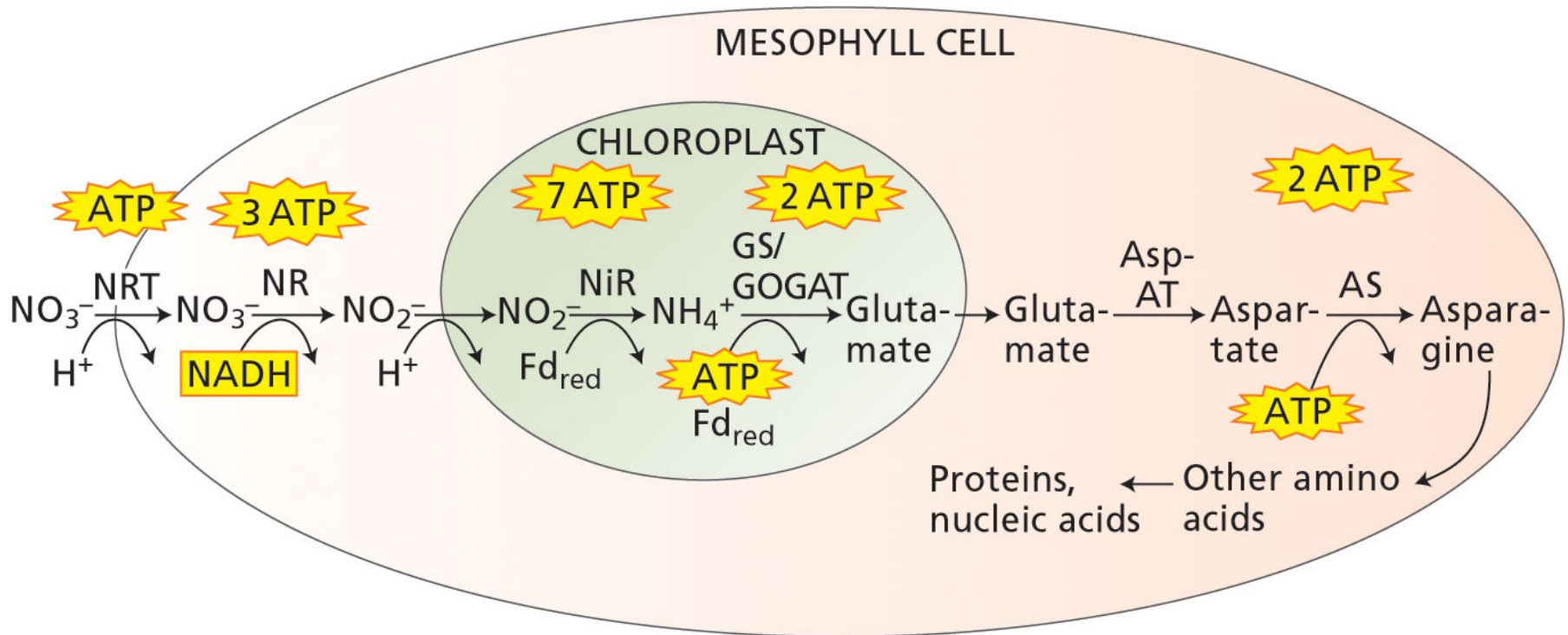


Fig. 2. Model of Nitrate Reductase Dimer Showing the MoCo Complex and NADH as the Source of Electrons



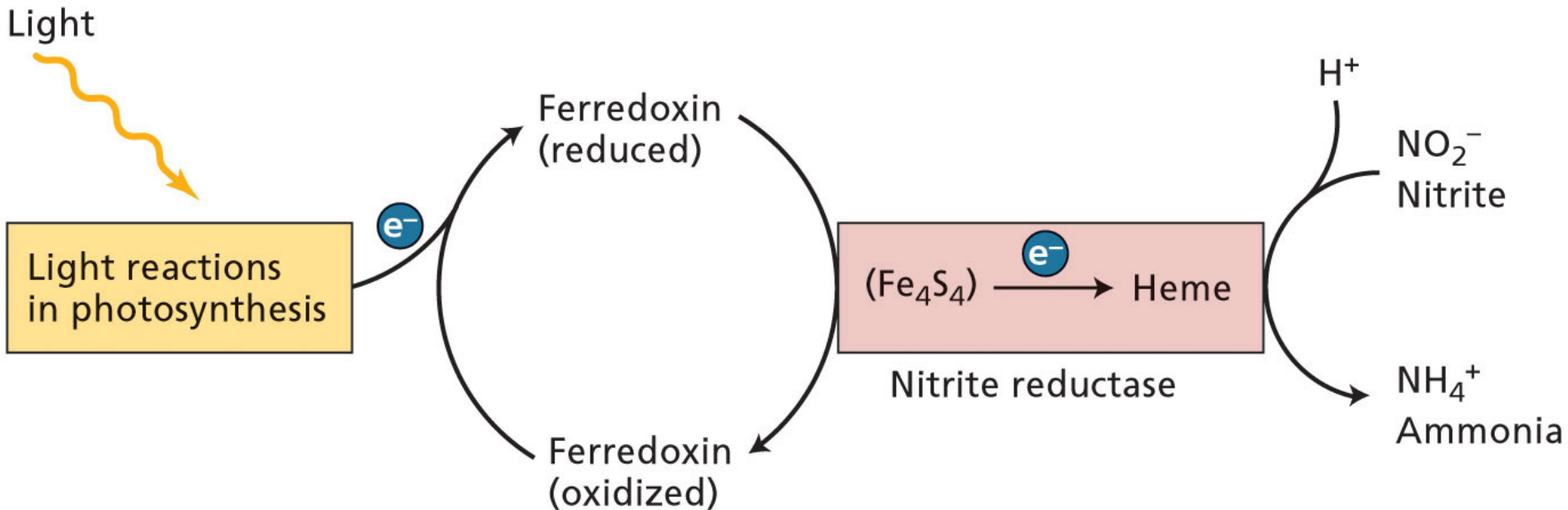
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Fig. 3. Summary of Nitrogen Assimilation in a Plant Leaf Cell



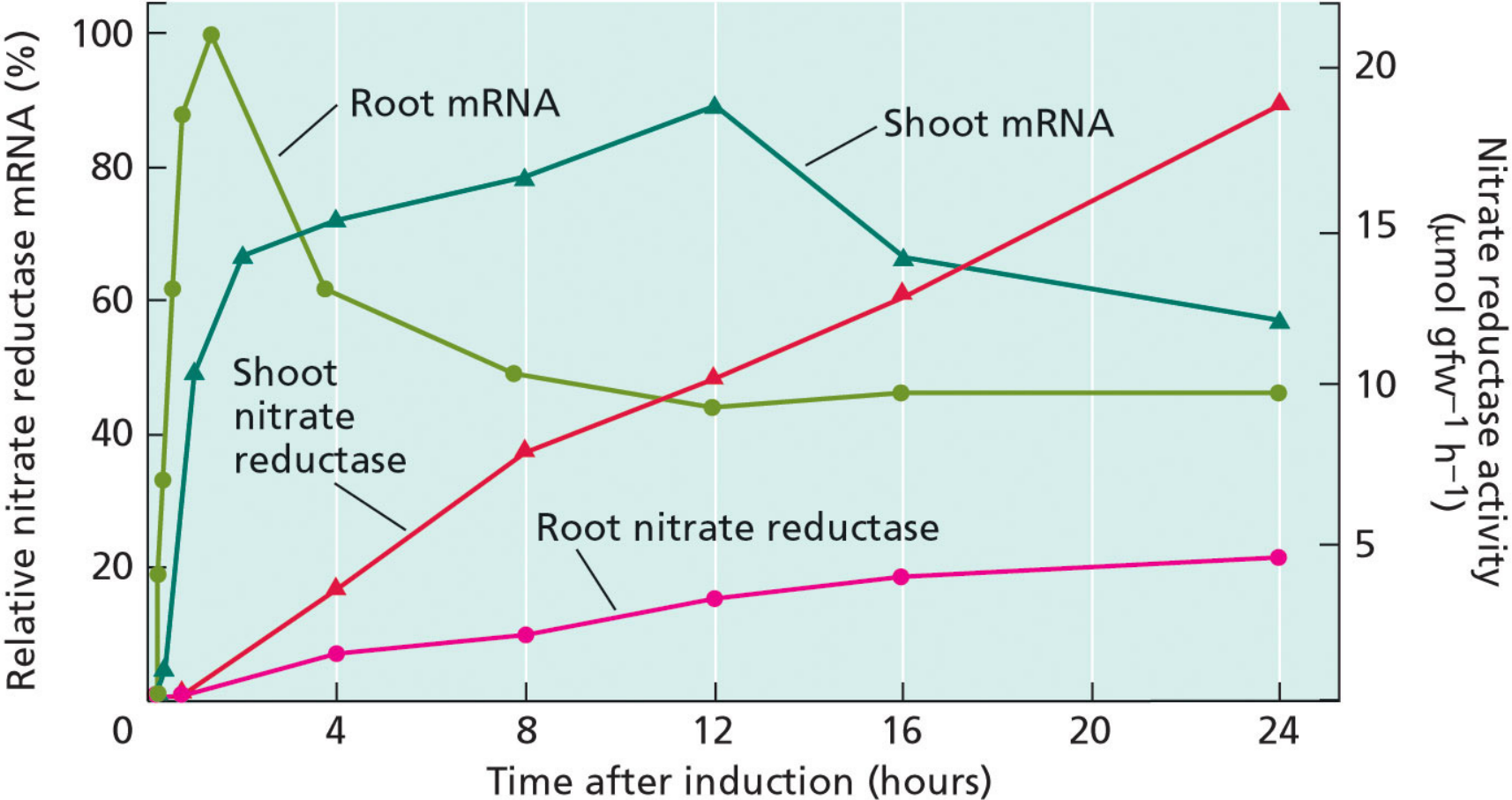
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# Fig. 4. Reduction of Nitrite to Ammonium in Chloroplasts Using Electrons Provided by the Light Reactions of Photosynthesis



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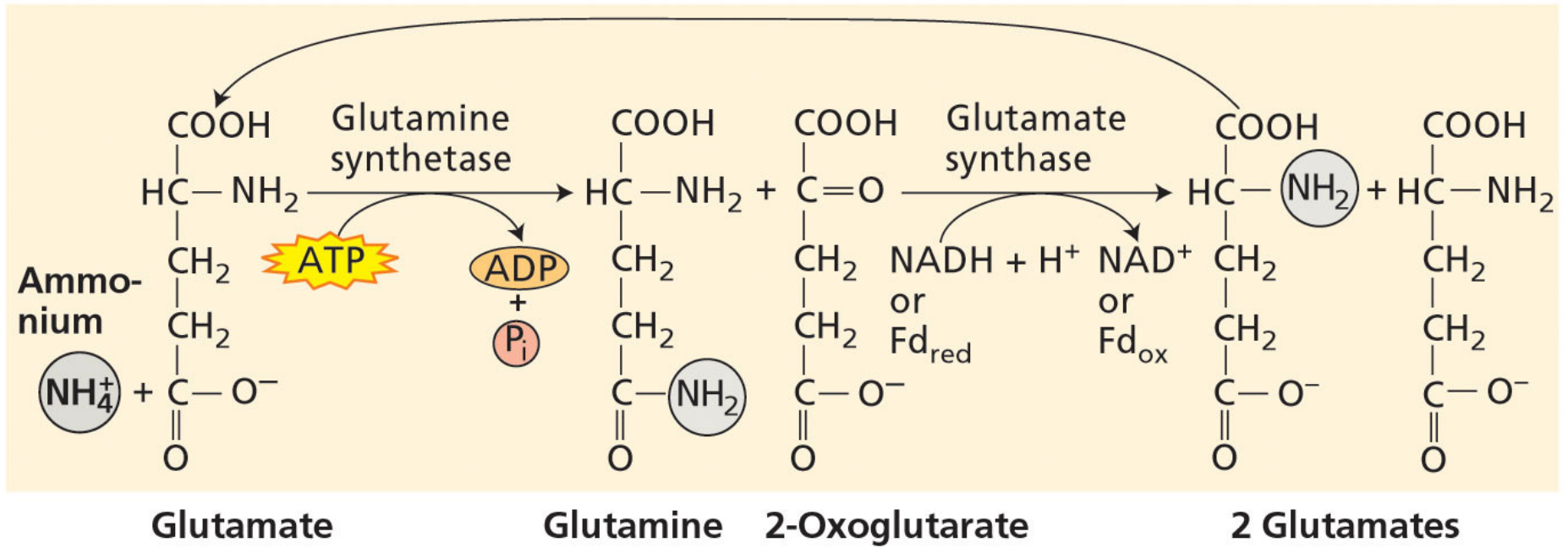
# Fig. 5. Stimulation of Nitrate Reductase mRNA and Enzyme Activity in Leaves and Roots of Barley By Nitrate Addition



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# Fig. 6. The GS-GOGAT Pathway for Ammonium Assimilation

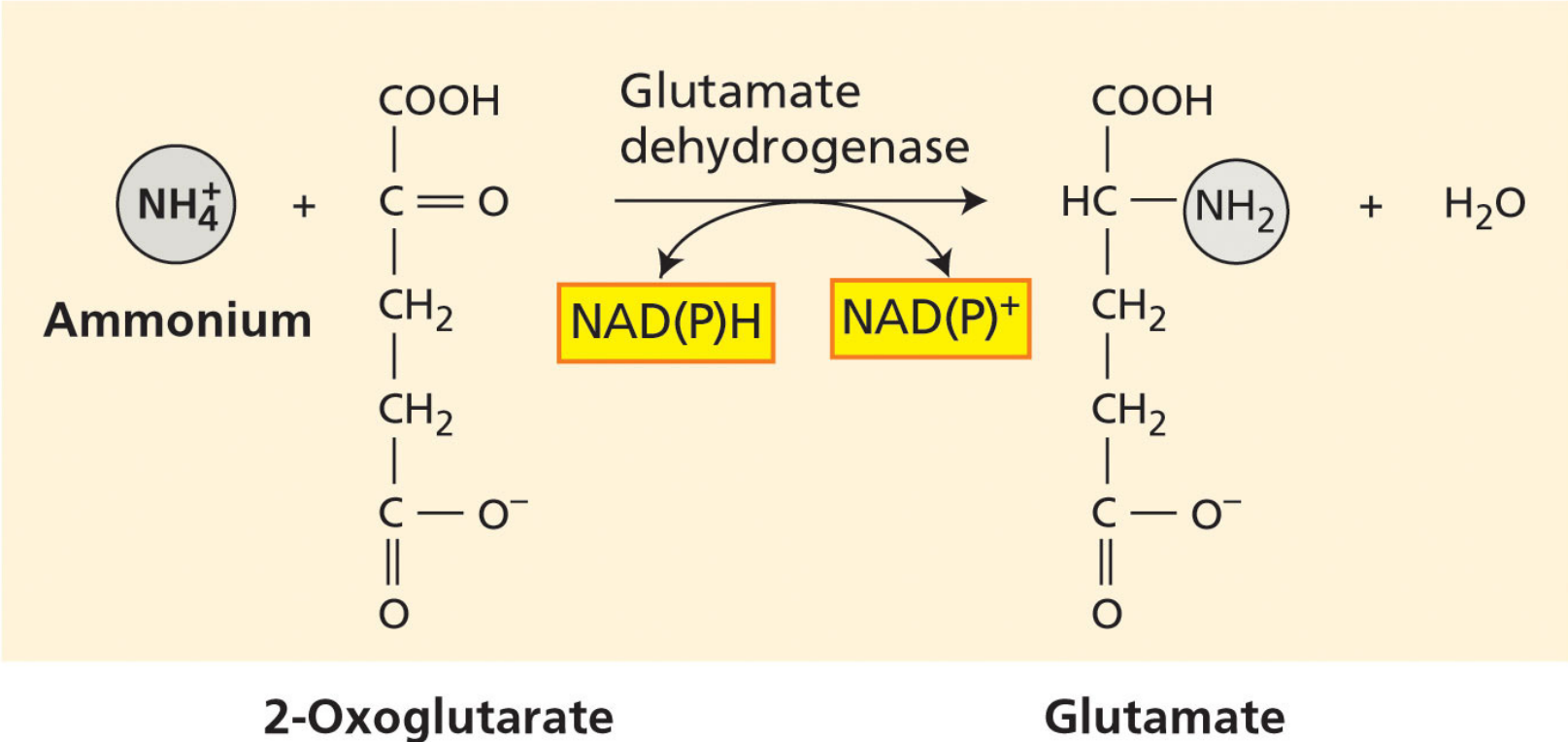
(A)



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# Fig. 7. Glutamate Dehydrogenase Pathway for Ammonium Assimilation

(B)



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Fig. 8. Model for ammonia assimilation given in Fig. 8.8 of Marschner (1995)

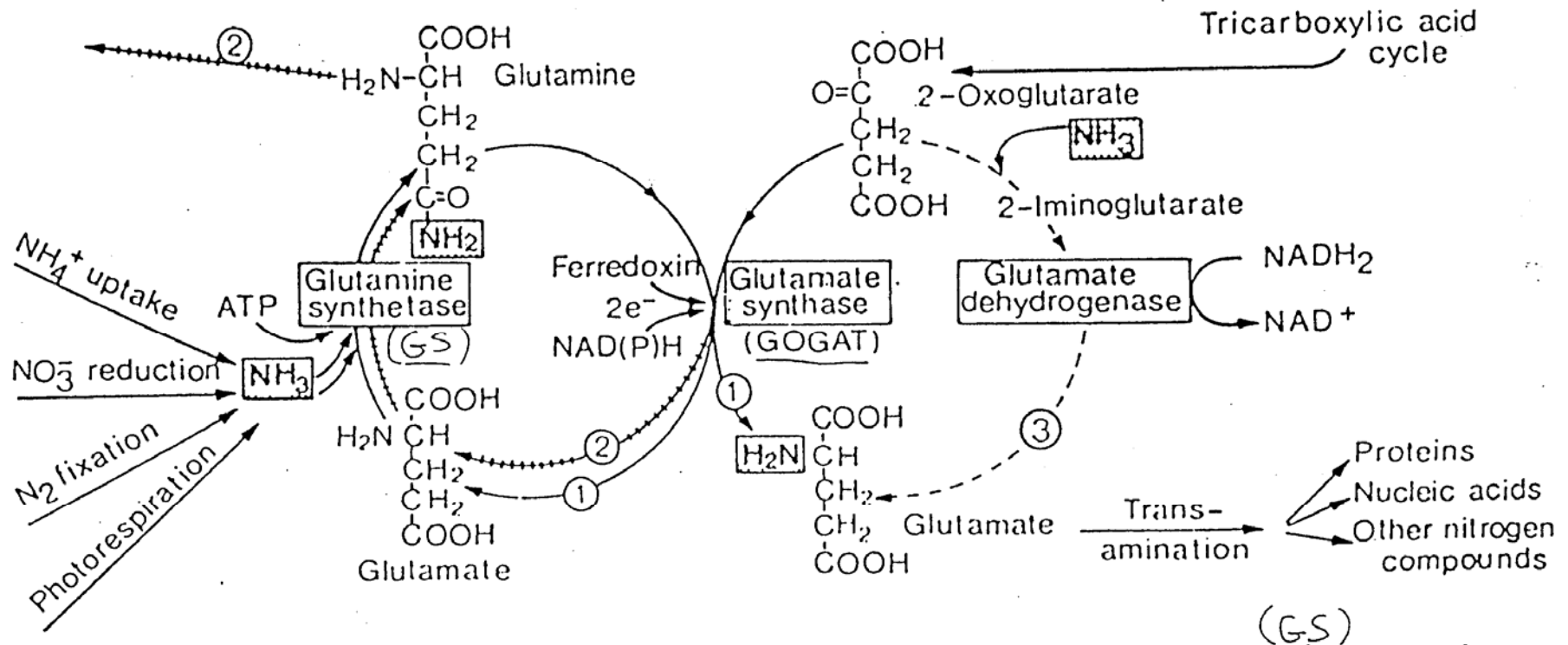
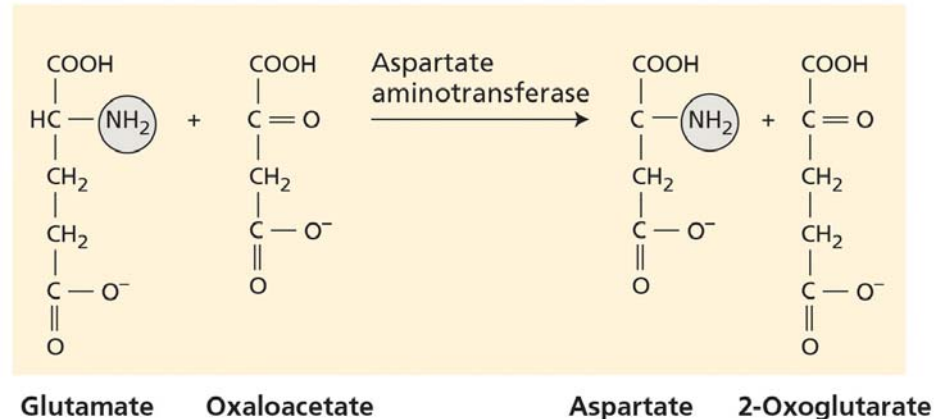


Fig. 8.8 Model of ammonia assimilation pathways. (1,2) Glutamine synthetase-glutamate synthase pathway, with low  $\text{NH}_3$  supply (1) and with high  $\text{NH}_3$  supply (2). (3) Glutamate dehydrogenase pathway. GOGAT, Glutamine-oxoglutarate aminotransferase.

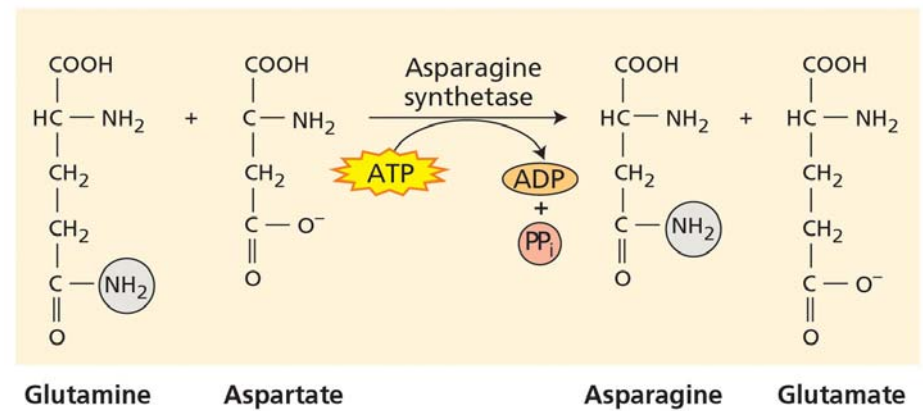
# Fig. 9. Glutamate and Glutamine Can Rapidly Be Converted to Aspartate and Asparagine, and Ultimately All Amino Acids Necessary For Protein Synthesis

(C)



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(D)



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Table 5. Oxo and Amino Acids

<b>Oxo Acid</b>	<b>Amino Acid</b>
2-oxogluterate	Glutamate
Oxalo acetate	Aspartate
Glyoxylate	Glycine
Pyruvate	Alanine
Hydroxypyruvate	Serine
Glutamate- $\gamma$ -semialdehyde	Ornithine
Succinate semialdehyde	$\gamma$ -amino-butyrate
A-keto- $\beta$ -hydroxy butyrate	Threonine