SUMMARY AND CONCLUSIONS
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Heterocystous and unicellular diazotrophic cyanobacteria are oxygenic photosynthetic organisms capable of efficient growth and multiplication at the expense of light, water and air. Much attention has been and is being focussed on these organisms in the hope that, photosynthetic reactions that generate reductant from water can be coupled to the reduction of nitrogen and protons, thus constituting a biophotolytic system in which solar energy can be used to generate the desired products NH₃ and H₂, the former as a source of nitrogen fertilizer and other industrial uses including as an easily exploitable source of H₂ and the latter mainly as a renewable source of future fuel in place of already progressively dwindling reserve of fossil fuel. Heterocysts of cyanobacteria are very efficient oxygen-protective systems for nitrogenase activity and N₂-fixation under aerobic photosynthetic conditions. The nitrogenase activity during N₂-fixation while converting N₂ to NH₃ also reduces H⁺ to H₂ under aerobic conditions. If the aerobic atmosphere is replaced by Argon or a mixture of Argon and the gases excluding N₂, the nitrogenase enzyme would function wholly and exclusively as H₂ producing enzyme at the expense of light and water. It is this unique cyanobacterial feature which has rendered them very potential photobiological source of H₂.

Heterocystous and unicellular diazotrophic cyanobacteria also contain a membrane-bound H₂ oxidizing enzyme called uptake-hydrogenase capable of efficient functioning under oxygenic photosynthetic conditions. This enzyme is found to be localized in heterocysts in heterocystous cyanobacteria and in the same cell of unicellular diazotrophic cyanobacteria which contains nitrogenase enzyme. In respect of localization of nitrogenase
enzyme and uptake-hydrogenase enzyme, unicellular forms are comparable to heterocysts of heterocystous form.

Functional significance of such common localization of the two enzymes is considered to result in optimization of N$_2$-fixation. However, much basic studies are required to understand the physiological significance of nitrogenase-uptake-hydrogenase interaction in cyanobacteria. In addition, the role of nutritional factors like carbon and nitrogen and energy factors like phototrophy and chemotrophy on relative regulation of the activities of nitrogenase and uptake-hydrogenase within, the unicells or heterocysts are almost unexplored. Furthermore, there are no genetic studies attempted to dissect out the functional interrelations of the two enzymes as well.

The present thesis has been an attempt to experimentally examine the functional interrelationship of the two enzymes in unicellular and heterocystous diazotrophic cyanobacteria in relations to genetic factors, carbon nutrition, nitrogen nutrition, phototrophy and chemotrophy.

The salient features of this study are:

1) Fixed nitrogen inhibits both nitrogenase activity and uptake-hydrogenase activity in heterocystous cyanobacteria mainly because of their inhibitory effect on heterocyst formation.

2) The activities of nitrogenase and uptake-hydrogenase within heterocyst is differentially regulated by fixed nitrogen and organic carbon.

3) Derepressed aerobic N$_2$-fixing cyanobacterial systems also become derepressed for uptake-hydrogenase system thereby indicating their common genetic and physiological regulation as well.

4) Regulatory unit responding to NH$_4^+$-repression signal seems to be distinctly different for heterocyst than that from nitrogenase system.
5) Isolated heterocysts contain nitrogenase, uptake-hydrogenase activity but lack active nitrate reductase enzyme.

6) Lack of nitrate reductase activity from heterocysts further supports the view that heterocyst is a physiologically specialized cell, mainly meant for carrying out metabolic processes capable of optimizing $N_2$-fixation.

7) The reason for localization of uptake-hydrogenase within heterocyst appears to be carbon-limited status of heterocysts.

8) Symbiotic association and chemotrophy, both conditions cause total lack of uptake-hydrogenase activity.

9) Physiological or genetical inactivation of nitrogenase activity does not seem to influence uptake-hydrogenase activity.

10) Inhibitors of photosynthesis blocks both the enzyme activities.

11) DCMU$^r$-mutant and Atrazine$^r$-mutant strains of *Nostoc muscorum* showed resistance to PSII activity in the presence of the herbicides.

12) Both the DCMU$^r$-mutant and Atrazine -mutant strains showed cross-resistant relationship.

13) The mutation to Atrazine-resistance was accompanied by the loss of uptake-hydrogenase activity.

14) The mutational loss of uptake-hydrogenase activity has resulted in $H_2$ toxicity to nitrogenase activity.

15) Uptake-hydrogenase activity has a role in regulating nitrogenase activity in *Nostoc muscorum* either by preventing $H_2$-inhibition of nitrogenase activity or through beneficial recycling of $H_2$ produced by nitrogenase during $N_2$-fixation.