Heterocysts and importance of nitrogenase

Heterocysts are the specialized cells found in nitrogen fixing cyanobacteria. These cells lack chlorophyll and have thick walls. They are the site of nitrogen fixation, for which they produce the enzyme nitrogenase. Heterocysts fix nitrogen from dinitrogen (N_2) in the air using the enzyme nitrogenase in order to provide the cells in the filament with nitrogen for biosynthesis. Nitrogenase is inactivated by oxygen, so the heterocyst must create a microanaerobic environment. Heterocysts produce three additional cells walls including one of glycolipid that forms a hydrophobic barrier to oxygen. Heterocysts usually have prominent cyanophycin granules at poles adjacent to vegetative cells.

The vegetative cells of the cyanobacteria usually obtain a fixed carbon by photosynthesis. The lack of water splitting in photosystem-II prevents

heterocysts from performing photosynthesis so the vegetative cells provide them with carbohydrates. The fixed carbon and nitrogen sources are exchanged through channels between the cells in the filament. Heterocysts maintain photosystem I allowing them to generate ATP by cyclic photophosphorylation. The heterocysts also lack Rubisco and Calvin cycle enzymes so that Co_2 fixation is limited to the vegetative cells. Thus carbohydrate has to be transported into the heterocysts probably in the form of maltose. Glucose is oxidized via the pentose phosphate pathway to yield NADPH in the reaction catalyzed by glucose-6-phosphate dehydrogenase. The ammonia produced by nitrogen fixation is assimilated by glutamine synthetase and majority of glutamine is transported to the vegetative cell where it is converted into glutamate synthase (GOGAT). The Glutamate which is formed by glutamate synthase is

returned to the heterocyst to assimilate another molecule of ammonia. In this system there is elegant division of labour. The newly fixed ammonia is rapidly assimilated into amino acids.