INTRODUCTION TO NITROGEN REDUCTION

Nitrogen is the most abundant element in earth's atmosphere. It makes up about 80% of the air around us. It is also a key component of biomolecules. Nitrogen contributes a crucial part of amino acids, which in turn make up proteins, which are the cell's machinery. Nitrogen also provides a crucial part of DNA, which transmits our genetic code and governs the expression of those proteins. Although less well known, many nitrogen-containing natural products such as alkaloids play important roles in biology.

Getting that nitrogen out of the air and into the cell is a Herculean task. Nitrogen in the air is present in its elemental form, which is diatomic nitrogen or dinitrogen, N_2. The nitrogen in biomolecules is always found individually; it is always bound to other atoms, especially carbon and hydrogen, but never to other nitrogens. That means the two nitrogen atoms in dinitrogen atom have to be cleaved apart so that they can be combined with other atoms in these useful molecules. That's a problem. N_2 is exceptionally stable. Breaking the bond between the two nitrogen atoms costs about 225 kcal/mol. Most of the other bonds in the universe are not nearly so strong.

So how do we break that incredibly strong bond and combine it with other atoms to make molecules? For most of our history, we didn't (we being people). Neither could other animals. Neither could plants. Microbes could do it all along, though.

Certain bacteria, called diazotrophs, contain an enzyme called nitrogenase that can catalytically convert dinitrogen to ammonia. Some diazotrophs, called rhizobacteria, have a symbiotic relationship with specific kinds of plant roots. They provide ammonia or amino acids to the plant and the plant provides them with organic compounds such as malate that can be metabolised to obtain energy.

$$N_2 + 6\,H^+ + 6\,e^- \rightarrow 2\,NH_3$$

All plants need nitrogen to grow, but by evolving to have this symbiotic relationship with rhizobacteria, legume plants have found a distinct advantage over others.

Other bacteria actually live on ammonia. They use it for metabolism the way other organisms use carbohydrates. In doing so, they oxidise the ammonia to nitrites the way other organisms oxidise carbohydrates to carbon dioxide.

$$NH_3 + O_2 \rightarrow NO_2^- + 3\,H^+ + 2\,e^-$$

There are even bacteria that oxidise the nitrites.

$$2\,NO_2^- + O_2 \rightarrow 2\,NO_3^-$$

Source : http://employees.csbsju.edu/cschaller/Reactivity/nitrogen/NFintro.htm