A4. Abiotic Synthesis of Nucleobases

As mentioned above, nucleobases can be made under abiotic conditions with appropriate sources of carbon molecules with nitrogen. These include hydrogen cyanide, cyanoamide (NH2CN) (along with ammonia), hydrogen cyanide, cyanogen (C2N2) and cyanoacetylene (HC3N). Cyanoamide and cyanoacetylene can both react with water to form urea and cyanoacetaldehyde, respectively. The latter two can condense to form cytosine as shown below.

Figure: Abiotic Synthesis of Cytosine

A major problem that has plagued prebiotic researchers is how the product of the carbon-oxygen compound (sugar) links to the product of the carbon-nitrogen compound (nucleobase) to form the nucleoside. Recent research by Powner et al has offered an innovative solution. Instead of forming the sugar and base in separate reaction, and then linking them covalently, the combined molecule could be synthesized in a single set of linked reactions. Inorganic phosphate serves as both a general acid/base catalyst (HA/A- in the figure below) in these new reactions in the formation of an important intermediate, 2-amino-oxazole, and as a nucleophilic catalyst.

Figure: Abiotic Synthesis of 2-amino-oxazole
Glyceraldehyde, 2-amino-oxazole, and inorganic phosphate can react to form a ribocytidine phosphate. Possible reaction mechanisms are shown below.

Figure: Abiotic synthesis of a ribocytidine phosphate without condensation of a preformed ribose and cytosine

Contributors
