SYSTEMS CHEMISTRY ASSEMBLY OF RNA AND PEPTIDES

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Introduction

The discovery that nucleotides and amino acids can both be made by cyanosulfidic chemistry [1] suggests that the assembly of these building blocks into higher order structures should be carried out in mixtures if we want to simulate how biomolecules could have come into being on early Earth. Following this logic we have discovered RNA aminoacylation chemistry that could have led to the emergence of translation.

My view of the present state of research on prebiotic RNA chemistry

I think that RNA should not be viewed in isolation, but as part of a double act with peptides. This is because nucleotides and amino acids are most plausibly made prebiotically by cyanosulfidic chemistry and because the roles of RNA and proteins in extant biology are so intertwined. I think the genetic code and translation are rooted in an early phase of synergistic macromolecular assembly from nucleotides and amino acids.

My recent research contributions to prebiotic RNA chemistry

We have focused on two aspects of RNA chemistry recently. Firstly, we have connected the cyanosulfidic chemistry synthesis of nucleotides [2] to a very specific geochemical scenario on early Earth (Fig.1).

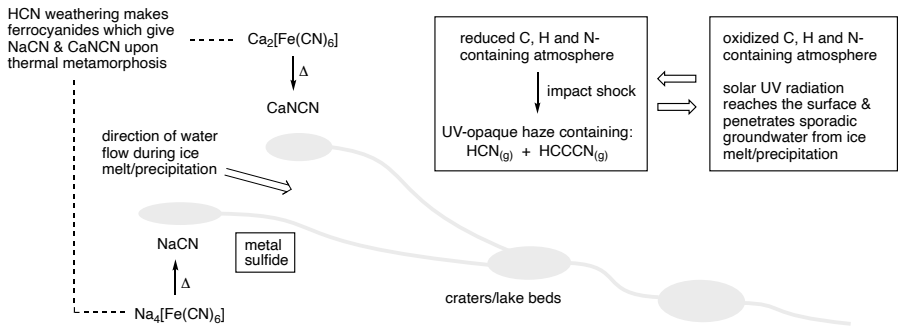

Fig. 1. Setting the stage for cyanosulfidic synthesis of nucleotides and amino acids. The chemistry would play out during and after sporadic flow of groundwater.

Secondly, we have discovered that the selectivity of aminoacylation of tRNA acceptor stem-overhang mimics by interstrand aminoacyl-transfer [3] is dependent on the sequence of the terminal three base pairs of the stem (Fig. 2). This discovery suggests how tRNAs could have been selectively aminoacylated as a prelude to the development of translation according to the genetic code.

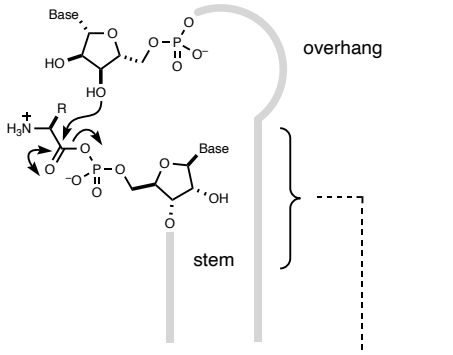

Fig. 1. Interstrand aminoacyl-transfer in an RNA acceptor stem-overhang mimic.

Outlook to future developments of research on prebiotic RNA chemistry

I think that clues from experimental chemistry will allow us to describe an ever more detailed geochemical scenario that drove multistep organic synthesis of building blocks destined to become biological on early Earth. I further think that translation and the synthesis of loosely coded peptides comprising about half the canonical amino acids must have been a very early process. Recapitulation in the laboratory should one day allow us to create living systems from feedstock molecules such as hydrogen cyanide, hydrogen sulfide, cyanoacetylene and inorganic phosphate.

Acknowledgments

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References

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