DOING BIOLOGICAL INFORMATION DIFFERENTLY. TWO BIOPOLYMER ALIEN LIFE FORMS.

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Introduction: A challenge associated with detecting life in NASA missions arises because any life that we are likely to encounter will almost certainly be billions of years removed from its origins. Thus, the molecular biology of found alien life need not directly reflect its origins, although it might contain vestiges of an original molecular biology that would.

For example, the complex three biopolymer system used in today's *terran* life, where proteins encoded in DNA create most selectable phenotypes only after information transfer using mRNA, was almost certainly *not* the original Darwinian system. However, the structure of adenine found in terran DNA and RNA (and its missing third hydrogen bonding moiety) might reflect the constraints of prebiotic chemistry that began Darwinism on Earth.

Today's 3-biopolymer system presumably arose via a series of accidents that added proteins to pre-existing RNA catalysts, eventually displacing them. However, natural history could have proceeded differently, even on Earth. Instead of inventing a new biopolymer (protein), the RNA world could have enhanced the intrinsic capabilities of its RNA catalysts by expanding their number of independently replicable nucleotides, adding protein-like functionality to these, and evolving a two-biopolymer system where DNA was optimized for genetics and RNA was optimized for catalysis.

Indeed, the presence of modified and functionalized nucleosides in terran tRNA and rRNA suggests that this avenue of improvement was tried before it was abandoned after translation was invented. However, on other worlds, this alternative natural history might have been pursued to yield a very different molecular biology that we might find hard to recognize.

These historical choices have consequences. For example, the 3-biopolymer life form familiar in terran biology has no chemical mechanism to allow reverse translation; no chemistry exists to allow a protein molecule that has discovered a useful phenotype to directly generate a gene that encodes it. Rather, evolution of the terran 3-biopolymer system requires the death of individuals that lack the gene for a useful protein. For any species that births only a few children and devotes considerable resources to each of these, this can be a seriously inefficient way to solve biological problems.

In contrast, a two biopolymer system that creates catalytic RNA molecules from DNA molecules optimized tto "do" genetics could easily support a reverse translation process that allows a phenotypically useful RNA molecule to direct the synthesis of its own gene. This offers the potential for "Lamarckian" evolution of a sort. Indeed, one can conjecture that if RNA catalysis can be made sufficiently robust expansion in functionalization of the RNA genetic alphabet such life would be more successful than life based on Earth's cumberson 3-biopolymer molecular biology.

The only way to address this conjecture is by experiment. Here, we will report recent work to synthesis a 2-biopolymer evolvable system and studies on it.

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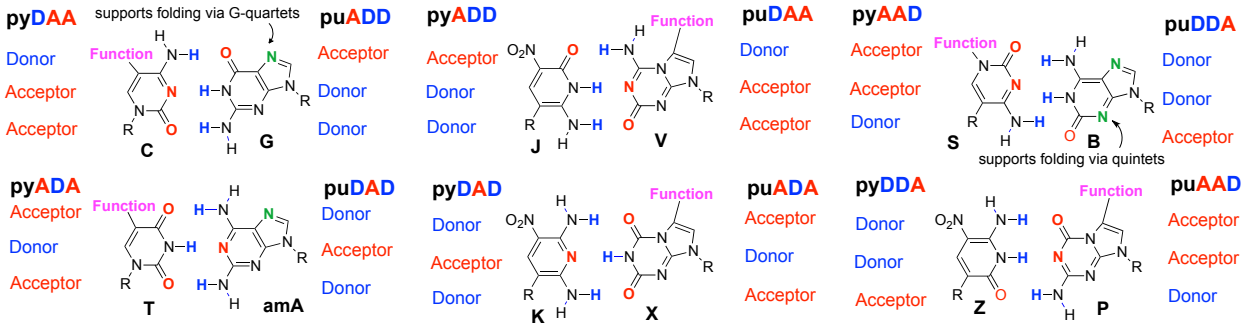

Expanded RNA optimized to carry protein-like functional groups, to encourage tertiary folding, and to otherwise be optimized for catalysis, even as it retains the potential for Watson-Crickery, including direct synthesis for expanded DNA systems and the direction by useful RNA molecules for the synthesis of encoding DNA genes.