

RNA ligation and the origin of tRNA.

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A straightforward origin of transfer RNA, (tRNA), is difficult to envision because of the apparently complex idiosyncratic interaction between the D-loop and T-loop. Recently, multiple examples of the T-loop structural motif have been identified in ribosomal RNA. These examples show that the long-range interactions between the T-loop and D-loops seen in tRNA are not an essential part of the motif but rather are facilitated by it. Thus, the core T-loop structure could already have existed in a small RNA prior to the emergence of the tRNA. The tRNA might then have arisen by expansion of an RNA that carried the motif. With this idea in mind, Di Giulio's earlier hypothesis that tRNA evolved by a simple duplication or ligation of a minihelix RNA was re-examined. It is shown that an essentially modern tRNA structure can in fact be generated by the ligation of two 38-nucleotide RNA minihelices of appropriate sequence. Although rare, such sequences occur with sufficient frequency, (1 in 3×10^7), that they could be found in a standard in vitro RNA selection experiment. The results demonstrate that a series of RNA duplications, as previously proposed, can in principal account for the origin of tRNA. More generally, the results point out that RNA ligation can be a powerful driving force for increased complexity in the RNA World.

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