Evolution of the division of labor between genes and enzymes in the RNA world

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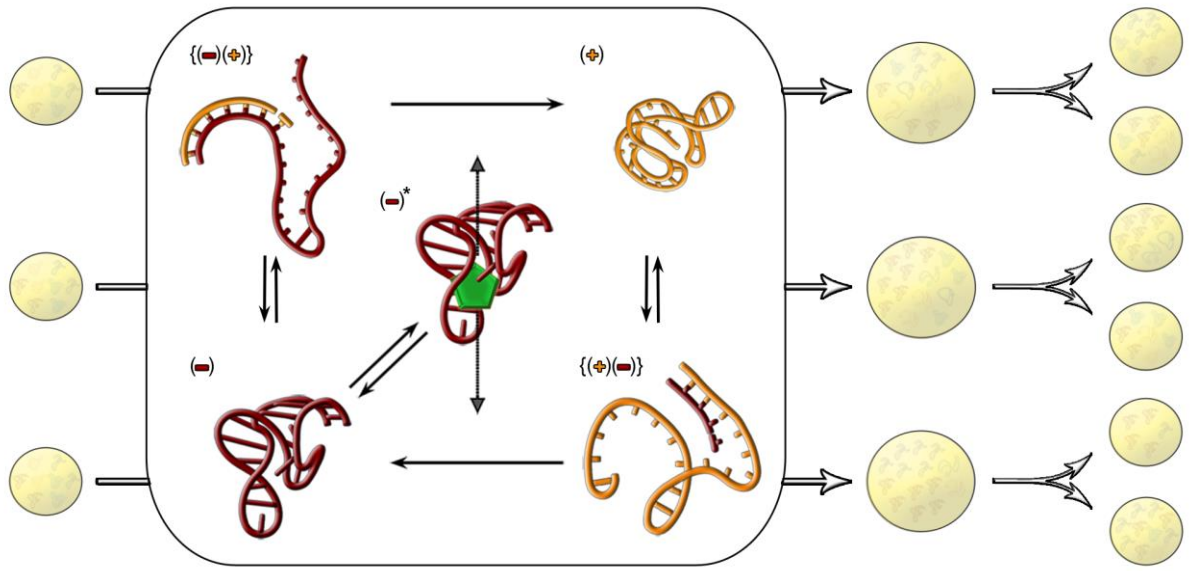
The RNA world is a very likely interim stage of the evolution after the first replicators and before the advent of the genetic code and translated proteins. Ribozymes are known to be able to catalyze many reaction types, including cofactor-aided metabolic transformations. In a metabolically complex RNA world early division of labor between genes and enzymes could have evolved, where the ribozymes would have been transcribed from the genes more often than the other way round, benefiting the encapsulating cells through this dosage effect. Here we show, by computer simulations of protocells harboring unlinked RNA replicators that the origin of replicational asymmetry producing more ribozymes from a gene template than gene strands from a ribozyme template is feasible and robust. Enzymatic activities of the two modeled ribozymes are in trade-off with their replication rates, and the relative replication rates compared to those of complementary strands are evolvable traits of the ribozymes. The degree of trade-off is shown to have the strongest effect in favor of the division of labor. Although some asymmetry between gene and enzymatic strands could have evolved even in earlier, surface-bound systems, the shown mechanism in protocells seems inevitable and under strong positive selection. This could have preadapted the genetic system for transcription after the subsequent origin of chromosomes and DNA.[1]



References:

[1] Boza G, Szilágyi A, Kun Á, Santos M, Szathmáry E. Evolution of the Division of Labor between Genes and Enzymes in the RNA World. *PLoS Comput Biol* 2014, **10**(12): e1003936. doi:10.1371/journal.pcbi.1003936