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Numeric structure of genetic code in natural evolution: energy insight

Moldavanov A.
2774 Sunnybridge Drive, Burnaby, Canada
trandrei8@gmail.com

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Motivation and Aim: Earlier was shown that the process of energy evolution in open thermodynamic system (OTS) is characterized by occurrence of the k dissimilar evolutional scenarios [1]. On other hand, it is well known the critical role that the preferable nucleotides such as adenine (A), cytosine (C), guanine (G) and thymine (T) with segregated energy signatures play in assembly of deoxyribonucleic acid (DNA). So, the aim is to find the mechanism to reconcile coexistence of preferable nucleotides with structuring of energy evolution and support the known numeric appearance 64 (20) for total number of possible unique combinations in genetic code (GC).
Methods and Algorithms: This research is based on found analytic solution for interplay between two different stochastic processes. The first process is the flow of random quadruplets of DNA nucleotides A, C, G, T while the second one is permanent reproduction of structuring in process of energy exchange in DNA.
Results: It was shown that process of energy development in OTS features the discrete spectrum, where the special role belongs to first three harmonics that come as points of bifurcation (*PoB*) [2]. So, from an energy standpoint, process of exchange in DNA's assembly can be described from two angles. On one hand, DNA's assembly comes as a random codon-based realization of flow of 4 preferable nucleotides. On other hand, effective evolution is only possible if taken energy phase resides within the 3-part bifurcation area. Hence, we have to find a compromising solution for coexistence of 4 nucleotides within 3 acceptable *PoB* areas. As a result, in combinators terms we come to a classic problem for placement of 4 "balls" (nucleotides A, C, G, T) over 3 "bins" (*Phase 1, Phase 2, Phase 3*) as shown in the Figure. If order of "balls" is important, then solution for numerical structure of *GC* yields the total number of 64 unique codon combinations, otherwise of 20. So, we see that each evolutionary step is accompanied by realization 1 out of 64 (20) unique combinations, which squeezes available chemicals A, C, G, T into the *PoB* triplet (Fig. 1).

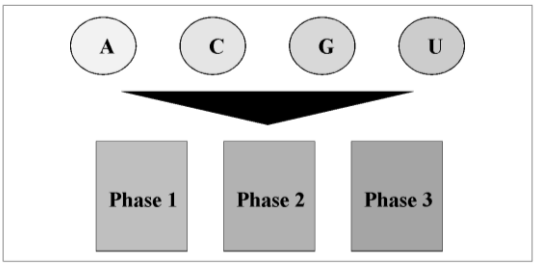

Fig. 1. Schematic setup for draw in placement of 4 nucleotides (A, C, G, U) over 3 available energy phases of different evolutional context (*Phase 1, Phase 2, Phase 3*)

Conclusion: Above results give a key for understanding of the possible way for forming of the known numerical structure of GC. The 64 (20)-scenario matrix comes as the work-horse for practical realization of GC algorithm. Nature drives above matrix repeatedly, creating codon chains from the quite limited number of available elements.
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