The essence of genetic code – Part 1

Miloje M. Rakočević
University of Niš, Faculty of Sciences and Mathematics, Department of Chemistry,
Višegradska 33, 18000 Niš, Serbia

Abstract. The paper presents the properties of the genetic code, as follows. First, the genetic code has not evolved, but was pre-biotically complete, in terms of constituents: four Py-Pu bases and 20 amino acids (MMR, 2004). Hence, it is not degenerate but is generated as such: the genetic code as a chemical-biological-semiotic unity.

Keywords: Genetic code, Amino acids, Mirror symmetry.

The fact that in the genetic code there is a mirror symmetry of subsets of amino acid molecules (of the number of atoms in them), independent of their chemical properties (Solutions 1and 2)[1], supports the hypothesis[2] that the key, that is essential[3] property of the genetic code is not only chemical-biological unity, than more broadly: chemical-biological-semiotic unity.

[010/101 as 2 / 5] [(3 x 2 and 2 x 5)]:

00-11-22 / 22-11-00 → 00 -11- 22 -11-00 →
→ **02, 13, 24, 16, 05**

..... Solution (1)

01G 01	02A 04	+	11N 08	12D 07	=	20
03V 10	04P 08	+	13S 05	14T 08	=	31
05I 13	06L 13	+	15C 05	16M 11	=	42
07K 15	08R 17	+	17F 14	18Y 15	=	61
09Q 11	10E 10	+	19W18	20H 11	=	50
(51±1)			(51±1)		00 / 01 01 / 10	

..... Solution (2)

[1] Details of the explanation of the order of amino AAs by chemical similarity in Solution 2 are given in: MMR, 2019. Table 2, p. 14.

[2] I indicated in the *Synopsis* that this group of planned papers will be in hypothesis status. [DOI 10.31219/osf.io/me8sj]

[3] "… the existence of such a harmonic structure with unity of a determination with physical–chemical characteristics and atom and nucleon number at the same time appealed to Aristotle and to his idea of unity of form and essence" (MMR, 2004, p. 233).

Alanine stereochemical type:	Non-alanine st. types:
less complex: AL, KR, FY	less complex: G
more complex: DE, NQ, HW	more complex: P
middle coml. : SC, TM	middle coml. : V-I

….. Solution (3)

$[A_{04}L_{13} + (D_{07}N_{08}+E_{10}Q_{11}) + (F_{14}Y_{15} + H_{11}W_{18})] = 111 \pm 0$
$[G_{01}V_{10} + (S_{05}C_{05}+ T_{08}M_{11}) + (D_{07}N_{08}+E_{10}Q_{11}) + A_{04}L_{13} + F_{14}Y_{15}] = 122 \pm 0$
$[(G_{01}V_{10} + P_{08}I_{13}) + T_{08}M_{11} + K_{15}R_{17} + E_{10}Q_{11} + F_{14}Y_{15}] = 133 \pm 0$
$[(A_{04}L_{13} + K_{15}R_{17}) + (F_{14}Y_{15} + H_{11}W_{18}) + (D_{07}N_{08}+E_{10}Q_{11})] = 144–1$

... Solution (4)

Genetic code, generated in a strict relation to the chemical code[4] in many ways possesses specific uniqueness. Some of the examples of that uniqueness are presented in Solutions (1 to 4.)[5]

The representation of the ordinal numbers of amino acids (in Solution 2) by means of mirror symmetry of the Dirac type[6] could be considered numerology if the mirror symmetry of the number of atoms were not presented above; also if one did not know about the regularities that connect the ordinal number of amino acids and the number of atoms in amino acid molecules (MMR, 2019, Fig. 4, p.22)

As we can see, not only zeros (0) and ones (1) are mirrored, but also number "1" (01) and number "2" (10) (Solution 2, bottom right). Nature as such therefore reads, at least in the case of natural codes, genetic and chemical code, the binary number system and the decimal number system, each separately, but also in their unity.

[4] Analogies of genetic and chemical code (MMR, 2018a, 2018b).

[5] The classification of AAs into four stereochemical types (Solution 3) belongs to Popov (1989), while the further classification is ours.

[6] Dirac type of mirroring: electron / proton; or electron / positron.

If the order is read AAs in columns of two decades, then it is also the order of numbers from a series of odd and a series of even numbers. This also applies to codons, if this order is read through p-adic mathematics (Dragovich, 2011; Dragovich et al, 2006-2021). This further indicates the need for the GC Table to be viewed in three dimensions (Eigen & Schuster, 1998; Swanson 1984; Rakočević, 1994, Fig. 4.1, p. 54). On the other hand, when p-adic mathematics is known to be based on the ratio of primes and the set of natural numbers, and this relationship is also found in the Periodic System of the Elements (Determination by Lucas series) (Trifonov & Dmitriev, 1981)[7], then we have another proof of the strict relationship between GC and PSE; that is, between the genetic code and the chemical code. From the third side, the fact that the Periodic System is determined by the relationship among prime numbers and natural numbers, is also a proof that the PSE is not only physical-chemical unity, than more broadly: physical-chemical-semiotic unity. [If so, then it is understandable whence semiosis in the genetic code. science.][8] Had it not been for Ferdinand de Saussure and Charles Sanders Peirce who saw the inevitability of the existence of semiology or semiotics, today we would have to set out in search of such a science.]

[7] Lucas's series is in relation to the Fibonacci series, so we can also say that Trifonov and Dmitriev also showed the determination of the PSE by the Golden mean. Of another way of determining PSE directly by Golden mean comes from us (MMR, 1998a).

[8] Barbieri, 2008, in Conclusion: "The major conclusion of this review is that biological semiosis is a reality because semiosis is based on codes, and organic codes are experimental realities. An equivalent formulation is that all living creatures are semiotic systems because organic codes exist in all of them.";

MMR, 2018a, pp. 30-31: "Rumer (1966) suggests that encoding by dinucleotide aggregations is mediated by 'grammatical' formalism (the relation between words and the root of the word), semantics (one-meaning and multy-meaning codon families) and by semiology, i.e. semiotics (the classification of nucleotide doublets after the number of their hydrogen bonds which appear here as 'signifiant' and 'signifié' (signifier and signified) at the same time, that is as their unity (De Saussure, 1985, p. 99)."

Golden mean determination

F_{14}				Y_{15}
L_{13}				A_{04}
Q_{11}		60	66	N_{08}
P_{08}				I_{13}
T_{08}				M_{11}
S_{05}				C_{05}
G_{01}				V_{10}
D_{07}				E_{10}
K_{15}		78		R_{17}
H_{11}				W_{18}

Table 1/ Table 2. (MMR, 1998)

F	14		15	Y
L	24	(65)	12	A
Q				N
P	16		24	I
T		(61)		M
S	06		15	C
G				V
D	22		27	E
K		(78)		R
H	11		18	W

(66 -1) / (60+1) / 78±0

Notice the mirroring with Tab. 3:
65-61-78 / 78-61-65

Table 1 (on the left). „The Cyclic Invariant Periodic System (CIPS) of canonical AAs. ... at the index – the atom number within amino acid side chains. In the middle position there are chalcogene AAs (S, T & C, M); follow – in next "cycle" – the AAs of non-alanine stereochemical types (G, P & V, I), then two double acidic AAs with two their amide derivatives (D, E & N, Q), the two original aliphatic AAs with two amine derivatives (A, L & K, R); and, finely, four aromatic AAs (F,Y & H, W) – two up and two down. The said five classes belong to two superclasses: primary superclass in light areas and secondary superclass in dark areas. Notice, that each amino acid position in this CIPS is strictly determined and none can be changed" (Rakočević, 2011, Figure 6, p. 832).

Table 2 (on the right). "Table is generated from [Table 1] with … a new amino acid grouping. In relation to [Table 1], instead 60, 66, 78 atoms here are (60+1), (66-1) and 78±0 of atoms." (arXiv:0903.4110 [q-bio.BM], Tab. 13, p. 13).

Golden mean determination

F_{14}				Y_{15}
L_{13}				A_{04}
Q_{11}		60	66	N_{08}
P_{08}				I_{13}
T_{08}				M_{11}
S_{05}				C_{05}
G_{01}				V_{10}
D_{07}				E_{10}
K_{15}		78		R_{17}
H_{11}				W_{18}

Table 1/ Table 3. (MMR, 1998)

F_{14}		Y_{15}
L_{13}	(78)	A_{04}
K_{15}		R_{17}
P_{08}		I_{13}
T_{08}		M_{11}
	(61)	
S_{05}		C_{05}
G_{01}		V_{10}
D_{07}		E_{10}
Q_{11}	(65)	N_{08}
H_{11}		W_{18}

Table 3 (on the right). “Table is generated from [Table 1] with … a new amino acid grouping. In relation to [Table 1], instead 60, 66, 78 atoms here are (60+1), (66-1) and 78±0 of atoms.”

0	$11 \times 1 = 11$ $11 \times 2 = 22$ $11 \times 3 = 33$	$11 \times 1 = 11$ $11 \times 2 = 22$ $11 \times 3 = 33$	$11^2 = 121$
1	$12 \times 1 = 12$ $12 \times 2 = 24$ $12 \times 3 = 36$	$21 \times 1 = 21$ $21 \times 2 = 42$ $21 \times 3 = 63$	$12^2 = 144$ $21^2 = 441$
2	$13 \times 1 = 13$ $13 \times 2 = 26$ $13 \times 3 = 39$	$31 \times 1 = 31$ $31 \times 2 = 62$ $31 \times 3 = 93$	$13^2 = 169$ $31^2 = \overline{961}$
3	$14 \times 1 = 14$ $14 \times 2 = 28$ $14 \times 3 = ?$	$41 \times 1 = 41$ $41 \times 2 = 82$ $41 \times 3 = ?$	$14^2 = 196$

Table 4. Logical square of symmetric inversion within decimal number system. Full cyclicity and symmetry (with different digits) is realized only with the numbers 12/21 and 13/31, and their products by numbers 2 and 3, within the set of two-digit natural numbers (MMR, 1994, p. 235). [*Additional note* (2021.12.21): When in the sum of the number of atoms (Solution 4): 111, 122, 133; 144-1, read the first two digits, then we notice the correspondence with the patterns of the unique mirroring given here: 11/11; 12/21; 13/31; 14/41.]

References

Barbieri, Marchelo, 2008. Biosemiotics: a new understanding of life, Naturwissenschaften DOI 10.1007/s00114-008-0368-x

Dragovich, Branko, 2012. p-Adic Structure of the Genetic Code; in arXiv:1202.2353 [q-bio.OT].

Dragovich, B., Dragovich, A., 2006. p-Adic Model of DNA Sequence and Genetic Code, arXiv:q-bio/0607018v1 [q-bio.GN].

Dragovich B, Dragovich A.Y. (2009) A p-adic model of DNA sequence and genetic code. P-Adic Numbers, Ultra-metric Analysis, and Applications, 2009 Mar 1;1(1):34-41.

Dragovich, B., Dragovich, A. (2010) P-adic modeling of the genome and the genetic code. Comput. J. 53 (4), 432–441; arXiv:0707.3043 [q-bio.OT].

Dragovich, B., Khrennikov, A.Yu., Mišić, N.Ž., 2017. Ultrametrics in the genetic code and the genome. Appl. Math. Comput. 309, 350–358; arXiv:1704.04194 [q-bio.OT].

Dragovich B, Misic N.Z. (2019) p-Adic hierarchical properties of the genetic code. Biosystems, Nov 1;185:104017.

Dragovich, Branko., Khrennikov., Andrei Yu., Kozyrev, Sergei V., Mišić., Nataša Ž., 2021. *p*-Adic mathematics and theoretical biology, BioSystems, 199, 104288.

Eigen, Manfred; Schuster, Peter, 1979. The Hypercycle – A Principle of Natural Self-Organization, Springer, Berlin.

Popov, E. M., 1989. Strukturnaya organizaciya belkov, Nauka, Moscow.

Rakočević, M. M., Jokić, A., 1996. Four stereo chemical types of protein amino acids: synchronic determination with chemical characteristics, atom and nucleon number. J. Theor. Biol. 183, 345 – 349.

Rakočević, M.M., 1998a. The genetic code as a Golden mean determined system, Biosystems, 46, 283–291.

Rakočević, M.M., 1998b. The harmony of periodic system of chemical elements, Flogiston, 7 (Belgrade), 169-183 (in Serbian with an extended English summary).

Rakočević, M.M., 2004. A harmonic structure of the genetic code. J. Theor. Biol. 229, 221–234.

Rakočević, M.M., 2011. Genetic code as a coherent system, NeuroQuantology, 9 (4), 821–841. http://www.rakocevcode.rs

Rakočević, M.M., 2018a. The Cipher of the Genetic Code, BioSystems 171 (2018) 31–47.

Rakočević, M. M., 2018b. Analogies of Genetic and Chemical Code, Polyhedron, 153, 292–298.

Rakočević, M.M., 2019. Protein amino acids as a complete (periodic) system, Chemia Naissensis, Vol 2, Issue 1, pp. 1-43.
hhttps://www.pmf.ni.ac.rs/chemianaissensis/archives/volume-2-number-1-2019/.

Rakočević, M.M., 2021a. System-directed pairing of protein amino acids, OSF Preprints (Part I: DOI 10.31219/osf.io/bpqzt and Part II: DOI 10.31219/osf.io/suwzn

Rakočević, M.M., 2021b. A new type of mirror symmetry in the set of protein amino acids. arXiv:2108.01563 [q-bio.BM]

Rakočević, M.M., 2021c. Genetic code: the unity of chemism and semiosis, A hypothesis (Synopsis) DOI 10.31219/osf.io/me8sj

Rumer, Yu. B., 1966. O sistematizacii kodonov v geneticheskom kode, Doklady. Akad. Nauk. SSSR 167, 1393–1394.

Shcherbak, V. I., 1994. Sixty-four Triplets and 20 Canonical Amino Acids of the Genetic Code: The Arithmetical Regularities. Part II. J. Theor. Biol. 166, 475-477.

Swanson, R., 1984. A unifying concept for the amino acid code. Bull. Math. Biol. 46, 187–207.

Trifonov, D.N. & Dmitriev, I.S., 1981. O kolichestvennoi interpretacii periodicheskoi sistemi, in: Uchenie o periodichnosti, Nauka, Moskva, 1981.