Polyhedron 153 (2018) 292–298

Contents lists available at ScienceDirect

Polyhedron

journal homepage: www.elsevier.com/locate/poly

Analogies of genetic and chemical code

Miloje M. Rakočević

Department of Chemistry, Faculty of Science, University of Niš, Serbia

ARTICLE INFO

Article history:
Received 10 March 2018
Accepted 2 July 2018

Keywords:
Genetic code
Periodic system of chemical elements
Chemical code
Lanthanides
Protein amino acids

ABSTRACT

Starting from a previously established hypothesis on the existence of "the coherence of the chemical and genetic code" (Rakočević, 1991), new facts and new insights on the existence of essential analogies of the genetic and chemical code are presented. Among other relations, it appears a correspondence between the distribution of codons in the GC Table and the distribution of chemical elements in the PSE with respect to their even/odd parity and stability/instability of the isotopes. Also, based on the significant mathematical expressions a new essence of coding formalism in natural codes is showed.

1. Preliminaries

The reason why the possible analogies between mathematics of the Genetic code (GC) and mathematics of the Periodic system of chemical elements (PSE) have not been previously noted, lies in the fact that all 14 lanthanides are placed in the third group of PSE, i.e. at the same position as Lanthanum. However, this is in disagreement with Mendeleev's approach that every element in the PSE should have its own position. Namely, the book of B.M. Kedrov ([1], p. 188, Table 16) contains a variant of Mendeleev's Periodic Table, in which Mendeleev has not formally indicated the groups, but it is evident that each element occupies one position. In that Table, Lanthanum is located in the third group, Cerium in the fourth group and so consequently all other 13 elements, although two elements (Pm and Lu) were not known in Mendeleev's time. [Some Mendeleev's manuscript Tables can be seen in my website, http://www.rakocevcode.rs].[1]

This problem with lanthanides' positions in the PSE is still actual, because IUPAC (International Union of Pure and Applied Chemistry) has launched recently a new research project which should determine whether Lanthanum (with atomic number 57) or Lutetium (the last lanthanide, with atomic number 71), should be written in 3rd group of the formal Table of PSE (Appendix A).

Following Mendeleev's methodology, it was possible to show that the 14 lanthanides require exposition into 14 groups of the PSE. Then, together with the zeroth group, there are 15 groups [5] (Table 1 in this paper). If we have such an arrangement, then it is easy to recognize not only arithmetical but also some algebraic regularities in the PSE. In a previous work [5] we proposed a hypothesis that the PSE of the short period groups corresponds to the Boolean cube as well as the PSE of the long period groups corresponds to the Boolean hypercube; the role of the 16th group in such a case (in a cyclic ordering) plays either zeroth group or the first group.

In fact we mainly pay attention to this *chemical code*, because it is an analog of the *genetic code*.[2] [Mendeleev also entered the elements of the first group – Copper, Silver and Gold – twice, at the beginning and at the end of the PSE ([1], p. 128, photocopy XII).][3]

2. New insights

In Table 1 (in relation to Survey 1) it is shown that for [(s & p), d, f] elements, to the stability/instability border in PSE (to the Po, as 84th element), we have 8 times the pattern 5-3-1; then 2 times the pattern 0-3-1 and 4 times the pattern 0-0-1. Altogether 9-4-1 elements: 9 elements 8 times; 4 elements 2 times and 1 element

E-mail address: mirkovmile@mts.rs.
URL: http://www.rakocevcode.rs.

[1] There was, however, an attempt to "integrate" the lanthanides into the Periodic system, by Charles Janet 1849–1932), so each of them was in a separate group Appendix B). Unfortunately, it was only in our time recognized that Charles Janet was "unrecognized genius of the Periodic System" [11].

[2] "... the chemical code, built on the very principles mentioned and in complete accordance with the genetic code. ... All the relations in the chemical code and the genetic code are in accordance with periodicity and cyclicity of the natural number system ..." ([5], p. 1).

[3] In this paper, we will deal with only the standard genetic code, with the 20 canonical protein) amino acids, and all other variants of the genetic codes will be considered as "deviant codes" ([13], pp. 568–569; [2], p. 49).

https://doi.org/10.1016/j.poly.2018.07.004
0277-5387/

Table 1
Periodic system of chemical elements with 14 lanthanides in 14 groups (Table 4.2 in: [5], or Table 18 in: [6].

rows	periods	groups	I	II	III	IV	V	VI	VII	0	VIII	IX	X	XI	XII	XIII	XIV
			a b c	a b c	a b c	a b c	a b c	a b c	a b c	a	b c	b c	b c	c	c	c	c
1	1	a							H 1	He 2							
2	2	a	Li 3	Be 4	B 5	C 6	N 7	O 8	F 9	Ne 10							
3	3	a	Na 11	Mg 12	Al 13	Si 14	P 15	S 16	Cl 17	Ar 18							
4	4	a	K 19	Ca 20	b Sc 21	Ti 22	V 23	Cr 24	Mn 25		Fe 26	Co 27	Ni 28				
5		b	Cu 29	Zn 30	a Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36							
6	5	a	Rb 37	Sr 38	b Y 39	Zr 40	Nb 41	Mo 42	Tc 43		Ru 44	Rh 45	Pd 46				
7		b	Ag 47	Cd 48	a In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54							
8		a	Cs 55	Ba 56	b La 57	c Ce 58	Pr 59	Nd 60	Pm 61		Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68
9	6	c	Tm 69	Yb 70	c Lu 71	b Hf 72	Ta 73	W 74	Re 75		Os 76	Ir 77	Pt 78				
10		b	Au 79	Hg 80	a Tl 81	a Pb 82	Bi 83	Po 84	At 85	Rn 86							
		a	Fr 87	Ra 88	b Ac 89	c Th 90	Pa 91	U 92	Np 93		Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100
	7	c	Md 101	No 102	a Lr 103	a Ku 104	Ns 105	106	107		108	109	110				
		b															

Note: in the 7th period before of **Lr** instead "a" should stand "c", and before of **Ku** should be "b".

4 times; the patterns 9-4-1 and 8-4-2 as unique and very specific mathematical expressions (Eq. (1)).

$$(1^2 + 2^2 + 3^2 = 1 + 4 + 9) \;/\; \left(2^1 + 2^2 + 2^3 = \;2 + 4 + 8\right)$$

$$\sum_{n=1}^{3} n^2 = 14 \qquad \sum_{n=1}^{3} 2^n = 14 \tag{1}$$

$$(1^1 + 2^1 + 3^1 = \;1 + 2 + 3) \;/\; \left(1^1 + 1^2 + 1^3 = \;1 + 1 + 1\right)$$

$$\sum_{n=1}^{3} n^1 = 6 \qquad \sum_{n=1}^{3} 1^n = 3 \tag{2}$$

(I)	(m^1, m^2, m^3); (m = 4) $(n^1, n^2, n^3,\ldots,n^6)$; $(n = 2)$	. . . (3) ["*m*" as GC alphabet; "*n*" as binary alphabet, valid for the GC binary tree.]
(II)	$m^n = n^m = 16$ $(m = 4)$; $(n = 2)$	["*m^n*" as number of nucleotide doublets; "*n^m*" as number of four-codon families (16) in Table 5 as well as on the GC binary tree.]
(III)	If $(m = 4;\ n = 3)$, then "m^n" = 64	

Through designated exponentiations, from "*m*" follow nucleotide singlets in Pyrimidine-Purine (Py-Pu) alphabet, nucleotide doublets in Rumer's Table as well as nucleotide triplets in Table 5; and from "*n*" follow the number of branches on the GC binary tree ([8], Fig. 1), and corresponding GC Tables [3]. Further GC relations are given in Survey 2a and 2b.

Eq. (1) is related to the number of chemical elements in Table 1, while Eq. (2) is related to triads, diads, monads, respectively, in Tables 2 and 3 (in relation to Table 4). On the other hand, Eq. (3) corresponds with Tables 3–5. In addition, one can notice that in reality Eq. (2) precedes to Eq. (1) as a previous step in exponentiation, valid for the first three natural numbers. The expression in Eq. (3) shows the relationships within the GC (cf. Table 5. As a special case in Eq. (3) is the set $\{m^1, m^2, m^3\}$ $(m = 2 \times 2)$, in a correspondence with the set $\{2^1 + 2^2 + 2^3\}$ in Eq. (1), which means a correspondence among genetic code and chemical code; partially direct, and partially indirect correspondence.[4]

Table 1 is essentially a periodic system of short periods. As in the original works of Mendeleev, it can develop into a periodic system of long periods when it, *per se*, has a status of a block-PSE as a set of adjacent groups: **s**-block, **p**-block, **d**-block and **f**-block ([5], Table 4.3 or [7], Table 19; http://www.rakocevcode.rs) [Here: Table B1 in relation to Table B2 (Appendix B).][5]

Nevertheless, all three our Tables, from 1991, where just hypothetical, as it was also the hypothesis that it makes sense to consider PSE as a chemical code, now with this new insights into the correspondence with the genetic code, the one confirms the other: without the PSE Tables of this kind it is not possible to understand the essence of the GC, and vice versa – without insights into the correspondence with the GC we would not have any insight into existence of the chemical code, which makes up a unity with the genetic code, based at the same time on an analogous formalism as well as on a chemical essence.

In Table 2 we actually have the correspondence with the mathematical expression in Eq. (2): 1 set of monads, 1 set of diads, 1 set of triads; at the same time: within the set of monads the isotope number relationships are realized through the singlets of chemical elements; within diads through doublets, and within triads through triplets.

From the 1st to the 8th group, with sub-groups *a*, *b*, *c*, in the PSE (Table 1) the elements corresponding with the first member of the

[4] From Eq. (1) it follows also that the position of the hydrogen in the PSE can only be in the VII group, together with the halogen family, and neither in each other group ([10]: "A Coulombic model, in which all compounds of hydrogen are treated as hydrides, places hydrogen exclusively as the first member of the halogen family and forms the basis for reconsideration of fundamental concepts in bonding and structures. The model provides excellent descriptive and predictive ability for structures and reactivities of a wide range of substances.").

[5] The term "Block Periodic System" as well as "Block Periodic Table" appears to have been first used by Charles Janet, which idea is understandable (footnote [1]). That was because talking about blocks makes sense only if lanthanides are distributed into 14 groups [11].