Creation of the Genetic Code

By Craig Paardekooper BSc

Title: Creation of the Genetic Code

Sub Title : Review of the paper by Rakocevic "A Harmonic Structure of the Genetic Code"

Author : Craig Paardekooper, 17 Dacre House, Beaufort Street, Chelsea, London SW3 5BH, United Kingdom email: craig_pkooper@yahoo.com

Correspondence: Craig Paardekooper, 17 Dacre House, Beaufort Street, Chelsea, London SW3 5BH, 0207 795 0575, 07975 866 810, craig_pkooper@yahoo.com

Abstract

This paper is a review of the research of Rakocevic as presented in his paper "A Harmonic Structure of the Genetic Code". Rakocevic's findings are confirmed. A strong symmetry is revealed in Rakocevic's table – both horizontally and vertically. New data reveals that Rakocevic's patterns are framed around 5 key numbers - the prime numbers 37 and 73, and their midpoint 55, and the triangular numbers 666 and 703. A simple geometric pattern is proposed that integrates all 5 numbers. It is shown that 666 and 703 are the constituent triangles of the 73rd triangular number 2701 (37 x 73), and 703 itself is the 37th triangular number. These findings have implications for the origin of the amino acids, suggesting the operation of a primordial arithmetic process, and concur in this respect with the findings of Shcherbak.

Keywords: Symmetry, mathematics, prime number, arithmetic, triangular.

1. Introduction

The objective of this research was to review the findings of Rakocevic [1] who proposed the existence of a mathematical symmetry inherent in the molecular masses of the 20 amino acids. Rakocevic arranged the 20 amino acids into a 4 x 5 table as shown in table 1. He found that the molecular masses of the amino acids formed a pattern with horizontal and vertical symmetry, structured around multiples of the prime number 37. In particular, Rakocevic identified 666 and 703 as key numbers in the pattern.

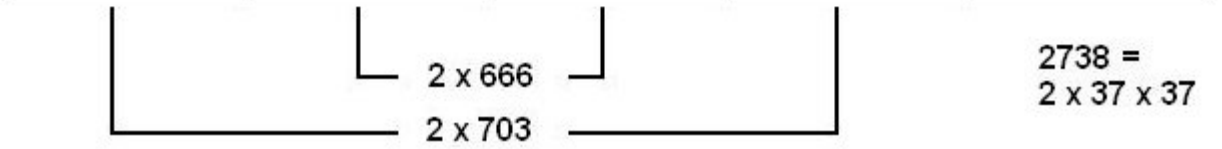
However, based on Rakocevic's own data, his patterns were only approximate. So the initial aim was to check Rakocevic's calculations against accurate values of the amino acid masses obtained from Wikipedia [2]. A second objective was to see if any additional patterns would be found.

1.1 Rakocevic's pattern

In Table 1 you can see each amino acid together with the molecular masses used by Rakocevic.

Table 1 : Showing the amino acid molecular masses used by Rakocevic

Aspartic Acid Mass 133.10	**Asparagine** Mass 132.12	**Alanine** Mass 89.09	**Leucine** Mass 131.18	**Total** Mass 485.49
Arginine Mass 174.2	**Phenyl Alanine** Mass 165.19	**Proline** Mass 115.13	**Isoleucine** Mass 131.18	**Total** Mass 585.7
Lysine Mass 146.19	**Tyrosine** Mass 181.19	**Threonine** Mass 119.12	**Methionine** Mass 149.21	**Total** Mass 595.71
Histidine Mass 155.16	**Tryptophan** Mass 204.10	**Serine** Mass 105.09	**Cysteine** Mass 121.16	**Total** Mass 585.64
Glutamic Acid Mass 147.13	**Glutamine** Mass 146.15	**Glycine** Mass 75.07	**Valine** Mass 117.15	**Total** Mass 485.5
Total Mass 755.78	**Total** Mass 828.88	**Total** Mass 503.5	**Total** Mass 649.88	**Grand Total** Mass 2738



Rakocevic's table of amino acid masses shows symmetry about the central row, and the total mass for all 20 amino acids is given as 2 x the square of a prime number 37.

What is more, the sum of the inner two columns is given as 2 x 666, also a multiple of 37, and the sum of the outer two columns is given as 2 x 703, also a multiple of 37

It so happens that 703 – 666 = 37, and 703 + 666 = 37 x 37. Consequently

outer columns - inner columns = 2 x 37
outer columns + inner columns = 2 x 37 x 37

If you draw a horizontal line through the central row, the masses are arranged symmetrically about the central row, so the horizontal line creates two sections each of mass = 703 + 666 or 37 x 37.

So we have horizontal and vertical symmetry – a true harmony.

It seems remarkable that such a simple and integrated pattern of symmetry should exist in the amino acid masses, and more so since it is centred on a large prime number – 37.

One might add that, since there are 20 amino acids, the average mass for each amino acid is 37 x 3.7 or 70.3 + 66.6.

1.2. Is Rakocevic's pattern precise?

As remarkable as this harmony of masses seems, Rakocevic's harmonies are only approximate.

The sum of the inner two columns only approximates to 2 x 666. It's actual value, according to the amino acid masses shown in Rakocevic's table, is 2 x 666 + 0.38.

Similarly, the sum of the two outer columns only approximates to 2 x 703. It's actual value, according to the amino acid masses shown in Rakocevic's table, is 2 x 703 – 0.34.

Also, the total mass for all 20 amino acids is 2738.04 rather than 2738.

1.3 A revised table containing precise data

Data of the exact molecular masses of all 20 of the amino acids is readily available on Wikipedia. [2] The masses are accurate to the second decimal place. These amino acid masses were collected by Stephen Coneglan and are shown in Table 2 below -

> *"Dear Craig,*
> *I individually checked the molecular weights for each of the 20 standard amino acids on Wikipedia. There were a few extremely slight errors in the weights of 5 amino acids that Rakocevic created. Amazingly, when these are adjusted to the Wikipedia values, exact divisions of the number 037 eventuate. Let me give you the details of the amendments that need to be made to the molecular weights for 5 of the amino acids. After you have considered the adjustments, perhaps you might want to comment on the exactness of the number 037 at your webpage.*
>
> *These are the 5 amino acids whose values should be adjusted in Rakocevic's table to reflect the values found for*

each at Wikipedia:

1.Tryptophan (W): 204.23
2.Isoleucine (I): 131.17
3.Histidine (H): 155.15
4.Leucine (L): 131.17
5.Glutamine (Q): 146.14

By adjusting the values for these 5 amino acids in Rakocevic's table, the following data apply in respect of the columns:

***Column 1**:*

1.Aspartic acid: 133.1
2.Arginine: 174.2
3.Lysine: 146.19
4.Histidine: 155.15
5.Glutamic acid: 147.13

The total for Column 1 is:

•133.1 + 174.2 + 146.19 + 155.15 + 147.13 = 755.77

***Column 2**:*

1.Asparagine: 132.12
2.Phenylalanine: 165.19
3.Tyrosine: 181.19
4.Tryptophan: 204.23
5.Glutamine: 146.14

The total for column 2 is:

•132.12 + 165.19 + 181.19 + 204.23 + 146.14 = 828.87

Column 3:

1.Alanine: 89.09
2.Proline: 115.13
3.Threonine: 119.12
4.Serine: 105.09
5.Glycine: 75.07

The total for Column 3 is:

•89.09 + 115.13 + 119.12 + 105.09 + 75.07 = 503.5

***Column 4**:*

1.Leucine: 131.17
2.Isoleucine: 131.17
3.Methionine: 149.21
4.Cysteine: 121.16
5.Valine: 117.15

The total for Column 4 is:

•131.17 + 131.17 + 149.21 + 121.16 + 117.15 = 649.86

From the Wikipedia data, the totals for all four columns are:

1.755.77
2.828.87
3.503.5
4.649.86

The following sums apply:

•Column 1 + Column 4 = 755.77 + 649.86 = 1405.63 = (2 x 703) - 0.37
•Column 2 + Column 3 = 828.87 + 503.5 = 1332.37 = (2 x 666) + 0.37
•Column 1 + Column 2 + Column 3 + Column 4 = 755.77 + 828.87 + 503.5 + 649.86 = 2738 = 2 x 37 x 37

The adjusted totals for the 5 rows are:

1.485.48
2.585.69
3.595.71
4.585.63
5.485.49

Incredibly, the combined molecular weight for all 20 amino acids comes out to an exact integer. That integer is 2738. There is no decimal remainder. The difference between the sums for Columns 1 + 4, and Columns 2 + 3, is mediated by a remainder of 0.37."

Stephen Coneglan (personal communication February 2010)

Table 2: Showing the amino acid molecular masses collected by Stephen Coneglan from Wikipedia

Aspartic Acid Mass 133.10	**Asparagine** Mass 132.12	**Alanine** Mass 89.09	**Leucine** Mass 131.17	**Total** Mass 485.48
Arginine Mass 174.2	**Phenyl Alanine** Mass 165.19	**Proline** Mass 115.13	**Isoleucine** Mass 131.17	**Total** Mass 585.69
Lysine Mass 146.19	**Tyrosine** Mass 181.19	**Threonine** Mass 119.12	**Methionine** Mass 149.21	**Total** Mass 595.71
Histidine Mass 155.15	**Tryptophan** Mass 204.23	**Serine** Mass 105.09	**Cysteine** Mass 121.16	**Total** Mass 585.63
Glutamic Acid Mass 147.13	**Glutamine** Mass 146.14	**Glycine** Mass 75.07	**Valine** Mass 117.15	**Total** Mass 485.49
Total Mass 755.77	**Total** Mass 828.87	**Total** Mass 503.5	**Total** Mass 649.86	**Grand Total** Mass 2738

485.48 +
585.69 +
half of 595.71

= 703 + 666 + 0.025

485.49 +
585.63 +
half of 595.71

= 703 + 666 - 0.025

2 x 666 + 0.37

2 x 703 - 0.37

2. Results

The results are intriguing, to say the least.

2.1 Pattern built around 37 and 0.37

The sum of the two inner columns now comes to 2 x 666 + 0.37.
And the sum of the two outer columns comes to 2 x 703 – 0.37.
See Table 2 above.

What is remarkable is the inter-relationship between 666, 703 and 37. As mentioned above, 666 + 37 = 703 and 703 – 37 = 666, so it is quite coincidental that the "fine-tuning" 0.37 should be added to 666 and subtracted from 703.

Also, with the more accurate data, the sum of all 20 amino acid masses becomes 2 x 37 x 37 precisely!!

2 x 666 + 0.37 can be rewritten as 2 x 703 – 2 x 37 + 0.37
2 x 703 – 0.37 can be rewritten as 2 x 666 + 2 x 37 – 0.37

The reason for rewriting these expressions will soon become obvious.

2.2 Pattern built around 73 and 0.73

On closer inspection, I noticed a new pattern.
The sum of the odd columns = 755.77 + 503.5 = 2 x 703 – 2 x 73 – 0.73
The sum of the even columns = 828.87 + 649.86 = 2 x 666 + 2 x 73 + 0.73

Comparing these equations with the ones we found previously you can see the extraordinary similarity of form –

Sum of inner columns = **2 x 703 – 2 x 37 + 0.37**

Sum of outer columns = **2 x 666 + 2 x 37 – 0.37**

Sum of odd columns = **2 x 703 – 2 x 73 – 0.73**

Sum of even columns = **2 x 666 + 2 x 73 + 0.73**

See Table 3

Table 3: Table of amino acid masses showing how column sums are related

Aspartic Acid Mass 133.10	**Asparagine** Mass 132.12	**Alanine** Mass 89.09	**Leucine** Mass 131.17	**Total** Mass 485.48
Arginine Mass 174.2	**Phenyl Alanine** Mass 165.19	**Proline** Mass 115.13	**Isoleucine** Mass 131.17	**Total** Mass 585.69
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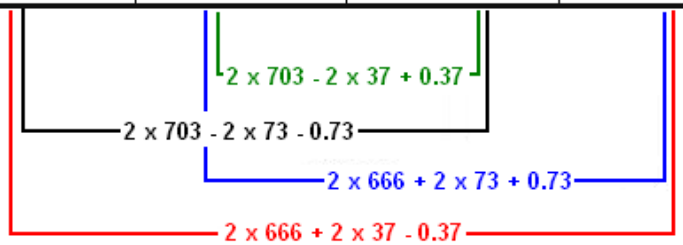
Glutamic Acid Mass 147.13	**Glutamine** Mass 146.14	**Glycine** Mass 75.07	**Valine** Mass 117.15	**Total** Mass 485.49
Total Mass 755.77	**Total** Mass 828.87	**Total** Mass 503.5	**Total** Mass 649.86	**Grand Total** Mass 2738

485.48 +
585.69 +
half of 595.71

= 703 + 666 + 0.025

485.49 +
585.63 +
half of 595.71

= 703 + 666 - 0.025



The sums of the inner columns and the sums of the outer columns are built around the prime number 37 and 0.37.

The sums of the odd columns and the sums of the even columns are built around the prime number 73 and 0.73, the digital reflection of 37 and 0.37 !!

These new patterns have been reviewed by Stephen Coneglan, and found to be PRECISELY correct –

> *"Craig,*
> *I just checked out your latest findings and saw the stuff involving the number 73. You have already demonstrated how the number 37 plays the leading role in the organisation of Rakocevic's table of the amino acids. To see the number 73 also playing a fine-tuning role to the '37-dependent' phenomena is really quite astounding. I had to double check your results for veracity.*
>
> *Indeed, I have found your contentions concerning the columns to be exactly correct! The following sums attain:*
>
> 1. *C1 + C3 = 755.77 + 503.50 = 1259.27 = (2 x 703) - (2 x 73) - 0.73*
> 2. *C2 + C4 = 828.87 + 649.86 = 1478.73 = (2 x 666) + (2 x 73) + 0.73*
>
> *Thus, you are perfectly correct when you assert that the number 73 plays the leading role in fine-tuning the data*

for these columns. We saw previously that the number 37 played the fine-tuning role for the respective outer and inner column sums of 1405.63 and 1332.37."

Stephen Coneglan (private communication February 2011)

2.3 Pattern of alternating cells built around 0.55

Vernon Jenkins compared the sums of alternating cells within the amino acid table. [3] See Table 4.

He found that –

Sum of odd cells (coloured white) = 1331.45 = 2 x 666 – 0.55
Sum of even cells (coloured blue) = 1406.55 = 2 x 703 + 0.55

Stephen Coneglan observed that 55 is the exact midpoint between 0.37 and 0.73

0.55 = 0.73 – 0.18
0.55 = 0.37 + 0.18

Table 4: Table showing amino acid masses - summing alternate cells

Aspartic Acid Mass 133.10	**Asparagine** Mass 132.12	**Alanine** Mass 89.09	**Leucine** Mass 131.17
Arginine Mass 174.2	**Phenyl Alanine** Mass 165.19	**Proline** Mass 115.13	**Isoleucine** Mass 131.17
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Glutamic Acid Mass 147.13	**Glutamine** Mass 146.14	**Glycine** Mass 75.07	**Valine** Mass 117.15

3. Discussion

3.1 The genetic code is organized around arithmetic structures

To quote Rakocevic –

> *"There is synchronic coherency with simple arithmetic structures, in the sense that a unity of form and essence is realised."*
>
> *"One should notice that even amino acids and their biosynthetic precursors are determined by basic arithmetic structures."*
>
> *"Still, there is more. The same pattern of coherency is demonstrated for the number of nucleons within the first nucleon, and for the molecule mass where other nuclides are participating."*

3.2 The pattern possesses irreducible complexity, and so constrains variation

Here are quotations from Rakocevic –

> *"The results show that if only one amino acid should be replaced within the 5 x 4 table of amino acids, then all symmetry will be lost – there will no longer be any balance or coherency."*

Given the arithmetic integration of the genetic code, Rakocevic comments –

> *"It is hard to see how any other kind of 'original form of life', could have been built with fewer than 4 purine-pyrimidine bases, and fewer than 20 amino acids, or with anything other than the twenty standard amino acid molecules."*
>
> *"That is the reason we can only consider an abiotic origin, and not by any means a biotic evolution of the genetic code."*

Rakocevic argues that the genetic code has remained unchanged since it was first created at the very beginning of life, and that physical and chemical determinants are inadequate to explain the patterns.

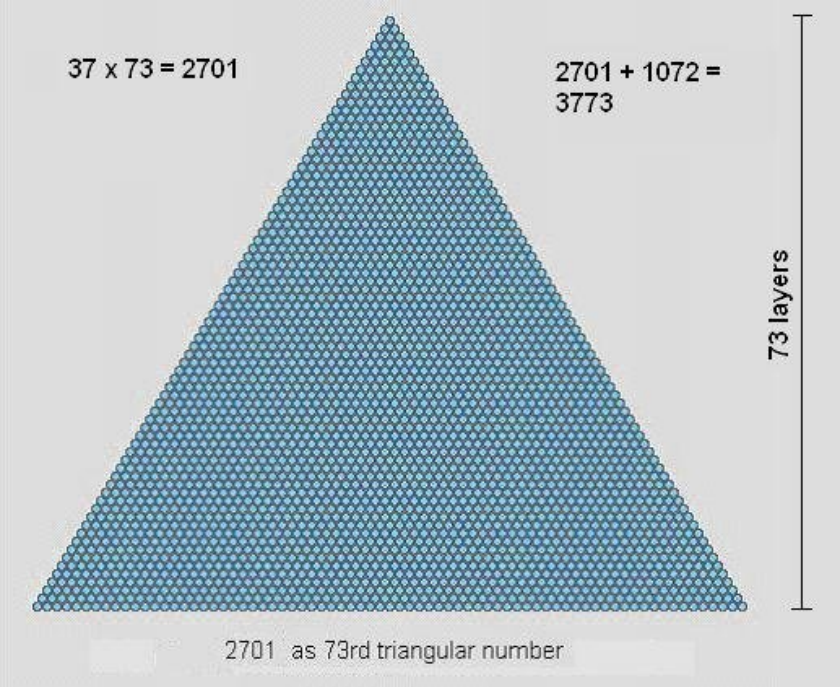
> *"However, with the knowledge of the synergy influence of previously discussed principles, particularly the principle of compromise, and the principle of coherence with simple arithmetic structures and regularities, it becomes clear that physical and chemical influences are limited. On the other hand, the genetic code is "frozen", but not during biotic evolution, but immediately at the very beginning from the very moment the code was created."*

3.3 The arithmetic structures integrate into a single geometrical pattern

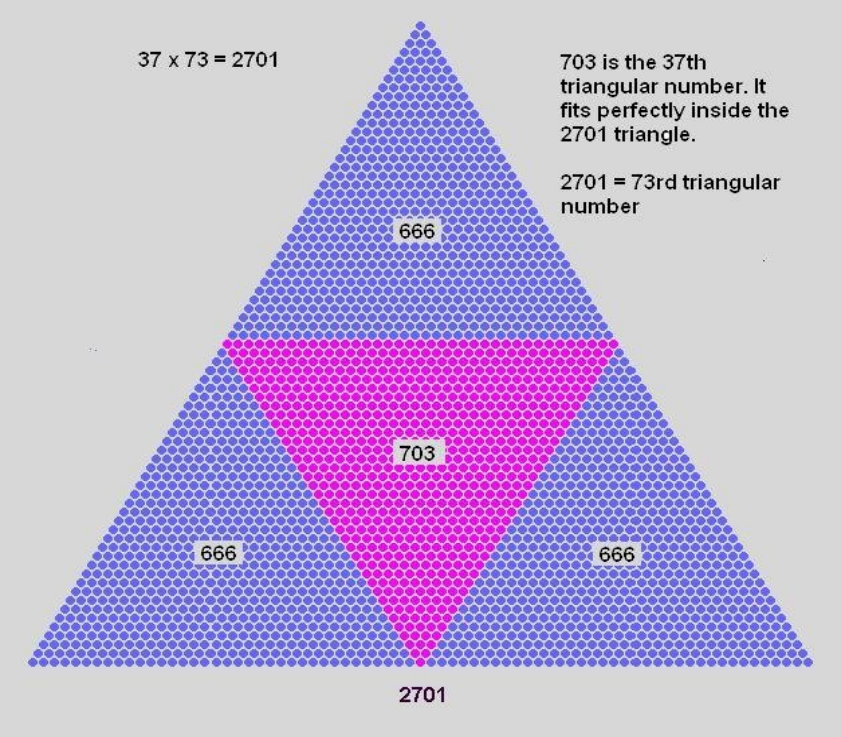
We might ask why the symmetrical patterns are constructed around a set of 5 numbers (37, 55, 73, 666 and 703). Is there any relationship between these numbers?

Curiously these 5 numbers integrate in a single geometrical pattern.

37 x 73 = 2701 = 73rd triangular number. It can be represented as a triangle with 73 layers thus –



703 is the **37th** triangular number and so it can be represented as a triangle with 37 layers. The 703 triangle fits perfectly within the 2701 triangle thus –

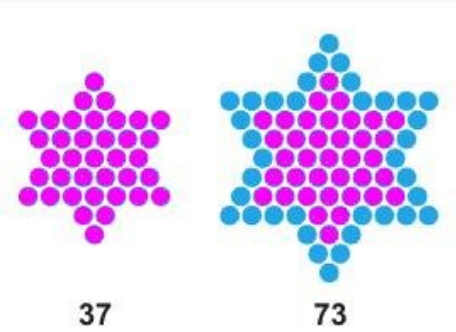


And the three triangles surrounding the 703 triangle each sum to 666 !!

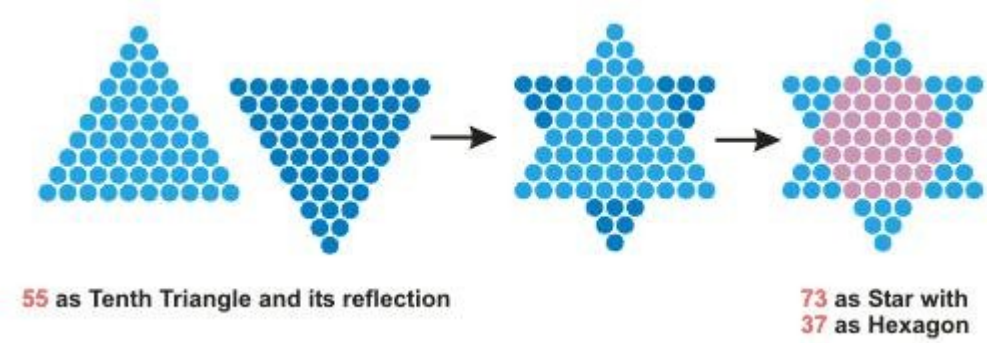
So this single geometric pattern integrates all 5 of the numbers found in the amino acid patterns. The 73rd triangle (37 x 73) incorporates the 37th triangle (703) and the number 666, and 55 is itself the mean of 37 and 73

3.4. The connection between 37, 73 and 55

Both 37 and 73 are prime numbers, and each is the digital reflection of the other. In addition, 73 can be represented as a hexagram, or star number, and 37 is the hexagram that fits perfectly inside the hexagram of 73.



55 is the midpoint between 73 and 37. In addition, the 73 hexagram is formed by the intersection of two triangles, each of 55.



So we can see how 37, 73 and 55 form an integrated geometry, and how 37 x 73 (the 73rd triangular number) integrates with 703 (the 37th triangular number) and 666.

Concluding Remarks

Accurate values of the amino acid masses confirm Rakocevic's findings – the pattern of amino acid masses possesses strong vertical and horizontal symmetry.

Furthermore, this symmetry is precisely structured around 5 numbers – 37, 55, 73, 666 and 703 , and these numbers are found to be integral to a single geometric pattern – the 73rd triangular number 2701, itself a multiple of 37 (37 x 73)

These arithmetic regularities suggest that a primordial arithmetic process may have been involved in shaping the genetic code. If so then we should expect to discover much similar regularity in the future. So these arithmetic patterns may have predictive value.

What's more, these arithmetic regularities may lay additional constraints upon variation. The mathematical harmonies appear to be intact, and must have remained so since the genesis of the code.

Stephen Coneglan says –

> *"These findings provide overwhelming proof that the number pairs (37, 73) and (666, 703) - are present in the fine-tuning of the molar masses of the amino acids. These molar masses are not a matter of private interpretation. They were taken from an open source website, Wikipedia, and are available for all to peer review and critique.*
>
> *The fact that the sums, above, wherein the numbers 37 and 73 play the fine-tuning role, are EXACT is surely something to behold.*
>
> *The breath-taking simplicity with which the sets of equations obey almost the same form…..*
>
> *It is quite amazing that the number 73 should also appear as a fine-tuning mechanism for the columns.*
>
> *I had wondered if there was any significance to the alternating values having an orb of allowance of 0.55.*
>
> *I think Craig's latest finding helps to answer this question. The values [37 - 55 - 73] have a profound numero-geometrical presence.*
>
> *To find their decimal expressions as the fine-tuning mechanisms for three essential divisions of Rakocevic's table (RT) is simply astonishing."*
>
> *Stephen Coneglan (private communication February 2011)*

Acknowledgements

Stephen Coneglan BA

Vernon Jenkins MSc.

References

[1] “A Harmonic Structure of the Genetic Code”, Journal of Theoretical Biology 229 (2004) 221-234, Miloje M. Rakocevic

[2] Here are the Wikipedia links for amino acid masses

http://en.wikipedia.org/wiki/Alanine
http://en.wikipedia.org/wiki/Arginine
http://en.wikipedia.org/wiki/Asparagine
http://en.wikipedia.org/wiki/Aspartic_acid
http://en.wikipedia.org/wiki/Cysteine
http://en.wikipedia.org/wiki/Glutamic_acid
http://en.wikipedia.org/wiki/Glutamine
http://en.wikipedia.org/wiki/Glycine
http://en.wikipedia.org/wiki/Histidine
http://en.wikipedia.org/wiki/Isoleucine
http://en.wikipedia.org/wiki/Leucine
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http://en.wikipedia.org/wiki/Proline
http://en.wikipedia.org/wiki/Serine
http://en.wikipedia.org/wiki/Threonine
http://en.wikipedia.org/wiki/Tryptophan
http://en.wikipedia.org/wiki/Tyrosine
http://en.wikipedia.org/wiki/Valine

[3] Vernon Jenkins – web reference: http://www.whatabeginning.com/Misc/Genetics/Rakbou.htm

About the Author

Craig Paardekooper has a long term interest in genetics, in the mathematical patterns found in nature, and a long term interest in philosophy. He graduated with a BSc in Psychology in 1990, and has studied and written on philosophical issues since then. He currently works freelance as a software developer and writer in London.