

Mathematical Genetics – Part 1

from Harav Yitzchak Ginsburgh

The Largest Word in the Pentateuch

The Largest word in the Pentateuch, meaning the word with the greatest number of letters, appears in *Parshat Va'eira*, in one of the verses describing the second of the Ten Plagues, the plague of frogs,

*The river will swarm with frogs and they will ascend and come into your house, into your bedroom, and on your bed, and into the houses of your servants, and your people, into your ovens and into your dough.*¹

The word is “into your dough” (וּבִמְשָׁאֲרוֹתֶיךָ) and has 10 letters. The first thing that comes to mind is that perhaps this phenomenon of ten relates to the Ten Plagues themselves, as though to say that all of the Ten Plagues are alluded to in this unusual word that appears in the context of the second plague of frogs.

The numerical value of וּבִמְשָׁאֲרוֹתֶיךָ is 985, a number whose significance we will have to try to understand.

The verse in which this word appears has 15 words. 15 is the triangle of 5, so we will draw this verse in a triangular figure. But, first let us note that the inner structure of the verse (defined by the *etnachta* cantillation mark) divides it into 10 words and 5 words. Contextually, the first 10 words address Pharaoh himself and the remaining 5 refer to his people. Indeed, Rashi on this verse notes this shift in reference and explains that because Pharaoh was the first to conjure up a plan how to enslave the Jewish people, the frogs punished him first then went on to his people. This division of the 15 words into 10 and 5 is known as “a whole and a half” in Kabbalah. From a geometrical point of view, the first 4 rows of the triangle of 5 have 10 words and the final row contains the remaining 5:



וְשֵׁרָץ
 הָיָאֵר צַפְרָדִּים
 וְעָלוּ וּבָאוּ בְּבִיתְךָ
 וּבְחָדָר מְשֻׁבָּבָד וְעַל מִטְתְּךָ
 וּבְבֵית עֲבָדֶיךָ וּבְעַמְּךָ וּבְתַנּוּרֶיךָ וּבְמִשְׁאָרוֹתֶיךָ

Note that the word **וּבְמִשְׁאָרוֹתֶיךָ** is the 15th and final word of this verse. Interestingly, if we add 15 to 985, we get 1000, or 10 (alluding both to the number of letters in the word and to the number of plagues) to the 3rd power. We will come back to this phenomenon later.

The entire verse possesses 78 letters, the triangle of 12. And again the internal structure divides the verse neatly in two. The first 10 words possess 45 letters, the triangle of 9 and the remaining 5 words possess 33 letters, the last three lines to complete the triangle of 12. Let us draw the verse in this form:

ו
 ש ר
 י ה ז
 א ר צ פ
 ר ד ע י ס
 ו ע ל ו ו ב
 א ו ב ב י ת ת
 ו ב ח ד ד ר מ ש כ
 ב ך ו ע ל מ ט ת ך
 ו ב ב י ת ע ב ד י ך
 ו ב ע מ ך ו ב ת נ ו ר
 י ך ו ב מ ש א ר ו ת י ך

Since the word **וּבְמִשְׁאָרוֹתֶיךָ** has 10 letters, it can also be written in the form of the triangle of 4, like this:

ו
 ב מ
 ש א ר
 ו ת י ך

The Record Gematria in the Pentateuch

Now, from the largest word in the Pentateuch, let us turn to the word with the greatest value. This word appears in *parshat Korach*, in the account of the controversy of Korach, Datan, and Aviram against Moshe Rabeinu,

Is it not enough that you have taken us out of a land flowing with milk and honey so that we might perish in the desert, but you have also ruled over us forcefully.

The Hebrew word for “you have ruled over us” (תִּשְׁתַּרְר) has the greatest numerical value of all the words in the Pentateuch, 1500. 1500 is not just a nice round number. It is also the value of *Havayah* (יהוה) in what is known in Kabbalah as *haka'ah pratit* (meaning inner multiplication). To compute this we take the numerical equivalent of each of the four letters of *Havayah*,

yud (י) – 10

hei (ה) – 5

vav (ו) – 6

hei (ה) – 5

and multiply them by one another:

$$10 \cdot 5 \cdot 6 \cdot 5 = 1500$$

In this verse, תִּשְׁתַּרְר is the 11th word. Immediately it comes to mind that the largest word, וּבְמִשְׁאָרוֹתֶיךָ, was the 15th word in its verse. 11 and 15 are of course the values of the two halves of *Havayah*. The first two letters, יה, the holy Name *Kah*, equal 15. The final two letters, וה, equal 11. We will explore this in more detail later.

Since תִּשְׁתַּרְר possesses 5 letters, it completes וּבְמִשְׁאָרוֹתֶיךָ, which has 10 letters to form the triangle of 5, like this,

			ו		
			מ	ב	
			ר	א	ש
		ך	י	ת	ו
	ר	ר	ת	ש	ת

Additionally, this verse in *parshat Korach* contains 58 letters altogether and so completes (as the last four lines) the triangle of 12 (of the previous verse) to the triangle of 16, 136 letters. Let us add the Hebrew letters of this verse (הַמַּעַט כִּי הֶעֱלִיתֵנוּ מֵאֶרֶץ זְבַת חֶלֶב) (וּדְבַשׁ לְהַמִּיתֵנוּ בְּמִדְבָּר כִּי תִשְׁתַּרְר עָלֵינוּ גַם הַשְּׁתַרְר) to the letters of the verse from *Va'eira* to form the triangle of 16:

ו
 ש ר
 י ה י
 א ר ע פ
 ר ד ע י ס
 ו ע ל ו ו ב
 א ו ב ב י ת ך
 ו ב ח ד ר מ ש כ
 ב ך ו ע ל מ ט ת ך
 ו ב ב י ת ע ב ד י ך
 ו ב ע מ ך ו ב ת נ ו ר
 י ך ו ב ב מ ש א ר ו ת י ך
 ה מ ע ט כ י ה ע ל י ת נ ו
 מ א ר י ן ז ב ת ח ל ב ו ד ב ש
 ל ה מ י ת נ ו ב מ ד ב ר כ י ת
 ש ת ר ר ע ל י נ ו ג ס ת ש ת ר ר

All of these phenomena illustrate that the two words, the largest and the greatest, and the two verses in which they appear complement and complete one another.

The Largest with the Greatest

But, let us go another level deeper in our study of the largest and the greatest words of the Torah. The most important indication that these two words are meant to go together can be seen in their combined *gematria*.

$$985 + 1500 = 2485$$

Amazingly, 2485 is the triangle of 70, alluding to the 70 faces, or aspects of the Torah.

Moreover, the combined value of the Hebrew names of the Five Books of Moses (the Pentateuch) exactly as they are written in the Torah: Genesis (**בְּרֵאשִׁית**), Exodus (**שְׁמוֹת**), Leviticus (**וַיִּקְרָא**), Numbers (**בְּמִדְבָּר**), and Deuteronomy (**הַדְּבָרִים**), is also exactly 2485!

Let us take a closer look at the names of the books of the Pentateuch. First, note that together they possess 26 letters, the value of *Havayah*, God's essential Name. And, these 26 letters divide neatly into 15 in the first three books (**בְּרֵאשִׁית שְׁמוֹת וַיִּקְרָא**) and 11 more in the last two books (**בְּמִדְבָּר הַדְּבָרִים**), just as *Havayah* divides into 15 and 11, as noted above.

The average value of the names is $2485/5 = 497$. But, note that this number is built into the names, since the *gematria* of the names of the 1st, 3rd, and 5th books (**בְּרֵאשִׁית וַיִּקְרָא הַדְּבָרִים**) is $3 \cdot 497$ while the *gematria* of the names of the 2nd and 4th books (**שְׁמוֹת בְּמִדְבָּר**) is $2 \cdot 497$!

Now let us add together the *gematria* of the largest and the greatest words of the Torah together with their locations in their respective verses. We have then,

$$2485 + 26 = 2511$$

2511 is the product of 81, "I" (אֲנִי), and 31, the holy Name, *Kel* (אֵל). Amazingly, these two words appear in sequence only twice in the entire Bible, once in the order "I am *Kel*" (אֲנִי אֵל) and once in the reverse order, "*Kel* am I" (אֵל אֲנִי). Of course, regardless of the order, multiplying them by one another gives the product 2511:

- "Remember history, for I am God [*Kel*] and there is no other god, nor nothing like Me."²
- "I will not execute the fierceness of my anger, I will not again destroy Ephra'im, for God [*Kel*] am I and not a man, the Holy One in your midst, and I will not enter the city [like an enemy]."³

Pythagorean Triplets

Let us delve further into the significance of 985, the value of וּבְמִשְׁאָרוֹתַיִךְ. In another article, we discussed the Pythagorean triplets of the form a, b, c , where $b = a + 1$ and of course $a^2 + b^2 = c^2$. The triplets we saw were

- 3, 4, 5
- 20, 21, 29
- 119, 120, 169.

The next such triplet is:

- 696, 697, 985

So, here we have found 985.

The triplet preceding 3, 4, 5 is:

- 0, 1, 1

This means that 985 is the fifth number in the series: 1, 5, 29, 169, 985.

The sum of these first four numbers, 204, was discussed in the other article.

The sum of all five number (including 985) is $1189 = 29 \cdot 41$ (secret of Yehudit and Matityahu⁴). But, note that the sum of the numbers in the fifth triplet, 696, 697, 985 is $2378 = 2 \cdot 1189 = 58 \cdot 41$. In the Bible, these two numbers represent King Rechavam (Solomon's son in whose reign the Jewish people were divided into two kingdom, the northern and the southern). Rechavam ruled at age 41 and lived to age 58.⁵ In potential, Rachavam was meant to be the Mashiach, as he was the first descendant of King David's through Solomon.

Recursion and Mathematical Genetics

Now we would like to ask, what is the rule—the algorithm—for the recursive function that generates this series. The rule involved is quite common in many series. Its recursive nature can be likened to genetics, where the next generation is a product of the previous generation with some shift, or correction provided by even earlier generations. For this reason, we describe recursive functions of this sort as *mathematical genetics*.

To illustrate the recursive rule involved, it is best to organize a, b, and c in three columns:

a	b	c
0	1	1
3	4	5
20	21	29
119	120	169
696	697	985

Stated in genetic language, we can say that the rule for the c column is: the “son” equals 6 times the “father,” minus the “grandfather.”

In mathematical notation, we would write:

$$c_k = 6c_{k-1} - c_{k-2}$$

For example, $985 = 6 \cdot 169 - 29$

Interestingly there is another rule that produces the c column, stated again in genetic language: the son equals 7 times the difference between the father and the grandfather plus the great-grandfather. Or, in mathematical notation,

$$c_k = 7(c_{k-1} - c_{k-2}) + c_{k-3}$$

For example, $985 = 7 \cdot (169 - 29) + 5$

Sometimes the correction is provided from outside the “family,” as in the case of the a column. The rule there can be described as: the son equals 6 times his father minus his grandfather plus 2, where the 2 is a pure correction factor coming from outside the family. Or, in mathematical notation,

$$a_k = 6a_{k-1} - a_{k-2} + 2$$

For example $696 = 6 \cdot 119 - 20 + 2$

The rule for the b column is the same, except that the external correction factor is minus 2, or,

$$b_k = 6b_{k-1} - b_{k-2} - 2$$

For example $697 = 6 \cdot 120 - 21 - 2$

Interestingly, if we now adopt the second variation of the rule for column c , taking into account four generations, the rule is the same for every column. Explicitly,

$$a_k = 7(a_{k-1} - a_{k-2}) \pm a_{k-3}$$

$$b_k = 7(b_{k-1} - b_{k-2}) \pm b_{k-3}$$

For example: $696 = 7 \cdot (119 - 20) \pm 3$ and $697 = 7 \cdot (120 - 21) \pm 4$

Another advantage of the second variation is that it does not include the external correction (± 2 or -2) of the first variation. In other words, all is in the family. Though it requires knowing more family history (4 generations, instead of 3) it is in the end more uniform and more elegant.

With both variations, the father's input is positive, the grandfather's is negative, and, as seen only in the second variation, the great-grandfather's input is positive once again.

Conclusion

What we have observed here (the 2 rules and their advantages) is true of all similar recursive functions in general and those that appear in the Torah specifically.

In the forthcoming second article on this subject of mathematical genetics, we will explore other recursive functions that are produced by various topics in Torah.

1. Exodus 7:28.

2. Isaiah 46:9, זָכְרוּ רֵאשֻׁנוֹת מַעֲוָלָם כִּי אֲנֹכִי אֵל וְאִין עוֹד אֱלֹהִים וְאֶפֶס כְּמוֹנִי.

3. Hosea 11:9, לֹא אֶעֱשֶׂה חֲרוֹן אַפִּי לֹא אֲשׁוּב לְשַׁחַת אֲפָרָיִם כִּי אֵל אֲנֹכִי וְלֹא אִישׁ בְּקִרְבִּי קְדוֹשׁ וְלֹא אָבוֹא בְּעִיר.

4. See http://www.inner.org/torah_and_science/mathematics/triangles-that-make-squares.php

5. I Kings 14:21.